Submission

to **2013 Informatics Europe Best Practices in Education Awad**

Title of the submission:

Informatyka + – Outreach to Prospective Informatics students

Key words:

informatics for all school students, outreach, computational thinking, blended learning, educational platform, virtual environments

Applicant

Maciej M. Sysło, professor in Mathematics and Computer Science

Faculty of Mathematics and Informatics,
Nicolaus Copernicus University
Chopin str. 12/18, 87-100 Toruń, Poland
syslo@mat.umk.pl

Institute of Computer Science, University of Wrocław
F. Joliot-Curie str. 15, 50-383 Wrocław, Poland
syslo@ii.uni.wroc.pl
http://mmsyslo.pl/

Warsaw School of Computer Science (**WWSI**)
Lewartowskiego 17, 00-169 Warsaw, Poland

Statement

Submission is on behalf of Warsaw School of Computer Science, which ran the described here Project, supported by the European Union Grant. President of WWSI: **Andrzej Żyławski.**

Abstract. We presented a regional project **Informatyka +** which consisted of outreach activities of tertiary education institutions and academic teachers, addressed to prospective informatics (computer science students). We expect and have gathered some evidence that these activities increase motivation and preparation of school students for their future decisions to study computer science or related fields and become computer specialists. The approach which we used can be viewed as implementation of computational thinking to teaching and learning informatics (computer science) topics and applications of computing in various areas of students' interests.

Description of the Project and its achievements

Background

There is a general opinion that school students are not prepared to make a decision about their future career and professional life related to computer science. Moreover they misunderstand what computer science really is. In the last 10 years one can observe a substantial decrease in the number of computer science enrollments (for instance it was estimated that it dropped in half in the USA). There are a number of arguments which are important in this context and support the idea of outreach [1]activities:

1. Many people, among them education policy makers, teachers, academics and parents confuse computer science and information technology and limit informatics in education to provide students and teachers with computers and Internet access.
2. Informatics education in school does not clear up the myths about computer science, for instance it is still confused with computer programming.
3. Today almost all students have computers and access to Internet at home. They have tasted enough information technology while growing up and want something different at the university level. To change this, informatics classes should prepare students for further study instead of being satisfied with the knowledge and skills they have already learned.
4. Youth's infatuation with technology does not extend to their desire to learn the discipline of computer science – one of our goals in outreach activities is to motivate students to go 'beyond the screen' and investigate how computers and software work so they can create their own computer solutions.
5. One of the challenges to a curriculum in computer science is to catch up to the new technology and to adjust it to rapidly changing markets and users' expectations.
6. There is still a demand for experts and specialists in various areas of computer use and applications who are competent in the range of the university curriculum in computer science. A computing degree can help to find a job in science, engineering, health care, finance, and so on. The availability of jobs, as well as the impact of computing in society should motivate students to study computer science.

The White Paper by the CSTA lists a number of challenges and requirements that must be met if we want to succeed in bridging the gaps in education and improve education in informatics as a computer science discipline:

- students should acquire a broad overview of the field of computer science;
- informatics instruction should focus on problem solving and algorithmic (computational) thinking;
- informatics should be taught independently of specific application software, programming languages, and environments;
- informatics should be taught using real-world problem situations;
- informatics education should provide a solid background for the professional use of computers in other disciplines.

One of our goals is to show how we partly met these challenges in our approach to informatics education for all students in schools in Poland, and enhance and support schools by some outreach activities, such as Project **Informatyka +**.

[1] **Outreach** is an effort by an organization or a group (here curriculum teams, universities) to connect its ideas and practice to the efforts of other organization (here schools), groups, specific audiences, or the general public

Informatics Education in Poland – In the Past and Today

In the education system in Poland, **informatics education** consists of two types of classes and/or activities:

- separate informatics classes;
- across-curriculum integration of computers, information and communication technology, and Internet with learning and teaching of all subjects.

The first informatics classes in Poland were organized in the mid sixties. The main topics of instruction were algorithms for numerical calculations and programming in Algol 60 – algorithmics was restricted to numerical methods. The first national curriculum for informatics as an independent subject was proposed in 1985. In the mid 90's, the term 'information technology – IT' (later 'information and communication technology – ICT) was accepted by the education policy makers in Poland and a new subject information technology was introduced to the curriculum by the Education Reform of 1997 and as a result information technology became the high school independent subject in 2002. Informatics as separate subject for all students has returned to high schools as a result of the reform of 2008.

