ISSN 1392-5016. ACTA PAEDAGOGICA VILNENSIA 2015 35
DOI: http://dx.doi.org/10.15388/ActPaed.2015.35.9189

Changes in Mathematical Olympiad Problem Sets in Latvia

Maruta Avotina
Mathematics, Lecturer
University of Latvia,
Address: Zellu Street 29, Riga, LV-1002, Latvia,
E-mail address: marutaavotina@inbox.lv

Agnese Šuste
Mathematics, Lecturer
University of Latvia,
Address: Zellu Street 29, Riga, LV-1002, Latvia,
E-mail address: agnese.suste@lu.lv

Students' average results in mathematical olympiads in Latvia are quite low, and this is a signal that something is not right. To improve students' results and motivation, in the last two years some changes were made in the Olympiad problem set. Our goal is to investigate how these changes affected students' average results and attitude towards mathematical olympiads. In the paper, we describe changes that were made to the mathematical olympiad problem set, consequences and conclusions.

Key words: *mathematical olympiads, problem set, "repeated" problem, "topic" problem, "school level" problem, students results.*

Introduction

Nowadays, great attention is devoted to the STEM education and problems associated with it. Based on data about grade 12 students final exam results published by the National Centre for Education of the Republic of Latvia (Centralizēto eksāmenu vidējo rezultātu salīdzinājums 2013–2015, 2015), we see that results in mathematics are low as compared to other subjects (see Figure 1). Exams in English, Latvian and mathematics are compulsory, but exams in physics, chemistry and biology are optional, so a student can decide whether to take it or not. This is the reason why results in physics, chemistry and biology are higher and do not describe the overall situation. In 2015, for example, 14 616 students took exam in mathematics and only 529 students took exam in chemistry. Low results

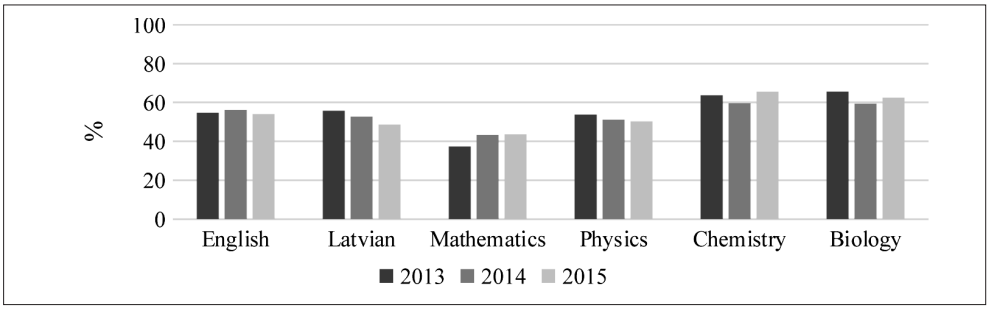

Figure 1. ***Grade 12 students' average results in final exam***

in mathematics have an influence on mathematical Olympiads.

In Latvia, the Mathematical Olympiad system has a long and rich in tradition history. This year, there was held the 65th State Mathematical Olympiad and the 42nd Open Mathematical Olympiad. In these Olympiads can participate students from grade 5 to grade 12. There are five problems for each grade students, they have five hours to solve them. Each problem is worth 10 points, so the total is 50 points. In a regional Olympiad (second round of the State Mathematical Olympiad) there are about 6000 participants, in the Open Mathematical Olympiad participate about 3200 participants. All Olympiad problems and solutions can be found on the web, for example, see (Uzdevumu arhīvs, 2015). For many years there have not been any changes in the problem set, and in 2014 some changes were made in the problem set. Our aim is to determine what are the consequences by analyzing teachers and students' survey data and students' results.

