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CONTESTS IN ASTRONOMY: A CHALLENGE TO PREPARE PROBLEMS

Abstract. During the recent years the number of international contests in astronomy for secondary school pupils (usually known as Olympiads) has had an increasing tendency. More precisely, at present there exist three Olympiads which are planetary oriented. Bearing in mind the efforts done by the present authors to prepare collections of these international problems for the pupils from Serbia it is easy to understand the quantity of work which is necessary for collecting as many problems as possible. In addition, providing new telescopes implies preparing manuals for their use. In order to have an accessibility of all that material digitisation appears as something indispensable.

Keywords: contests in astronomy, secondary school, digitisation.

1. Introduction

The present authors have been active in composing problem collections (e. g. [1[). Solving tasks is an integral part of teaching natural sciences. Solving tasks connects natural laws, definitions and principles with situations from real life and the environment, that is, with concrete problems that can be found in everyday life. That is why the production ie. composing tasks is of great importance. Teaching natural sciences is accomplished entirely by solving qualitative, quantitative, graphic and experimental tasks. Tasks should be carefully chosen so that their creation covers the entire theoretical basis of the teaching area, that they are a realistic representation of reality and, what is most important, that they are interesting to the pupils. The purpose of the tasks is for pupils to determine whether they understand the material of a certain area and whether they can apply the learned laws and definitions to a specific problem. Certainly, before creating tasks, it is necessary to learn the laws, definitions and relationships between physical quantities related to the given area. Such undertaking can require a lot of work, it depends on what contests are considered. Today, astronomical contests targeting secondary school pupils (usually age between 15 and 20), or even younger ones, are numerous. If the aim is to have widely based international contests, focused on a group of countries, say from the same continent, those connected by use of the same language, or even, countries from all over the world, then each participating country should prepare its representatives. This implies international selection, usually carried out by means of national contests. Then the important task of the national jury is preparing the problems for the national contest. Certainly, the experience acquired from the international contests, also exchange of

problems between two countries, are valuable. The consequence is that the number of available collections accessible online or as a printed material becomes rather high.

If we want to have very many of them in Serbian, then a lot of work is required in their preparation (not only translation), but also technical preparation. Among the publications mentioned here only one is ready to be published on the internet. As for the other ones, it is necessary either to ask the permission of the author(s) to put them on the internet or they require additional technical preparation. We shall do our best to place these publications in the Virtual Library of the Faculty of Mathematics.

Therefore, presenting information on the sufficient increasing of astronomical contests in the world for persons under 20 may be of interest. Additional information can be found in [2] and [3].

2. Contests

2.1. Introductory. For the purpose of all necessary actions concerning astronomical contests in the framework of the Society of Astronomers of Serbia as early in 2002 a special organ – National Astronomical Olympic Committee (in further text NAOC)– was founded. During the recent time (2014-2023) Dr Sonja Vidojević was chairwoman and Dr Slobodan Ninković was vicechair of NAOC, both among the authors of the present paper.

In the period 2014-2023 NAOC organised contests within Serbia and the entire preparation for the participation of Serbian teams in international contests. Out of the contests within Serbia two levels are of special interest: Regional (covering parts of Serbia) and Republican (level of the whole country) .

In their structure regional contests were purely theoretical. Each of them consisted of three questions and four problems. The purpose was selection for the higher level – Republican Contest. In order to be selected every contestant had to gain at least 30% of the total number of points. Besides, for any contestant who in the previous year had got a medal at an international contest the participation in the regional one was not mandatory.

Taking into account the usual structure of international contests the Republican Contest in Serbia always consisted of two parts: theoretical (problems, usually five) and practical (data analysis and observational rounds). The best five contestants acquired the right to contest at an international contest; when it was possible to have two teams, then the maximum number of contestants from Serbia might attain ten.

2.2. Astronomical world contests. An international contest may be one targeting a part, rather large, of the Earth, for instance, Asian-Pacific Astronomy Olympiad and Olimpiada Latinoamericana de Astronomía y Astronáutica, or that aimed at globality (the whole planet).