It is interesting to note that informatics as an independent and separate subject has been in the national curriculum and in the schools in Poland since its introduction in 1985[2]. Are there any other such country?

The actual curriculum of separate informatics subjects was approved at the end of 2008 and introduced to primary schools (1-3) and to middle schools in 2008 and to primary schools (4-6) and to high schools in 2012. The changes made to the existing curriculum were important to any outreach activities taken by a tertiary education institution. From one side, it may be assumed that school students are familiar with the topics listed in the curriculum, and from the other side – outreach activities should enhance and extend the curriculum topics. It is very **important to connect outreach activities to what is actually taught in schools** – one can easily lose attention and interest of school students when the topics are far from what they know and from what they can follow. As a teacher in the project **Informatyka +**, prior to my lectures and workshops, I usually asked school teachers who accompany students from schools how advanced their students are in algorithmics and programming. Similarly did other members of our staff in this project.

In the new curriculum for high schools **information technology** disappeared as an independent subject and informatics has been introduced in its place, at least 1 hour per week for one year. In consequence, beginning of 2012, there is also **informatics for all students** in high schools, as it is in middle schools.

Informatics (understood as computer science) remains in high schools as an elective subject and is taught only in some schools. Students may also take an external final examination (*matura* in Polish) in informatics.

In informatics for all students the main emphasis is put on problem solving with computers using the methodology based on **computational thinking**. Problems may come from various fields, in particular from school subjects, and students may use a variety of informatics tools for solving them. Students are expected, as outcomes, to be able to:

- discuss and analyze various problem situations;
- develop and formulate specifications of various problem situations;
- design a solution of a problem by choosing a solution method and computer tools, such as a programming language, application or education software;
- run a solution on a computer and test and evaluate its properties such as complexity (efficiency) and correctness with regard to the specification;
- present a solution and discuss its applications to other problem situations.

[2] The author of this submission has been involved in all this activities, in the past and presently.

Additionally to problem solving skills, all students in high schools are expected to publish in the web their own educational content and use e-learning to enhance and enrich their learning environment by including open content and courses.

A new textbook for informatics for all students in high schools appeared in 2012. A **project based learning** (**PBL**) is proposed as a working method and **computational thinking** as an approach to problem solving. Moreover, **flipped classroom** strategy was proposed to enhance school time with off-school students' activities.

Description of the Project Informatyka +

Informatics education in the new national curriculum as described above aims at better preparation of school students for general education as well as for their future choice of a next step in education and professional life related to computer science and its professional applications. The outreach activities in the Project Informatyka + refer to the new curriculum by enhancing and deepening students' curriculum achievements, also extending them in the case of talented and gifted students.

Informatyka + was and still is one of the largest outreach projects in Poland. It was ran by the Warsaw School of Computer Science (WWSI), a private university established in 2000, one of the few private schools which offer a master degree in computer science. The author of this submission coordinated scientific and education activities in this Project. The Project was financed by the EU Funds. It was addressed to high school students in five regions (states – *województwo*) in Central and Eastern Poland and more than 1000 high schools, 17.000 students, and 300 teachers participated in this project in 2008-2012.

Project goals
The main goals of the Project Informatyka + were as follows:

- elaborate and implement innovative methods of teaching and learning key competencies in informatics and its applications;
- improve and extend off school students' activities in developing key competencies in informatics and its applications;
- extend students' interests about job market expectations and better preparation for their future choices of professional development;
- extend opportunity talented and gifted students have to improve their informatics interests and competences, in particular those students who are interested in taking part in numerous informatics competitions;
- improve students' school achievements (measured by school grades) in informatics and in other related subjects;
- provide schools with open education content in informatics and its applications;
- introduce school students to an academic type of instruction which differs significantly from school lessons;
- develop teachers' competences in working with students talented in informatics.