"Repeated" Problem

In mathematical Olympiads, problems are usually different from problems in the school curricula. Most of students and teachers do not really know what to expect and how to prepare for the competition. This was one of the reasons why in 1989 the "repeated" problem was included in the problem set. The "repeated" problem is a problem that is the same or slightly changed as some that was given in the same grade one or two years ago. The changes are not significant – some data (e. g., numbers, story) may be changed, but the idea of the solution remains the same.

There are very different viewpoints whether the "repeated" problem should be included in the problem set and what do we want to achieve by including it; for example, see (Kaibe, Rācene, 2009), (Opmanis, 2008), (Opmanis, 2011). Some positive aspects are that students have material for practice, they are stimulated to study problem-solving ideas, and there is a greater possibility not to obtain zero points. There are also some negative features: reproducing the solution without understanding, cheating during the Olympiad, a student can get maximal points even if he does not understand the solution of the problem.

Unfortunately, lately the "repeated" problem does not achieve the expected result – average results achieved in this problem are very low, and sometimes the results are even worse than for the same problem in a previous year (see Figure 2).

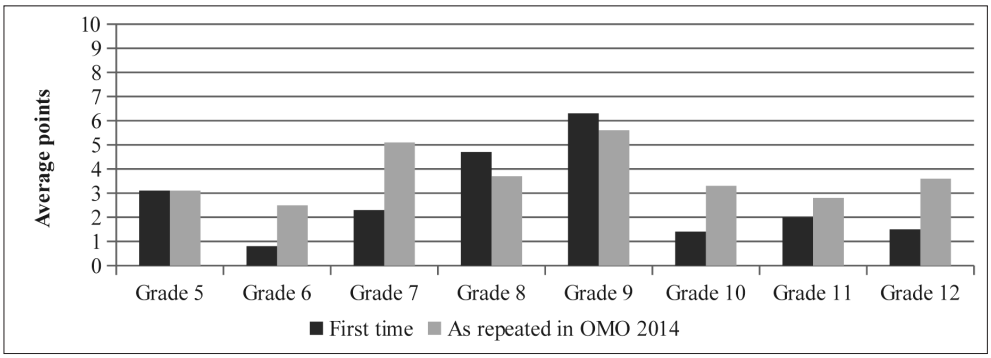

Figure 2. ***Average points in "repeated" problem in the Open Mathematical Olympiad 2014***

If we analyze the results more closely, we see that many students do not solve a "repeated" problem at all or receive 0 points, that is, there is not even a single good idea that could lead to the solution (see Figure 6). Also, a lot of students achieve 1 to 3 points, which means that there are just some useful ideas without further applications.

Since there are many negative affects according to the "repeated" problem, it was decided not to include such problem in the problem set and make other changes to improve students' results and motivation to participate in mathematical Olympiads.

How to make a Problem Set More Suitable for Students

In 2014, there was conducted a survey about mathematical Olympiads in Latvia. In the survey participated 248 mathematics teachers from different places of Latvia. The aim of the survey was to find out teachers' opinion about mathematical Olympiads and experience in advanced mathematics teaching.

Most of the teachers have pointed out that mathematical Olympiad problems are difficult (see Figure 3) and that there is a need for changes in the problem set.

In the regional Olympiad participate about 6000 students, and only about 11% of them obtain more than 25 points, which is half of the maximal number of points (see Figure 4). The small number of students who receive a high score is not as alarming as the large number of students who receive a low score – about 45% of all participants receive not more than 10 points which means that student cannot

