

# Back into the fold

Modernizing Croatian science and education

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Like many small countries, Croatia faces the dual challenge of creating a sustainable economy in a globalized world and of providing its citizens with a secure future. This challenge is considerable and is not made easier by the fact that Croatia declared independence only in 1991, and secured it only after a violent war ending in 1995. The country is now a candidate for membership of the European Union (EU), and has received a North Atlantic Treaty Organization (NATO) membership invitation, yet the economic and social repercussions of the war and the former Communist rule of the country are still felt. Of course, the situation in Croatia is comparable with those in other former Communist countries in Eastern Europe: the challenge is how to catch up with the economically and scientifically advanced nations in Western Europe. Given its particular situation, the Croatian Government has decided that the most efficient strategy to create and ensure a sustainable long-term future for Croatia is to invest in education and to strengthen the research base of the country. Here, I describe the steps that we have already taken along this road, and our future strategy for creating a knowledge-based economy in Croatia.

The Republic of Croatia is a country in south-eastern Europe with a population of ~4.4 million (Central Bureau of Statistics of the Republic of Croatia, 2007). The Kingdom of Croatia was founded in 925 AD when the first king, Tomislav (910–928) of the Trpimirović dynasty, was crowned. In the year 1102, the Kingdom of Croatia formed a personal union with the Kingdom of Hungary, and Croatia spent the next 800 years in various alliances with other powers in the region. At the end of the Second World War, Croatia became a constitutive federal republic of the

Socialist Federal Republic of Yugoslavia. It finally declared independence on 25 June 1991, but was forced to fight a 4-year war caused by aggression against Croatia, which finally ended with a Croatian victory that liberated the occupied territory and reunified the country. By the end of January 1992, most countries had recognized Croatia as an independent state, and the last Serb-held enclave in Eastern Slavonia was returned to Croatia in 1998 under the supervision of the United Nations.

In 2007, the average gross domestic product per capita in Croatia was ~€8,500 and the economy grew by ~6% with inflation at 2.9% (Ministry of Finance, 2008). As many commentators have noted, creating a knowledge-based economy is the key to the future success of Croatia in a globalized world. Consequently, the budget of the Ministry of Science, Education and Sports (MSES) was increased by ~50% during the period between 2003 and 2008, which testifies to the acknowledgement by the government of the vital role that education and science have in the future of the country. The current budget for the MSES is just more than €1.6 billion.

Since 2004, the MSES has initiated major reforms intended to turn Croatia into one of the leading knowledge-based economies in the region (Petrovečki *et al*, 2006). More than 1,000 national and international experts, teachers, professors, scientists and members of the Croatian Academy of Sciences and Arts have worked together to develop a strategy for reforms and their implementation. Eight new agencies have been established within the system, two existing ones have been reformed, and 13 specialized expert bodies have been formed and entrusted with

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the development, monitoring and evaluation of the system. The MSES budget has increased considerably since 2003, and 6,907 new jobs have been opened in the science and education sector, which is the largest increase in the history of the country (MSES, 2007). The resulting strategic plans have been summarized in the *Education Sector Development Plan 2005–2010* (MSES, 2005) and the *Science and Technology Policy 2006–2010* (MSES, 2006). The consistently increasing funding from the government and two loans from the World Bank now amount to a budget of €67.8 million for developing the education sector, and €31 million for reforming Croatian science and technology. In fact, 'Science and Research' and 'Education and Culture' were the titles of the first two chapters that Croatia closed in negotiations with the EU, which demonstrates a great extent of harmonization between the Croatian education systems and those of the EU member states.

Croatia is actively forging closer links in the science and technology sectors with other countries, particularly those in the EU, Israel and India. Croatia and India signed a joint declaration in 2007 to confirm a mutual interest for further cooperation, and established a joint fund for the development of scientific and technological projects into which each side will invest €500,000 annually. Similarly, Croatia signed an agreement with Israel in 2007 for a joint fund for scientific research with an initial budget of

~€200,000. The areas of cooperation for these funds include oceanography, biotechnology/biomedicine, pharmaceuticals, shipbuilding, information technology, geographic information systems (GIS) and global navigation systems (GNS). In June 2007, the international agreement for the participation of Croatia in the Seventh European Framework Programme for Research and Technological Development (FP7) was signed (Fig 1). Since 2005, Croatia has participated in the Sixth Framework Programme: it contributed €6.4 million and received about €16.2 million, which makes it one of the most successful transition countries (Primorac, 2008).

