Preface

SECIII – Social, Ethical and Cognitive Issues of Informatics and ICT

Welcome to the post-conference book of SECIII, the IFIP Open Conference on Social, Ethical and Cognitive Issues of Informatics and ICT (Information and Communication Technology) which took place from July 22-26, 2002 at the University of Dortmund, Germany, in co-operation with the German computer society (Gesellschaft für Informatik). Unlike most international conferences, those organised within the IFIP education community are active events. This wasn't a dry academic conference – teachers, lecturers and curriculum experts, policy makers, researchers and manufacturers mingled and worked together to explore, reflect and discuss social, ethical and cognitive issues. The added value lies in what they, the participants, took away in new ideas for future research and practice, and in the new networks that were formed, both virtual and real.

In addition to Keynote Addresses and Paper Presentations from international authors, there were Provocative Paper sessions, Case Studies, Focussed Debates and Creative Exchange sessions as well as professional Working Groups who debated particular themes. The Focussed Debate sessions helped to stimulate the sense of engagement among conference participants. A Market Place with follow-up Working Groups was a positive highlight and galvanised participants to produce interesting reports. These were presented to the conference on its last day. Cross-fertilisation between the papers generated some surprising and useful cross-referencing and a plethora of social, ethical and cognitive issues emerged in the discussions that followed the paper presentations.

As the Patroness of SECIII, the Federal Minister of Education and Research, Edelgard Bulmahn, commented: "Information and communication technologies (ICT) increasingly enter all industrial and service sectors – not only in Germany, but world wide. The rapid development has led to a large supply of highly qualified jobs and a shortage of skilled manpower. We are all facing similar challenges which are reflected in the concept of this meeting: How can we support young people's, and especially young women's, interest in studies and vocational training in the ICT professions? How can we create reliable systems providing effective protection against misuse, thus building trust? What contributions can collaboration between educational institutions and industry make? How can we make sure that the potential of information and communication technologies will benefit all; how can we prevent a divide between an 'information elite' on the one hand and the less informed people on the other?"

As mentioned SECIII was an interactive conference in which these and many other questions and issues were raised and discussed. For example, in the Provocative Paper sessions the following issues were debated:

- One notebook per teacher: A sustainable concept for a wide ICT integration in school, Beat Döbeli Honegger and Marc Pilloud;
- Computer science as a profession in Germany: An academic perspective, Esther Ruiz Ben and Britta Schinzel;
- Practical use of multi-media in teacher training, Friedhelm Schumacher;
- Ethical apprenticeships?, Barry Blakeley;
- Paradigm shift on education through thematic modelling under object oriented support, Clara Amélia de Olivera.

In the Market Place conference participants presented views, materials and ideas on whiteboards for discussion with interested colleagues. This provided input for various Working Groups that were active during the conference. On the final day of the conference each Working Group gave a short presentation on the results of their work. All of the reports of the Working Groups have been included in this book. The results from the groups show strong convergence with the issues to be discussed at the forthcoming World Summit on the Information Society (WSIS Geneva 2003) [http://www.itu.int/wsis/]

The SECIII conference was held on the large, modern campus of the University of Dortmund. The university has about 25 thousand students and offers more than 30 Masters programmes, from mathematics to journalism. Teacher education is offered at all levels. With 3,500 students the Department of Computer Science is Germany's largest Computer Science department. It offers theoretical and applied programmes as well as teacher education programmes in Computer Science.

The campus of the University of Dortmund is located close to the successful Technology Park where the 'Dortmund-Project' helps to set up new anchor industries in information and communication technologies, micro-system engineering and e-logistics. With the disappearance of heavy industry from Dortmund, research and technological innovation are the new raw materials of the region's economy.

Conference Organisation

That this conference attracted such a large number of interested academics and ran so smoothly is a credit to all of the people involved in organising SECIII - IFIP, the International Programme Committee and the National Organising Committee.

The IFIP Contribution

Two IFIP Working Groups adopted the organisation of the programme of SECIII:

- Working Group 3.1 on Secondary Education, Chair: Deryn Watson,
- Working Group 3.2 on Higher Education, Chair Tom van Weert (past)/ Joe Turner (present).

More information on IFIP and its Working Groups can be found on: http://www.ifip.or.at

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The Conference Themes

Within the broad title for the SECIII conference four themes were identified as being of critical importance. The keynote presentations, contributed papers and working group debates all focused on these themes.

