Teaching Informatics as a Subject

1 Introduction

The following theses concern the teaching of informatics, which is synonymous to the teaching of the basic concepts of information technologies. We are not discussing the use of information and communication technologies across curriculum.

2 Why should we teach informatics?

Modern information and communication (particularly internet and multimedia) technologies (IT) are more and more dominating our private sphere as well as our social and working environment. They are changing the way we think, way we talk, the way we watch our world, shortly: they are affecting the foundations of our society. Therefore the schools are facing the task to enable their students

1. to make use of these technologies in an economical and efficient way as well as
2. to control and judge their consequences.

The teaching of user skills meets some serious obstacles, as there are:

1. there is a broad variety of different user interfaces: different systems often expect very different sequences of actions to perform the same work routine. It is not possible to train on all possible systems.
2. the outlook of the systems is changing very fast: what fits today is not working tomorrow. Nobody can to foresee which user interfaces will be the fashion in the coming year.

To control and judge the consequences of the rapid evolution of IT means to understand at least in principle the way they are constructed and the way they work, because it is equivalent with the ability to assess their inherent possibilities. [FR95]

Thus we have shown that we have to teach the basic concepts of modern information and communication technologies: the students should learn

1. to build proper mental models of the systems that explain their peculiarities [BB89],
2. to look at them as universal, complex tools, feeling no emotions, suspecting no mysteries.

This has to be done by teachers who are carefully and specifically educated in informatics which means that they have completed a particular course of
studies at university. [FR96] This is impossible to guarantee in the case that informatics is
teach within other subjects.

3 What should we teach in informatics ?

The raw material of all information- and communication technologies is information. Every
treatment of information follows the same process pattern:

1. The first requirement of any operation is a suitable representation of the informations:
a proper model of a real life situation or a proposed system is formed and described
by adequate means, data structures are constructed and realized, a message is encoded
following the rules of an communication protocol.

2. Once there is such a representation, it is possible to change it (information processing)
or exchange it (communication): a system model is improved by refinement or
abstraction, data structures are changed by an algorithm that has to be constructed and
encoded to make it runnable, datagrams are exchanged.

3. After (ex-) changing the representation it has to be interpreted in order to produce
informations that are entirely new or that were not yet known at this particular place or
by this particular subject: the system model is interpreted by a programmer, the state
of a data structure causes some output on the screen, an electronic mail is read.

The described pattern induces the range of contents we propose to teach: techniques and
concepts of representation, processing and interpretation of representations.

Not every subject is teachable in schools: following Bruner [BRU60, BRU66, SCH96] we
have to observe at least three principles:

1. generality: the concepts should be applicable or observable in multiple ways and
different areas,
2. durability: what is taught today should be relevant at least for some years in the
future
3. teachability: of course we have to take into accounts the students abstraction level and
specific abilities related to their particular age.

The results of these reflections is a set of concepts that form the skeleton of our proposed
curriculum [for details see also HBB97, HB96]:

1. Modeling techniques: precise description of complex systems by diagrams concerning
decomposition, subsystems, data flows, message sequences, states and transitions,
causal relationships
2. typical data structures as objects of information processing: atomic types, sequences,
records and variant records
3. typical applications of these structures: representation of arrays, relations, graphs, trees
and typical data structures of standard software
4. fundamental strategies of problem solving: “divide et impera”, top-down, bottom up,
algorithmic, rule-based, object oriented strategies
5. algorithms and their description by programming languages: atomic structures of
algorithms handling sequences and trees, searching in networks (graphs),
fundamentals of programming languages
6. local and global networks: description by graph, typical topologies
7. basic concepts of communication: addressing techniques, protocol stacks, services of
computer networks,
8. synchronisation of parallel processes: common data structures (semaphores),
monitoring, handling of deadlocks, problems of consistency
9. assessment of representations, systems and solutions: borders of computability, basics
of cost-benefit analysis, manipulation of data

10. problems data protection: legal situation, management of data access, encryption techniques

4 How should we teach informatics?

We base our methodical approach on the psychological concepts of cognitive flexibility [SJ90] and cognitive networks [AN85]. Above all we demand to arrange the lessons around larger project sequences. We propose to follow the process of modeling and simulation, using adapted methods of modern software engineering [see BRO95, BFG93, BO94, JA91, RBP91]:

1. The teacher selects a problem to be solved or a real life system to be simulated. It should be as close to the students experience of life as possible in order to illustrate the concepts. The complexity has to be high enough to prevent solutions by naive, intuitive means. This will motivate the students to learn and use new techniques.

2. The starting point of the real project forms an informal description of the problem. Hereby the students are forced to close reflections on the problem.

3. This step represents the most important learning process: we construct a (as much as possible formalized) model of the situation, using adequate description techniques.

4. Basing on the model we construct a realization of our solution respective a simulation of the system, aiming to illustrate and check our model. According to the students interests this will be the most popular part of the project.

5. In conclusion of the project we review all our work: the correspondance between informal description, model and simulation is inspected, the cost-benefit analysis is performed, the consequences of our solution are judged, we think about possible improvements.

5 References