Project organization
In this project students participated in:

- lectures (2 hours);
- lectures (2 hours) followed by computer workshops (3 hours);
- extensive workshops (24 hours);
- competitions, such as: the Informatics Olympiad, Beaver, "Our school in Internet", on 3D graphics, and web contest;
- summer computing camps in an attractive spa – a combination of vacation activities with plenary lectures and discussions, workshops, and on-line competitions.

Moreover, in-service courses were also offered for teachers to improve and develop their competencies in working with students talented, gifted, and particularly interested in ad-

vanced informatics topics. Lectures and computer workshops were delivered in WWSI, in one of the five Regional Centers of the Project located in schools, and in schools.

Extensive workshops have been organized for **contestants** of the Olympiad in Informatics. More than 1000 students participated each year n the Beaver, which becomes a very popular (as Kangaroo in mathematics) **international competition** in informatics and ICT.

295 students took part in **Summer with Informatics**, summer computing camps in an attractive spa – a combination of vacation activities with plenary lectures and discussions, workshops, and on-line competitions.

The courses were offered on two levels:

- basic – addressed to all students, supposed to extend the curriculum knowledge in various informatics topics;
- extended – these are mainly extensive workshops (24 hours), addressed to students interested mainly in deepening their informatics skills.

The Educational platform Fronter was used in the project as a communication medium, as an element of **cloud computing** http://informatykaplus.edu.pl/infp.php/ (the platform is hosted in Oslo). It still contains all course materials (lecture notes, presentations, education software, programming codes, etc) prepared by teachers and students used the platform to save their works done during workshops. Then students could use all these materials anytime and anywhere when they return home or to school and want to continue their work in class. The platform was also used to build and run tests and to collect students' opinions about the course they attended.

Informatyka + contributed also to the **Polish Open Computer Science Platform** (*Polska Wszechnica Informatyczna*) which is a collection of more than 60 recorded lectures delivered by well known specialists in various areas of informatics and its applications (WWSI got a prize for this project) http://www.pwi.edu.pl/.

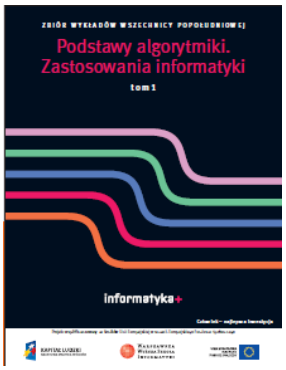
Project topics

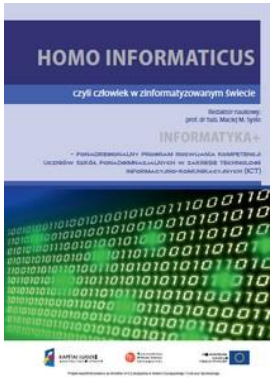
The Project Informatyka + consisted of five thematic modules (we list also titles of some courses within modules):

1. **Algorithmics and Programming**: Searching and sorting – the power of order, Simple computer calculations – can all be computed, Algorithmic techniques, Shortest paths and trees, Data structures and their use (advanced), Advanced algorithms, Matura (final examination) in informatics.
2. **Data Base**: Data base – fundamentals, SQL language (basic and advanced level), XML documents in data base, Technology ADO.Net, Data mining, T-SQL language.
3. **Graphics, Multimedia, Internet techniques**: Graphics editor – GIMP, Working with multimedia, Searching for multimedia in the Internet, Creating dynamic Internet services, Making movies.
4. **Computer Networks**: Computer networks – basic principles of construction and operating, Networks as communication media, Network security, Wireless networks, LAN and WAN.
5. **New Tendencies in Informatics and its Applications**: Algorithms of the Internet, Can computers make business, Concurrency in informatics and in our life, Data exploration, JavaScript, Is P = NP or how to win million dollars in Sudoku, Enigma and contemporary cryptography, Past and the future of informatics – elements of history of informatics, Logic and computers, Introduction to neural networks, Medical informatics.

The courses were prepared and ran by teachers from WWSI and from other universities in Warsaw and in Poland. There were more than **70 courses offered**. For each course its authors prepared handouts (electronic and paper versions; from 15 pages for a lecture to 50 pages for a 24 hour workshop), Power Point presentation (used during a lecture part of the

course), tests and some other materials for students, see:
http://informatykaplus.edu.pl/infp.php/moduly_tematyczne.html for details.





