

The BEBRAS Contest on Informatics and Computer Literacy – Students' Drive to Science Education

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Abstract

The paper deals with information technologies in general education and competitions as motivator for engaging pupils in technology education. It is of high importance to provide pupils with skills both to use computer technologies and to understand them in more profound way. After the short survey of the curriculum on information technologies at Lithuanian comprehensive schools and after pointing out the fact that certain elements of informatics or computer science are no longer available for all pupils the paper explores the ways in which pupils could be engaged with this science. One of the solutions could be competitions. The contest on informatics and computer literacy named BEBRAS may be the key to the potential of science knowledge and attractive way to bind up technology and education. The first Bebras contest was conducted in Lithuania 2004. Now more than ten countries have joined. The structure, goals, technology, and assessment are described in the paper. Problems (tasks) are the keystone of the contest. Attraction, invention, tricks, surprise should be desirable features of each problem presented to competitors. The problems have to be selected carefully, taking into account the different aspects of each problem. Some examples of problems from contest 2007 are presented.

Keywords

Computer education, contest, informatics curriculum, information technology, problem solving

INTRODUCTION

Pupils like to compete. There are several competitions related to computers and information technology over the world. Some of them are well-known, e.g. the International Olympiads in Informatics. They are, however, focused exceptionally on developing algorithms and programming (Dagiene, 2004).

The idea of developing competitions on informatics and computer literacy for school students was raised in Lithuania in 2003. The main principles of the new contest are borrowed from the international mathematical contest "Kangaroo", which is very popular in Europe (International..., 2008). The new contest was named "Bebras" (in English "Beaver"). Beavers look like persistent stickers, who endeavor for perfection in their field of activities and beaver away to reach the target. Their everyday job seems to be a trial: the one who pulls down more trees will stem more streams... Therefore, the competition was named after the hard-working, intelligent, and lively beaver.

The history of the Bebras contest began in Lithuania on September 25, 2004, when experimental trial, in which 779 pupils participated, was held. Its aim was to check selected technologies of the contest and to evaluate the level of complexity of the presented problems. After a month, on October 21, the first Lithuanian Bebras contest took place. In the 4th Bebras contest more than 7000 pupils participated (IT Contest..., 2008).

Informatics is one of the science disciplines. We couldn't state, however, that the subject has extreme attractiveness among pupils. Informatics has been taught in some countries, mostly as an optional subject. A decade ago some countries (Lithuania among them) had quite

strong teaching of informatics in secondary education. Nowadays most countries focussed on teaching computer literacy and integrating information technology (IT) in various school subjects.

As it is pointed out in the UNESCO recommendations, the content of the information and communication technology (ICT) course in schools has an extremely important role (Anderson, 2002). If the main competencies of the last century were regarded as a combination of “three R” – Reading, wRiting, aRithmetics – our time invites us to search for something fundamental and necessary. IT course emphasizes three main parts: information search, text processing, and work with numerical data. These three are relevant everywhere and for everybody. Consequently, these are the things that should draw the main part of IT school course compulsory for all. Thus, on one hand, it is important to nurture common skills on ICT. On the other hand, certain knowledge of informatics and computer awareness are required as well.

It makes sense to say that everyone should be provided with the common course on ICT, but only those who are interested in science should be taught informatics. Thus informatics naturally becomes an optional subject. Nevertheless the following questions may be raised: what measures should be implemented in order to familiarize pupils with issues of informatics and what is the way to draw their attention so that they would decide to choose the subject? One of the possible solutions is to include the part of the informatics' course in IT curriculum. Another solutions is to organize contests (the Bebras contest is one of the suggestions) on informatics, that would capture pupils' attention and they would decide to take course in informatics (Katz, 1992, Pohl, 2002, El:SPIEL..., 2008). The paper deals with both solutions implemented in Lithuanian school programme.

INFORMATION TECHNOLOGY CURRICULA FOR GENERAL SCHOOLS IN LITHUANIA

The teaching of informatics has a lineage tradition in Lithuanian schools; a rich experience in the field has been accumulated (Dagiene, 2006). The model of compulsory course of teaching informatics in upper secondary schools (grades 11 and 12) has been developed (General Curriculum..., 2002). After some time the compulsory teaching of the subject “began to shelve down” – into grades 9 and 10 (General Curriculum..., 2003, General Programme..., 2005).

