

Olympiads in Informatics: Macedonian Experience, Needs, Challenges

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Abstract. The introductory part of the paper includes the brief description of the current Macedonian educational system, including information about national ICT policy, primary and secondary education curricula, technological equipment, the level of using ICT in education, and projects related with ICT.

Presently, there is enforced computerization of our country (an enormous increase in numbers of computers in primary and secondary schools, free education for computer illiterate and efforts are made for full computerization of every aspect of the society).

This paper is about national informatics competitions in Macedonia for secondary school students, their organization, and scope. Computer Society of Macedonia (CSM) is the organizer of National competitions. The regular activities of CSM also include: organization and execution of seminars for permanent education of IT teachers in secondary and elementary schools, and there are efforts made to influence national education of IT.

CSM organizes four levels of state annual competitions with two groups of original problems. The top ranked four contestants at the Olympiad represent Macedonia at the international competitions: BOI and IOI.

Some of the conclusions or recommendations follow:

- **state education:** IT education, especially programming is not continuous (it should be); mentors fall behind with developments in the field of programming, they need guidance, seminars, materials, all kinds of support;
- **finances:** permanent funds have to be established; companies still do not see their interest to support the competitions, it has to change;
- **materials:** there are plenty of materials, tasks with their solutions, discussions and tests; many of them are available at the IOI official site; but, there is need of further guidance in using them, even including some additional education material;
- **coordination:** the coordination at the higher level is needed, (when and how the young students should start with programming, what should be their first programming language, Pascal, C, C++, C# or Java).

Key words: education, competition, programming, computerization, olympiad in informatics, Macedonia.

1. Brief Description of the Macedonian Educational System

1.1. General Data

The Republic of Macedonia has a territory of 25.713km² and population of 2,022,547 citizens, according to the last census.

The school education system in Macedonia has two levels – primary (grades 1 to 8, until this year and Grades 1 to 9 from the next school year) and secondary (grades 1 to 4) each culminating with a state certificate, namely, the certificate for completion of primary education and the secondary school diploma. Primary education consists of two stages – Elementary (grades 1 to 4) and lower secondary (grades 5 to 8). Children start their initial education at ages six or seven. Under Macedonia’s constitution, primary education is compulsory, and there are efforts for secondary school to be compulsory by next school year.

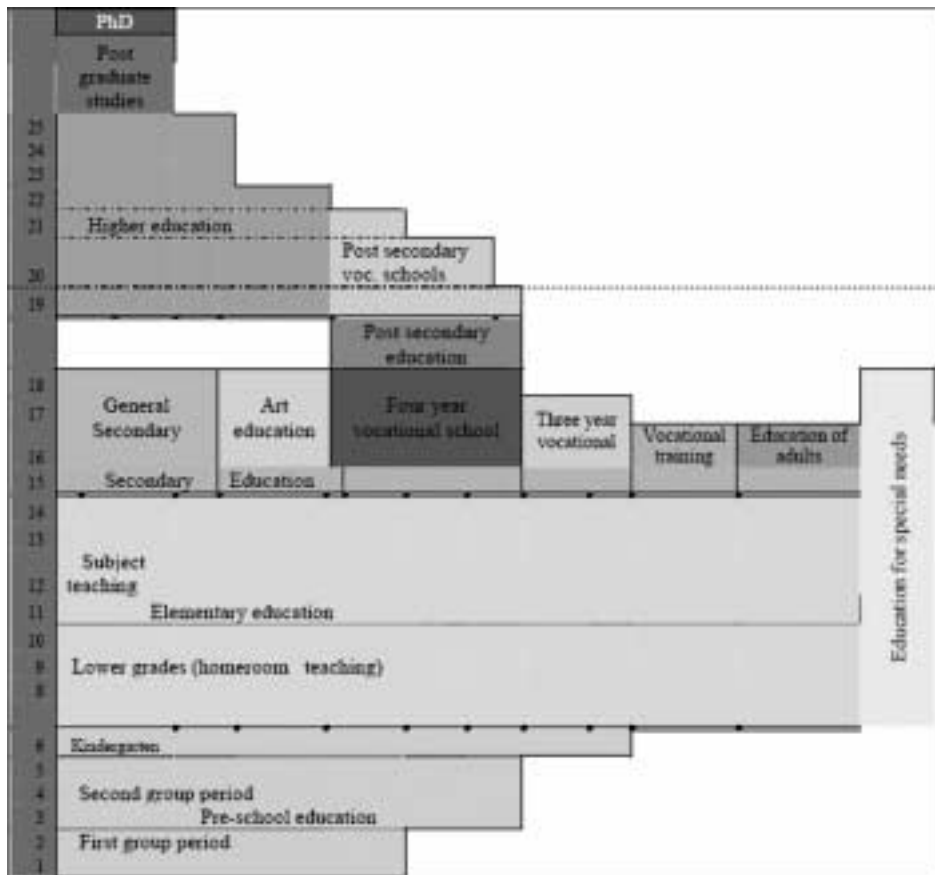


Fig. 1. Graphic display of the system of education in the Republic of Macedonia.

