Lecture Notes in Computer Science 4226

Commenced Publication in 1973
Founding and Former Series Editors:
Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

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Informatics Education – The Bridge between Using and Understanding Computers

International Conference in Informatics in Secondary Schools – Evolution and Perspectives, ISSEP 2006
Vilnius, Lithuania, November 7-11, 2006
Proceedings

Springer

Volume Editor

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Library of Congress Control Number: 2006935052

CR Subject Classification (1998): K.3, K.4, J.1, K.8

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN 0302-9743
ISBN-10 3-540-48218-0 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-48218-5 Springer Berlin Heidelberg New York

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11915355 06/3142 5 4 3 2 1 0

Preface

Although the school system is subject to specific national regulations, didactical issues warrant discussion on an international level. This applies specifically to informatics didactics. In contrast to most other scientific disciplines, informatics undergoes substantial technical and scientific changes and shifts of paradigms even at the basic level taught in secondary school. Moreover, informatics education is under more stringent observation from parents, potential employers, and policy makers than other disciplines. It is considered to be a modern discipline. Hence, being well-educated in informatics seemingly ensures good job perspectives. Further, policy makers pay attention to informatics education, hoping that a young population well-educated in this modern technology will contribute to the future wealth of the nation. But are such high aspirations justified? What should school aim at in order to live up to such expectations?

ISSEP 2005, the 1st International Conference on Informatics in Secondary Schools – Evolution and Perspectives already showed that informatics teachers have to bridge a wide gap [1, 2]. On one hand, they have to show the inherent properties that informatics (or computer science) can contribute to general education. On the other hand, they are to make pupils computer literate. Under the constraint of limited time available for instruction, these different educational aims come into conflict.

Computer-supported teaching or eLearning is to be considered distinct from informatics education. However, in many countries, informatics teachers still have to support the eTeaching activities of their colleagues. They might even be the only ones to support eLearning. But even in situations where teachers of other subject areas are sufficiently computer literate to use computer support in their own courses, they will expect students to arrive already technically prepared by informatics courses.

Considering this spectrum, the program of the 2nd International Conference on Informatics in Secondary Schools – Evolution and Perspectives, ISSEP 2006, was mainly structured into discussions on what and how to teach. Those aiming at educating "informatics proper" by showing the beauty of the discipline, hoping to create interest in a later professional career in computing, will give answers different from the opinion of those who want to familiarize pupils with the basics of ICT in order to achieve computer literacy for the young generation. Addressing eLearning aspects as seen from the perspective of informatics didactics are another only moderately related set of issues. This spread of topics raises the question of what is a proper examination to assess students' performance. Furthermore, one has to see that school-informatics is still (and will remain in the foreseeable future) a subject in transition. Hence, teacher's education was also in the focus of ISSEP 2006. Consequently, the selection of papers contained in these proceedings address the topics just mentioned. Further discussions of these and related topics are covered in "*Information Technologies at Schools*" [3], the remaining part of the proceedings of ISSEP 2006.

The 29 papers contained in this volume were selected out of a total of 204 submissions and invited contributions. The accompanying volume [3] contains 70

scientific papers. Some 50 rather school-practical contributions targeted for the "Lithuanian Teachers Session" are made available on a CD (in Lithuanian) [4]. Each scientific paper was reviewed by at least three members of the Program Committee. The reviewing process and the ensuing discussion were fully electronic.

This volume, although consisting mainly of contributed papers, is nevertheless the result of an arrangement of papers aiming in their final versions to contribute to the specific facet of the program they were accepted for. The remainder of this preface shows how they contribute to the various facets of the conference.

The core of papers contained in this volume center on the *tension between* making pupils familiar with the *fundamental ideas* upon which the discipline of informatics rests, following an aim similar to education in physics or chemistry, *and ICT* or *computer literacy* instruction. *Dagienė, Dzemyda, and Sapagovas* open this series of papers by reporting the development of informatics education in Lithuania. Due to the political and related social changes in this country, the differences as well as the similarities to developments in other countries are of particular interest. The following papers address the issue of familiarizing students with informatics fundamentals from very different angles. *Kalaš* describes a course where a Logo-platform supports explorative learning. Specific focus is given on (behavioral) modeling, visualizations of fractions, and biological growth. From the different examples, students can identify structure and finally develop algorithmic problem-solving skills. *Hromkovič* describes his approach of relating the beauty of informatics to students attending a course supplementary to general school education. The paper presents the rationale behind kindling pupils' interest in informatics as a distinct science and explains related didactical aspects. Still at the "high end" of informatics education is the extra-curricular program described by *Yehezkel and Haberman*. Departing from the assumption that in general teachers lack experience and credibility as professional software developers, the authors developed a program where graduates from secondary level schools work on a real project under the mentorship of professional software developers.