Internet and mobile communications usage becomes an everyday tool. It is important to create conditions for the students to satisfy their modern learning and self-education needs. It is necessary to seek that children could develop their information skills and find material suitable for versatile learning, that teachers would advise what to use and how, and relate the academic knowledge with the interests of students and the social needs (Grigas, 1993, Dagiene, 1997).

In regard with the changed role of the ICT as well as with the needs of pupils and school communities, the curricula – general programmes – of all subjects in lower secondary schools (grades 5-10) were substantially revised and renewed. Therefore the new IT curriculum for lower secondary schools was developed and approved by the Ministry of Education and Science of the Republic of Lithuania (General Programme..., 2005).

The curriculum on IT for lower secondary schools is aimed at co-ordination of a separate course on IT with application of these technologies for different purposes; partial integration is performed. Usage of IT is especially recommended during the lessons of Lithuanian and foreign languages, art, mathematics and natural history.

The education programme of lower secondary schools, starting with the fifth grade, includes a separate course on IT, a part of which will be integrated with other subjects in future.

It is proposed to appoint a total of 68 hours in grades 5-6 for the course on IT and 34 hours integrating IT with other subjects. Integration with art (topic “Drawing with the computer”) and mother tongue as well as foreign languages (topic “Internet and electronic messages”) is suggested. The analysed topics are directly related with the aforementioned things; nevertheless, other things are also recommended, particularly the project activities combining several subjects.

Thirty-four compulsory hours and 68 integrated hours for IT are suggested in the course designated for grades 7-8. Integration with other subjects is recommended, for example: mother tongue, art, mathematics. Teaching of other subjects using ICT during the lessons or after-school activities is also encouraged.

The course on IT in grades 9-10 is aimed at summarising and systematising students’ knowledge as well as at purposeful usage of their skills, drawing attention to the right application of the technologies and their legitimacy. For those who wish to grasp the principles of computer work and its management, an optional module on algorithms shall be proposed (at the moment it is included in compulsory IT course). For the course on IT in grades 9-10, 34 obligatory hours, 17 optional hours and 17 integrated hours are recommended. The IT course designated for grades 9-10 is more specific, intensive and requires systematic summarisation of knowledge.

IT lessons, both separate and integrated, shall be conducted in the computer labs. During the practical trainings the work should be performed using different software: keyboard simulators, systems developed for preparation of texts and graphical material, so that students could become familiar with the internet, e-mail, searching on the Web, fundamental concepts of the computer, *etc.* Application of educational aids developed for teaching different subjects is especially recommended.

Starting with the 2005-2006 school year one hour per week of an IT course appeared in the fifth grade, in 2006-2007 school year the obligatory course on IT was conducted both in grades 5 and 6 as well as in grades 9-10. Starting with the 2007-2008 school year the obligatory course on IT is conducted in all grades of lower secondary schools (5-10). Integrated courses appear gradually in grades 5, 6 and 9. In grade 10 a test for students on computer literacy is arranged.

The new model will completely enter into force starting with the 2010-2011 school year. Then the tenth grades will not have the obligatory IT course – only the optional one consisted of several elective modules. The modules should introduce various basic aspects of informatics to students, by “bridging the gap” between fundamentals and the dynamic world of computing. Programming is an important and purposeful activity, therefore it is planned that at least one optional module for programming should be presented to grades 9-10 (Table 1).

Table 2. Optional IT course: programming module

Grades 9–10	Basic topics
Elements of algorithms and programming	Conception of algorithm, ways of writing Programming languages, compilers Preparation of algorithms, coding and running the program Dialog between program and user Entering and output of data, printing formats Main actions of algorithms: assignment, loop Simple data types Stages of program development Control data and correctness of program Programming style and culture Simplest algorithms and their programming

The IT course for upper secondary grades 10-12 is being essentially revised. Several optional modules mostly oriented to the requirements for study courses in higher educational institutions are being developed. Since the number of computers in schools is increasing, schools have faced problems on practical application of education on ICT; this can be particularly said about their integrated usage in different fields of activities of teacher and student. The content of IT is directed towards the trends of information technology usage and training in this field in other European countries. Developing algorithms and programming is one of the optional modules.