At the moment there exist three contests in astronomy which have no geographical boundaries. Those are: International Astronomy Olympiad (IAO), International Olympiad on Astronomy and Astrophysics (IOAA) and Open World Astronomy Olympiad (OWAO).

Among them IAO is the oldest one (founded in 1996). Teams from Serbia (in the beginning officially from Serbia and Montenegro) took part in IAO regularly from 2002 to 2011, except in 2003. Then the contest consisted of two parts - theoretical (problems) and practical (two rounds: data analysis and observational).

IOAA was held for the first time in 2007. Teams from Serbia have taken part regularly from 2009 (also in this year). The structure of this contest is more complex, it

contains theory (problems), data analysis, observational round, planetarium round and group contest.

OWAO is the youngest of the three, founded in 2022. There are two options for contestants – to participate remotely or to be personally present. It contains: theory, data analysis and computer round based on two ways – observationally and expressly. Serbia has never taken part.

The following may be added why three world Olympiads. IAO is organised in a specific way. It bears very much the signature of its founder, Michael Gavrilov. His merits are beyond any dispute. In fact IAO was converted into an international contest, because it had been a contest within USSR before (Russian Federation). However, the founder insisted on some rules which might be applicable for the Russian Federation, say too low age limit of the contestants, etc, but not acceptable within a much larger community. The composition of problems belongs to him with no possibility to be seen by national team leaders before the moment of their translation. The national team leaders have no influence on the Statute. They also have no isight in the work of their contestants, so no appellation is possible. All of this contributed to initiative to form a another world Olympiad in 2007, such as IOAA. As for the third one (OWAO), the reason is vey simple. The beginning of hostilities between Russia and Ukraine in 2022 contributed to voting if the Russian team would be allowed to participate. Thus the three last events (2022, 2023 and 2024) were held without a Russian team. The response of Russia is very clear, to form OWAO.

3. Composing tasks

3.1. General. Every task is a functionality check for acquired knowledge (solving problems or situations met for the first time by a contestant).

Solving a problem is a process with objective that a contestant on the basis of descriptions of phenomena, given conditions and data, should be able, applying well known laws, theories and definitions, using mathematical apparatus and logic, to determine the required unknown quantities.

Tasks should be composed to make it possible a concretisation of applying the acquired knowledge, but also they are expected to improve the reasoning ability of the contestants.

The mere knowing of definitions, laws and formulae is no complete knowledge, it must have a practical application, where the role of the tasks is essential because they illustrate the problems which contestants will meet when they start to practice a given occupation.

3.2. Task classification. Tasks most generally could be classified as follows. Qualitative (logical), which require a logical consideration and inferring without using a mathematical apparatus, i. e. one should establish relations within a set of given quantities or objects, as well as the course of phenomena for given conditions. An example follows.

Indicate the superfluous object: Venus, Earth, Mars, Jupiter, Saturn (Venus, it has no satellites).

Quantitative (includes calculation), which require applying mathematics. Before it is necessary to analyse the task qualitatively in detail and only afterwards to solve it quantitatively by use of mathematics. An example follows.

Determine the elevation (above horizon) of the Sun at noon in Belgrade (latitude about 45 degrees) on the equinox day. The result is obtained by subtracting 45 (latitude) from 90, i. e. approximately 45 degrees.

3.3. A correctly composed task. The following conditions ought to be satisfied:

a. written correctly as for the grammar and orthography;

b. to have an unequivocal/unique solution;

c. solvable within a plausible time;

d. obtaining solution is possible by applying well known mathematical and natural laws and definitions;

e. solution to be verified independently by at least two persons;

f. to be realistic reflection of reality and, not less important, to be interesting to contestants;

g. Solving tasks correctly is important, no doubt, but physics and related sciences are less in equations, but more in applying fundamental and innovative ideas. This line of thinking should be incorporated into the task conditions for which the task author is responsible.

4. Preparations of contestants

4.1. General. Astronomy appears as a separate subject only in the last form of secondary school (valid not for all kinds of such schools). For this reason it is necessary to organise an extra-teaching including all ages between 15 (even younger sometimes) and 19. Because of lack of money trainers have been mostly obliged to work as volunteers.

