ISSN 1392-0340
E-ISSN 2029-0551

Pedagogika / Pedagogy
2015, t. 118, Nr. 2, p. 31–43 / Vol. 118, No. 2, pp. 31–43, 2015

LIETUVOS EDUKOLOGIJOS UNIVERSITETAS

Statistical Survey: the Proportion of Students Willing to Become Teachers of Mathematics

Romanas Januškevičius[1], **Dalius Pumputis**[2]

[1] Lithuanian University of Educational Sciences, Faculty of Science and Technology, Department of Mathematics, Studentų St. 39, LT-08106 Vilnius, Lithuania, romanas.januskevicius@leu.lt
[2] Lithuanian University of Educational Sciences, Faculty of Science and Technology, Department of Mathematics, Studentų St. 39, LT-08106 Vilnius, Lithuania, dalius.pumputis@leu.lt

Abstract. The article discusses the problems of mathematical literacy of graduates from secondary schools as well as the problems related to the increasing gap between higher and secondary education institutions in Europe and in Lithuania, whereof education system has been undergoing the reform. The results of a statistical survey, which was carried out in Lithuanian University of Educational Sciences, are also presented. The survey focused on the analysis of the answers of the selected population of students to the question 'What is the proportion of students willing to become teachers?' The answer to this question has received highly controversial evaluations from specialists of the Ministry of Education and Science of the Republic of Lithuania, who administer financing of universities, on the one hand, and specialists in educational science, who have been conducting the aforesaid surveys and research, on the other hand. The simple statistical analysis and some methods of survey sampling were applied to solve this problem. Differently from the situation of earlier years, the survey results show that nowadays the above-mentioned proportion of students is growing.

Keywords: *lack of mathematical knowledge, problems of education reform, sample survey, study vouchers, teachers' profession.*

ISSN 1392-0340
E-ISSN 2029-0551

Introduction

Since September 2009 the most capable graduates with highest academic achievements from secondary education institutions of Lithuania have been granted the so-called 'study vouchers' and higher education students with a good academic record have received state funding for the whole period of their studies. The authors of the reform expected the system of 'study vouchers' to increase the competition among higher education schools. Moreover, it may be considered as a more transparent way of allocating state funds, when financing is ascribed to a particular individual rather than to an institution. However, there is a big number of study programmes, for which there are no competing ones and in such cases the system 'study vouchers' does not change anything because there is no competition.

The student is able to bring his / her 'study voucher' to any institutions, which may result in a bigger disproportion among higher education institutions and radically distort the formation of demand of the society for the most needed specialities. According to Apynis and Mazėtis (2011), there are only fewer than 20 students in the first year of studies in all the study programmes that train teachers of mathematics and informatics in Vilnius University and Lithuanian University of Educational Sciences. In 2012 the number of such students totals only 17. This is due the decrease in teacher training programmes and forced competition of future teachers of mathematics and other exact sciences with future teachers of choreography, physical training or educators for the study vouchers.

Since the number of 'study vouchers' for places in the study programmes ascribed to the group of education and training studies in 2012 totalled 568 (in 2011 there were 740 of such study vouchers, i.e. this year the state order has been decreased by 23 percent), the negative consequences of the conducted education reforms are obvious: specialities of teachers of mathematics and informatics received only 3 percent of the 'study vouchers'. What is more, in the school year of 2012–2013 as many as 4009 (i.e., more than 14 %) out of the total number (28 158 teachers) of teachers working in Lithuania were those of mathematics and informatics (Statistics Lithuania, 2013). Thus, a lack of young teachers of mathematics and informatics is likely to emerge in 4–5 years.

After the first phases of the reform, the results of student admission to higher education institutions in Lithuania revealed that the implemented model of the study voucher will not facilitate attainment of the set goals, i.e., higher quality studies, optimisation of higher education network and proportional redistribution of the entrants among university and non-university sectors of education (Želvys, 2009).

The goal of the conducted statistical survey is to analyse the students' attitude towards the profession of teacher of mathematics, the study reform, which is currently under implementation (and the so-called 'study vouchers') as well as towards the place of teacher training institutions in this reform. The topicality of this research was conditioned by the 'reasoned' discussion that the bigger proportion of graduates from teacher training

ISSN 1392-0340
E-ISSN 2029-0551

universities do not even consider becoming teachers and that their main purpose is only to obtain a university diploma.