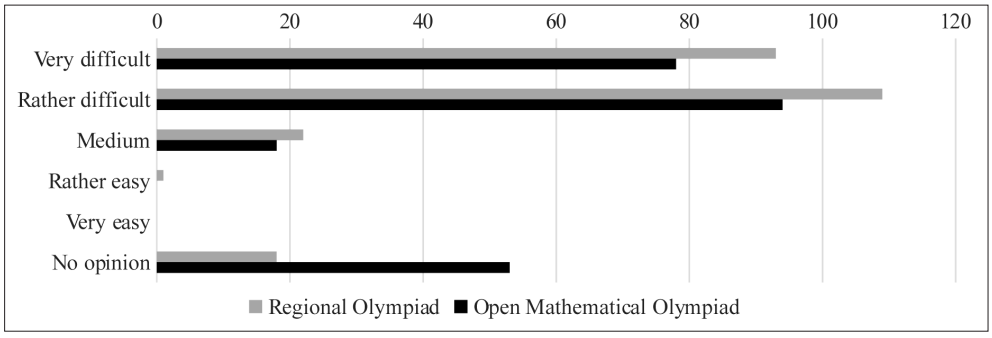

Figure 3. ***Teachers' view about the complexity of mathematical olympiad problems***

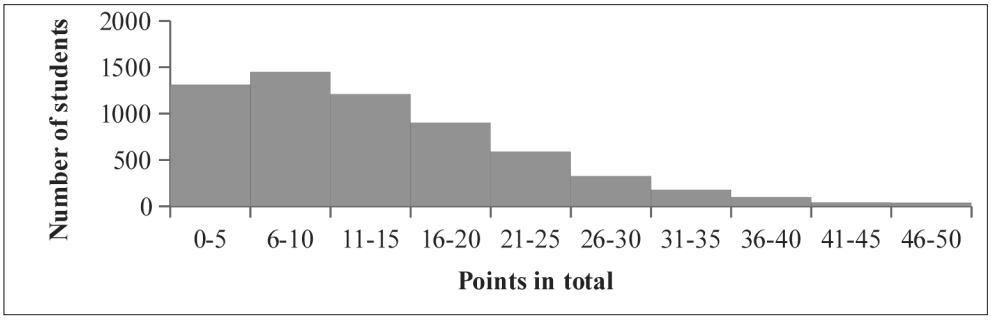

Figure 4. ***Students' results in the Regional Olympiad 2014***

solve completely even one problem. If a student gets very low results, it can negatively affect his desire to participate in mathematical competitions.

Psychologist R. Niedre emphasizes that for a student who can receive high scores, this score is a motivation to do more to become better, and thus his achievements will only grow, but for the students who regularly receive a low score the results decrease their learning motivation (Es un skola 24. raidījums, 2014).

Students' participation in the Olympiad can be considered as successful if they have understood all or almost all formulations of the problems, used most of the time allowed for solving, correctly solved at least one problem, and also dealt with some or any of the others. Otherwise, we can talk about an unsuccessful participation which adversely affects a student's confidence in his own worth or abilities, reduces his reliance and generally takes away the desire to participate in the same level of mathematical problem solving competitions (Ģingulis, 2009)

In the survey, there was a question about what should be changed in the problem set to make it more suitable for students. The majority of teachers think that there should be included one difficult "school level" problem so that a student who is good at regular classes can solve at least one problem and receive some points (see Figure 5). Also, many teachers think that a "repeated" problem should be included because a student can prepare and not to get zero points.

Taking into account the survey results as well as the results of the mathematical Olympiads, it was decided to make changes in the problem set.

The "school level" problem

In the school year 2013/2014, in the Olympiad problem set there was a "repeated" problem and also was included one problem from the corresponding grade school mathematics curricula. This problem is a bit harder than problems solved in regular classes, so that a student who is good at regular classes can solve it. For example, in Estonia, in the Olympiad problem set also are included some "school level" problems, and a number of school problems is different accordingly to the grade, see (Piirkonnavoor 2014, 2014).