The basic educational level is uniform countrywide, both in terms of curriculum and school-leaving certificates. The secondary level of education consists of two educational branches – general education and vocational education. Duration of study in general education is 4 years, and in vocational education – 3 or 4 years.

There are 341 primary schools and 92 secondary schools in total in Macedonia, with approximately 330,000 primary and secondary school students.

Three strategic national documents in the field of education and information society are the “National program for the development of education 2005–2015”, the “National Strategy for development of Information Society” and the “National Strategy for Development of Electronic Communications and Information Technologies”. These strategies are expected to be a base for drafting policies that will define all aspects of the information society in Macedonia.

1.2. *“National Program for the Development of Education 2005–2015”*

In April 2006 The Parliament of the Republic of Macedonia has accepted the “National Program for the development of education 2005–2015”. It sets out a roadmap to ensure coherent and systematic reform towards decentralization in vocational education and training. Also, at the same time, the following accompanying program documents were accepted:

- program for development of pre-school education;
- program for development of primary education;
- program for development of secondary and post-secondary education;
- program for development of higher education;
- program for development of ICT in education;
- program for professional development of the education staff;
- program for development of institutional reforms;
- program for provision and quality control of education;
- European Language Portfolio.

1.3. *“National Strategy for Information Society Development” and “National Strategy for Development of Electronic Communications and Information Technologies”*

In 2005, as a result of the partnership between Government, civil and business sector, the “National Strategy for Information Society Development” with accompanied “Action plan” were drafted and adopted with wide consensus. They define the measures related to the basic infrastructural foundation for information society which are necessary for implementation and development of the basic postulates of information society (e-governance, e-education, e-business, etc.), and the ultimate goal of the strategy is the goal we are all striving at – improving the quality of living in Macedonia.

The next step in the development of information society is drafting the “National Strategy for Development of Electronic Communications with Information Technologies” that will be fundamental document that will define the infrastructure of the information and communication technologies.

1.4. *Trends in Macedonian Education*

As for education, the general approach in Macedonian schools is the traditional one. We have to reflect attention to, and understanding of, some of the particular challenges facing educators in the educational community – lack of student motivation and preparation for the rigor of learning different subjects, accompanied by a lack of appreciation of the value and utility of the kind of skills acquired in introductory courses. There is a need for digital content and free access to digital libraries. Primary and secondary educators are not satisfied with the level of communication and coordination with the universities. They need organized and traditional professional training and other forms of permanent education, including educational electronic or printed magazines, as good examples of additional learning material.

In accordance with the best European and world educational models, practices and standards, and accepting the basic concepts of the modern national educational policies in the developed countries: long life learning, student centered education, education as the key for economical success, learning society etc., we have to emphasize:

1. We have to get students motivated by connecting what they do in the classroom to the world in which they live and work, to help students gain a deeper understanding of the world of sciences through a series of interactive lectures, guided discussions, and to help students realize that what they are learning will help them tackle problems in other courses and give them a “can do” attitude that will serve them well in all types of careers.
2. The next challenge is the real need for increasing the usage of the ICT in different subject education. It includes various multimedia tools, Internet, digital materials, etc. The educators and students prefer labs instead class-rooms. It is also worth including some forms of distance education in our schools.
3. There is also a need for rapid and widespread dissemination of “best practices” in Math and Science education and a need for dissemination mechanisms that include thoughtful reflection on the intellectual and pedagogical basis for such innovations and mechanisms to aid others in adapting those new approaches in the classroom and lab.
4. We need to force active-engagement methods that improve learning and situations where Math and Science students work with peers to make predictions, help construct knowledge and solve regular, and more complex problems.

2. Accelerated Computerization of the Macedonian Schools

Thanks to the former Macedonian President Boris Trajkovski and the donation of the Government of the People’s Republic of China (PRC), 5300 computers were obtained and installed in Macedonian primary and secondary schools in the period 2003–2005.