Methodology of Research

The aforesaid reform has had a severe effect on the training of the young generation of teachers of mathematics: only in the last three years the number of students, which have chosen the study programs of Mathematics and Informatics at Lithuanian University of Educational Sciences, has drastically gone down (namely by 40 percent), consequently, resulting in a reduction in the number of teachers. Thus, the target population in the first stage of the research included the students of the aforesaid study programs, which totalled $N = 294$ elements in April 2013. It is obvious, that the success of a first year student's start at higher education institutions is firstly conditioned by a secondary school, whereas fulfilment of his / her further expectations depends on the process of studies; therefore, to ensure comprehensibility of the survey, the questionnaire was supplemented by the following questions:

- In your opinion, is level of preparation of pupils for studies and life in secondary schools decreasing?
- Do you regret choosing studies in our university?

Seeking to estimate the parameters of the population (for example the proportion of the students, who plan to work at school after graduation of the university), the simple random stratified sample was selected. The procedure of forming the sample of this kind may be divided into several stages (Krapavickaitė, Plikusas, 2005; Särndal et al., 1992): division of the population into a number of distinct non-overlapping subpopulations called *strata*, sample size determination, sample size allocation and selection of simple random samples from every stratum. Each of these stages will be discussed in a more detailed way.

Stratification of the population

Since the estimates of the population parameters in the case of the stratified sample are more accurate when the strata consist of the elements that are as similar as possible from one or another perspective (for example, in terms of attitude, similar values of quantitative and qualitative variables), the population was divided into the three strata on the following basis:

1) First and second year students of the Bachelor study programme of Mathematics and Informatics and the Bachelor study programme of Informatics (this stratum consists of $N_1 = 59$ elements);
2) Third and fourth year students of the Bachelor study programme of Mathematics and Informatics and the Bachelor study programme of Informatics (this stratum consists of $N_2 = 202$ elements);

3) First and second year students of the Master study programme of Mathematics and Informatics (this stratum consists of $N_3 = 33$ elements).

We think that under the above indicated stratification of the population, elements are more similar to each other within strata than between them.

Sample size

Sample size determination depends on the accuracy requirements for the estimates of the population parameters. If an estimator $\hat{\theta}$ of a certain parameter θ is unbiased and normally distributed, then one can require that the absolute value of the difference $\hat{\theta} - \theta$ with the probability $1 - \alpha$ (α –probability of error) would be lower than the selected positive value d (absolute tolerable error). In the theory of the finite populations statistics it is proved that the sample size n, which meets the aforesaid accuracy conditions, is defined by the following equation:

$$d = z_{\alpha/2}\sqrt{V\left(\hat{\theta}\right)}, \tag{1}$$

where $z_{\alpha/2}$ is $1 - \alpha / 2$ -quantile of the standard normal distribution, $V\left(\hat{\theta}\right)$ – variance of the estimator $\hat{\theta}$.

The estimated parameter in this statistical research is the proportion p of the population (for example, the proportion of the students, who have already been working and are further going to work at school; the proportion of the students, who think that the level of preparation of school students in secondary schools for studies and life is deteriorating, etc.). If, in the case of the simple random sample, the population proportion is estimated by the sample proportion and the estimator $\hat{\theta}$ is normally distributed, the sample size n, which satisfies equation (1), equals:

$$n = \frac{1}{\frac{1}{N} + \frac{d^2(N-1)}{Np(1-p)z_{\alpha/2}^2}}. \tag{2}$$

When no advanced information on the estimated proportion is available, it is suggested writing 1/2 instead of p in the formula (2).

Despite the use of the stratified sample instead of the simple random sample, the sample size is calculated in this paper according to the formula (2). Such choice may be motivated by the following: appropriate stratification of the population results in more accurate estimates of the parameters. Thus, if, in the case of the simple random sample the targeted accuracy is achieved using a certain value of sample size, let us say n^*, then in the case of the stratified sample (with the same value of the sample size n^*), the requirements for accuracy are even better met.

ISSN 1392-0340
E-ISSN 2029-0551

Setting $\alpha = 0.1$ and $d = 0.06$ (which means that the required absolute value of difference $\hat{p} - p$ with the probability $1 - \alpha = 0.9$ is lower than $d = 0.06$), yields: $n = 115$.