The e-literate society – the role of informatics, computer science and ICT

Everybody should be taught, should know and should understand key principles and acquire a range of transferable skills, which would help them to use the technologies of today as well as the technologies of the future. This would help to resolve many of the equity issues which exist in society, e.g. access to technology and information, equal opportunities for men and women, disadvantaged groups, loss of cultural richness and diversity. What role could the educational system play in determining the knowledge and skills and creating a more equitable society? What criteria should be developed to measure and evaluate success in this field?

ICT – agent of change and social conflict

The rapid development of ICT has led to many conflicts in society and sharpened specific issues: unemployment, differential access to information, cyber crime, the generation gap, North-South divide. On the other hand it offers promising perspectives: ICT has dramatically transformed our daily life and work, new professions are emerging, new economic frameworks are developing. New educational initiatives, such as life long learning and multimedia, have been formulated. Should education be making students aware of these issues by exploring ways in which these could be resolved? How can education increase social responsibility and integrate it into learning? Will society have to accept crime (e.g. on the Internet), social disorder and disadvantage and how can education of computer scientists produce socially responsible persons? Can the agent of change and social conflict be harnessed to resolve these problems?

E-learning – meeting the challenge of technology on society through new partnerships

Educators, teachers, trainers and their students are expected to use ICT in more imaginative ways in all aspects of teaching and learning. In facing up to this, new partnerships are being established e.g. between schools and industry (in creating courseware and teaching modules), between different educational institutions (in developing online-courses) or between local social groups to engage persons currently outside the computer community. In all cases e-learning offers new experiences to education and poses the challenge of developing new tools like authoring systems, intelligent tutor agents, and co-operative and collaborative learning environments that shall realise the potential of ICT.

Paradigm shifts in education and professional life

New technologies offer new possibilities for teaching. Education must develop a new paradigm to accommodate the technologies and these possibilities. It's important to integrate the impact of technology on society, but generally educators are not well prepared or motivated to explore issues associated with law, ethics or media education. What tools, what content, what experiences and what resources should be designed to help shape the new paradigm of didactics of computing and what concepts should be adopted?

The Conference Proceedings

The structure of this book was relatively obvious. The Keynote Sessions were all about generating and stimulating debate that lasted throughout SECIII. Without exception the Keynotes were extremely successful, sparking discussion - even argument - and forging partnerships and small groups who explored controversial issues in great detail and then shared their conclusions readily with all conference attendees.

We decided that the first section of the book should present all of the Keynote papers and that it would be valuable to present the international papers associated with each of the four themes, organised into their sub-topics. The final section of the book should present the reports from the Professional Working Groups. Importantly these Reports provide paths down which development of issues might proceed or ways in which specific problem issues might be best addressed.

SECIII Conference Proceedings therefore takes the following form:

1. INTRODUCTION

When speaking about computers and ethics everybody quotes James Moor:

"computer ethics is the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology." (Moor 1985)

Without mentioning specific ethical issues, Moor insisted that computer ethics must involve technology and substantial scientific and technological evaluation. In his perspective it is difficult to make a clear distinction between computer ethics and computers and society issues. Other influential authors were Deborah Johnson (Johnson 1985; 1994; 2001) and Joseph Weizenbaum. The latter explicitly touched upon the question of ethics, indicating the types of research that he would not undertake, except after careful consideration and with defined limits (Weizenbaum 1976). Similar preoccupation was noted in the ACM Computing Classification Systems under 'Computing Profession' - but the word ethics does not appear explicitly before 1991. Amongst curriculum proposals, an ACM/IEEE-CS Task Force in 1991 proposed a specific module on 'Social, Ethical, and Professional Issues' covering topics like the historical and social context of computing, responsibilities of the computing professional, and intellectual property rights (ACM/IEEE-CS 1990). Other modules have been added in the 2001 ACM/IEEE-CS proposal (ACM/IEEE-CS 2001).

In this paper, I will initially consider the most recent proposals of curricula, which are the structure that specialists find suitable for the field of *Ethics of computing* (my preferred term). I will then confront, from experience that we have in IFIP since 1988, theory and practice, and derive recommendations for defining the most urgent ethical issues in computing today, and those considered worthy of a specific educational programme. I will outline the main themes that appear in textbooks and reflect current thinking. IFIP is an academic and professional body and my reflection will be mostly at that level.

2. RECENT STRUCTURED PROPOSALS IN CURRICULA FOR COMPUTER SCIENTISTS

The widely publicised report 'Consequences of Computing: A Framework for Teaching the Social and Ethical Impact of Computing' tries to link the topics of ethical analysis and the levels of social analysis (ImpactCS 1996).