If one of the reasons why a "repeated" problem was included was to give a chance for a student to receive some points

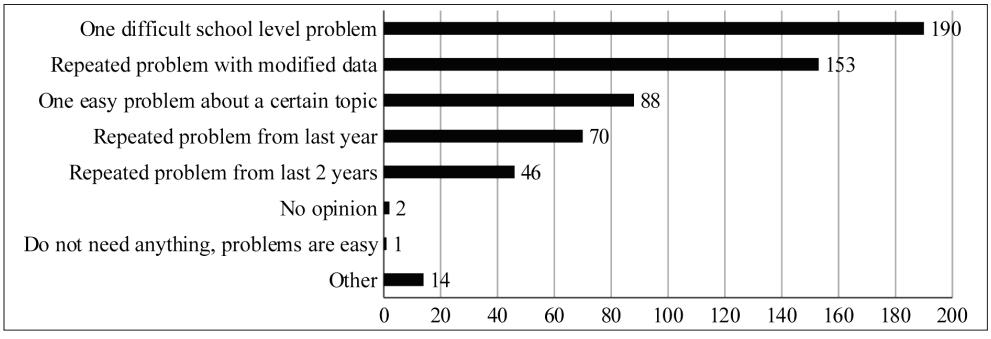

Figure 5. ***Teacher recommendations how to make a problem set more suitable for students (2014)***

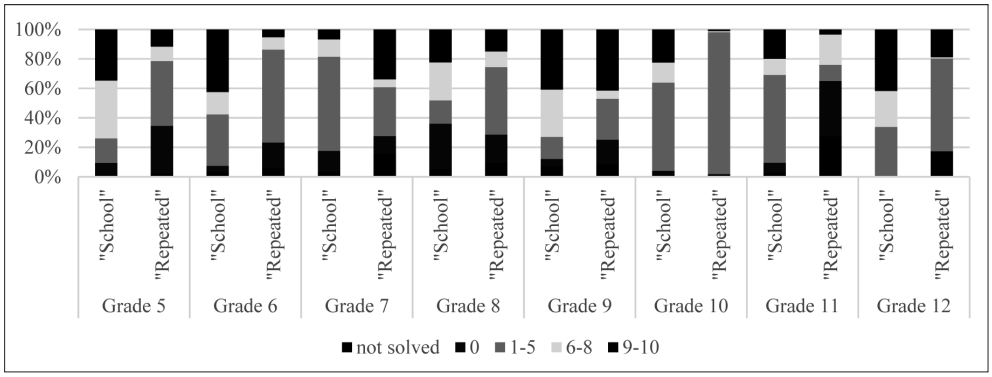

Figure 6. ***Students' obtained points in the "school level" problem and "repeated" problem in the Open Mathematical Olympiad 2014***

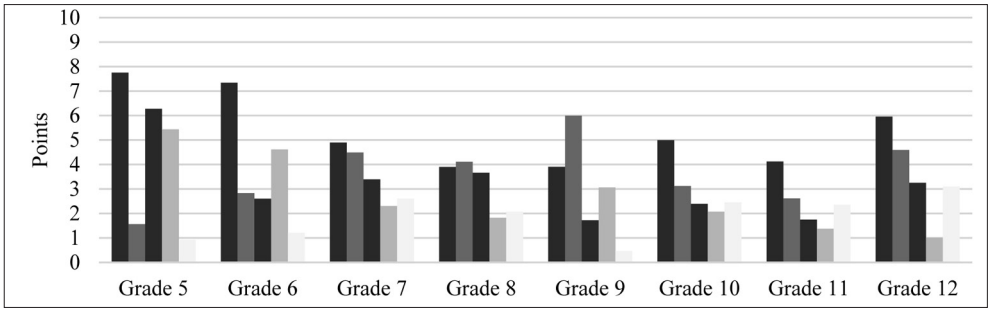

Figure 7. ***Average points acquired in each problem in the Regional Olympiad 2015***

in the Olympiad; then, analyzing students' results (see Figures 6 and 7), we see that in the "school level" problem results are better.

Almost in all grades (except for grades 8 and 9), the average points in the "school level" problem are higher than in other problems (see Figure 7, for all grades the "school level" problem was problem number 1).

The average points received in the "school level" problem depend on the theme in the curricula, because some themes are easy for students and some are difficult. For example, for Grade 9 (see Example 1) difficult was the theme and thereby results were lower, but for Grade 12 (see Example 2) it was rather an easy problem.