Sample size allocation

When population is stratified and the sample size n of the stratified sample is determined, it is necessary to decide how big samples will be drawn from each stratum under the condition that the total of these sample sizes (let us define them by n_1, n_2, ... and n_H, where H – number of the strata) would be equal to n. It should be noted that the union of these samples defines the stratified sample used in the survey.

When the strata are of different size and the distributions of survey variables are unknown, strata sample sizes can be calculated using the proportional allocation, i.e. according to the formula:

$$n_h = n\frac{N_h}{N}, \quad h = 1,2,...H.$$

Applying this formula for our data, we obtain: $n_1 = 23$, $n_2 = 79$, $n_3 = 13$.

Selection of the samples from the strata

Further, the simple random samples of the previously determined size were selected from each stratum, the union of which makes up the stratified sample used in the research. Forming the sample of this kind, the samples from the strata are selected separately and independently regardless of the samples selected in other strata.

Survey

Striving for acquisition of the sample data, the method of questionnaire survey was applied. The questionnaire form specially designed by the authors contained statements on the changing attitude of students towards teacher's profession, the undergoing study reform and evaluation of the study quality. The data obtained during this survey were processed employing Microsoft Office Excel 2010.

Estimator used

A proportion of the elements of the sample, having an attribute of interest, is the standard estimator of the population proportion, which is applied in the case of the simple random sample. In case of the stratified sample (thus, also in this statistical survey), the population proportion is estimated by the following simple only design-based estimator:

ISSN 1392-0340
E-ISSN 2029-0551

$$\hat{p}_{str} = \frac{1}{N}\sum_{h=1}^{H} N_h \hat{p}_h, \quad (3)$$

where $\hat{p}_h$ – the proportion of the elements in the sample of the stratum *h* that have a particular attribute.

Results of Research

Growth in the gap between the higher and secondary education institutions

The reformed teaching of school mathematics introduced in the second part of the 20th century resulted in a too formal teaching of mathematics in secondary schools. However, correction of mistakes led to the other extremity – important themes and concepts of mathematics were withdrawn from school textbooks of mathematics, educators rather than specialists of the study subject started writing textbooks of mathematics. Such situation led to emergence of such curiosities as attempts to humanise the Pythagorean theorem.

A big number of professional mathematicians in Europe criticize the quality of teaching contemporary school mathematics. For example, Gunter M. Ziegler, who is a professor at Freie University in Berlin, is dissatisfied with the current quality of teaching mathematics in German schools due to a big number of reasons that are pointed out in his article (Ziegler, 2012).

When experiments with mathematics, the oldest and the most conservative study subject, which is also likely to be considered the most respectable, started, the gap between the level of school and university knowledge significantly widened. This is confirmed not only by the opinions of the representatives of other national universities (Kaminskienė et al., 2013; Stankus, 2008; Stankus, Dagienė, 2010) but also by the conducted research. The graphic presentation of the questionnaire results received to the question 'In your opinion, is level of preparation of pupils for studies and life in secondary schools decreasing?' from the respondents of the described sample is shown in Fig. 1.

The data indicate that approximately 66 percent of students, who are recent graduates from secondary schools, think that the level of professionality of a secondary school is getting lower (Note: hereinafter pointing out that *x* percent of the students expressed their opinion *y*, we will have in mind the estimate of the proportion of all the students in the population, who express the opinion *y*, calculated according to the formula (3) and expressed in percentage form).

This problem is likely to be characteristic not only of Lithuanian schools – analogous negative tendencies have been observed by researches in foreign universities for some

ISSN 1392-0340
E-ISSN 2029-0551

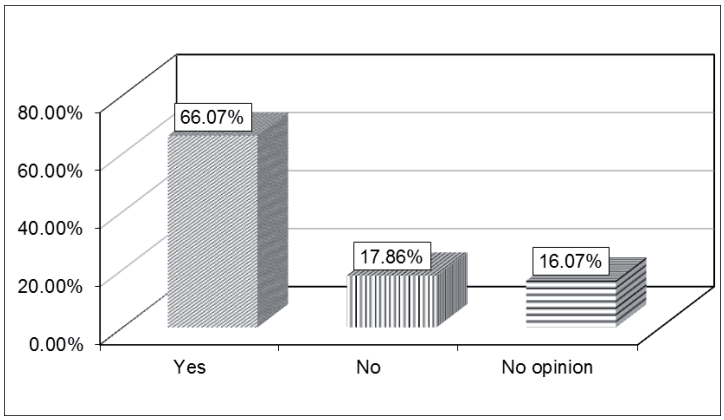

Fig. 1. *In your opinion, is level of preparation of pupils for studies in secondary schools decreasing?*

time already (Hus et al., 2011; Liston, O'Donoghue, 2009; Metje, 2007; Mumba et al., 2010; Özdem et al., 2010; Wikiel, 2008).