The proposal exhibits certain weaknesses - the heterogeneity of some categories in the levels of social and the unclear distinction between responsibility and ethical issues (Berleur 1996). Nevertheless, their grid, which is proposed for different technologies such as Electronic Communication, Medical Technology and Artificial Intelligence, helps teachers and students remain open-minded about the main issues associated with specific uses of ICT. It allows the mapping of Levels of Social Analysis (individuals, communities and groups, organisations, cultures, instiutional sectors, nations and global) against a range of Topics of Ethical Analysis (responsibilities and ethical issues). The main idea is that in discussing problems people may acquire desirable social and ethical skills. However, the ethical issues which are covered: individual and professional responsibilities, and more specifically quality of life, use of power, risks and reliability, property rights, privacy, equity and access, honesty and deception, are in a way privileged. I recognise that most of those issues have an ethical content, but I do not know why those categories were chosen and not others.

Table 1. Social and professional issues

ITEM	TOPIC	HOURS
SP1	History of computing	1
SP2	Social context of computing	3
SP3	Methods and tools of analysis	2
SP4	Professional and ethical responsibilities	3
SP5	Risks/liabilities of computer-based systems	2
SP6	Intellectual property	3
SP7	Privacy and civil liberties	2
SP8	Computer crime	
SP9	Economic issues in computing	
SP10	Philosophical frameworks	

In 'Computing Curricula 2001', the Social and Professional Issues identified in 1991 have been considerably expanded, although they represent only 16 of the 280 core hours (ACM/IEEE-CS 2001). They are shown in Table 1. Even the last three categories, although very important, are elective hours.

These two curriculum examples illustrate the convergence of opinion about the key topics associated with the ethics of computing: professional and ethical responsibilities, risks and liabilities (and reliability), intellectual property, and privacy and civil liberties.

To complement this overview, Table 2 illustrates the topics covered in eleven Handbooks since 1985, Moor's publication date (Johnson 1985; 1995; 2001), (Ermann 1990), (Kallman 1993), (Forester 1994), (Oz 1994), (Johnson-Nissenbaum 1995), (Kizza 1998), (Spinello 2000), (Langford 2000).

Table 2. Books on ethics of computing

TOPIC	Included in HANDBOOKS
Privacy and security	10
Theory	9
Software ownership, Copyright, IPR	8
Liabilities (Defective programs)	7
Codes and Professional ethics	7
Legal issues	5
Computer crime	4
Hacking, Viruses	4
Power, Democracy	4
Quality of worklife	3
Justice (distribution of work) - Employment , Third World, AI	3
Whistle blowing	2
AI, Expert systems	2
Networked world	2
Free speech, Control of content	2
Internet Governance and regulation	1
Quality of personal life	1
Strategic Defence Initiative (SDI)	1
Risks of computing	1
Pornography	1
Encryption	1
Netiquette	1
Digital divide	1

If we consider the top categories, which appear in more than half of these books, it is obvious that the ethical issues which are perceived today as the most important may be summarised as follows (Table 3):

Table 3. Quoted ethical concerns

Broad Issue	Specific issue
Classical	Privacy
Classical	Risks and security
Classical	Intellectual property rights
Classical	Responsibility, reliability and liability in designing information systems or software
Classical	Professional codes of ethics or of conduct
Classical	Computer crime
Recent Internet-related	Equity of access
Recent Internet-related	Digital divide
Recent Internet-related	Pornography
Recent Internet-related	Netiquette

Informatics - The Science of Minimal Systems with Maximal Complexity

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Key words: Fundamental Ideas, Curriculum Research, Minimalism, Construction Kit

Abstract: It is a fundamental idea of computer science to search for, define, analyze, and operate with construction kits consisting of small sets of basic building blocks and a small number of operations to combine the building blocks to larger objects. While the construction kit is mostly simple, it often defines a vast, complex field that consists of all possible objects that can be built from the building blocks by using any (finite) sequence of combinations of operators. This idea affects and structures many areas of computer science. We present examples from several fields, including imperative and functional programming languages, computable functions, Turing and register machines, Boolean functions, data types, object-oriented programming, characterisations of formal languages along with examples from other disciplines. How can informatics lessons profit? If lessons are oriented towards a fundamental idea, the idea may explain, structure, and integrate many different informatics subjects and phenomena by a single recurring scheme. On the other hand, the construction kit principle belongs to the sphere of everyday thinking so students already have a basic intuition of the concept which may enhance their understanding when entering any field where the idea applies.

1. INTRODUCTION

In recent years we have elaborated Bruner's concept of fundamental ideas and made it accessible for informatics lessons (Bruner 1960). Here we

consider in detail a fundamental idea of computer science - orthogonalization - and show that it has a wide area of application and may guide many fields of school informatics.