In that context, during the last couple of years USAID became one of the main actors in the education reform and transformation process in Macedonia. The result of USAID

involvement in this process was establishing the following projects: “Macedonia Connects”, “E-school” and “Primary education project”.

“Macedonia Connects project” enabled broadband Internet access to be readily available and affordable throughout the country and facilitated its use by all sectors of society, besides schools. “Macedonia Connects” has resulted in Macedonia becoming the first all-wireless internet country in the world.

“E-Schools Project” resulted in creation of 460 computer labs with PRC computers in all primary and secondary schools. Also, a series of training programs were conducted for most of the secondary and primary school teachers, focusing on use of ICT through project-based learning strategies and networking. One of the main “e-School project” activities was the translation and adaptation of the software package titled “ToolKID”, based on Comenius Logo, for use by K-4 children. This educational software, together with four manuals was donated to 100 primary schools throughout Macedonia. Besides, a large number of teachers passed the training for using this software. This process continues.

As was described before, the PRC donation and USAID projects were the main factors for initialization of the process of computerization in our schools.

Since the last elections, the new Government has made outstanding efforts to accelerate the computerization of our schools. They tried to establish a new Ministry for IT affairs, but unfortunately, it was not accepted by the opposition parties, who prefer IT Agency, instead Ministry. However, a new Minister for Informatics Society was included in the Government.

For the first time in Macedonia, the subject “Informatics” will be obligatory in primary schools by the 2007/2008 year. Besides, as the result of the achievements of the former and current projects in this field, as well as the newest government efforts for full computerization of Macedonian society (an enormous increase in numbers of computers in primary and secondary schools, free education for computer illiterate, etc.), we are witnessed the increased level of implementation of ICT in the Macedonian education.

One of the last initiatives of the Government in this field was establishing the Council for implementation of ICT in primary and secondary school in Macedonia. The members of this Council are people from: universities, schools, actual of former IT projects, IT companies, and other governmental and nongovernmental organizations. The main areas of work of this Council are: computer installation and maintenance, creating digital materials, as well as teacher ICT training.

This year, the Government is promoting two very important IT projects: “Computer for each child Project”, and “Free Internet for all citizens Project”.

In the framework of the first project, the Government has a very ambitious computer procurement plan: 50.000 computers (2007), 100.000 computers (2008 and 2009). In this year (2007) budget, 10 million euros were predicted for this procurement.

Outside of education, the Government is making efforts for full computerization of the Macedonian society. It is worth mentioning the project “Electronic health personal file for each citizen”, as one of the EU requirements, and the project in collaboration with Ministry of justice, for creating a system for court’s document management.

There is serious lack of IT staff in Macedonian administration. All unemployed IT experts that apply, will be accepted. They could be a part of the Macedonian history in the process of creating the informatics society. After opening the new University in Shtip, this year, it is expected more than 2.000 IT students to enroll in our universities annually. The additional impact will be 125 grants for IT students that will be approved by the Government, annually.

One of the observed options to increase the number of IT experts is organization of IT trainings for the prequalification of the unemployed graduated electrical engineers and other technician experts, by the Government and the private sector.

Many dilemmas, such as “laptops or desktop computers”, or “free and open source software or proprietary software”, need to be overcome. Taking into account the lack of proper school electricity infrastructure and the lack of the proper protection from thefts and damages in the past, security, insurance, and maintenance of the computers still remain the issues to be considered. The other questions that remain in the new, large-scale situation are the following: motivation of the teachers and students to use the increased ICT capacity, awareness for the computer as student’s need, digital content according Macedonian curricula, fast and high quality internet access, etc.

The two important initiatives to take into consideration as support in the computerization of the schools are: the USAID’s “Primary Education Project” (PEP) and “Portal for primary and secondary schools”.

The “Primary Education Project” is the latest USAID’s initiative targeting all public primary schools in Macedonia. PEP seeks to improve the quality of instruction and increase employment skills in youth. This project is a continuation of a cluster of USAID-funded projects to strengthen education in Macedonia and support decentralization efforts, as Macedonia seeks entrance to the European Union. This project has four components: renovate select schools and improve energy efficiency; increase access to and improve use of information technology; improve math and science education; and improve student assessment.

The educational portal was funded by the USAID, and prepared and maintained by both the “Macedonia Connects Project” and the “E-School Project”. From the beginning of the 2007/2008 year, this portal will be responsibility of the Ministry of education and science.