Example 1 (*"school level" problem for Grade* 9). Solve the equation $\frac{5}{x^2-9}-\frac{1}{3-x}=\frac{1}{2}$.

Example 2 (*"school level" problem for Grade* 12). Solve the equation $(x-2)\log_{\sqrt{6}}(x^2-5x)=2x-\log_{\sqrt{6}}36$.

After the Olympiad, teachers and students were asked to fill in the questionnaire about the problem sets. Teachers pointed out that it was very well that a "school level" problem was included, and this problem was corresponding to each grade school mathematics curricula; some of them mentioned that was is a good "warm up" and hopefully there would be fewer students whose total score would be 0.

Most of students have answered that the "school level" problem was easy to understand, easy to solve, and similar problems they solve in the regular classes, but there were students who said that this problem was difficult. Some excellent students pointed out that such problem should not be included, because it was too easy and not challenging.

The "topic" problem

In the school year 2014/2015, in the Olympiad problem set there was included the "school level" problem, but instead of a "repeated" problem there was a "topic" problem. One of the aims why the "repeated" problem was included in the problem set was to give students a chance to prepare for the Olympiad. Most of teachers before the Olympiad together with students just solve previous year problems without any explanations or ideas why this problem is solved like this. The idea of the "topic" problem is to give a theoretical material and practical examples so that teachers and students learn not only some special solutions, but also have a theoretical basis and general problem solving methods.

At the beginning of the school year, it has been stated that one problem will be about the topic that will be announced one month before the Olympiad. This year, using the prepared material with examples, students and also mathematics teachers learned the topic "Method of Invariants", see (Invariantu metode, 2015). Theoretical material differs according to the grade. In the Olympiad problem set there was included one problem similar to examples in the published theoretical material.

Results in the "topic" problem and the "repeated" problem are quite similar – depending on the difficulty of the problem some problems are solved better and some worse (see Figures 8 and 9). The average points by problems are given in Figure 7 where for all grades the "topic" problem was problem number 2.

After the Olympiad, teachers have pointed out that it is a good idea to replace a "repeated" problem with a "topic" problem, the theoretical material was very useful, and not only students but also some teachers learned something new; hopefully, the "topic" problem will be in next Olympiads problem sets and there will be new theoretical materials with examples.

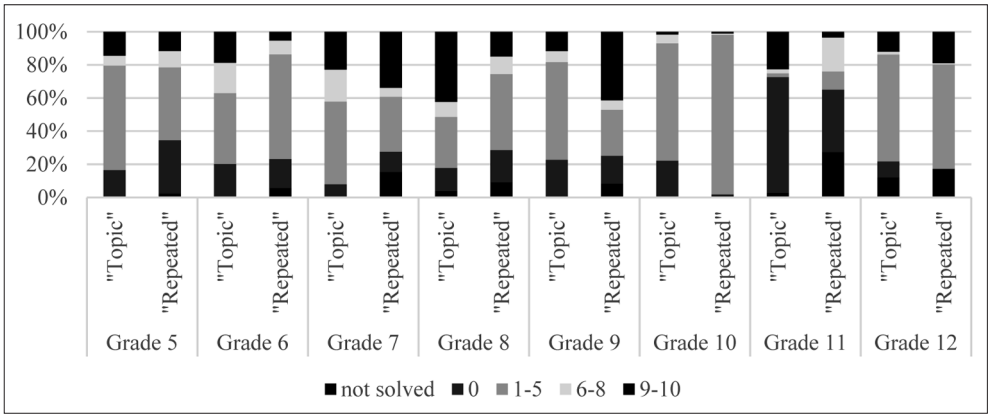

Figure 8. ***Students' obtained points in the "repeated" problem 2014 and the "topic" problem 2015 in the Open Mathematical Olympiad***

