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Preface

Informatics Education – Supporting Computational Thinking contains papers presented at the Third International Conference on Informatics in Secondary Schools – Evolution and Perspective, ISSEP 2008, held in July 2008 in Torun, Poland.

As with the proceedings of the two previous ISSEP conferences (2005 in Klagenfurt, Austria, and 2006 in Vilnius, Lithuania), the papers presented in this volume address issues of informatics education transcending national boundaries and, therefore, transcending differences in the various national legislation and organization of the educational system. Observing these issues, one might notice a trend. The proceedings of the First ISSEP were termed *From Computer Literacy to Informatics Fundamentals* [1]. There, broad room was given to general education in ICT. The ECDL, the European Computer Driving License, propagated since the late 1990s, had penetrated school at this time already on a broad scale and teachers, parents, as well as pupils were rather happy with this situation. Teachers had material that had a clear scope, was relatively easy to teach, and especially easy to examine. Parents had the assurance that their children learn "modern and relevant stuff," and for kids the computer was sufficiently modern so that anything that had to do with computers was considered to be attractive. Moreover, the difficulties of programming marking the early days of informatics education in school seemed no longer relevant. Some colleagues had a more distant vision though. They already proposed in their papers to weave conceptual knowledge into the strictly application-focused instruction of how to handle computers; and how to handle widely used general application software.

A trend of the still young second millennium to be witnessed external to school is that personal computers have penetrated households and citizens are increasingly using the Internet not only as a professional resource but also privately as an information resource as well as an infrastructure for communicating with relatives and friends, along with companies and public authorities. Politicians encouraged this and publicized e-learning as "learning of the future." As technical competence for e-learning was missing in the broad base of educators, e-learning was initially pushed into the domain of those who could handle computers, i.e., teachers of informatics. The proceedings of the Second ISSEP, *Informatics Education – The Bridge between Using and Understanding Computers* [2], reflect this situation in so far as they focus, next to discussions about the breadth of informatics education, on programming instruction and programming contests, but also on ICT and on e-learning.

The fact that informatics education, due to its relationship with technical devices, is bound to act swiftly in response to societal trends can be seen from the proceedings of the Third ISSEP. While the call for papers still voiced the theme "Informatics Education – Contributing Across the Curriculum", it is well justified to label these proceedings *Informatics Education – Supporting Computational Thinking*. Placing a focus on "computing" might seem at first glance like returning to the roots of informatics education forced by some stubborn teachers, blindly excited about programming. It is not! It is a reaction (and to some extent an anticipation) of the fact that not only personal

computers have penetrated homes but quite often laptops have penetrated school bags. Even more important, the cell phone (mobile phone, in some countries referred to as "handy"), a device highly popular not only with children, can no longer be considered simply as a telephone, i.e., as a device for oral communication. It has gradually become a universal communication device. Its SMS facility makes it a teletype devise, its camera a multi-media device, and its addressability an Internet access device. School is not needed to teach kids how to handle this highly powerful and therefore also quite complex device. Kids learn this from their peers. This phenomenon, however, places new challenges on informatics education.

Consequently, the basics of using computers can no longer benefit from the excitement of using sophisticated technical equipment. The mobile phone in the possession of children has already become a more sophisticated device for a spectrum of limited tasks than a mere PC. What remains? If informatics education is constrained to ICT-education, it is training about skills that are not terribly motivating for a substantial portion of a class. Studies have shown that too much ICT training does specifically turn off girls [3, 4]. A personal experience I had recently in this respect involved a young lady asking me on the basis of her school education in informatics "How can you be so excited about such a dull subject?"

Several authors in these proceedings respond to these challenges by addressing the issue of what informatics education has to offer young people beyond the skills of how to use computers. The answers have a broad range. Computing in the sense of algorithmic constructions are among them as well as focusing on physical constructions by building small robots. Others focus rather on the intellectual challenge of anticipation and combining critical thinking, motherhood, and possibly also some mathematics before venturing into a brute force (algorithmic) solution. In summary, one might see a trend toward "back to the roots" of algorithms and programming. But these concepts are not to be seen from the computer scientist's perspective or from the perspective of preparing pupils for a computer science profession. They are rather to be seen from the teacher's perspective, preparing students for a life in an environment loaded with information and information technology and for preparing them with problem-solving strategies that got cultivated in the computing domain but whose scope extends computing by far.

Due to the trends mentioned above as well as to effective training measures of in service teachers, e-learning got out of the focus of informatics teachers. The didactical challenges involved with e-learning still require further discussion. But these discussions better take place in didactical conferences of the respective discipline. Only some infrastructural issues remain in the realm of informatics experts, and these were discussed at the conference.

The 32 papers contained in this volume consist of 28 contributed papers, selected out of 63 submissions and 4 invited contributions. They were reviewed by at least three members of the Program Committee and can be grouped into the sections introduced below.

