Pišek – Programming with Blocks Competition
A new Slovenian Programming Competition

Matija Lokar

University of Ljubljana, Faculty of Mathematics and Physics
Matija.Lokar@fmf.uni-lj.si

Abstract. Promoting computer science through programming competitions is widespread all around the world. Computer competitions for students in Slovenia have a long and respectable history - they date back to the nineteen seventies, soon after the subject Computer Science was introduced in the official curricula as an elective course. These competitions were used to promote the field as well as to enrich computer science education. In the paper, we will present the current situation in Slovenia. In the last years (under the cover of ACM Slovenia) we established an almost complete vertical line of competitions that encompasses the youngest and reaches up to university students. As we observed a huge gap in attendance between highly successful Bebras competition and the competition on the next level, we started to prepare a new competition, named *Pišek - Programming with Blocks Competition* with the goal to address the area between computational thinking and problem solving with programming and algorithms. We based the development of the competition on the experience IOI-France had with their Algorea competition.
The main part of the paper is the presentation of the competition. We discuss some of the decisions about its structure. Some data about the two trial competitions we conducted this spring are presented. We conclude with a call to cooperation between interested countries.

Keywords: programming competitions · block-based programming languages · motivation

1 Introduction

It is widely believed that participating in various competitions can be a valuable learning experience ([19]). As Katz states in [20] competition makes the studying of various subjects more attractive. The same holds true for teaching and learning informatics (i.e. computer science; an equivalent terminology often used in Europe). Dagiene claims in [13] that informatics competitions may be the key to fully exploiting the potential of new knowledge and an attractive way to connect technology and education.

Various forms of competitions can be identified, covering vastly different areas of computer science from robotics, multimedia, and artificial intelligence to the usage of spreadsheets. They are conducted in various forms - they can

be held online or on-site, be project-based or task-based. Nevertheless, most of Computer Science competitions for students are programming contests focusing on algorithms, exemplified by the model of the International Olympiad in Informatics, see ([15]) or ACM International Collegiate Programming Contest ([5]). Students are required to solve algorithmic problems and implement the solutions as computer programs. The students' programs are checked for correctness by automatically testing their input/output behaviour.

2 Computer competitions for students in Slovenia

Computer competitions for students in Slovenia have long and respectable history ([7]). It all started in 1977 with the idea to enhance the subject of computing, which was introduced in the school year 1971/72 into the curricula as an elective subject in Slovenian secondary schools. The competition was well accepted. In the past four decades, many generations of high school students attended these competitions and today they mostly represent the skeleton of the Slovene computing community. Today, the former competitors are professors at universities, researchers at institutes, and above all, it is impossible to imagine the Slovenian ICT industry without them ([10]).

The changes in curricula and different approaches influenced computing competitions. As already discussed in Section 1 there are different ideas about the content and the form that competitions in computing should follow. We will limit our presentation to competitions in programming, organized under the Slovenian chapter of ACM ([1]).

Until 2020, ACM Slovenia organized three computing competitions ([1]). Their official (Slovene) names are:

- Bober - mednarodno tekmovanje iz računalniškega razmišljanja (Bebras - International Competition in computational thinking)
- RTK - Srednješolsko tekmovanje ACM iz računalništva in informatike (RTK - high school competition in computer science)
- UPM - Univerzitetni programerski maraton (UPM - university programming marathon)

The first two competitions are aimed at primary and secondary school students (K - 12). The third one is for university students, although secondary school students are allowed to participate and each year there are approximately 20 such students. All competitions are based on international ones (Bebras([8]), IOI([18]) and ACM ICPC([17])). RTK and UPM competition are also used to select Slovene national (or Universities') representatives at corresponding international competitions.

In Table 1 the data on the number of contestants for last few years is given. As competitions have different levels, the numbers are given for the competition at the lowest (school') level, where there is no limit on the number of contestants allowed to participate.

Table 1. Number of contestants last 10 years

year	BEBRAS	RTK	UPM
2019 - 2020	28803	306	123
2018 - 2019	33356	341	126
2017 - 2018	29561	310	156
2016 - 2017	29124	351	171
2015 - 2016	24714	309	186
2014 - 2015	16797	306	210
2013 - 2014	11653	278	159
2012 - 2013	8147	234	153
2011 - 2012	3380	273	174

There is quite a significant drop in the numbers between the primary and secondary school competitions, namely, between the number of contestants in Bebras and in RTK competition, a gap which is not apparent in the competitions in other subjects. We discuss several possible reasons, and one of the most probable ones is the fact that RTK is mostly based on the knowledge of programming, which is all but absent in our curricula ([24,11]). We expected the introduction of more programming into the curricula in the primary and secondary schools [24,11] there will be a significant increase in the number of contestants at the RTK competition. However, the increase has so far not been substantial.