By *orthogonalization* of a field Δ, following a term in linear algebra, we denote the definition of a number of basic elements Δ_e of the field along with a set K of operations ($K=\{K_1,...,K_n\}$, n small) on the basis each as small and simple as possible, such that every other object of the field may be generated by finitely many applications of operations on the basic elements (Figure 1). The result is a minimal generating system $B=(\Delta_e,K)$, consisting of the basis and the operations, that may be considered as a construction kit for the field.

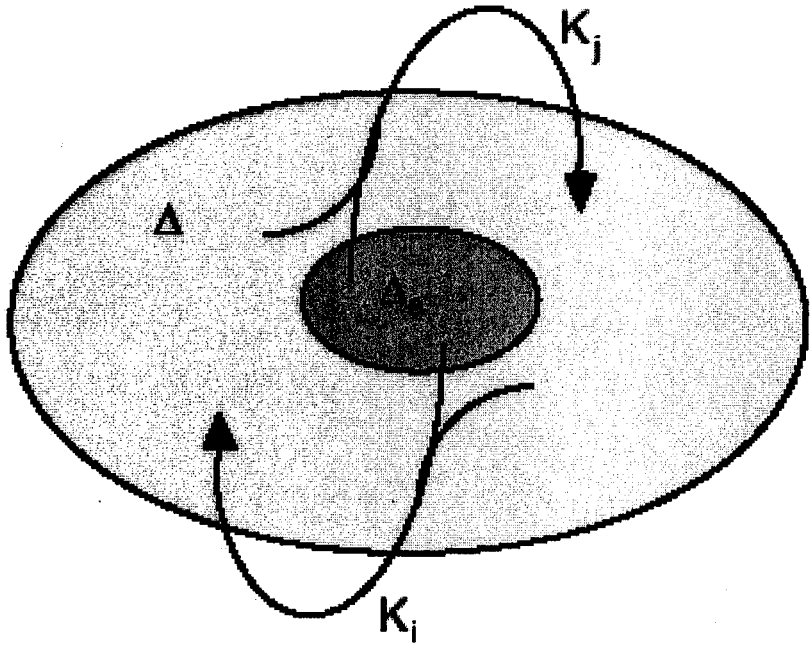

Figure 1. Principle of construction kits

We analyse orthogonalization with respect to didactic criteria and illustrate its relevance by presenting examples and applications in several areas of informatics.

We use the term *complex* to denote systems that are vast and diverse in their inner structure, while we call descriptions of systems *complicated* if they are vast and varied and hard to grasp. There is no direct relationship between the complexity of a system and the complication of its description. While the system, particularly a real life system, may be complex in nature,

it may have a simple, short description. We must avoid complicated descriptions if the systems are simple, and search for descriptions as minimal as possible if the systems are complex, to be able to understand, master, or manage them.

2. BACKGROUND

In 1960 Bruner formulated the teaching principle that lessons should predominantly orient towards the structure (the so-called *fundamental ideas*) of science. In recent years we have adopted the concept, made it and the relevant notions precise, and transferred it to informatics lessons by defining fundamental ideas of informatics (including algorithmization, structural dissection, (artificial) languages and orthogonalization). We have also proposed lessons suitable for teaching certain ideas in school (Schwill 1993; Schwill 1997).

We define a fundamental idea as a schema for thinking, acting, describing or explaining which satisfies the following criteria:

Horizontal Criterion. A fundamental idea is applicable or observable in multiple ways and in different areas of informatics. It organizes and integrates a wealth of phenomena.

Vertical Criterion. A fundamental idea may be demonstrated and taught on every intellectual level - "any subject can be taught effectively in some intellectually honest form to any child at any stage of development" (Bruner 1960). A central methodological means guiding the education of fundamental ideas on different levels of understanding is the *spiral principle.* This recommends three representations of concepts to be learned - *enactive* (lower level), *iconic* (medium level), and *symbolic* (highest level).

Criterion of Time. A fundamental idea can be clearly observed in the historical development of computer science and will stay relevant in the future. Importantly lessons based on fundamental ideas will not become dated as quickly as conventional lessons - a major advantage in teaching informatics which exhibits such dynamic evolution.

Criterion of Sense. A fundamental idea has meaning in everyday life and is related to ordinary language and thinking. Only a precise definition turns an idea "with sense" into an exact concept "without sense". When we teach a fundamental idea early in the student's schooling, we may give a first impression of the idea by using everyday situations as starting points for lessons.