On the other hand, the attitude of school students towards fundamental sciences has also been changing. If 25–30 years ago young people thought of the scientist's career as of very prestigious, the results of the recent research (Lamanauskas, Augienė, 2011) revealed that *upper secondary school students do not relate their future with scientific research activities, researcher's career is considered to be not perspective and of low prestige.*

Perception of outcomes

Many students and undergraduates seem to think of mathematicians as old, white, middle-class men who are obsessed with their subject, lack social skills and have no personal life outside maths. The student's views of mathematics itself included narrow and inaccurate images that are often limited to numbers and basic arithmetic.

The paragraph we just quoted is the summary of the study 'Maths Images & Identities: Education, Entertainment, Social Justice' carried out by three British sociologists Heather Mendick, Debbie Epstein and Marie-Pierre Moreau at the 'Institute for Policy Studies in Education' at London Metropolitan University in 2008. It was based on the survey of British students.

A similar attitude has been widely spread in Lithuania. Therefore, the question 'What proportion of students have intention to become teachers of mathematics?' has become of utmost topicality and the answer to this question has received highly controversial evaluations from the specialists of the Ministry of Education and Science of the Republic of Lithuania, who administer financing of universities, on the one hand, and specialists

ISSN 1392-0340
E-ISSN 2029-0551

in educational science, who have been conducting the aforesaid surveys and research, on the other hand.

Thus, it is necessary to identify what goals a student pursues studying at university. The answers of the respondents to the question 'What was your purpose of entering the university?' are presented in Fig. 2.

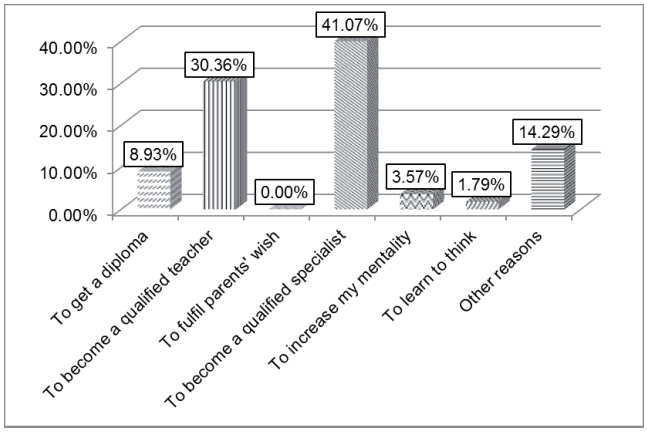

Fig. 2. *What was your purpose of entering the university?*

As it can be seen from the respondents' answers, the majority of them would like to become qualified specialists or qualified teachers; however, the concepts of *qualified specialist* or *qualified teacher* are likely not to be perceived the same way by everybody. It should be noted that the number of students, who are planning to search for a job at school has considerably increased (see Fig. 3).

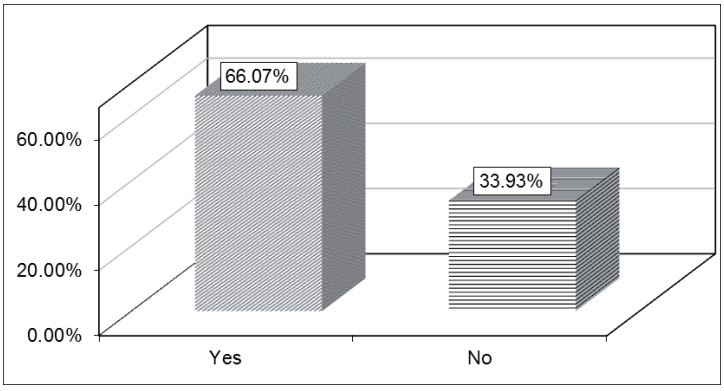

Fig. 3. *Are you going to look for a job of a teacher after graduation?*

ISSN 1392-0340
E-ISSN 2029-0551

Professor mathematician V. Uspensky from the famous Lomonosov Moscow State University expressed the following opinion regarding experience of learning mathematics at school (Mathematics for the Humanitarians, 2004): '*The result of such teaching mathematics in a secondary school is hatred towards this study subject. And this happens not only because of bad teachers of mathematics. The society does not have any understanding of what goals are attained while teaching mathematics... This concerns not only mathematics but also literature and other study subjects*'. Referring back to the Figure 2 'What was your purpose of entering the university?', it is necessary to point to the alarming fact that there is a small number of respondents, who prioritised the ability to learn to think. Who if not a teacher of mathematics has to not only encourage but also to teach school students to think? To think consistently, logically, rationally, reasonably...