As one may notice from Lithuanian IT curriculum, the main attention is being paid to satisfy user's needs and to develop computer literacy. Teaching of the basics of informatics has become quite poor. Pupils get familiar with the basic knowledge on informatics in grade 6, when they have Logo course. However, very few lessons are provided for this, moreover the teaching process here depends very closely on the knowledge and activeness of the teachers themselves.

Faintly bigger attention is being paid to developing algorithms and programming, but these are included in optional modules. Therefore "Bebras" contest gains bigger and bigger value in motivating pupils to understand computer and master it creatively.

STRUCTURE AND SCORING OF THE "BEBRAS" CONTEST

The "Bebras" International Contest in Informatics and Computer Literacy is a motivation competition in informatics that addresses all lower and upper secondary school pupils divided into three age groups: Benjamin (age 11-14), Junior (age 15-16), and Senior (for upper secondary level). By using a computer pupils have to solve 15 to 21 tasks of different levels within 45 minutes (each task takes between 1 to 4 minutes to be solved). Two general types of problems have been used: interactive tasks and multiple-choice tasks.

Goals

The main goals of the "Beaver" contest in informatics and computer literacy are to promote interest in informatics and information technology for all school students, to motivate students to learn and master computers. The competition should help to engage pupils to take an interest in computing and information technology application from the very beginning at school.

Understanding and handling the basics and foundations of computer science is more important than knowing a lot of details. The use and interpretation of results comes prior to being able to prove results. Controlling computations, calculations and estimations is more significant than being able to do computations by oneself.

Of course there is a need to learn very well the basic computer managing technique, but computers has to be understood at many levels, including: as a fundamental culture and not as a collection of buttons and instructions; as a development of ideas not a finished work; as a explanation of the concepts.

The "Bebras" contest should encourage pupils to understand computers deeper and to use modern technologies in their learning activities more intensively and creatively. It should bring all school students together and encourage them to brainstorm and share their experiences.

As information technology becomes a commonly used tool of education, this playful contest could ensure that boys and girls will equally benefit from it. We hope that the „Beaver" contest on informatics and computer literacy encourages students to learn the skills that will be needed in the labour market in future.

Cognitive, social, cultural and cross-cultural aspects are very important while using technology – the competition will put strong emphasis on culture and language. The “Beaver” contests should help educational community to clear up school students who can use ICT in most creative and profound way.

Technology

In Lithuania (also Poland, Latvia) the PDF technology is used for the contest while in some other countries internet-based technology is applied. The PDF is universal file format that preserves fonts, images, graphics, and layout of any source document, regardless of the application or platform used to create it.

The local organizers have to download from the official “Beaver” site (www.bebbras.lt) the software (Acrobat Reader with some extra programs for testing computers and collecting results) and PDF registration form (its aim is to collect the basic information about the participants: contacts, number of students and computers involved). The filled forms have to be uploaded to the server of the National Examination Center, which organized collection and preliminary processing of the results.

On the day of contest, at fixed time known in advance, the “Beaver” site reveals the passwords for opening of the problems. The contest starts when the first problem is opened and ends when time allowed for solution expires. The program forms the coded answer file. The local organizers must collect these files and upload them to the server of the Centre. When the answers are collected, the program investigates them, calculates the results, sorts them according to schools, regions, age groups, etc.

Assessment

All the “Bebbras” contest tasks are divided into three levels of complexity. The tasks are being assessed by the following schema: the easiest level of complexity (in each age group) - by 3 points, the medium – by 4 points, and the hardest – by 5 points.

Correct answer adds as many points as indicated to the task, incorrect one – minuses 25% of the indicated points (*i.e.* – 0,75, – 1, and – 1,25 point, respectively), unanswered problems – 0 points. To avoid negative results, each participant must start having the amount of points equal to the total number of the problems (*e.g.* 18 points, if there are 18 problems provided to be solved).

