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Contributing to 21st Century Education

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Preface

The International conference on Informatics in Schools: Situation, Evolution and Perspectives, hosted by the Comenius University in Bratislava, was the 5^{th} in the series of ISSEP conferences.

The series started in 2005 under the title "International Conference on Informatics in Secondary Schools: Evolution and Perspective" in Klagenfurt, Austria on the occasion of the 20th anniversary of compulsory formal informatics education in Austrian secondary schools (gymnasia). A substantial aim was to bring local teachers into contact with developments and ideas forming the basis of informatics didactics in other countries. Consequently, the proceeding were split into two parts. One appeared in the Lecture Notes in Computer Science series of Springer Verlag [LNCS 3422], the other one, published by Ueberreuter, a local publishing house, gave both, Austrian teachers and international visitors, a forum for presenting "Innovative Concepts for Teaching Informatics".

The concept of split proceedings as well as the idea of bringing local teachers in contact with the international community has been preserved over the years. The focus of topics shifted slightly. At the second ISSEP, held in 2006 in Vilnius, Lithuania, the overall theme was "Informatics Education – The Bridge between Using and Understanding Computers". Thus, the spectrum addressed ranged from programming and algorithmics via ICT-education to e-learning [LNCS 4226]. In the accompanying volume, "Information Technologies at School", published by TEV Pulishing House, e-learning, ICT, and Informatics competition are widely described. Corresponding to the theme "Informatics Education – Supporting Computational Thinking" [LNCS 5090] the third ISSEP, held 2008 in Toruń, Poland, shifted the focus away from ICT and e-learning. One section of the accompanying proceedings, published by Nicolaus Copernicus University, Toruń, had in contrast a section linking informatics with mathematics instruction. This trend continued in both proceedings of the fourth ISSEP, January 2010 in Zürich. It focussed on "Teaching Fundamental Concepts of Informatics" [LNCS 5941].

For the fifth ISSEP, held in fall 2010 in Bratislava, Slovakia, it was decided to broaden the scope by including aspects of informatics or informatics-related education also at lower grades. This led to a reinterpretation of the ISSEP acronym to "International conference on Informatics in Schools: Situation, Evolution and Perspectives". There were two reasons for considering the spectrum of formal IT-related education over all age groups, i.e., including primary school and for some countries even aspects of IT-related motivational activities in Kindergarten [3].

Firstly, this expansion of scope is a consequence of trends to be observed in various countries, where some aspects of informatics-related education have been shifted from the secondary to the primary level. This shift is a consequence of changes in educational policy as well as of the fact that informal (but incomplete)

peer-group instruction and factual use of modern information technology (from cell-phones to home-computers), have penetrated the life of even very young kids. Since this early educational confrontation of children with information technology has consequences on secondary level curricula, extension of the scope became a necessity. A second reason for extending the scope of the ISSEP-conferences is the fuzziness surrounding the definition of "secondary education" in various countries. While formal education starts in most countries at the children's age of 6 or 5, the duration of primary education varies. A range of 4 to 6 grades is rather common. Due to different national stratification of the educational system, the variance in duration and age-groups embraced by secondary education is even broader [2]. Consequently, depending on nation and gender, the shift from primary to secondary education falls into the critical period of beginning adolescence. This is a good reason not to focus on organizational structures of national school systems but consider the whole spectrum of school and ask authors to be specific about the age group or grade they are referring to in their contributions.

Out of 69 submissions from 20 countries the Program Committee selected 20 papers from authors of 12 countries for inclusion in this volume[1]. Each paper was reviewed by at least three members of the Program Committee in an electronic reviewing process. The papers in this volume have been arranged into the topical groups briefly described below.

This volume is opened by three papers representing the *Spectrum of Options* to be considered in *Informatics Education*. Pavel Boytchev shows the wealth of a creative learning process during which a student (apparently highly motivated) acquired programming knowledge on her own in an investigative process with minimal guidance. Valentina Dagienė leads readers into an opposite corner of the educational spectrum by addressing a host of informatics-related topics relevant for contemporary learners. The breadth of topics addressed is due to various recommendations of international bodies that are mainly concerned with economic and political issues. Therefore, they are also concerned with guidance for (inter-)national education policy. The ensuing paper by Juraj Hromkovič and Björn Steffen might be seen as a counter position they share with a substantial part of the scientific community involved with informatics education. Thus, it defines a further corner point specific for informatics instruction: the need to present pupils the core-concepts of informatics. This aims to present informatics as a science contributing to our contemporary society. Obviously, these concepts are of a more fundamental nature than short-lived application-oriented skills, part of society is asking school to teach.