Following the Report of the expert working group for the analysis of the presence of computer and informatics content in primary and secondary Slovenian school programs and the preparation study on the possible changes (RINOS) (see [12]) we detected a need for a competition to surmount this drop in the number of contestants between the Bebras and RTK competitions.

Therefore, we decided to prepare a new form of competition, a competition where block based programming language is used. One of the main goals was, if we paraphrase Dagiene in [13], to prepare a well-organized competition with interesting, playful, exciting problems, which will invite children to use programming to explore the understanding of reality, the possibilities and deficiencies of computing.

3 Pišek - programming with blocks competition

The idea for a new competition in programming has been present in Slovenia for quite a long time. The main goal of this new competition (besides enhancing the knowledge of participants in computer science) was to attract more students to lear programming and to encourage them to participate in the RTK competition later on. We already have quite a success with the Bebras competition (the ratio between the number of participants and all primary and secondary school students is constantly among the highest of all participating countries). On the other hand, children's interest in programming is growing in Slovenia, too. So our

(very ambitious) plans were to attract at least 25% of the population competing at the Bebras competition. So we were well aware (as that means approximately 8000 participants) of the necessity in using automatic evaluation system.

Teachers in primary schools also suggested we should use block oriented programming languages, which are becoming increasingly common in introductory computer science classes all over the world ([31]). They suggested Scratch ([28]), as it is mostly used in the elective subject Computing in the Second educational cycle (from the 4^{th} to the 6^{th} grade). However, we were somewhat hesitant to use Scratch. Namely we (an informal group discussing the possibility of a new Slovenian programming competition) mostly see Scratch as expressed in the official web page [29] "With Scratch, you can program your own interactive stories, games, and animations — and share your creations with others in the online community. Scratch helps young people learn to think *creatively, reason systematically, and work collaboratively* — essential skills for life in the 21st century." We did not want to "drop" the possibility of sharing with community, using and creating multimedia, working collaboratively and similar which obviously cannot be automatically evaluated. We imagine that Scratch would mostly be used in Slovenian schools as a tool that "provides students with an opportunity to express their creativity through stories, games, and animations"([23]) Our idea is that Scratch is more appropriate for a different kind of contests, where creativity is encouraged and artistic merit rewarded, for example in competitions described in [4,16].

Fortunately at the 2017 International Bebras Tasks Workshop we were introduced to the Algorea system ([6]), developed by the French IOI Team. The system supports automatic assessment of programs written in Blockly ([9]), Google's block oriented programming language. We were fortunately just in the process of preparing an e-textbook "Visual Programming - E-textbook for the introduction to programming" ([2]), which is also based on Blockly. Colleagues from the French IOI Team kindly enabled the hosting of the Slovene language translation and adaption of the Algorea on their system.

Technically, we were prepared and in 2018, our first tasks appeared in our new portal. The new system is called *Pišek* (*Chicklet* – available at [22]) in contrast to Putka (Chicken) where we run our RTK and UPM competitions ([27,26]).

Fig. 1. Pišek Competition logo

As the competition was still in its alpha phase of preparation, we decided to use the portal as an open collection of tasks solvable with Blockly where

programs are checked for correctness by automatically testing their input/output behaviour. We managed to prepare more than 250 various tasks. The majority were original, but we also used the exercises given in the e-textbook ([2]).

We had the possibility to observe the first contact with the system in three primary schools where students in 4^{th} or 5^{th} class (aged from 9 to 11 years) already had some experience with Scratch (between 6 - 12 hours). Even without teacher's intervention, they had no problems with Blockly. That further supported our decision to choose Blockly as the programming language used at System Pišek.

3.1 Organization and execution

First impressions are long lasting. This familiar phrase is true for the first encounter of the student with a task, a tool, and with a competition as well. Therefore, we decided that we should use all of the school year of 2019/20 to perform a few pilot competitions, where we could finalize the rules of the competition, especially which divisions/categories the competition should have. We also wanted to test our abilities to "prepare a well-organized competition with interesting, playful, exciting problems, which will entice children to use programming to explore understanding of reality, possibilities, and deficiencies of computing" (in [13]).

The first pilot competition The format of the first pilot was as follows. We had five categories, depending on our school system[1]: 4^{th} - 5^{th} class primary school, 6^{th} - 7^{th} class primary school, 8^{th} - 9^{th} class primary school, 1^{st} - 2^{nd} class secondary school and 3^{rd} - 4^{th} class secondary school.