In order not to lose focus, the paper by *Szlávi and Zsakó* contrasts two aspects of informatics education: the aim to teach future users of IT-systems and the aim to educate future programmers. The presentation is stratified according to educational aims attainable at particular age levels. In spite of the contrasts highlighted by this paper, *Antonitsch* shows that there are bridges between teaching applications and teaching fundamental concepts. His paper, based on a database application, can be seen as a continuation of bridging approaches reported by Voss (departing from text-processing) and by Antonitsch (departing from spreadsheet-modeling) at ISSEP 2005 [1]. Raising the student's curiosity by showing informatics' concepts in such varied disciplines as mathematics, biology, and art is the subject of *Sendova's* paper. Her approach ensures a low entrance-barrier, but still leads to elementary algorithmic and programming skills.

Clark and Boyle analyze the developments in English schools. Although the British school system differs quite a bit from its continental counterpart, the trends identified by analyzing developments form 1969 onwards find their analogs in most other countries that introduced formal informatics education. Special consideration might be given to their projection into the future. Currently, we still live in a situation where most parents are not computer literate. But this deficiency will gradually vanish

during the years to come. How should school react to a situation when pupils become computer literate following their parents' or their peers' IT-related activities?

The selection of papers on fundamentals is terminated by the work of *Haberman*. It directly leads into both the section on programming and the section on ICT. Specifically, Habermann focuses on the educational milieu and on a gap in perception as to what computing (informatics) is all about. Perhaps resolving this terminological issue, as it has been resolved in distinguishing between learning basic arithmetic (calculating) and mathematics, might solve some public misunderstandings and related problems.

The papers in the initial part of the proceedings focus on the question of *"What to teach?"* To a varying extent they address this question in the context of constrained time to provide the respective qualifications to students. The succeeding set of papers addresses didactical issues of a core aspect of instruction about informatics proper, i.e., *programming and algorithms*. The key question there is: "*How to teach (programming)?*" This part of the proceedings is opened by *Hubwieser,* who explains how object-oriented programming was introduced in the context of a situation where the overall time for informatics education was restricted with respect to initial plans. While Hubwieser's approach for Bavaria foresees a focus on object-oriented software, the paper of *Weigend* addresses three basic issues related to the problem that the capability of performing a task (procedural intuition) is still insufficient for being able to formulate the individual steps necessary to conduct this task (e.g., to write a program). A Python-based system is proposed to overcome this mental barrier. But the problem of finding an appropriate algorithm has many facets. *Ginat* shows the dangers of focusing exclusively on the mainstream strategy of divide-and-conquer for solving algorithmic problems. He points to examples where a global perspective is necessary for obtaining a correct and efficient solution. One might perceive of this paper as a counterpoint to mainstream teaching. It makes teachers and students aware that problem solving needs a rich repertoire of strategies and recipes. There is no once-and-for-all solution.

Kurebayashi, Kamada, and Kanemune report on an experiment involving 14- to 15-year-old pupils in programming simple robots. The authors' approach combines playful elements with serious programming. It is interesting to see that their experiments showed the particular usefulness of this approach for pupils with learning deficiencies.

The master class in software engineering described by *Verhoeff* attaches well to the approaches followed by Hromkovič and by Yehezkel and Haberman. Pupils are invited to this extra-curricular master course which is co-operatively taught at school and at university. The approach of having students complete a small programming project in a professional manner is described in detail. Another concept of a pre-university course to foster algorithmic thinking is described by *Futschek*. He gives three specific examples that can be studied with young people transiting from school to university.

Laucius presents a socio-linguistic issue. While English is the language of computing, one cannot assume too much previous knowledge of this language with pupils if – as for most countries – English is a foreign language. In the case that the local language uses even a different character set, problems are aggravated. Hence, this issue is addressed in several papers by Lithuanian authors. The critical question,

however, might be how far one should go in localizing computer science. The "foreign" language is definitely a hurdle. However, controlled use of the foreign language allows one to clearly separate between object-language and meta-language. To close this circle, the paper by *Salanci* returns to object-oriented programming by presenting an approach for a very smooth, stepwise introduction to working with software-objects.