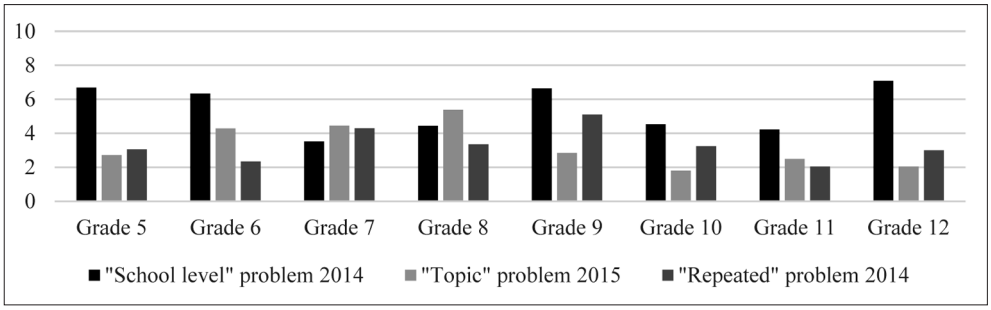

Figure 9. ***Students' average results by problems in the Open Mathematical Olympiad***

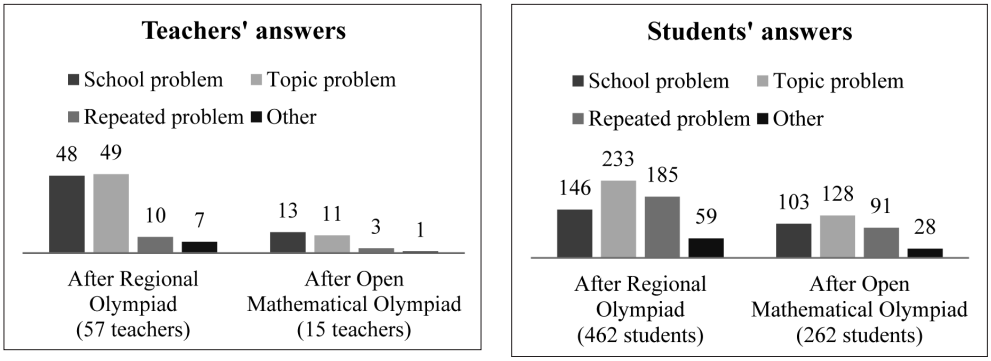

Figure 10. ***Students' and teachers' answers about what kind of problems should be included (2015)***

Students' comments on the "topic" problem: "I liked it. Since I studied the material I solved it perfectly!" A "good problem, but it could be more difficult" "My teacher thought me about the method of invariants – I immediately realized what to do. I liked to use the obtained knowledge like this." "An interesting idea to include such a problem instead of a "repeated" problem." "I think that it is much better to know the topic and actually learn something when you prepare for the Olympiad, and not uselessly learn by heart the solutions from the previous year."

In 2014, before any changes had been made to the problem set, most of teachers wanted one problem from the school curricula to be included and taught that it was good that in the Olympiad problem set the "repeated" problem was included (see Figure 5).

In 2015, after changes (included a "school level" problem and a "topic" problem), teachers altered their point of view about the "repeated" problem – only few teachers think that the "repeated" problem should be included. Students' opinion differs whether it is good to include a "school level" problem. Approximately half of students answered that the "topic" problem should be included, but also many students think that a "repeated" problem should be in the problem set (see Figure 10).

Conclusions

Developing problem-solving skills are some of the main goals of any education.

The "topic" problem has no big influence on the average results, but students who prepare for an Olympiad obtain new knowledge and acquire better results. If we want good results and educated students, we need to qualify teachers so that they can give their knowledge to students, and the "topic" problem and theoretical material is one way how to educate teachers.

The "school level" problem has a positive influence on students' results, students see the relationship with school mathematics and are motivated to learn in regular classes better and on a more advanced level.