Usually each group is given two hours to perform the contest, collect the results, and send them to the organizers. Preliminary results have to be calculated and announced as soon as possible.

In Lithuania, all “Bebbras” participants as well as local organizers receive certificates of thanks from “Beaver” Organizing Committee. Winners of every age group, as well as the prize winners of each class are awarded with “Beaver” diplomas and valuable prizes established by sponsors. By the way, the “Bebbras” contest is subject of individual participation like Olympiads but the schools are usually rewarded for active involvement.

THE BEBRAS CONTEST IN EUROPE

After the first “Bebbras” contest in Lithuania was held, the idea to involve foreign countries has emerged. After a while an auspicious opportunity occurred: in 2005, Lithuania was host country of the well-known Baltic Olympiad in Informatics. It was a good opportunity to advertise the “Bebbras” contest at least for participants of the Olympiad (Denmark, Estonia, Finland, Germany, Latvia, Sweden, and Poland).

During the Baltic Olympiad the international “Bebbras” workshop for creating tasks was organized. In addition four countries were invited and participated in the “Bebbras” workshop

(Austria, Egypt, Israel, and The Netherlands). Participants spent a lot of time discussing the structure and development of the contest as well as preparing tasks. It was decided to run the “Bebras” contest each autumn (October-November) and to make the workshop for creating tasks a half year before.

In spring 2006, the second international “Bebras” workshop was organized in Lithuania and the International Bebras Organizing Committee was established (Bebras..., 2008). The main goal of the workshops is to develop a set of tasks for the coming Bebras Contest. After one year, the third international Bebras workshop was organized again in the same place as previously. Two more countries joined the workshop: Slovakia and Ukraine.

At the moment some countries have already been running the international “Bebras” contest for their pupils, some are still in a preparation stage. In 2007, the “Bebras” contest appeared to be very successful: in Germany – 21 802 participants (www.informatik-biber.de), in Estonia – 2978 participants (www.miksike.ee), in Lithuania – 7015 participants [8], in Poland – approx. 7000 participants (www.bobr.edu.pl), in the Netherlands – 2405 participants (www.beverwestrijd.nl), and in Austria – 1400 participants (<http://at.beverwedstrijd.nl/>).

THE DEVELOPMENT OF “BEBRAS” CONTEST TASKS IN INFORMATICS

Competitions are based on selection of good tasks. Interest in competitions essentially depends on problems. Of course, advertisement of the contest as well as activeness of teachers play also an important role, nevertheless tasks remain the crucial issue. Especially if we wish not only motivate pupils to learn informatics, but also to reveal them the wide range of matters in informatics and to bring out the topicalities. Besides, problems should capture the attention of teachers so that they could get interested and encourage pupils to participate; it’s important that teachers would be stimulated to discuss the problems with pupils when contest is over.

Attraction, invention, tricks, and surprise should be desirable features of each problem presented to competitors. The problems have to be selected carefully, taking into account the different aspects of each problem, *i.e.* what educational power it contains and how to interpret its’ attractiveness to students (whether it stimulates the motivation of learning).

Since the very first “Bebras” contest organizers were searching for more exciting problems and distinguishing particular task groups; the consultations on the topics to be involved were continually held. Some of the principles on the structure of problems and the selection of topics were discussed in publications (Opmanis, 2006, Dagiene, 2006). The selection of topics for problems is related to teaching of the basics of informatics, therefore common elements of education in informatics in all countries (at least European) are taken in consideration when developing tasks.

Further we introduce several distinctive tasks of the “Bebras” international contest on informatics and computer literacy that were applied by most of the countries involved.

Tasks for Benjamins

Example 1 (interactive task)

Tom has constructed a robot, which is controlled with the help of keyboard consisting of 20 keys. One of the keys is a shift key (Shift), which is used only along with any of the command keys (A1, A2, ...D4). The arrow keys (←, ↑, →, ↓) cannot be used along with any other key.