Enhancement of the prestige of teacher in the society

This is a welcome trend. The diagram presenting the answers to the question 'Are you going to look for a job of a teacher after graduation?' shows that slightly more than 66 percent of the respondents are planning to choose teacher's job in 2013, which is a joyful trend and was similar in 2010 and 2009 but not in 2008 (Januškevičius, Januškevičienė, 2009) (see Fig. 4).

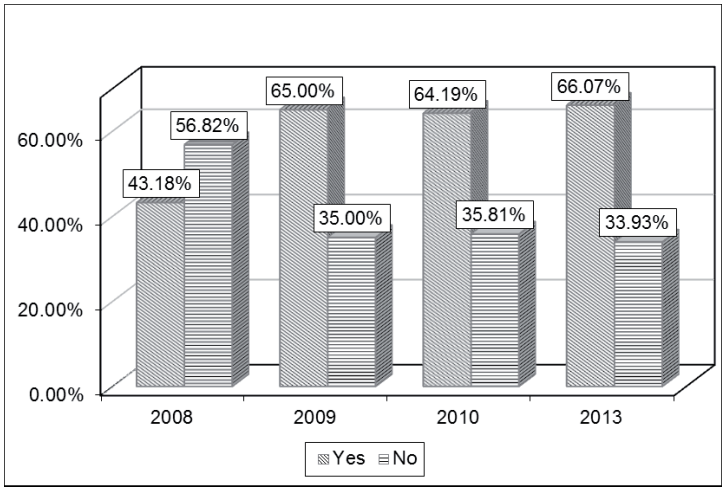

Fig. 4. Are *you going to look for a job of a teacher after graduation?*

However, the number of entrants to the study programmes of Mathematics and Informatics has been annually decreasing. Making attempts to clarify the reasons why so few graduates chose studies of mathematics, it was natural to start with the question regarding the quality of studies. The results of the survey showed that as many as 96 per-

ISSN 1392-0340
E-ISSN 2029-0551

cent (!) of students that have chosen the study programs of Mathematics and informatics at Lithuanian University of Educational Sciences do not regret choosing studies in this university (see Fig. 5).

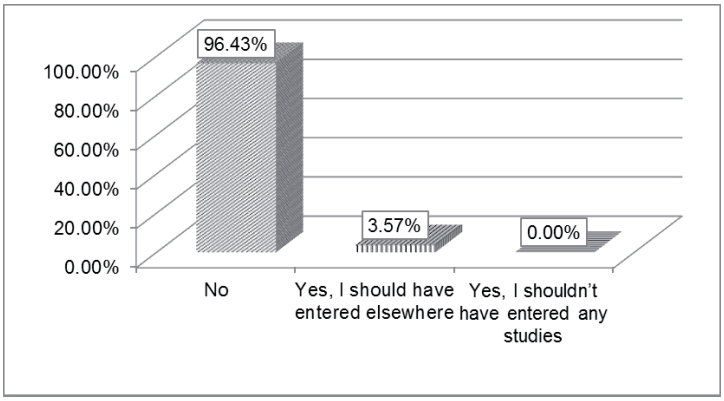

Fig. 5. *Do you regret choosing studies in our university?*

It is necessary to pay attention to one more quite dangerous trend – having chosen the model of free competition in the current stage of Lithuanian higher education development and failing to fully fill groups of specialities of exact sciences with students, the universities that are financed according to numbers of admitted students will be forced to withdraw these specialities and replace them by others.