The section on "Informatics, a Challenging Topic" starts with the paper by Syslo and Kwiatkowska. In this opening lecture, the authors introduce readers to the development of informatics education in Poland. The paper nicely shows, with this national example of Poland, some of the observations mentioned above and urges informatics instruction to instill computational thinking on students. The fact that computing skills

have to be nurtured already with young pupils is alluded to in the paper by Dagiene and Futschek. They discuss tasks for the Bebras contest, addressed at pupils of grade 5 to 12, stratified into 3 age groups. Diks and Madey report in their keynote on work with Polish contestants at International Olympiads in Informatics (IOI). They show how students are prepared to perform well in such international competitions and how their career as informatics professionals progresses.

The next section focuses on informatics as a technical discipline in presenting "Didactical Merits of Robot-Based Instruction." Programming is not seen as the way to instruct computers but as the way to move a technical device, the robot. The advantage with robot programming, which is of course computer programming in a special way, is not only that the effects of the program can be seen immediately – this would also apply, e.g., to spreadsheet programming – but that students have to think in terms of integrated systems.

Rhine and Martin describe a series of learning modules created in the context of an interactive robotics course. They focus specifically on the integrative aspects of mathematics, geometry, physics, and informatics. Wu, Tseng, and Huang report on different learning effects observed with students working with physical robots and those working just with robot simulators. Kamada, Aoki, Kurebayashi, and Yamamoto describe their (inexpensive) robot building kit and its programming language. In the following paper, members of this group, Kurebayashi, Aoki, Kamada, Kanemune, and Kuno, report on a learning unit using this robot construction kit for building a tri-axial robot. They report that students had a better understanding about automatically controlled systems after taking this course. Thus, they met their aims of knowledge transfer.

Issues concerning "Transfer of Knowledge and Concept Formation" is the linking theme of the next section. Knowledge transfer from solving abstract problems to concrete design issues is addressed in Ginat's keynote. Departing from the statement that design is a fundamental skill in computer science, he analyzes students' skills to find all simple non-intersecting polygons that can be drawn on a grid structure consisting of 3×3 equidistantly placed points such that the area enclosed equals a fixed amount ($2\ cm^2$). He uses the relationship between forms identified by students and forms missed by them to hypothesize different skill deficiencies of the experimental subjects.

The paper by Sendova, Stefanova, Nikolova, and Kovatcheva reports on a course establishing ICT skills with teachers. It is placed in the transfer section, however, because the actual theme of this contribution is on the transfer of ideas to enhance motivation. This general concept can be successfully applied in any other kind of informatics instruction. Its essence is to motivate learners by integrating them into the educational process in such a way that they transcend the role of observers by becoming constituent members of the teaching venture in a form where teaching and learning flows into each other.

Schulte's duality reconstruction also departs from an ICT vantage point. On the basis of analyzing a word processor, he introduces the notion of didactical lenses which allow students to perceive structural as well as functional aspects of the material covered. Thus, the perspective of the engineer and the perspective of the application specialist become visible and students can thus construct a multifaceted image of the discipline.

Romeike considers transfer issues from a motivational perspective. In school, students quite often are forced to solve problems that are too remote from their personal

problems to trigger motivation. The different performance children show in solving challenges of their daily life (such as using a mobile phone to its full extent) and in solving typical simple algorithmic problems lets the author conclude that instead of pre-canned artificial algorithmic problems, school should offer open challenges with a stepwise progression of difficulty. Gruber also looks at various approaches to raise the motivation of pupils, zooming in particularly on in-classroom differentiation.

The section on "Object Orientation and Programming" starts out with *Hubwieser's* paper on an analysis of learning objectives in object-oriented programming. The motivation of the analysis resulted from the need of writing a textbook. However, the message conveyed transcends this immediate problem domain. Conducting a similar analysis might help in various situations to protect teachers from rushing into the most modern developments of the professional side of the discipline without considering didactical consequences and without considering whether students can be accompanied along the whole trip from showing them a concept and making them convincingly aware of the usefulness of this concept.

Weigend takes a modeling perspective in pleading to make a distinction between the existential aspects of a state and its possessive elements. Benaya and Zur's deliberations are based on empirical results, studying the performance and problems faced by students, who already know how to program in an algorithmic language, in a course that introduced them to object-oriented programming in Java.

Yovcheva proposes what she refers to as a "spiral approach" of teaching programming. Departing from simple mathematical problems, a spiral of increasing complexity is defined in such a way that youngsters learn programming in small chunks, the bites being small enough to be comprehended and big enough to solve the problem at hand. A different angle of introducing students to algorithmic problem solving is presented by Haberman, Muller, and Averbuch. They recommend fostering critical thinking of students by dragging them away from starting programming too quickly. The authors challenged students with a core example backed up with variations. The problems are set such that the text of the examples varies only moderately, while the solution to the problems become, with some variations, almost trivial for those who apply good motherhood and some mathematical reasoning; in other cases, a slight modification of the problem substantially raises the complexity of the required solution.