The majority of the tasks on the primary school levels were tasks on the net (Fig. 2), where the main character (chicklet, bee, scout ...) moves and performs various goals.

Within the given time (40 minutes) the contestant could try as many times as they wished to submit the task. They immediately received feedback on whether the task was solved properly or not.

Beside tasks on the net, the second most used type were Turtle graphics tasks (Fig. 3).

Most of the tests for secondary school categories as well as one of the tasks in the upper two categories in primary school were "classical" programming tasks as it can be seen in Fig. 4.

We also used various forms of the tasks. For example, the task in Fig. 3 requires that the student corrects the given program. Using block-based language allows us to make a Parsons Puzzle type of problems ([25]), like the task in Fig. 5. We would also like to note that this particular task was chosen in the second pilot to be the one that all contestants will probably solve.

[1] In Slovenia children enter primary school at age 6. The primary school has 9 grades and high school has 4 grades

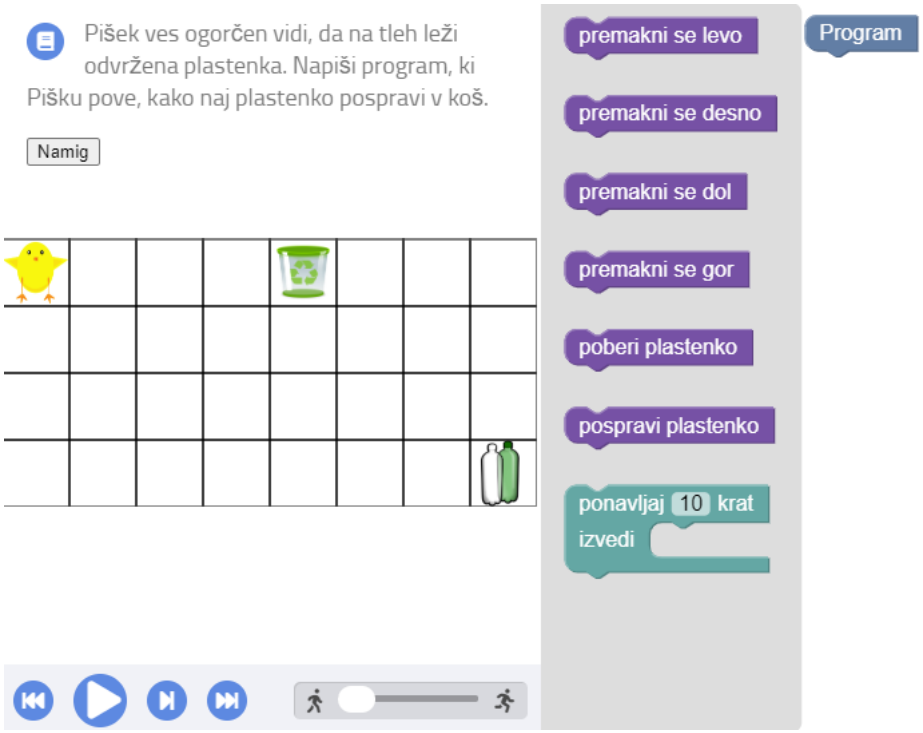

Fig. 2. Task on a net

We could also modify the difficulty of the task with (or without) prescribing the maximum number of blocks allowed (see upper right corner in Fig. 3, where the limit is used). In addition, a part of the task preparation was also the decision on how to present the available blocks. In Fig. 4 we used all the default blocks given in Blockly, arranged into categories. In the task in Fig. 2 only the necessary blocks are given, while in Fig. 3 there are some superfluous blocks. This can have a significant impact on the rate of the students' success in solving the task.

A well-appreciated property of Blockly we used quite often, is the possibility to make your own blocks with their own behaviour. We used new blocks with the behaviour appropriate for the task given, even though they are the same algorithmically. So for example in Fig. 2 we have a block "poberi plastenko" ("pick up the bottle") and in Fig. 5 a block "pojej deteljico" ("eat the clover"). We could also "hide" some unnecessary complexity (for example, in a certain task a block "read all the date in a table" was provided).