Papers on *ICT instruction* constitute the ensuing part of the proceedings. They can be seen as a companion to the discussion presented so far. *Micheuz* discusses the selection of topics to be covered in ICT lessons from the perspective of an increasing autonomy within a school system that is at the same time burdened by new constraints (reductions) on the number of courses it may offer. It is interesting to note that an "invisible hand" managed to ensure convergence of the topics finally covered. SeungWook Yoo et al. explain how adoption of model curricula helped to solve problems in informatics education in Korea. *Syslo and Kwiatkowska* conclude this set of papers by noting that the link between mathematics education and informatics education is essentially bi-directional. However, in most current school-books only one of these directions is made explicit. The paper presents some examples where mathematics education could benefit from adopting concepts of informatics.

The widely discussed topics of school informatics addressed so far need context. This context is to be found in the relationships between (maturity) *exams* and informatics instruction, as addressed by *Blonskis and Dagienė*. With the wealth of extra-curricular activities and competitions such as the International Olympiad in Informatics, the question of proper scoring, notably the issue of arriving at a scoring scheme that is not de-motivating to those who are not victorious, becomes of interest. *Kemkes, Vasiga, and Cormack* propose a weighting scheme for automatic test assessments. Their results are generally applicable in situations where many programs are to be graded in a standardized manner and assessments are strictly functionality-based.

Teachers' education and school development is a different contextual aspect. *Markauskaite, Goodwin, Reid, and Reimann* address the challenges of providing good ICT courses for pre-service teachers. The phenomenon of different pre-knowledge is a well-known didactical problem when familiarizing pupils with ICT concepts. This problem is aggravated in educating future teachers. Some of them will be recent graduates – possibly even with moderate motivation to learn (and use) ICT – while others might look back on a non-educational professional career that may have involved already substantial contact with computing. Special recommendations of how to cope with this problem are given. The focus of *Butler, Strohecker, and Martin* is, in contrast, on teachers that are already experienced in their profession but follow a rather traditional style of teaching. By entering a collaborative project with their pupils, constructivist teaching principles can be brought into practice. Moreover, changes in the teacher's and students' roles become noticeable. The ensuing open style of learning is appreciated by all parties of the school system and the approach spreads quite well throughout Ireland.

The proceedings conclude with contributions related to *eLearning*. *Kahn, Noss, Hoyles, and Jones* report on their environment supporting layered learning. This environment allows pupils to construct games where the outcome depends on proper application of physical principles by the student-players. Enriching the model, one

can increase the depth concerning physics instruction. But the layered approach also allows one to manipulate games in such a way that finally (fragments of) programs can be written by the students.

ePortfolios currently attract a lot of attention in didactical circles. *Hartnell-Young's* paper is a worthwhile contribution to this debate, as it presents results from four schools and a special cluster, each with different aims targeted specifically for the student population to be supported. In any case, scope and aspirations were limited but results were encouraging. The paper might well serve as a warning for those who believe a particular ePortfolio can satisfy all those goodies portfolios can support in principle. Remaining at the level of meta-cognition, *Giuseppe Chiazzese et a*l. present a tool that makes students aware of the activities (partly subconsciously) perfomed while surfing the Web. Pursuing these ideas further, a transition from computer literacy to Web literacy might be finally achieved at school.

The proceedings conclude with two papers referring to aspects of internationalizing and localizing instructional software. *Targamadzė and Cibulskis* describe the development of the Lithuanian Distance Education Network, a project pursued on the European international level. *Jevsikova* provides a detailed list of issues to be observed when one prepares courseware intended for use on an international level.

A conference like this is not possible without many hands and brains working for it and without the financial support of graceful donors. Hence, I would like to thank particular in the General Chair and the members of the Program Committee, notably those who were keen to review late arrivals as well as those colleagues who provided additional reviews. Special thanks are due to the Organizing Committee led by Roma Žakaitienė and Gintautas Dzemyda. Karin Hodnigg deserves credit for operating the electronic support of the submission and reviewing process, Annette Lippitsch for editorial support for these proceedings.

The conference was made possible due to the support of several sponsors whose help is gratefully acknowledged. Printing and wide distribution of its two volumes of proceedings were made possible due to a substantial contribution by the Goverment of the Republic of Lithuania, and the Ministry of Education and Science of Lithuania. Finally, hosting of the conference by Seimas, the Lithuanian Parliament, is gratefully acknowledged.

November 2006 Roland Mittermeir

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Main Sponsors

ISSEP 2006 and the publication of its proceedings were supported by the Government of the Republic of Lithuania, and Ministry of Education and Science of the Republic of Lithuania.

Table of Contents

The Spectrum of Informatics Education

Teaching Algorithmics and Programming

The Role of ICT-Education

Exams and Competitions

Teacher Education and School Development

eLearning