The section closes with two papers following slightly different strands of ideas. Adamaszek, Chrzastowski-Wachtel, and Niewiarowska intend to help novice programmers stumbling over pointers and related concepts by introducing VIPER, a visual interpreter for Pascal. Blonskis and Dagiene report on an analysis of programs developed by students during their maturity exams.

The following section, "Strategies for Writing Textbooks and Teacher Education," starts out with two contributions reporting the authors' reflections and recommendations for textbooks introducing students to informatics. Freiermuth, Hromkovic and Steffen explain in a keynote lecture their way of teaching fundamental concepts using LOGO as didactical vehicle. In doing so, they also establish bridges between computer science and mathematics. Noteworthy is their remark that a systematic way of teaching avoids gender problems in programming courses. Kalas and Winczer also strive for an introductory text that should "build respect for informatics as a science and as a subject." But they follow a different strategy. While the group from ETH is

liberal with space needed to express their ideas, the colleagues from Bratislava submit to the trend of short messages. They show how to fit 10 chapters into a total of 48 pages while still striving at a constructivist approach, following the progressive pattern of using, understanding, and creating information technology.

A totally different approach is presented in the paper by Nishida, Idosaka, Kofuku, Kanemune and Kuno. They strive to popularize Bell, Witten and Fellows' concept of "Computer Science Unplugged" and report the experience they obtained with this approach in three schools.

The section closes with papers on teacher training. Ragonis and Hazzan report on a course for preparing pre-service computer science teachers for Israeli high schools. It covers a broad spectrum of topics from an informatics didactics perspective. While in this course, programming, though addressed from various angles, is just one among several topics, the ensuing paper by Kolczyk focuses specifically on how informatics teachers should present algorithms. It departs from the vantage point that planning, i.e., proper anticipation of situations yet to come and reflecting about potential alternatives of reaction, is a key capability to be developed before programming. On this basis, the paper shows how planning may be trained in small progressive steps. This approach to programming starts already at the primary level and progresses to later phases of the curriculum. The paper by Grgurina reports on teacher training at the University of Groningen. After an explanation of the Dutch system of teacher formation, a concept of highly supervised training on the job is described.

Almost antithetic to the Dutch approach are the reports from Latvia and from Lithuania. Both apply e-learning technology to upgrade their teachers. The paper from the Latvian colleagues, placed in the e-learning section, specifically addresses the problem of smoothening the difference between Riga and the countryside. Dagiene, Zajančkauskiene, and Žilinskiene focus on this technology as a means and an end in so far as they argue for e-learning as a powerful and purposeful way of motivating teachers to use the technology they are to familiarize students with for their own learning. The details of the targets to be achieved by this program are reported in the paper opening the next section.

The section on "National and International Perspectives on ICT Education" starts with a paper from Dagiene, reporting on the implementation of the national strategy for the introduction of information and communication technologies into the Lithuanian educational system. This contribution, reporting on a progressive strategy of introducing IT in grade 5 to 10, is followed by a report on a project assessing spreadsheet knowledge and skills of French secondary school students, presented by Tort, Blondel and Bruillard. The study shows that, when ICT is to be used in a mode remote from those domains where it has penetrated private life, formal education is still a necessity. This section closes with a paper by Micheuz, arguing for a harmonization of informatics education in Europe on the terminology level as well as on the level of concepts. The NCTM standard for mathematics is proposed as an example from a related discipline. Various initiatives aiming at structuring informatics education are mentioned.

The proceedings close with tree papers dealing with "e-Learning" issues. This section starts with a contribution from Eibl and Schubert reporting on design criteria for e-learning systems considering security aspects. Damaševičius and Štuikys aim for

reusable learning objects, reporting their experience of producing generative components. Lavendels, Sitikovs, and Krauklis report on the use of information technologies for reducing the gap between teachers in the capital of Latvia and country-side teachers. It is noteworthy to mention that this is the initiative of a university, to broaden the base of their students by providing pupils from the countryside with access to modern education in informatics.

A conference like this is not possible without many hands and brains working for it or without the financial support of graceful donors. Hence, I would like to thank particularly the General Chair and the members of the Program Committee and all the additional reviewers for ensuring the quality of papers accepted. Among them, Carol Sperry deserves specific mention as she helped some authors to improve linguistic aspects of their text. Special thanks are due to the Organizing Committee led by Anna Beata Kwiatkowska and to Annette Lippitsch for editorial support for these proceedings.

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April 2008 Roland Mittermeir

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