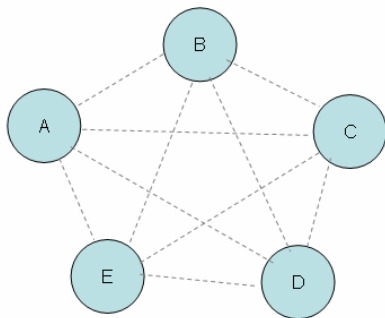
A1	A2	A3	A4
B1	B2	B3	B4
C1	C2	C3	C4
D1	D2	↑	D4
Shift	←	↓	→

The command keys can be used both separately and along with the shift key. Any key on the keyboard can be pressed just severally or along with the shift key.
 How many different commands the Tom's robot can perform if the arrow keys cannot be pressed along with the shift key?

- A 15
- B 19
- C 34
- D 38

Example 2

There are five towns in Beavers' State: A, B, C, D, and E. The government intends to build the railroads but there is not enough money to interconnect all the towns. Therefore the following decision was made: the towns should be connected by as little roads as it is possible to ensure, however, that each town would be reachable by changing a train not more than once.



Mark these roads on the draft.
 Click the towns which, according to you, should be connected by railroad. In case you click towns that are already interconnected, the railroad between them will vanish.

Tasks for Juniors

Example 3



Old computers used a control unit, *i.e.* desk with the bulbs, which demonstrated binary numbers.
 How many different numbers the given unit can show?

- A 8
- B 256
- C 128
- D 16

Example 4

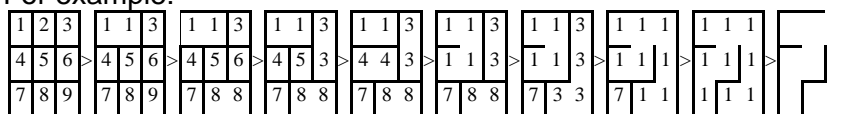
Beaver is familiar with the algorithm which is very useful when building a labyrinth. The labyrinth is to be built from the rectangular blocks.

The algorithmic steps of beaverish labyrinth are following:

The location is marked as a rectangular grid. The cells are understood as rooms.

1. Number them in the consecutive order: from left to right, from top to bottom.
2. Combine two adjacent rooms with the different numbers by eliminating the wall in-between them.
3. Leave the smaller number of two combined rooms to the newly obtained room.
4. Repeat the 2nd and the 3rd steps until you get one room. Its number will be 1.
5. Eliminate one external wall and make the entrance.
6. Eliminate one external wall and make the exit.

For example:



Which of the labyrinths will you obtain after following the above given algorithm?

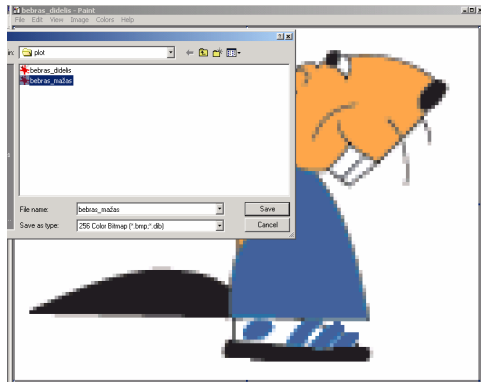


Example 5

Lina had an image of 128x96 pixels and 256 colors bebras.bmp, those file size was 13366 bytes. In order to reduce the picture he resized its dimensions into 64x48 pixels.

Which of the given file sizes should he get after saving the image in the same format?

- A 3342 bytes
- B 4150 bytes
- C 13366 bytes
- D 6633 bytes



Tasks for Seniors

Example 6

In 1991 a common standard for encoding of alphabets and supplementary symbols of almost all languages in computers was adopted.

What is the name of this standard?

- A ASCII
- B MIME
- C Unicode
- D HTML

beaver

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Example 7

A robot generates text strings (E) according to the defined scheme. The strings are being generated just of letters “a” and “b”. The most simple text string is “ab”. Other strings can be generated:

1. By adding “aa” to the right side of the previously created string E, i.e. “Eaa”.
2. By adding “b” to the both sides of the previously created string, i.e. “bEb”.
3. By combining two strings created as it was described above, i.e. “E₁E₂”

Which of these text strings cannot be compounded according to the above-mentioned rules?