We invited several teachers to take part with their students in the first pilot. The response was very good and at the end, we had 654 participants from 10 primary schools and 7 secondary schools. The first pilot took place in the first week of February. Each class teacher decided the exact time within this week

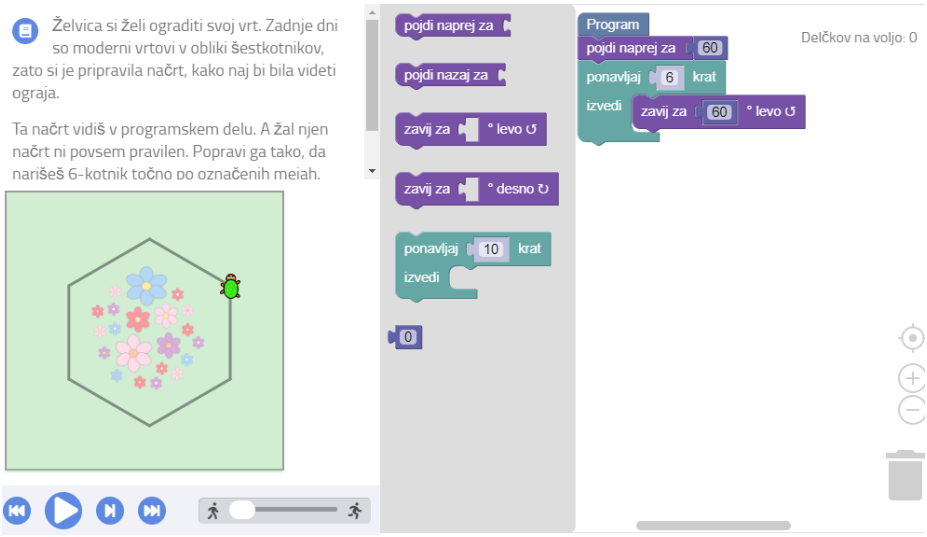

Fig. 3. Turtle graphics tasks

when the students competed. Teachers who had integrated the contest in their teaching activities supervised the contestants.

Teachers as well as students were very satisfied with the competition and the majority of the students expressed their intent to participate again in the next pilot or in the "real" competition next year.

The second pilot competition At the end of the first pilot participants answered several questions about the competition. We asked them about their perceptions regarding computing, participation (and success) at the Bebras competition, about the grades in some subject they received in the last school year, as well as about their opinions regarding the difficulty of the tasks, the format of the competition and similar. When we analysed the results of the competition and the data from the questionnaires we learned a lot. The detailed analysis is in the works and we will report about the findings in the forthcoming papers. The most important conclusion we got from the first pilot was that we should try with a different categorization. Namely, there was quite a difference within the same category of the contestants' opinion about the perceived difficulty of the tasks. The teachers–mentors also observed that there was a huge difference in the students' abilities within the same category which is quite often not directly connected to the class the student attends. We considered those comment when we prepared the second pilot due in April. Of course, we could not have too many categories or we would not be able to provide enough tasks. After lots of discussions and exchanges of opinions we changed the categories (partially following RTK system) into:

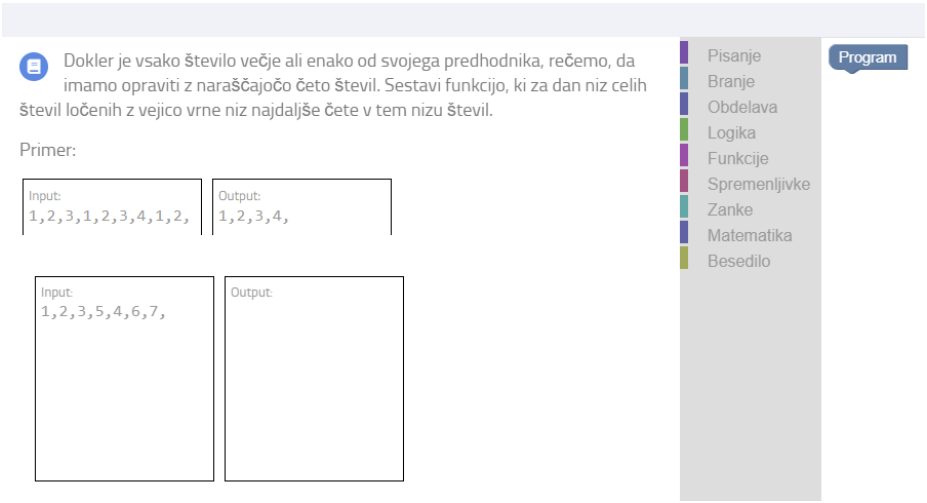

Fig. 4. Classical programming task

- 4^{th} - 6^{th} class primary school - Beginners,
- 4^{th} - 6^{th} class primary school - Advanced,
- 7^{th} - 9^{th} class primary school - Beginners,
- 7^{th} - 9^{th} class primary school - Advanced,
- secondary school - Beginners,
- secondary school - Advanced,
- secondary school - Experts

For the second pilot we also prepared the list of the programming concepts the tasks in each category will address ([21]).