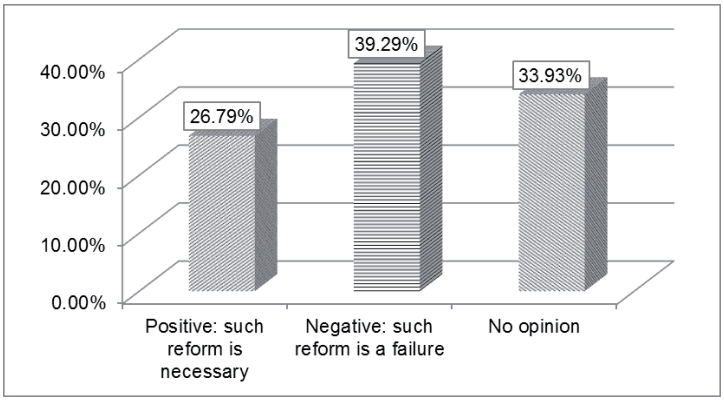

Fig. 6. *What is your opinion about the undergoing study reform and the so-called 'study vouchers'?*

ISSN 1392-0340
E-ISSN 2029-0551

Therefore, the publicly expressed opinion that today insufficient attention is paid to the fact who are going to change currently working teachers of mathematics, physics and chemistry, when they retire, receives more and more support. The strategists of Ministry of Education and Science should consider the students' opinion about the study reform and the so-called 'study vouchers' – only 27 percent of the respondents support the reform (see Fig. 6).

Discussion and conclusion

Insufficient attention is paid to training of young generation teachers, who will have to replace the currently working teachers of mathematics, informatics, physics and chemistry, when they retire. As many as 39.3 percent of the respondents do not approve of the study reform in Lithuania, when the most gifted graduates with highest academic achievements from secondary education institutions of Lithuania have been granted the so-called 'study vouchers' and higher education students with a good academic record receive state funding for the whole period of their studies. This reform is supported only by 27 percents of the respondents.

It was revealed that the attitude towards teacher's profession has stated changing lately. Slightly more than 66 percent of the respondents-mathematicians responded positively to the question 'Are you going to look for a job of a teacher after graduation?' in 2013, which expresses a very positive trend.

As many as 96 % of the respondents do not regret choosing the speciality of teacher of mathematics. This shows high evaluation of the quality of studies and a belief in the advantages of the chosen speciality, adapting to changeable (frequently complicated) current economic and social conditions.

The example of the conducted statistical survey proved that seeking for more accurate estimates of the parameters of the population (for example, those of the proportion of the students' in the population, who plan to work at school after graduation of the university), it is expedient to select the simple random stratified sample. The procedure of forming the sample of this type may be divided into several stages: 1) division of the population into a number of distinct non-overlapping subpopulations called *strata*; 2) sample size determination, 3) sample size allocation; 4) selection of simple random samples from every stratum. Each stage is discussed in detail, emphasizing the influence of the discussed procedures on the possible errors of the estimates.

References

Apynis, A., Mazėtis, E. (2011). The problems of mathematics education at secondary schools and gymnasia. *Lietuvos matematikos rinkinys. LMD darbai,* 52, 67–71. Retrieved from: ftp://ftp.

science.mii.lt/pub/publications/52_TOMAS(2011)/MAT_INFORMATIKOS_DESTYMAS/met_Apynis_Mazetis.pdf.

Hus, V., Kordigel, M., Özdem, A. (2011). Questioning as a mediation tool for cognitive development in early science teaching. *Journal of Baltic Science Education,* 10 (1), 6–16.

Januškevičius, R., Januškevičienė, O. (2009). Importance of the logical thinking and tendencies and problems of mathematical education in Lithuania. *Pedagogika,* 94, 99–104. Retrieved from: http://www.biblioteka.vpu.lt/pedagogika/PDF/2009/94/janol99-105.pdf.

Kaminskienė, J., Rimkuvienė, D., Raškinienė, D. (2012). Analysis of the first-year students' mathematical preparedness at the Lithuanian university of agriculture. *Pedagogika,* 105, 53–60. Retrieved from: http://www.biblioteka.vpu.lt/pedagogika/PDF/2012/kamrimkras53-59.pdf.

Krapavickaitė, D., Plikusas, A. (2005). *Basics of the Sample Theory. Imčių teorijos pagrindai*. Vilnius: Technika.

Lamanauskas, V., Augienė, D. (2011). Scientific research activity evaluation: Lithuanian upper secondary school students. *Journal of Baltic Science Education,* 10 (3), 195–208.

Liston, M., O'Donoghue, J. (2009). Factors influencing the transition to university service mathematics: part I a quantative study. *Teaching mathematics and its applications,* 28, 77–87.