ICT in Education: Aspirations and Tensions

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Key words: Education, Future, ICT, Learning Models, Policy Makers, Recommendations

Abstract: Eight 'axes of tension', around which developments in the exploitation of ICT will revolve to achieve aspirations for schooling, are identified and explored in this paper. Possible interactions between these tensions and aspirations with the educational promises held out by the technology and constraints on change and innovation are illustrated with three main scenarios to portray possible futures for schooling. The main aims of the paper are to motivate and direct debate, and to provide access to a framework that others may use to etch out and explore their own preferred visions for the future of education.

1. INTRODUCTION: THE THINK PROJECT

Initiated by the European Schoolnet (EUN) and sponsored by the European Commission, the THINK project was designed to articulate and explore policy options in six national contexts, and an EU-wide one, for the exploitation of ICT to develop and strengthen school systems (Wood, 2002). The focus was on future educational *uses* of ICT, not provision of technical infrastructure. The time scale to be envisaged was short - three to five years.

Four scenarios were identified:

In **scenario 1**, ICT serves to augment the centralised control of all aspects of schooling, strengthening state regulation of curricula goals, content, delivery, pedagogy, formative and summative assessment, accreditation and finance.

In **scenario 2**, policy makers acknowledge the fundamental uncertainty concerning the nature of the impact of ICT on learning and teaching processes. Any state controls are relaxed to engender and support a research and development role for teachers and schools. Schools strive to become knowledge producers and learning organisations.

In **scenario 3**, the most radical future, the role of schools as organisations designed to promote learning how to learn, responsible citizenship and as key nodes in new communities is brought to the fore as their function for knowledge transmission is downplayed.

A **4th scenario**, in which ICT fails to deliver and 'melts down', considers various possible failures in policy (in)actions that undermine attempts to innovate with ICT.

The first three scenarios overlap with those etched out over a much longer time horizon by OECD (2000; 2001). The THINK project thus provides a means of mapping aspects of policy options for the short-term future onto potential longer-term changes in school systems.

2. AXES OF TENSION

When ICT becomes mission critical for educational systems, several processes will be set in chain that will generate new tensions and dilemmas for schools and education authorities. The main dynamics driving innovation in schooling stem from strategies adopted to resolve a set of "axes of tension" created by the impact of the technology on learning.

2.1 Axis 1 - Innovation with ICT is inhibited and stifled by failure to re-think the curriculum.

Propositions: The definition of what is worth knowing and the skills and tools implicated in what it is to be knowledgeable are being transformed by the impact of technology on all aspects of professional, vocational, private and public life. There is a growing tension, and an inherent contradiction, between demands for radical change in educational priorities and processes and the expectations and goals embodied in school curricula.

The current trend is simply to pile new learning objectives and teaching responsibilities on top of the traditional ones. This creates an unnecessarily heavy load, undue stress and a confusion of aims for schools.

In scenario 1, this tension is refuted. The belief is that the curriculum can remain relatively intact, although there is some extension of the educational pathways available in the later years of schooling. The view taken is that

through appropriate changes in pedagogical practice schools can achieve both the old and the new priorities.

In scenario 2, the tension is accepted. A strategy is developed that preserves a core of traditional curricula goals and assessments but also creates significant space for innovation. School achievement is assessed by two independent means. One is based on national examination and the second on innovative, school-based assessments. Schools have the task of innovating in order to meet the new educational priorities.

In scenario 3, the traditional conception of school learning as primarily concerned with the mastery of a pre-determined body of knowledge is rejected. The overarching objective is to create and develop a system in which schools become the core centres of community life and the development of skills in self-managed learning, critical thinking and responsible citizenship form the major goals of schooling. Decision-making about specific educational goals, strategies and practices are primarily the responsibility of the school and its community. Their task is to translate overall priorities for education into practice. ICT networking is exploited to engage the expertise of different communities in new ways of assessing the value and impact of innovative approaches to learning and teaching.

2.2 Axis 2 - Innovation with ICT fails, being inhibited and stifled by a failure to capture the imagination and support of parents and the public.

Propositions: A tension exists between the need for radical change demanded by educational policy and the majority sentiments of parents, the media and the electorate. Attempts at educational reform are currently ignoring this tension, remaining too inward looking and failing to exploit the technology to modernise the policy making process itself.

In scenario 1, this tension is not acute in the short term since the curriculum and examinations reflect the status quo and have majority support. Investment in ICT and in teacher training rests on the promise that it will enable the extended educational priorities to be realised through improved teaching and learning. ICT networking is used widely in attempts to maintain the support and educational involvement of parents.

In scenario 2, public confidence will be supported by the fact that recognisable elements of the traditional curriculum and certification are maintained in the early stages of reform. Strategies to capture the public imagination and support include the use of networking to communicate and disseminate innovative uses of ICT for teaching and learning identified in the course of peer assessment by teachers.