This portal will link the teachers and the students from all primary and secondary educational institutions in a virtual working environment. The education portal would provide on-line resources for the school directors, teachers and the students and would enable them to easily share their experiences and practices. The education portal will mark the beginning of a new quality of the education system in Macedonia, thus bringing it closer to the modern education trends and practices in the world.

The goal of this portal is to enable public access to all information regarding the secondary and primary schools and a wide range of services for the students and the teachers.

Through this portal, the visitors have access to the list of all schools and their contact information. All secondary and primary schools have the opportunity to create their own

web page which will be hosted on the portal, and all students and teachers will be able to get an e-mail address.

The on-line collaboration and exchange of information and experiences of all teachers and students from primary and secondary schools and the educational system institutions are enabled through the discussion forums which are already functioning on the portal. Other functionalities, such as the calendar and the library of uploaded documents, are under construction.

Pedagogical, psychological, methodological, social and other aspects of this process of computerization are also important. It is not just a question of developing basic computer literacy, but also of improving teaching and learning, improving curricula and teaching methods, improving assessment, and promoting: critical thinking, active inquiry-based learning, problem-based learning, student-centered learning, etc., that will support building of the 21 century student skills.

3. COMPUTER SOCIETY OF MACEDONIA (CSM)

On the initiative of a group of professors at the Institute of Informatics, Faculty of Natural Sciences and Mathematics, and Ss. Cyril and Methodius University – Skopje, in 2000 in Ohrid the Computer Society of Macedonia – CSM (or Association of IT teachers in Republic of Macedonia) was formed. CSM continued the activities of the computer scientists which, until 2000, were part of the Association of mathematicians and computer scientists of Macedonia.

One of CSM's primary efforts is to promote the informatics society in Macedonia. Members of CSM are people from different profiles: enthusiast computer scientists, teachers in elementary and secondary schools, professors and teaching assistants at universities in Macedonia, and others.

The main goals of CSM are:

- 1) establishment, promotion and advancement of informatics, as well as its application;
- 2) implementation of informatics in all parts of society, especially in education;
- 3) organization of competitions in informatics for secondary school students and college and university students.

The first steps towards implementation of informatics in Macedonia were made in the early 1980s. In 1990 in Prilep, the first state competition of informatics for secondary school students was held. Three years later, the local competitions started to take place regularly. This year both the 18th National Competition and the 15th Local Competition took place.

In 1997, The Macedonian Olympiad of Informatics (MOI) was established as an annual event. This year the 11th MOI took place.

As Macedonian representatives, teams of young computer scientists each year participate in the Balkan Olympiad of Informatics (BOI) and in the International Olympiad of Informatics (IOI).

Today CSM successfully works on the aimed goals, and its membership continues to grow.

Further on, some of the regular activities of CSM will be mentioned. They include: organization and execution of seminars for permanent education of IT teachers in secondary and elementary schools and national and international competition of informatics.

3.1. *Seminars for Informatics Teachers*

Since 2000, the seminars for primary and secondary school informatics teachers take place annually. Generally, the seminars are held during the CSM annual meetings or the national competitions.

CSM has a long term experience in organizing trainings for IT teachers in the framework of their permanent and life-long education. All these years after being established in 2000, CSM is the main organizer of such trainings and workshops that include the following topics: didactics and methodology in teaching computer science, interactions in education, preparing IT lessons, implementation of ICT in the primary and secondary schools in Macedonia and different software packages (FrontPage, Dream Weaver, Photoshop, PageMaker, Microsoft Word, Microsoft Excel, PowerPoint, etc.). Most of these trainings were held in the lecture rooms and labs of the Institute of informatics under the Faculty of natural science. CSM is the link between the Institute of informatics, an institution with 20 years experience in the field of IT teachers' education and IT teachers after their graduation.

The following lists some of the lectures that were organized by CSM.

- “Report on the survey in the Primary and Secondary schools in Macedonia about the state of computer equipment and informatics courses in the process of education”.
- “Current issues about the state of informatics courses in the Macedonian schools”,
- “Current states of the informatics instruction in the primary and secondary schools in Macedonia”,
- “National program for the development of education in Republic of Macedonia 2005–2015”,
- “Indicators of applicability and the impact of ICT in the education”,
- “Some aspects about the informatics courses and IT teacher preparing for instruction”.

Also, CSM organized several workshops for different software packages (Power Point, Front Page, Corel Draw, PhotoShop, Front Page, and Page Maker).