Selected materials were also published in books:

1. Two volumes of selected course materials, edited and augmented.
2. Book: ***How to Work with Students Talented in Informatics – A Guide for Teachers*** – a collection of articles on how to work with students talented in computer science, written by national experts on informatics olympiads, teachers working with talented students, and also by school psychologists.
3. Book: ***Homo Informaticus – Introduction to Contemporary Informatics*** – written by internationally recognized experts in various branches of computer science and its applications, such as: logic (A. Szałas), algorithmics (K. Diks, J. Grytczuk), programming languages (G. Jakacki), data base (K. Stencel), informatics in medicine (R. Tadeusiewicz), informatics in global economy (W. Cellary), computers in education (M.M. Sysło), IT professions (A. Żyławski), history of computing: people, ideas, machines (M.M. Sysło).

All the books were sent to all 1000 schools which participated in the Project, also they were distributed among libraries and other interested persons.

The approach which was used in running courses and is seen in the materials can be viewed as implementation of **computational thinking** to teaching and learning informatics (computer science) topics and applications of computing in various areas of students' interests.

Project achievements are described below in the section **Evidence of impact.**

Availability of the curriculum materials

The Project materials are now available to all interested students, not only in high schools, but also at the university level, and to all teachers in high schools:
http://informatykaplus.edu.pl/infp.php/moduly_tematyczne.html.

Available are (for more than 70 courses), in electronic form (interested persons may get some of these materials in printed version):

- Written handouts (from 15 pages for a lecture to 50 pages for a 24 hour workshop).
- Power Point presentations (used during a lecture part of the course).
- Tests used in the classroom.
- Recorded lectures.

A limited number of copies of the books are also available:

- Two volumes of selected course materials, edited and augmented.
- Book: *How to Work with Students Talented in Informatics – A Guide for Teaches*

- Book: *Homo Informaticus – Introduction to Contemporary Informatics*

We plan to publish a revised version of *Homo Informaticus* in the Science Publishing House (WN PWN), also its version in English.

All courses and their materials have been designed based on the current informatics curriculum for high schools and therefore can be used by high school students and by teachers in schools as well as in off classroom learning activities.

Since the materials are available in electronic form and were produced using the public funds, they are available everywhere and anytime to all students and teachers in Poland, not only for those who took part in the Project activities in 2008-2012.

It was interesting to notice during the Project activities that the courses attended were continued in school classroom with the students' works saved in the platform Fronter. It was a practical experience in using a **cloud environment**, first such an experience for most of the school students and also teachers.

Evidence of impact of the Project

The organizers of the Project are very satisfied with the students´ opinions about the Project, especially with the impact of the Project on students' learning and on their positive attitude toward the proposals of courses and other activities. The organizers of the Project have gathered some evidence that the Project activities have increased motivation and preparation of school students for their future decisions to study computer science or related fields and become computer specialists.

The Project appeared to be our great success – **17 386 school students** (among them were **5425 girls**) participated in the Project in 2008-2012, some of them attending more than one course and project activities; 74% from high schools, and 26% from vocational high schools. Many students still are in contact with project teachers and take part in special interest groups at WWSI.

3096 courses were organized in WWSI and in 5 Regional Centers of the Project. **296 extra lectures** wee delivered in other schools. **212 students groups** visited WWSI for workshops (5 hours).

More than **1000 schools** in 5 regions of Poland were supported in the Project by having a chance to participate in the Project and receiving project materials; some of the activities (lectures, workshops were organized in schools, not only in the project centers). Today, students and teachers from all schools in Poland have access to the project materials (lecture handouts, presentations, tests, books, recorded lectures). The project materials constitute now a large collection of **Open Educational Resources**.

Tables 1-5 contain some results of the questionnaires filled in by participants of the courses (after a course) and of other project activities.

Table 1. Why have you decided to take part in the Project?

Reason	**%**
I like informatics and want to learn more	63%
My knowledge of informatics is on a low level and I want to improve it	13%
In our school informatics is taught on a low level	8%
There are no extra informatics activities in our school	7%
Others	9%

Generally, as shown in Table 1, students in schools want to improve their knowledge of informatics and the Project was a good opportunity to do so.