- A bbabbaab
- B bbabbabb
- C bbabbaaa
- D bbabbbaa

CONCLUSION

Competitions play an important role as a source of inspiration and innovation. In order to encourage pupils to learn informatics we have to look for the attractive forms. The international contest on informatics and computer literacy named BEBRAS could be one of such forms. This contest may be the key to the potential of new knowledge and attractive way to bind up technology and education. The International Bebras Organizing Committee invites everyone interested in this initiative to think about contest, to investigate the local situation and to join us.

We are open for all kinds of proposals and ideas of collaboration and hope to find friends and partners in all countries. Integration of information technology into teaching process and

involving pupils to understand technology in deeper way should be our target, and we have to try to reach it together.

We are ready to share our experience, technology, and future plans with all who are interested. We expect that it will foster your own competitions similar to the Bebras or will encourage you to join us. We are sure that well-organized contests with interesting, playful, exciting problems, and attractive awards will invite pupils of all countries to use computers reasoning and to explore understanding of realities, possibilities, and failings of technology.

REFERENCES

- Anderson, J., Weert, T (2002). Information and Communication Technology in Education. A Curriculum for Schools and Programme of Teacher Development. Division of Higher Education, UNESCO, 2002.
- Bebras - International Contest on Informatics and Computer Literacy (2008). Internet WWW-site: <http://www.bebas.org/>
- Dagiene, V. (2006). Information Technology Contests – Introduction to Computer Science in a Attractive Way. In Informatics in Education, 2006, vol. 5, N 1, pp. 37-46.
- Dagiene, V. (1997) Learning via Electronic Mail: What and How? Education for the 21st Century, 2-4 December, Cape Town, 1–10.
- Dagiene, V., Dzemyda, G. Sapagovas, M. (2006) Evolution of the Cultural-Based Paradigm for Informatics Education in Secondary Schools – Two Decades of Lithuania Experience. In Lect. Notes in Computer Science, vol. 4226. R. T. Mittermeir (Ed.), 1–12.
- Dagiene V., Skūpiene J. (2004) Learning by competitions: Olympiads in Informatics as a tool for training high grade skills in programming. 2nd International Conference Information Technology: Research and Education. T. Boyle, P. Oriogun, A. Pakstas (Eds.), London, 79–83.
- EI:SPIEL game. Internet WWW-site: <https://www.ei-spiel.de> (In German) [accessed 2008-01-15]
- General Curriculum and Education Standards (2003). Pre-school, Primary, and Basic Education. Ministry of Education and Science of the Republic of Lithuania, Vilnius.
- General Curriculum for General Education School in Lithuania and General Education Standards for Grades XI-XII (2002). Ministry of Education and Science of the Republic of Lithuania, Vilnius.
- General Programme for Basic Education on Information Technologies (2005). Ministry of Education and Science of the Republic of Lithuania, Vilnius.
- Grigas G. (1993) An experiment of computer programming practice by e-mail. Interpersonal Computing and Technology, v. 1, N. 2, 1-10.
- International “Kangaroo” Mathematics contests (2008). Internet WWW-site: http://www.sms.edu.pk/IKMC_sms.php
- IT Contest “Bebras” (2008). Internet WWW-site: <http://www.bebas.lt>
- Katz L G and Chard S C (1992) Engaging Children’s Minds: the Project Approach Norwood N J, Ablex.
- Opmanis M., Dagiene V., Truu A. (2006). Task Types at “Beaver” Contests Standards. In: V. Dagiene, R. Mittermeir (Eds.), Proc. of the 2nd Int. Conference „Informatics in Secondary Schools: Evolution and Perspectives“, Vilnius, November 2006, pp. 509–519.
- Pohl W. Finding Talented Young People for Informatics. In Open IFIP-GI-Conf. on Social, Ethical and Cognitive Issues of Informatics and ICT, Book of Abstr., Univ. of Dortmund, Germany, July 2002, pp. 77.

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