The most significant activity in 2005 and 2006 was the procurement of the free annual distance learning program “Administering computer networks” for 219 informatics teachers from primary and secondary schools in the Republic of Macedonia, in the period between 30th September 2005 and 30th September 2006. This training, which consisted of 35 Soft Skill courses, was organized by Clear View and financed by USAID, at the initiative of Computer Science of Macedonia.

The training “Creating and Maintaining Web Pages with MAMBO Tool” for all IT teachers from the secondary schools was organized and realized in two phases: train-

ing of the core group of 21 trainers, and training for all IT teachers from the secondary schools in Republic of Macedonia. The partner organizations for these trainings were “World Learning”, “Macedonia Connects” and CSM. In May 2007, the same training was organized for over 700 primary school teachers, most of them IT teachers.

3.2. *Competitions of Informatics*

CSM is the sole organizer of competitions of informatics for secondary school students in Macedonia. There are four levels of domestic competitions held annually from February to May:

- electronic competitions (over 200 contestants),
- local competitions (150 contestants, in average),
- national competition (50 to 75), and
- Macedonian Olympiad of Informatics (15–20).

According to the total of the results of all the competitions, the best four contestants are selected and they represent our country at the international competitions.

By the year of 2005, there already have been held:

- 6 electronic competitions of informatics,
- 15 local competitions of informatics,
- 18 national competitions of informatics,
- 11 Macedonian Olympiads of Informatics – MOI.

Each year the Macedonian team, consisting of Leader (usually a university professor), Deputy Leader (a professor or teaching assistant) and four contestants that were the best at the domestic competitions (electronic, local, national and MOI) takes part in BOI and IOI.

It is worth mentioning that Macedonia participated for the first time at the 3rd BOI, 1995 in Bulgaria, and at the 8th IOI, 1995 in Hungary. Macedonia organized BOI 2000 in Ohrid.

3.3. *Other Activities*

Some of the activities of CSM address the curricula and syllabi in education, with the purpose of improvement and more successful implementation of informatics in the education and society as a whole:

- accepting the basic concepts which rest on the contemporary national educational policies in the developed countries:
 - “lifelong learning”,
 - “a society that learns”,
 - “education as a precondition for economic success”;
- improvement of the information system;
- enhancement of the level of informatics knowledge of teachers and students;
- increased application of ICT in education;

- management and coordination of projects.

At this year's annual meeting a decision was made to update the membership of CSM. According to the approved plan for 2007, the main activities of CSM in the following period of time will be:

- participation in the 15th BOI in Moldavia,
- participation in the 19th IOI in Croatia,
- organization of seminars and training for permanent education of the IT teachers,
- dealing with the issues teachers meet in everyday working environment,
- active participation in future activities concerning the formation of the Chamber of educational staff in RM, which will unite all teachers' associations, societies and federations in Macedonia,
- taking an initiative for organizing informatics competitions for the primary school students,
- enabling free digital materials for IT teachers for their further (long life, permanent, and continual) education
- introduction of informatics and increasing of the number of classes in informatics an all levels in education, from preschool to university,
- reactivation of BIT⁺ – magazine for affirmation of informatics.

Nowadays, there is a process of enforced computerization of our country (an enormous increase in numbers of computers in primary and secondary schools, free education for computer illiterates, and efforts are made for full computerization of every aspect of our society). The question remains how to use all these resources for producing better contestants, thus promoting IOI concepts and ideas.

4. IOI, Plenty of Materials, Reorganization, Responsibility

IOI has accumulated a wealth of knowledge and experience during almost 20 years of existence. The decision has to be made what to do with it, and what is the best way for using it.

A logical thing to do would be further dissemination and coordination with all the participant countries in order to achieve better results and further improve programming skills of contestants.

The latest project of the Computer Society of Macedonia is the mass process of collecting and indexing various valuable electronic materials (electronic books, essays, papers, multimedia tools, programs, etc.) accessible on the Web, by IT teachers in three different areas: programming, informatics education, and computer science. There is a team, established by CSM, responsible for accepting these materials from the teachers, that selects the most appropriate ones, classifies them, in order to make them accessible for all IT teachers. The common rules we respect during this process is meticulous care for copyrights and intellectual property, and prioritizing the free materials. The fact that each material contains information for the teacher(s) who "discover" it on the Web, displays the effort of each volunteer and their contribution to the process. Motivating teach-

ers to do the best, team work is enhanced. All teachers are given the chance to express themselves thus building common values.