All of these agreements and partnerships, however, will not be sustainable without far-reaching reforms of the education sector to increase both the number and the quality of the trained students graduating to the workplace. To enhance the quality of primary education from grade one to grade eight—6 to 14 year olds—the Croatian National Education Standard (CNES) has been developed. Its goals are to modernize traditional education in Croatian schools by reducing the extent to which education is seen as the simple memorization of facts, strengthening the role of applied knowledge and skills, and emphasizing interdisciplinary insight and creativity. Importantly, the CNES aims to improve the intellectual freedom of teachers and to encourage research-oriented teaching. In the school year 2005/2006, the implementation of the CNES was evaluated in 49 primary schools: the results revealed higher scholastic achievement in those that implemented the CNES than in those that did not. Beginning with the school year 2006/2007, the CNES has been introduced into all primary schools, in which more than 380,000 pupils are enrolled.

Also starting with the school year 2006/2007, all primary school pupils have the opportunity to learn two foreign languages, and more than 1,200 teachers have been employed to guarantee this. Furthermore, approximately 1,400 Croatian primary and secondary schools have been equipped with Internet access and web domains, and about 600,000 pupils now have individual e-mail addresses. Similarly, most Croatian universities and student dormitories have been equipped with broadband Internet connections within the framework of the Croatian Academic and Research Network (CARNet).



**Fig 1** | Dragan Primorac (right), the Prime Minister of Croatia Ivo Sanader (middle) and the EU Commissioner Janez Potocnik (left) during the signing ceremony of the Memorandum of Accession of the Republic of Croatia to the Sixth Framework Programme on Research and Development of the EU. After the successful participation of Croatian scientists in the programme over the past year, Minister Primorac has signed the second Memorandum on the full participation of The Republic of Croatia in the Seventh Framework Programme of the EU.

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The main problem that we have encountered during the education reforms is a lack of premises. In early 2003, approximately 6% of primary schools operated in three shifts and 25% operated in two shifts. This multiple shift arrangement is the legacy of the former education system: the first shift is usually from 07:30 to 12:15, the second from 12:15 to 15:30, and the third from 15:30 to 19:30. The situation in secondary schools was even worse, as three out of four had to operate in two shifts. We have therefore concentrated our efforts on rebuilding the education infrastructure, and have renovated or built 288 schools and school sports halls during the past 3 years. With support from the World Bank and the European Investment Bank, we plan to build or reconstruct 160 more schools and school sports halls in the next 4 years.

The Croatian Government has also extended the scope of compulsory secondary education from a total of 11 to 12 years, which will prevent more than 70,000 students from dropping out of school over the next 10 years. To facilitate this change, the government has introduced a series of measures, such as free textbooks, free transport, free accommodation in student dormitories, and the material and human resources that are necessary to make secondary education accessible to everyone. Despite negative demographic trends and constantly declining numbers of eighth-graders, this initiative has resulted in excess of 1,000 more secondary school students this year than in the school year 2006/2007.

Starting in the 2009/2010 school year, fourth-grade students at grammar schools and fourth-grade students at vocational or art schools (aged 18–19 years) will take a national standardized exam: the State Matura. The introduction of the State Matura will advance and ensure the quality of education, and it will replace the entrance exams at most of the higher education institutions. In addition, a national standardized evaluation of student achievements has been

conducted in secondary schools since 2006 and in primary schools since 2007. These national exams have established an external evaluation system for Croatian education and are harmonizing the academic achievements of students across the country. In line with these endeavours to improve its education system, Croatia took part in the Programme for International Student Assessment (PISA), coordinated by the Organization for Economic Cooperation and Development (OECD; Paris, France), for the first time in 2006. The science tests showed that Croatian students ranked twenty-sixth among the 57 participating countries, and ranked twentieth on the 'identifying scientific issues' scale (OECD, 2007).

Croatian higher education is also undergoing thorough changes. The 2008 budget for higher education has been increased by €143 million in comparison to 2003. Additional loans of roughly €429 million have made it possible to modernize existing university campuses in Zagreb, Rijeka, Split, Osijek, Dubrovnik, and Mostar in Bosnia and Herzegovina. Most importantly, the higher education system has been restructured and harmonized according to the 1999 Bologna Joint Declaration of the European Ministers of Education (Bologna, 1999; Caddick, 2008). First, the curriculum was restructured into three cycles: a 3-year or 4-year BA/BSc programme, followed by a 1-year or 2-year MA/MSc programme and concluding with a 3-year PhD programme. These changes, and the European Credit Transfer and Accumulation System, have been successfully implemented and are now being followed by the development of a quality-assurance system. To facilitate the mobility of students, Croatia has also adopted a more-effective and less-bureaucratic mechanism to recognize foreign educational qualifications. In line with the policy of the polycentric development of higher education in Croatia, six polytechnics in Vukovar, Knin, Gospić, Šibenik, Slavonski Brod and Čakovec, one school of professional higher education in Virovitica and the University of Juraj Dobrića in Pula have been established. According to the 2007 Bologna Process Stocktaking Report (Bologna Follow-up Group, 2007) on the progress of implementing the Bologna principles in 46 countries, Croatia made exceptional progress and was given an average mark of four out of five. In five out of 12 areas, Croatia was given the highest mark of five.