Considering these papers individually, one or the other participant of the conference might put forward valid counter-arguments resulting from a particular position of teaching informatics in school. However, seen in conjunction, the arguments voiced in those papers span an area and it is important that educators

[1] All of the other papers presented at ISSEP 2011 are included in the accompanying conference proceedings [4].

perceive this area's full breadth. A school-class is not an amorphous aggregate of humans pertaining to a given age group. It is a collection of individuals. Teachers have to bridge the gap between the prescription of the curriculum to be followed for all pupils and the particular educational needs of each individual student, be these due to special abilities or special deficiencies, as addressed in the paper from the Japanese group on teaching handicapped students.

Out of this group of papers one can also sense a terminological tension between the terms "informatics" and "computer science". Most countries use just one of these terms when referring to informatics or IT-related instruction. In other countries the distinction between using information technology (IT- or ICT-related instruction) and providing insight into the conceptual and technological basis of modern information technology is made explicit in the curriculum. Authors have been asked to clarify whether they are referring to instruction concerning basic conceptual elements of the discipline or to instruction concerning skills on using information technology in order to act as a versatile citizen in a modern and well-developed economy.

The second section of the proceedings contains three papers grouped under the heading *National Perspectives*. The first paper, with Maria Carla Calzarossa as leading author of a team consisting of four scientists from four Italian universities, reports on the way ICT-concepts are taught in schools belonging to eight regions spread over Italy. It is followed by a paper from Peter Micheuz describing the results obtained by a working group aiming to align ICT-instruction with engraining aspects of computational thinking for the pupils belonging to the age-group from 10 to 14. Maciej Sysło's paper on Outreach to Prospective informatics Students establishes the link to the next section. After describing recent developments in the curriculum of Informatics for Polish schools of various levels, it provides an overview of the broad spectrum of Polish outreach activities.

The section *Outreach Programs* commences with an overview paper written by an international team of five authors describing and comparing outreach programs they once proposed and that are now internationally well recognized. The spectrum ranges from Computer Science Unplugged (Tim Bell) via cs4fn (Paul Curzon) and CS Inside (Quintin Cutts) to Bebras (Valentina Dagienė), and the Israeli approach of supporting pupils specializing in CS in a comprehensive venture by bringing them into direct contact with well-known academics and having them participate in an industrial software engineering project (Bruria Haberman). The second paper in this section focusses on CS-Unplugged in a non-traditional manner. Hiroki Manabe and his co-authors report on lessons they conducted with handicapped pupils in Japanese schools. Due to the physical constraints of these persons, applying CS-Unplugged as originally proposed by Bell, Witten, and Fellows [1] is unsuitable or even impossible. Hence, the authors provide these pupils with a computer interface that allows them to overcome senso-motoric or other physical deficiencies in a simulated environment. Ernestine Bischof and Barbara Sabitzer, concluding this section, describe on an exemplary level a project where, similarly to CS-Unplugged, core computer science topics have been framed into contexts even young pupils can relate to. The

paper mainly reports key results from the evaluation of the interventions done in schools. Among those results was the observation that marked gender differences became noticeable only with older age groups. They were not noticeable in primary schools. Attentiveness to these interventions in primary school was highest among the age groups studied. Hence, arguments suggesting that core-concepts of informatics have to be reserved to age groups past 12 years, or CS as a technical subject is more attractive to boys than to girls, have to be considered with scepticism or – considering also other papers addressing this topic – have to be dismissed. Pointing at deficiencies in teachers' capabilities to adopt this or a similar approach on their own, links to the next section.

Teacher Education is apparently a key side condition for good informatics education in any country. Since a substantial portion of active teachers got their teaching degree before informatics had been defined as regular subject in school, in-service teacher education plays a critical role in informatics. Noa Ragonis and Anat Oster-Levinz focus on a practicum program of students enrolled in a pre-service teacher education degree program. A specific focus of this paper is on the multi-facetted evaluation program these student-teachers are subjected to. The other paper on teacher education was contributed by Daniela Bezáková and Michal Winczer. It explains the author's approach to teaching informatics teachers concepts of theoretical informatics. The approach is directed to pre-service as well as to in-service teachers. It particularly addresses issues resulting from the students' limited background in mathematics. The significance of this approach is due to the fact that especially in the generation of teachers perceiving informatics education only from an ICT-perspective, theoretical informatics plays a secondary role. They consider the concepts it provides too abstract and not sufficiently applicable in the pupils' daily life. One has to question though, whether such arguments are not mainly put forward as self-defense to cover up didactical deficiencies. A series of counter-arguments to such a short-sighted line of arguments are raised in the paper by Hromkovič and Steffen appearing in the introductory section "Spectrum of Options".

