MOTIVATIONAL APPROACH TO TEACHING MATHEMATICS IN BACHELOR AND MASTER STUDY

P. Böhm, M. Vojteková, Z. Štofková

University of Žilina, The Faculty of Operation and Economics of Transport and Communications (SLOVAKIA)

Abstract
Motivation is the engine of every human activity. Much attention is paid to the motivation especially in the psychology of work. If we look at the strategy of successful companies, we find that their management are trying to incorporate complex mechanisms to encourage their employees to give maximum performance. If we look at the teaching of mathematics, where the teacher works in a similar role as the company management, we find that these methods are usually not used.

There are many reasons why the performance of the students is not satisfactory, but the vast majority of students suffer from a lack of motivation. In mathematics, more emphasis is placed on content than on form. Hence mathematics for students becomes incomprehensible and unattractive subject. One possibility to change the attitudes of students is the use of motivational incentives.

In this paper, we provide strategies for stimulating students to learn course content. We mention some well-known motivation techniques that can be used to affect the students’ attitude to learning mathematics. Most important contribution to increasing the motivation of students is the attitude of the teacher. We provide several effective motivation principles that we use in our teaching practice.

Keywords: Motivation, motivation techniques, attitude.

1 INTRODUCTION
Every three years the Organization for Economic Cooperation and Development (OECD) tests 15-year-olds around the world on their math, science and reading skills. The latest OECD Programme for International Student Assessment, PISA 2015, includes data from 72 countries and economies, including all 35 OECD members and 37 other countries and economies [1]. The performance of Slovak pupils is significantly lower than the average for pupils from the OECD countries. Moreover, we are observing a downward trend in the performance of our students in all three areas. The trend in years 2006 – 2015 is shown on Figure 1.

![Figure 1. Results of Slovakia in PISA testing, years 2006 – 2015](image)

Testing of high school students also revealed big regional differences and it will be necessary to reduce the gap between regions [2], [3].
Most teachers admit that we have to seriously deal with this topic and that changes are necessary. One of the most demanding tasks is to motivate students to have an interest in learning.

Motivation is the engine of every human activity. Much attention is paid to this topic especially in psychology. If we look at the strategy of big companies, we find that their management incorporate advanced mechanisms to encourage their employees to give maximum performance. The aim of this strategy is to support their enthusiasm for work and to improve their work productivity. In other words, they try to create positive and active atmosphere in their companies.

In education, teachers work in a similar role as the company management and it’s their responsibility to create good working atmosphere. The motivation strategies are rarely used in education of mathematics, however.

There are obviously many reasons why the results of students are not good enough and it is difficult to determine one general reason. In most cases the lack of motivation is one of the most important ones. Apathy and passive attitude to the study – and it holds especially for mathematics – are common amongst students. Many students of our university also just wish to pass the exam without any interest into the subject at all.

From year to year the students in a first year of study have less mathematical knowledge and their mathematical skills are weakest. Surprisingly, in recent years we noticed problems with mathematical skills that are already practiced in the elementary school. Students experience problems with such basic tasks as simplification of fractions or solving linear equations. Negative attitude of some students usually spreads over entire class and leads to overall passivity. It also encourages students to think: “I’ve got no talent in mathematics, I will never learn it”. One way of improving this attitude is to increase their motivation.

2 METHODOLOGY

Motivation is a complex of psychologic processes that activates, leads and keeps person's behaviour in some direction. Motivation is an answer to a question: “Why person performs this particular activity?” In psychology the following law is frequently used:

\[ \text{Performance} = \text{abilities} \times \text{motivation} \]

This law suggests that for common student the zero performance is possible only in case of zero motivation. That's why the motivation attitude is placed on the first place of importance.

We usually distinguish between inner and outer motivation. Inner motivation is considered as a state which makes person to do something for his own experience, for fulfilment of his own needs. In case of outer motivation a person’s activity is based on outer impulses called incentives - success, reward, punishment. Inner motivation that was originally started by interest may be later transformed into outer motivation (to avoid failure or overcome the difficulty). Inner motivation is more valuable, of course. In case of inner motivation, person's needs take a bigger role. The inner motivation is used in teaching process by means of organizing the education process the way that fulfills the student’s psychological needs.

The creative activity is the biggest level of learning activity. Its sources of motivation are cognitive motives. The following needs are the motivation for creative activities [4]:

- cognitive needs,
- need to explore, solve problems, find problems,
- need for the diversity, the change,
- need to play, to manipulate, to experiment,
- need for self-realization, need for quality performance,
- need for independence.

Amongst students cognitive needs may gain a high level of intensity. When facing a problem, student is driven by effort to solve it. He deals with it in a long time and unsolved problem is continually reappearing.
2.1 Motivation and teacher

In teaching process teacher can affect students by his own activity. He can use some of the well-known forms of motivation [5]:

1. **Motivation by asking questions**: In this case teacher leaves students to look for the answers to the questions teacher has asked. It means teacher doesn’t present the new knowledge directly.

2. **Motivation by a conversation**: Teacher deliberately manages the conversation by listening to the students’ opinions, asking them to give solutions to the problem. He suggests one solution or a part of a solution while leaving the other parts to students.

3. **Motivation by a problem**: The problem is presented to students at the start of the lesson. Its task is to engage the students’ attention. Five rules for motivation problems are:
   - the rule of the surprise,
   - raising doubts,
   - creation of cognitive uncertainty,
   - giving difficult, at first glance unsolvable task,
   - presentation of clear contradiction, claiming facts in defiance of common sense.

4. **Motivation by presenting historical remarks**: A short historical overview should be an introduction or appendix to every topic. A small interesting event in the life of famous people can be motivating too. It doesn’t have to be a mathematician at all.