Table 2. How much have you learnt during the lecture you cannot learn in school

Topics	Yes	No	No opinion
Algorithmics and programming	45%	20%	35%
Data base	64%	10%	26%
Graphics and multimedia	53%	16%	31%
Computer networks	54%	17%	29%
New trends in informatics	57%	12%	31%

Table 3. How much have you learnt during the workshop you cannot learn in school

Topics	Yes	No	No opinion
Algorithmics and programming	37%	28%	35%
Data base	56%	13%	31%
Graphics and multimedia	54%	19%	27%
Computer networks	49%	18%	32%
New trends in informatics	61%	16%	23%

Tables 2-3 illustrate that the contents of the courses, although closely related to the curriculum, extend significantly what students can learn in schools. These figures confirm our choice of topics and their range.

It is also interesting, regarding the academic style of teaching/learning (lecture + workshop), that for 73% of school students lectures were important preparations for workshops, and for 77% – workshops were very important to better understand lectures.

Table 4 illustrates the best impact of the Project – for 60-70% of students it was positive regarding their interests and knowledge in informatics.

Table 4. Students‘ opinion toward usefulness of the courses

Question	Yes definitely	Yes	No	No definitely	No answer
Are you interested in studying informatics in the future?	33%	33%	24%	10%	0%
Do you think that participation in the Project will influence your future decision about your career?	22%	42%	26%	9%	1%
Has the course improved your knowledge and skills in informatics?	41%	47%	9%	3%	0%
Has the course encouraged you to develop your knowledge and skills in informatics by yourself?	26%	49%	22%	3%	0%
Have the materials been useful in the course?	55%	36%	7%	2%	0%

The figures in Table 5 show the impact of the Project on how students are doing in schools after taking some project courses or taking part in some other project activities. Moreover, as one of **the most important result of the Project** we consider the figures in the last row, collected from students who each year graduated from vocational high schools.

Table 5. Students' opinion toward influence of the courses

Question	Yes	No
After taking part in the Project, have you improved your grades in informatics?	67%	33%
After taking part in the Project, have you improved your grades in information technology?	65%	35%
Has your choice of informatics related study been influence by the Project?	62%	38%

It is worth mentioning that more than 90% of talented students, who took part in very extensive workshops (24 h) were very satisfied, especially those who were preparing for the final examination in informatics (*matura*) – I ran three such courses and all my students passed the *matura* with at least 50% points.

Extensive workshops have been also organized for contestants of the Olympiad in Informatics. In 2010, twenty students successfully reached the third final stage and two of them represented Poland in the International Olympiad in Informatics.

More than 1000 students participated each year in the Beaver, international contest in informatics and ICT. In 2010, 5 students won the II Prize and 8 students won the III Prize.

The Materials produced in the Project are very useful for at least 87% students, also in schools.

More than 93% of teachers taking part in the in-service training ran in the Project and coming with students to courses were satisfied with how the Project is ran, what students have learnt, and the Project can improve their school lessons and other activities in informatics.

Concluding comments, reflections

As the coordinator of the Project I must admit that I am very satisfied with running the Project, the enthusiasm of school students and teachers about our offer of courses and activities and the Project's impact on schools – they are really interested in improving instruction in schools and giving students new opportunity to learn and develop their skills in the area of informatics curriculum topics and applications.

Personally, let me share one of my experiences. I run some of the algorithmic courses. Once, a group of young students, mostly girls attended a course on introductory algorithmics. When before the workshop I learnt from their teacher that they have no experience in programming, I thought I would be in trouble but finally those students were able to understand three simple algorithmic situations (e.g. for given three numbers interpreted as the lengths of triangle sides, find the area of the triangle if it exists) and write in Pascal and run successfully three programs. As one of my colleagues (W. Cellary) put it: everybody can learn programming – now I strongly believe him. In fact, computer programming (in any sense) is a tool of computational thinking and as such should be a competence of everyone. It is not a surprise, that Marc Prensky, who first divided people into two categories digital natives (young generation) and digital immigrants, now declares **The True 21st Century Literacy Is Programming**.