The section *Informatics in Primary Schools* is opened by Andrej Blaho and Ľubomír Salanci's report on the principles pursued when developing an informatics curriculum for Slovakia. In Fig. 1 of their paper, the authors give a succinct overview of the various forces and needs to be considered when establishing an informatics curriculum for (primary) school. Before presenting the proposed approach they discuss why compromises have to be found between purist proposals. The paper closes with evaluative reflections on an initial implementation of the recommendations. Giovanni Serafini describes outreach activities of a team from ETH Zürich in order to teach pupils of (remote) primary schools computational thinking. The age group addressed consists of children between 8 and 13 years old. The programming language used has been Logo. But the aim of the approach was certainly not teaching some programming language but rather using Logo only as medium for kindling computational thinking. Interventions in two schools are described in detail. Gerald Futschek and Julia Moschitz also aim at instilling computational thinking with very young kids. Instead of a

computer-executable programming language they use cards for representing commands needed to load or unload colored wooden blocks into a toy train. Kids are challenged by arranging the cards in such a way that a robot can correctly load the train. Evidently, the arrangement of cards results in a "program" controlling the movement and work of this assumed robot. Later, the arrangement of cards might even be simulated in an environment like Scratch.

The section *Advanced Concepts of Informatics in Schools* is opened by a paper from David Ginat, Eyal Shifroni, and Eti Manashe on difficulties students have with the transfer of previously acquired knowledge when solving new programming tasks. The paper addresses these problems on the basis of five particular example-problems and the solutions as well as difficulties kids had in solving them due to specific transfer problems. Viera Krňanová Proulx focusses in her paper on "Program by Design". A systematic approach to problem solving following a well-structured design process is advocated. The approach is explicated by the description of design recipes for functions and methods, data definitions, and abstractions. The functional approach is extended for issues arising with object-oriented programming. The paper by Lucia Keller and her co-authors from ETH-Zürich presents a course on classical cryptology, offered by the Informatics-Didactics group of ETH to Swiss schools. Thus, this paper could also be seen as a further extension of the "Outreach"-section. The description of the approach is detailed enough for other teachers to follow it. However, in doing so, one must not ignore an aspect easily overlooked on first reading. The innovative idea is not to teach cryptology. It is rather to briefly present pupils some cryptosystem and have them break enciphered messages. This approach is didactically more elaborate than mere frontal presentation. However, the motivational effect and creativity stimulation obtained is apparently substantially higher.

The volume closes with a section on *Competitions and Exams*. The two papers on competitions might be seen as further extension of outreach programs, but all three papers have the proper composition of questions posed or the organization of the competition in their focus. Hence, they have been grouped into a common section. Monika Tomcsányiová and Peter Tomcsányi extend the widely known Bebras contest by proposing a "Little Beaver" contest for children aged between 8 and 9 years. After briefly describing Bebras, the authors contrast their approach to the contest targeted at pupils of 10 years upwards. They mention not only limits in the knowledge domain and abstraction capabilities but also senso-motoric and other general constraints to be considered when addressing a very young age stratum. On this basis, a pilot run was developed. The results obtained are described. An approach of developing a contest for pupils following the approach of the Kangaroo-contest in mathematics is reported in the paper by Violetta Lonati and her co-authors from the Università degli Studi di Milano. Their approach is explicitly defined as an outreach program for all pupils of a class. It should not depend on some specific prior training. The contest consists of two rounds asking questions of different complexity. A school-internal qualifying round is followed by a nationwide final round. The test examples of the

final round are (re-)used in in-service teacher education. The section closes with a paper on criteria for writing examinations. Haim Averbuch, Tamar Benaya, and Ela Zur report on an analysis of school-internal exams used to prepare students for the final matriculation exams in computer science conducted in Israel on the national level. Even if the paper and the study it reports upon is motivated by specifics of a top-level national exam, the criteria established by the authors are worth considering when designing any sort of comprehensive exams in informatics/CS.

Before closing, I should mention that a conference like this is not possible without the support of many individuals and organizations. Hence, I would like to thank particularly the General Chairman, Prof. Ivan Kalaš, and all members of the Program Committee as well as all additional reviewers for ensuring the quality of the proceedings. Carrol Sperry deserves special mention for helping some authors to improve the linguistic aspects of their respective paper. Special thanks go also to the Organizing Committee. I also have to be grateful to Annette Lippitsch for editorial support in copy-editing the papers contained in these proceedings.

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