REFERENCES

Centralizēto eksāmenu vidējo rezultātu salīdzinājums 2013.-2015. (2015) http://visc.gov.lv/vispizglitiba/eksameni/statistika/2015/dokumenti/!visi_sasn_3g.png

Es un skola 24. raidījums. (2014). http://www.atbalsts.lu.lv/lv/galerija/raidijumu-cikls-es-un-skola

Ģingulis, E. (2009). *Sacensības vienkāršu matemātikas uzdevumu risināšanā.* Rīga: Izdevniecība RaKa.

Invariantu metode. (2015). http://nms.lu.lv/wp-content/uploads/2015/06/Invariantu_metode_olimp_1415.pdf

Kaibe, Z., Rācene, L. (2009). Repetition is the Mother of Knowledge. *Proceedings of the 8th International Conference „Teaching Mathematics: Retrospective and Perspectives"*, Tallinn, p. 177–180.

Opmanis, M. (2008). Kam vajadzīgs atkārtotais uzdevums? http://vip.latnet.lv/lio/doki/kam_vajadzigs_atkartotais.pdf

Opmanis, M. (2011). Vēl dažas pārdomas par „atkārtoto" uzdevumu. http://vip.latnet.lv/lio/doki/Iespaidi_par_atkartoto_AMO_2011.pdf

Piirkonnavoor 2014. (2014). http://www.math.olympiaadid.ut.ee/arhiiv/piirk/pk2014/pk2014.pdf

Uzdevumu arhīvs. (2015) http://nms.lu.lv/uzdevumu-arhivs/latvijas-olimpiades/

LATVIJOS MATEMATIKOS OLIMPIADŲ PROBLEMINIŲ UŽDUOČIŲ POKYČIAI

Maruta Avotina, Agnese Šuste

S a n t r a u k a

Straipsnyje aptariama matematikos olimpiadų situacija Latvijoje ir gvildenama mokinių, dalyvaujančių šiose olimpiadose, prastėjančių rezultatų ir mažėjančios motyvacijos dalyvauti jose problematika, signalizuojanti, kad kažkas yra negerai. Matematikos olimpiadose dalyvavusių mokinių rezultatai rodo, kad daugumai mokinių kai kurios probleminės užduotys buvo per sunkios. Siekiant gerinti mokinių pasiekimus ir palaikyti motyvaciją, pastaraisiais metais buvo analizuojamos ir keičiamos probleminės olimpiadų užduotys.

Remiantis atlikta matematikos mokytojų apklausa, straipsnyje diskutuojama, kokio tipo probleminės užduotys turėtų būti įtraukiamos į olimpiadų užduotis. Ar olimpiadų probleminės užduotys turi būti panašios į tas, kurias mokiniai mokėsi spręsti per pamokas ankstesniais metais, ar tai turi būti probleminės užduotys, kurių sprendimo patirties olimpiadų dalyviai neturi? Ar matematikos olimpiadų užduotys privalo turėti sąsajų su mokykline matematikos programa? Kaip padėti mokiniams pasirengti olimpiadoms? Paprastai pasirengimo metu mokytojai siūlė mokiniams spręsti ankstesnių metų olimpiadų užduotis.

Ieškant atsakymų į minėtus klausimus, nuspręsta keisti matematikos olimpiadų užduotis. Sutarta vietoj anksčiau pamokose išmoktų spręsti probleminių užduočių į olimpiadų probleminių užduočių rinkinį įtraukti temines problemines užduotis, kurios atitinka mokyklos programos tematiką. Tai palengvino rengimąsi olimpiadoms, nes mokytojai galėjo skirti daugiau dėmesio konkrečios temos teoriniam pasirengimui ir išmokyti mokinius įvairių metodų probleminėms užduotims spręsti.

Straipsnyje pateikiami empiriniai duomenys, kokią įtaką Latvijos matematikos olimpiadų rezultatams turėjo minėti pokyčiai.

Pagrindiniai žodžiai: matematikos olimpiados, problemų grupė, teminės problemos, „mokyklos lygio" problemos, mokinių rezultatai.

Įteikta: 2015 09 21
Priimta: 2015 10 21