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The Croatian Government has so far guaranteed 10,000 scholarships for pupils and students. In 2007, it established the National Foundation for Supporting Pupil and Student Standards, which will initially provide another 1,000 scholarships to exceptional but financially challenged students according to the needs of the labour market. Funds for the scholarships will be provided from the MSES budget and donations from Croatia's strongest companies, and the goal of the Foundation is to secure €1.4 million by the end of 2008.

In parallel with the Bologna process, we are also improving the quality and scope of scientific research at Croatian universities (Pavelić *et al.*, 2006), with a particular emphasis on strengthening the ties between universities and scientific institutes, and between institutions of higher education and industry. The latter, however, depends on the readiness of industry to partner with academia. To enhance the role of academia in economic and social development, the Croatian Government has established the Agency for Adult Education. Its role is to stimulate continuous education that responds to the needs of the economy and to changes in technology. The aims of the reforms stipulated by the *Science and Technology Policy 2006–2010* and supported by the World Bank are as follows: restructuring public research institutes, and research and development centres; encouraging research partnerships among universities, scientific institutes and industry; providing support to early-stage researchers; encouraging interdisciplinary and cross-sector cooperation; and enacting business-friendly legislation. In 2006, the MSES introduced an international peer-review evaluation system for research-project applications, and new criteria for project funding, in line with EU standards, to stimulate and reward excellence, and to encourage the mainstreaming of resources into larger research programmes.

In addition to the EU framework programmes and the MSES, there are other sources of funding for Croatian science. The Croatian National Foundation for Science,

Higher Education and Technological Development—with a current budget of more than €16 million—stimulates excellence in research and innovation. The new Croatian Institute of Technology provides consulting services and financial support to entrepreneurs. Finally, the Business Innovation Centre of Croatia has been established to encourage technology transfer and commercialization through the development of small and medium knowledge-based enterprises, the establishment of technological infrastructure and business incubators, the creation of a venture capital fund, the facilitation of cooperation between the academic community and the private sector, and the enhancement of competitiveness and technological development.

Notwithstanding these developments and the additional funding available for higher education and research, any strategy that is intended to create a knowledge-based economy must not ignore the human factor. Indeed, the 'brain drain'—the loss of educated students and scientists—has been a scourge for many transitional countries, and Croatia is no exception (Žagrović & Đikić, 2008). The Croatian Government is trying to reverse this trend by increasing the threshold for tax exemption for scholarships and by subsidizing interest on mortgages for young scientists. Since 2004, the Scientist Return Project of the MSES has encouraged 65 Croatian scientists to return from abroad, and we are continuing to try to attract other expatriate scientists, as well as foreign scientists who are interested in working in Croatia.

In addition, the MSES held the First Congress of Croatian Scientists from Homeland and Abroad in 2004, and the Second Congress of Croatian Scientists from Homeland and Abroad in 2007; each of which gathered together more than 1,500 scientists to assess the current state of research in the country (Primorac, 2007). These conferences resulted in the establishment of a network of Croatian scientists at home and abroad, and the Unity through Knowledge Fund—with a €5 million budget—to stimulate networking and 'brain gain'; the return of Croatian scientists from abroad (Puljak, 2008). Another offshoot of the 2004 Congress was the launch of the Croatian Science Portal, which is an Internet-based platform that is intended to stimulate information exchange among scientists and encourage



their cooperation. The Croatian National Foundation for Science, Higher Education and Technological Development also started its Brain Gain Programme in 2005. Its Returnee Programme is financing the establishment of a research infrastructure with grants of up to €100,000.

Of particular relevance is the emphasis that we have placed on the education of junior researchers through a proactive policy of identifying and supporting the top 10% of university graduates (Pavelić *et al*, 2006; Polašek *et al*, 2007). Under this policy, more than 2,500 junior researchers have been encouraged to start a career in research. Moreover, the government took a major step towards the improvement of the financial status of those working in science and education when it signed an agreement with important labour unions to guarantee a salary increase of about 61% over the next 6 years.

**T**aken together, these are major, far-reaching and expensive reforms at every level of the science and education system in Croatia. It will certainly take time until we reap the first benefits in terms of economic success; however, the examples of other small countries that have made heavy investments in science and education—such as Israel, Ireland and Finland—and their encouraging successes show that such investment is probably the singular most efficient strategy that allows small countries to compete internationally. We

certainly hope that these investments into our future are not in vain, and that Croatia will become a competent and active participant in the further development of Europe towards a knowledge-based society.

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