4.2. Observational preparations. As for the extra-teaching which concerns observations, the observatory of "Ruđer Bošković" Society in Belgrade (Kalemegdan) has been usually the place for doing this. It is clear that any observational training can be hardly carried out without telescopes. NAOC now has two telescopes at its disposal. Both were obtained as donations where required by the donors: "exclusive purpose training pupils for contests". The first telescope is a Newtonian reflector, aperture diameter 200 mm, focal length 1000 mm, equatorial mounting EQ5 donated by Sonja Vidojević and Slobodan Ninković in 2014. The second one is a transportable Newtonian reflector, aperture diameter 150 mm, focal length 750 mm, equatorial mounting EQ3 donated by Vuk Radović who was a very successful contestant within Serbia, as well as at international Olympiad, in 2016. The latter one (Fig. 1) was named PRETEL (from Serbian words corresponding to transportability of a telescope).

Transportability makes it possible to send PRETEL to any place beyond Belgrade. Since to also enable a trainer to go with the telescope requires additional costs, there is a manual. The author of the manual Branko Simonović (Astronomical Society "Rudjer Bošković") digitised it so that the manual is sent as a CD. This CD contains:

a. instructions how to use the telescope;

b. observational tasks with solutions;

c. tasks without solutions foreseen to be solved by telescope users without assistance.

4.3. Literature. The literature necessary for the preparations consists of a university textbook and five problem collections. All of them have been digitised, though also exist in a printed form. These books were translated from English or Russian by Stevo Šegan, Nadežda Pejović, Zlatko Ćatović, Sonja Vidojević and Slobodan Ninković. For more details see [1].

The text book is:

– Astronomija: Klasika u novom ruhu,1998. Source in English *Spherical astronomy* / Robin M. Green : Cambridge University Press, 1985 - 536 str. : ilustr. ; 24 cm. ISBN 0-521-31779-7

The translation titles of the collections are:
– Astronomija: zbirka zadataka i praktičnih vežbanja, 2017. Source in Russian *Сборник задач и практических упражнений по астрономии* / Воронцов- Вельяминов Борис Александрович . - Москва : Наука, 1977, 271 + [1] стр. с 12 стр. илл. ; 21 цм.
– Astronomske olimpijade: zadaci sa rešenjima, 2017. Source in Russian *Астрономические олимпиады : задачи с решениями* / Сурдин Владимир Георгиевич . - Москва : Учебно - научный центр довузовского образования МГУ имени М. В. Ломоносова, 1995 . - 321 стр. илл. ; 24 цм. ISBN 5-888000-009-4
– Zadaci iz astronomije i astrofizike: zbirka zadataka sa Međunarodne olimpijade iz astronomije i astrofizike (2007-2012), 2014. Source in English *A Problem book in Astronomy and Astrophysics : Compilation of problems from International Olympiad in Astronomy and Astrophysics (2007-2012)* / Aniket Sule, editor. - Suceava : Cygnus, 2014. - XVII, 236 str. : ilustr. ; 24 cm. ISBN 978-973-1768-60-1
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Figure 1. PRETEL in Niš. The observer is Momčilo Tošić, pupil of „Svetozar Marković“ Gymnasium

5. Conclusion

The results presented here concern the efforts of the present authors which cover a time interval exceeding one decade with the main objective to help the secondary school pupils with special interest in astronomy and astrophysics in satisfying their desires to learn in these disciplines as much as possible. That there has existed a lack of astronomical literature in Serbian on the level of the mentioned age is evident, but due to the hard work of experienced astronomers, first of all NAOC members, this problem has been much reduced. So, now to the interested pupils a substantial literature is accessible. It comprises textbooks, collections of problems, but also manuals for using telescopes (NAOC now has two telescopes in its possession). All of this ought to have been digitized, which has been done. Of course, a lot of remains for the future work. The present authors hope that as many astronomical centres in Serbia as possible will be included, because the possibilities do exist, clearly thanks to the indispensable digitization process.

References

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