Continuation of the Project

We are making affords to continue the Project and to extend availability of its materials and achievements in several directions. To this end:

- we have applied to the Ministry of National Education to extend the Project to all regions of Poland;
- we want to make the Project activities permanent and continues in schools;
- we intend to extend the scope of the project by constantly adding new topics, courses, activities, prepared by teachers from other tertiary schools in Poland and also from abroad;
- we intend to invite to the Project results Polish students who study abroad;
- we plan also to translate some of the materials into English and make them available for students from abroad.

Today, some of these ideas and plans are included, at least partly, in another project **IT School** (http://it-szkola.edu.pl/), which is a continuation of Informatyka +, and is addressed to all regions in Poland and is constantly extending its scope by adding new topics, courses, activities. Presently more than 20 000 students from high schools in Poland have registered and are taking part in this new project activities. This project is supported only by WSWSI.

Recognitions, references, supports

The Project Informatyka + has been **awarded by the Ministry of National Education** as one of the Good Practice Projects in developing skills in the young generation, necessary to work and live in the information society and in the global economy.

ROZWIJANIE ZDOLNOŚCI

PROJEKT:

INFORMATYKA+ – PONADREGIONALNY PROGRAM ROZWIJANIA KOMPETENCJI UCZNIÓW SZKÓŁ PONADGIMNAZJALNYCH W ZAKRESIE TECHNOLOGII INFORMACYJNO – KOMUNIKACYJNYCH (ICT)

BENEFICJENT:

WARSZAWSKA WYŻSZA SZKOŁA INFORMATYKI

Informatyka+ to ponadregionalny projekt edukacyjny realizowany w latach 2008-2012. Jego głównym celem było podniesienie kompetencji uczniów w zakresie informatyki poprzez propagowanie edukacji informatycznej, stworzenie atrakcyjnej oferty zajęć pozalekcyjnych i otwartych zasobów dydaktycznych, wspomagających samokształcenie. Projekt był inicjatywą środowiska akademickiego na rzecz szkół ponadgimnazjalnych, dlatego w realizację zajęć, opracowanie materiałów i inne działania zaangażowani zostali wykładowcy szkół wyższych: Warszawskiej Wyższej Szkoły Informatyki, Politechniki Warszawskiej, Uniwersytetu Warszawskiego, Uniwersytetu Wrocławskiego i in.

W ramach Informatyki+ przewidziano m.in. opracowanie i wdrożenie innowacyjnych metod kształcenia kompetencji kluczowych w zakresie ICT i podwyższenie jakości pozalekcyjnych form zajęć, w tym podwyższenie kompetencji nauczycieli w zakresie pracy z uczniem zdolnym. Zaplanowano i przeprowadzono różnego rodzaju zajęcia, np. Wszechnicę Informatyczną, czyli wykłady i warsztaty w laboratoriach komputerowych rozszerzające podstawę programową, wychodzące poza programy szkolne. Dla uczniów szczególnie uzdolnionych, w ramach Kuźni Talentów Informatycznych zorganizowano specjalistyczne szkolenia umożliwiające indywidualny kontakt z wykładowcami i naukę w laboratoriach komputerowych, współpracę ze studenckimi kołami naukowymi czy udział w konkursach tematycznych. Dodatkowo, na zaproszenie szkół organizowano wykłady, kursy komputerowe i prezentacje w ramach Wszechnicy na Kołach. Przez portal PWI udostępniano zasoby edukacyjne. Powstały też programy zajęć pozalekcyjnych, poradnik dla nauczycieli, reportaże, nagrania wykładów i moduły dydaktyczne, również w formie e-booka.

Łącznie projekt objął 17 618 uczniów szkół ponadgimnazjalnych i 132 nauczycieli z województw: mazowieckiego, lubelskiego, podlaskiego, warmińsko-mazurskiego i łódzkiego. 80% beneficjentów stanowili uczniowie liceów ogólnokształcących i liceów profilowanych, a 20% – techników. Szczególną grupą byli uczniowie uzdolnieni, dla których opracowano materiały dydaktyczne na poziomie zaawansowanym, tj. rozszerzonym w stosunku do zakresu programu szkolnego. Uczniowie ci mieli możliwość uczestniczenia w zajęciach w grupach zaawansowanych, wyjeździe na letnie obozy szkoleniowo-wypoczynkowe i udziału w konkursach informatycznych. Weryfikacja uczniów uzdolnionych następowała na podstawie wypełnionej przez nauczyciela przedmiotów informatycznych „Karty ucznia uzdolnionego". Nauczyciele z kolei mogli wziąć udział w cyklu szkoleń z metod pracy z uczniami uzdolnionymi w zakresie informatyki.