The next pilot was planned for the third week in April. We planned to use the same format of the competition, namely the teacher on each participating school decides when exactly in the given week the competition will take place. The decision at which level (Beginners, Advanced, Experts) the student should participate was meant to be left to teacher-mentors.

Unfortunately, the COVID-19 pandemic changed our plans. As we had already prepared the tasks, we decided to try an online competition where each registered contestant had one try (40 minutes) in each category during the first week in May. We did not have the means (nor did we attempt) to check the appropriateness of the category the participant had chosen. We did not attempt to prevent multiple registrations of the same person, either. Therefore, this must be considered in the analysis of the results.

Due to the chaotic situation we did not attempt to publicize the competition widely. We just asked the teachers who participated as mentors in the first pilot to inform their students about the competition and to encourage them to participate. Altogether, we had 410 contestants. As many of them competed in

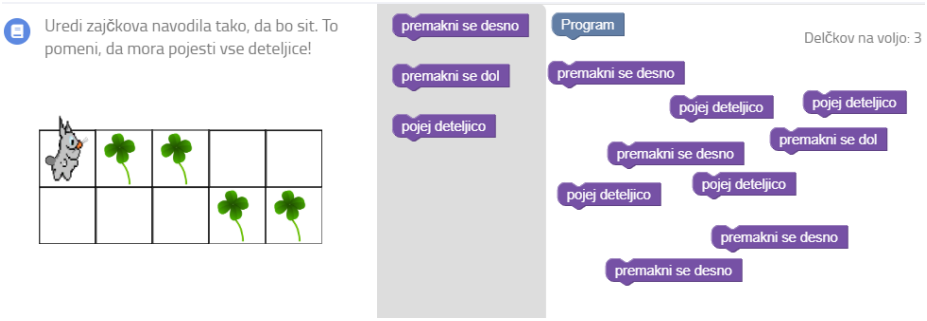

Fig. 5. Parsons Puzzle type of the problems

several categories, there were actually 296 students participating in the second pilot. Approximately half of them competed in the first category "4^{th} - 6^{th} class primary school - Beginners".

All in all the majority of the participants were satisfied with the competition. We also got the confirmation that the competition should be well accepted in schools.

For any and all interested the tasks used in both pilot competitions are now freely available at Pišek([22]), under "Stara tekmovanja" (Old competitions), where the tasks we prepared but didn't use are available as well.

3.2 Future plans

We plan to start with the first "real" competition in the school year of 2020/21. The competition will take place in the first two weeks of February 2021. We hope the situation with pandemic will allow the implementation of the competition where the contestants are supervised by their teachers. If we are be forced to use unsupervised online format (like in the second pilot) we will prolong the pilot phase of the competition for another year.

Till then we have to carefully analyse all the data gathered in both pilot competitions. In the second questionnaire we also asked the students to rank all the tasks' difficulty levels. We had namely tried to sort the tasks in the order from the easiest to the hardest. With all this data we have to carefully prepare the collection of contest's tasks.

If the school level competition is successful we will enhance the competition according to the model used at the Bebras and RTK competitions. Those two competitions are conducted at two lewels: school-wide in November (Bebras) and in January (RTK) and nation-wide in January (Bebras) and in March (RTK).

We will also try to establish our own contestant system (mostly due to the problems the youngsters have with the registration) with the possibility to use existing AAI infrastructure ([3]). This will allow students the possibility of using their existing school accounts, therefore the organizational burden will be lighter.

We are also developing a system allowing simple visual preparation of the tasks. That will allow us to invite teachers to submit their proposals for the tasks.

4 Conclusion

Our goals and desires for the competition mostly follow the same lines as expressed in the description of the Slovak Logo programming competition in [30]. We hope that Pišek - programming with blocks competition will continue and that more and more schools in our country will take part in it. Coding competitions are a great way for the students to apply their coding skills in a fun context, and the participants get the real-world experience of coding to solve a problem, which is essential in order to enhance their analytical skills and creativity.

We would be very happy if our competition proved to be an inspiration for colleagues in other countries to follow and if a programming with blocks competition eventually grew to become an international competition like Bebras ([14]). With the help of the international community it will be easier to prepare exercises of even higher quality. Namely, having a rigorous (i.e. accurate, unambiguous, succinct, complete and solvable), interesting and fun problem set is the key to a successful contest.

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