5. **Motivation with an emphasis on interdisciplinary connections**: It should be easy for teacher to select a real situation where mathematics is hidden and requires the formulation of the mathematical problem.

3 RESULTS

The attitude of teacher has an indispensable role in increasing motivation of students. Here we present several common rules:

1. Don’t judge the students right at the start. Unfortunately, some teachers hold an opinion that students are a priori lazy and they resist every stimulus. Even if long-term experience may seem to support this opinion, it is necessary to overcome this approach. If teacher has negative attitude to his students, no motivation impulses will ever work.

2. Motivation isn’t manipulation. Manipulative character of education is one of the main reasons why students don’t pay attention to the education process.

3. Expect the maximum performance form the students. If you show to students that you believe in their abilities, they start to act responsibly and conscientiously. Show them your conviction that they are able to achieve better results in case they work harder.

4. Don’t suppose all the students are cheaters. Yes, students are frequently cheating on exams. But if teacher has opinion, that all students are liars, he stimulates them just to find more advanced methods of cheating.

5. Emphasize the importance of the responsibility for their own performance. In real life, students will have to decide for themselves, they will have to take decisions themselves and they will have to take the responsibility for the decisions they take. Let’s teach them to act independently.

6. Don’t compare the real student to the ideal student. He doesn’t exist. The student’s motivation is reduced by systematic complaints that student is not working as hard as teacher would like.

7. Don’t compare student’s performance to your performance. Compare student to other students only.

8. Memory cannot replace thinking. Don’t require students to know difficult formulas. It’s better to practice the usage of formulas than just memorize them.

9. Change your opinion on students if necessary. Students can change their attitude to the mathematics and in this case teacher should change the attitude to the students. Teacher’s inertia in thinking usually doesn’t improve student’s motivation.
10 Show to students that you are interested in their achievements and that you care about them. Good relations between student and teacher imply that students don’t want to disappoint the teacher. Students try to respond to teacher’s care by students’ good results.

11 Don’t be afraid to admit that you made mistakes too. If teacher insists on his statements even in case they proved not to be true, he discourages the students.

12 We suggest moderate usage of Information and communication technology [6], [7]. It can make the education more entertaining and motivating [8]. E-learning is another modern way of teaching that may increase the motivation of some students [9], [10].

3.1 European Credit System ECTS

ECTS (European Credit Transfer System) is an important element of the Bologna process, meant to help international students make the most of their study abroad experience [11]. Initially, the ECTS was directed towards Erasmus students, as a tool for acknowledging courses and programmes they studied while abroad. Today, the ECTS is widespread all over Europe and it is also used for recognizing not just study exchange experiences, but full Bachelor's Master's and Doctorate degrees as well.

ECTS system is used at our university for almost 10 years. This system brings many new motivation factors, but it also comes with several features that may demotivate the students. Here we present 4 important questions that are not answered by the system; rather allow many realization possibilities.

1 Students receive the points from the written tests of knowledge in the course of the term and then other points on an exam. What is the best ratio of points that students can obtain during the course of the term so that it produces the highest motivation possible? Most frequently 40% of points can be obtained during the course and 60% of the points can be obtained on final exam. It is not clear if this is the ratio that motivates the students best.

2 Is it really encouraging for student that they start an exam with nonzero amount of points?

3 If student receives really small amount of points during the course term, is it possible for him to pass an exam (in case of intensive study)?

4 Is it ever possible to get approximately normal distribution of grades? In recent years between 40% and 50% of students got E grade on exam on mathematics. What should lecturers do so that students have better results on exam without considerably reducing requirements? The course content was cut down to almost a half during last decade but the student results haven’t improved. The distribution of grades for courses Mathematics 1 and Mathematics 2 are shown on Figure 2. It is apparent that the distribution is not normal with peak in grade E.

![Course evaluation - Mathematics 1](image1)

![Course evaluation - Mathematics 2](image2)

**Figure 2. Distribution of grades for courses Mathematics 1 and Mathematics 2**

4 CONCLUSIONS

Different lecturers, different subjects, different faculties can bring a wide range of opinions on these questions and offer different results. This creates possibility for discussion and comparison of results.

One of the most important ways to increase the students’ motivation is the improvement of the knowledge they got at high school. During the last two decades many school reforms tried to improve the students’ education on both grammar and high schools. They failed, however. We are experiencing the continuous reduction of the students’ knowledge, as PISA testing proves. We
suggest to remove the differential and integral calculus form the high school curriculum in favour of other parts of mathematics: algebraic expressions, fractions, irrational expressions and geometry.

We also suggested to make some changes to a math-related subject called Seminar on mathematics that is included in the first year of study at our faculty FPEDAS ŽU [12]. We suppose these changes will increase the students’ motivation. In recent years this course followed the mathematics course and just repeated the subject of mathematics course [13]. This year the subject of this course was changed. It is used mostly for the improvement of the knowledge the students should already receive at high school [14]. It includes the most important parts of high-school mathematics that is used during their university study. We believe this will improve the students’ performance in mathematics, help them overcome the gap between high-school and university study and motivate them to study harder and more efficiently [15].

At the start of the school year we also organize the 4-day course of high school mathematics for the newly admitted students. However, it seems that this course is not effective enough, because it is really difficult for students to capture all the high school curriculum in four days [16].

In our contribution we outlined only several ways to improve the student’s motivation. It may not be easy to change parts of the educational system if it is working the same way for many years. However, teachers have to admit that it really isn’t satisfactory to only pass the knowledge to students. It is vital to consider the way the students receive information. Passive education is inefficient and cannot create lasting knowledge.

ACKNOWLEDGEMENTS

This paper is an output of the science project VEGA 1/0696/16.

REFERENCES