12

z zakresu informatyki, których wartość została zweryfikowana podczas wykorzystania ich w trzyletnim cyklu zajęć, a także dobre praktyki współpracy szkół wyższych ze środowiskiem szkół ponadgimnazjalnych.

The Project has been also recognized by the **Ministry of Regional Development**:

The organizers of the Project have got many responses from schools which want the Project to be continued in the future and supported by the Ministry of National Education, also by Universities. There were many schools which cannot enter the Project because of limited capacity of WWSI and the regional Centres. Universities are also interested in such outreach activities which prepare students for their future choices and for study in computers science and related fields.

The Project has got very positive feedback from all its actors: students, school teachers, project teachers and project personnel. We all are very satisfied with its outcome.

Lists of references

References to the sites and materials closely related to the Project:

1. Bebras: International: http://bebras.org/en/welcome; in Poland: http://www.bobr.edu.pl/.
2. Fronter: http://webfronter.com/iplus/milacollegejunior/.
3. Informatyka +: http://www.informatykaplus.edu.pl/infp.php/.
4. IT School: http://it-szkola.edu.pl/
5. Polish Open CS Platform: http://www.pwi.edu.pl/
6. Sysło M.M., Outreach to Prospective Informatics Students, in: I. Kalas, R.T. Mittermeir, (eds.), *Informatics in Schools – Contributing to 21st Century Education*, Proceedings of the 5th ISSEP Conference, Bratislava 20011; LNCS 7013, Springer-Verlag, Berlin Heidelberg 2011, 56-70.
7. WWSI: http://www.wwsi.edu.pl, http://wscs.eu.

Other items referred to in the submission:

1. Computational thinking: http://www.iste.org/standards/computational-thinking.aspx.
2. CSTA K-12 Computer Science Standards, 2011,

http://csta.acm.org/Research/sub/CSTAResearch.html

3. Denning P.J., Who Are We?, Comm. ACM **44**(2001), 15-19.
4. Gurbiel E., Hardt-Olejniczak G., Kołczyk E., Krupicka H., Sysło M.M., Informatics for All Students (In Polish), Textbook for high school, WSiP, Warszawa 2012 (in preparation).
5. Gurbiel E., Hard-Olejniczak G., Kołczyk E., Krupicka H., Sysło M.M.: Informatics (In Polish), Vols. 1 and 2, Textbook for high school, WSiP, Warszawa 2012 (in preparation).
6. Running On Empty: The Failure to Teach K-12 Computer Science in The Digital Age, ACM, CSTA, 2010; http://csta.acm.org/Runninonempty/.
7. Stephenson C., Gal-Ezer J., Haberman B., Verno A., The New Education Imperative: Improving High School Computer Science Education, Final Report of the CSTA Curriculum Improvement Task Force, CSTA, ACM, February 2005; http://csta.acm.org/Publications/White_Paper07_06.pdf.
8. Sysło M.M., Kwiatkowska A.B., Informatics versus information technology – how much informatics is needed to use information technology – a school perspective, in: R.T. Mittermeir (ed.), From Computer Literacy to Informatics Fundamentals, Proceedings of the 1st ISSEP Conference, Klagenfurt 2005; LNCS 3422, Springer-Verlag, Berlin Heidelberg 2005, 178-188.
9. Sysło M.M., Kwiatkowska A.B., The Challenging face of informatics education in Poland, in: R.T. Mittermeir, M.M. Sysło (eds.), Informatics Education – Supporting Computational Thinking, Proceedings of the 3rd ISSEP Conference, Toruń 2008; LNCS 5090, Springer-Verlag, Berlin Heidelberg 2008, 1-18.
10. Wing J.M., Computational thinking, Comm. ACM **49**(2006), 33-35.