The positive experiences of this micro-level project (i.e., Macedonian experiment) encourage its recommendation to be practiced on the macro (i.e., IOI) level, as well as proposing the following improvements in further IOI society functions:

- IOI recommending continuing IT education to all IOI country Governmental educational and IT departments and to contribute with recommendation in the following fields: IT curricula, implementation of ICT in all subjects, teachers preparation and professional development;
- each country (responsible person to be announced, for example, each team leader in IOI 2007) should be responsible for the following things:
 - to send profile of the main organizer/organization of the national competitions, including: structure, funding, main activities, objectives etc.,
 - brief explanation of the national competitions system (team, coverage, selection process, trainings etc.),
 - to send a brief reports for all domestic competitions annually, before the IOI event, including students involved, results, tasks (task texts, different solutions in a certain programming language, additional explanations, and tests; all of these in English),
 - to send links to learning materials or information used during the competition preparation;
- eIOI establishing a special organizational team (body) which will analyze all this data and make efforts to:
 - organize this data,
 - make a selection of offered materials,
 - produce practical methodological manuals divided in chapters for all programming areas (graphs, dynamics programming, theory of numbers, etc.) for both, teachers and students, including theoretical parts, exercises, tasks, different solutions, and comparing solutions; going step by step from the easiest tasks to the most complicated. These manuals are supposed to help the teachers to overcome the gap between them and contestants thus enabling them to constantly upgrade their knowledge. It will also enable them to follow modern trends and use freely the most competent books for competitions preparations.
 - establish digital library of all previous IOI competitions;
- edeveloping an IOI distance learning education system for both teachers and contestants.

5. Conclusions

IOI has to think about extending the IOI competition platform with other forms of competition; junior Olympiads in programming, competitions such as IT projects, IT quizzes, creating Web sites and blogs, competitions in other languages (e.g., Logo), etc.

The afore mentioned proposals will ensure the gap between the developed and developing countries can be overcome. We have to create such situation with equal starting positions for each country, to create an excellent working environment for students and contestants, to enable IOI members to be proud of their involvement and to motivate them to increase the level of contribution in the future, thus spreading the IOI culture.

Here are some of the conclusions or recommendations:

1. state education: IT education, especially programming is not continuous (it should be); mentors can not follow on their own, they need guidance, seminars, materials, all kinds of support;
2. finances: permanent funds have to be established; companies still do not see their interest to support the competitions, it has to change;
3. materials: there are plenty of materials, tasks, with their solutions, discussions and tests; many of them are available at the IOI official site; but, there is need of further guidance in using them, even including some additional education material (see the comments above);
4. coordination: the coordination on the higher level is needed, (when and how the young students should start with programming, what should be their first programming language, Pascal, C, C++, C# or Java).

Appendix. Macedonian achievements at Balkan and International Olympiads of Informatics (BOI and IOI)

Table 1
Macedonian achievements at BOI, so far

3rd BOI 1995, Varna, Bulgaria	Zarko Aleksovski – bronze medal
4th BOI 1996, Nikozia, Cyprus	Zarko Aleksovski – silver medal
5th BOI 1997, Drama, Greece	Igor Trajkovski – bronze medal
	Zarko Aleksovski – silver medal
6th BOI 1998, Ankara, Turkey	Vladica Sark – bronze medal
	Vladica Sark – bronze medal
12th BOI 2004, Plovdiv, Bulgaria	Nikola Postolov – bronze medal
13th BOI 2005, Rodos, Greece	Nikola Postolov – bronze medal
14th BOI 2006, Nikosia, Cyprus	Dimitar Mishev – bronze medal

Table 2
Macedonian achievements at IOI, so far

8th IOI 1996, Veszprem, Hungary	Andrej Bogdanov, bronze medal
9th IOI 1997, Capetown, South African Republic	Zharko Aleksovski, bronze medal
	Zharko Aleksovski, bronze medal
15th IOI 2003, Kenosha, USA	Nikola Postolov, bronze medal

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M. Janceski (1965), master of IT sciences, teaching/research assistant at the Institute of informatics under the Faculty of natural sciences and mathematics in Skopje, president of the Computer Society of Macedonia since 2004, member of the Governmental Council for implementation of ICT in Macedonian schools since 2007. The leader of the Macedonian team on 6 BOI and 3 IOI, since 1998. Consultant and trainer in the crucial national projects in the field of IT and informatics.



V. Pacovski (1965) holds a Ph.D. in Computer Science, at the moment works at the Faculty of Civil Engineering; main field of work is Information Retrieval; has an extensive programming experience in database design and various programming languages, including Delphi as a RAD tool; Deputy leader at BOI '96 and IOI '05.