Mathematics for the Humanitarians. (2004). [Radio series episode]. In *Education*. Washington: Radio Liberty. Retrieved from: http://archive.svoboda.org/programs/edu/2004/edu.092204.asp.

Metje, N. (2007). Observing mathematics teaching in three different countries – lessons learnt? *Teaching mathematics and its applications,* 26 (3), 145–153.

Mumba, F., Mejia, W. F., Chabalengula, V. M., Mbewe, S. (2010). Resident scientists' instructional practice and their perceived benefits and difficulties of inquiry in schools. *Journal of Baltic Science Education,* 9 (3), 187–195.

Özdem, Y., Çavaş, P., Çavaş, B., Çakıroğlu, J., Ertepınar, H. (2010). An investigation of elementary students' scientific literacy levels. *Journal of Baltic Science Education,* 9 (1), 6–19.

Särndal, C. E., Swensson, B., Wretman, J. (1992). *Model Assisted Survey Sampling.* New York: Springer.

Stankus, E. (2008). Additional mathematical education for pupils. *Lietuvos matematikos rinkinys. LMD darbai,* 48 / 49, 16–22. Retrieved from: ftp://ftp.science.mii.lt/pub/publications/48-49_TOMAS(2008)/PLENARINIAI/Stankus.pdf.

Stankus, E., Dagienė, V. (2010). Mathematics and informatics teacher education perspectives. *Lietuvos matematikos rinkinys. LMD darbai*, 51, 160–163. Retrieved from: ftp://ftp.science.mii.lt/pub/publications/51_TOMAS(2010)/MAT_INFORMAT_DESTYMAS/Stan_Dag.pdf.

Statistics Lithuania. (2013). Statistics on teacher *training and the annual survey*. Retrieved from: http://db1.stat.gov.lt/statbank/SelectVarVal/Define.asp?Maintable=M3110319&PLanguage=0.

Wikiel, B. (2008). The evaluation of the effects of mathematical education in the context of examination skills. In *Proceedings of the SEFI 2008 Annual Conference*. Retrieved from: http://www.sefi.be/wp-content/abstracts/1236.pdf.

ISSN 1392-0340
E-ISSN 2029-0551

Ziegler, G. M. (2012). Mathematics School Education Provides Answers – To Which Questions? *Newsletter of the European Mathematical Society*, 84, 8–11. Retrieved from: http://www.ems-ph.org/journals/newsletter/pdf/2012-06-84.pdf.

Želvys, R. (2009). National scholarships – the first results of the experiment. *Pedagogika*, 96, 9–14. Retrieved from: http://www.biblioteka.vpu.lt/pedagogika/PDF/2009/96/zelv9-14.pdf.

Studentų, ketinančių tapti mokytojais, proporcija: statistinis tyrimas

Romanas Januškevičius[1], Dalius Pumputis[2]

[1] Lietuvos edukologijos universitetas, Gamtos, matematikos ir technologijų fakultetas, Matematikos katedra, Studentų g. 39, 08106 Vilnius, romanas.januskevicius@leu.lt
[2] Lietuvos edukologijos universitetas, Gamtos, matematikos ir technologijų fakultetas, Matematikos katedra, Studentų g. 39, 08106 Vilnius, dalius.pumputis@leu.lt

Santrauka

Straipsnyje nagrinėjamos vidurinių mokyklų absolventų matematinio raštingumo problemos, aptariami didėjančio aukštosios ir vidurinės mokyklos atotrūkio klausimai Europoje ir Lietuvoje, kurioje vykdoma švietimo reforma. Čia taip pat pristatomi statistinio tyrimo, atlikto Lietuvos edukologijos universitete, rezultatai, atspindintys atsakymą į klausimą „Kokia yra studentų, ketinančių tapti mokytojais, proporcija“, prieštaringai vertinamą Lietuvos Respublikos švietimo ir mokslo ministerijos darbuotojų, administruojančių universitetų finansavimą, iš vienos pusės, ir edukologijos specialistų, vykdančių minėto tipo tyrimus, iš kitos pusės. Atliekant šį tyrimą taikyti aprašomosios statistikos ir imčių teorijos metodai. Tyrimo rezultatai rodo, kad šiuo metu anksčiau minima proporcija turi tendenciją augti.

Esminiai žodžiai: *matematinių žinių stoka, studijų krepšelis, švietimo reformos problemos, imčių tyrimai, mokytojo profesija.*

Įteikta / Received 2014-10-20
Priimta / Accepted 2015-01-15