

Modernism, an Ethical Challenge for Informatics Education

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Abstract

Informatics as subject taught in school underwent a number of changes. Trends in the computer market and technological changes often served as change drivers. Such external stimuli are rather unique among school subjects. Consequently, change processes follow different lines of argument than in classical school-subjects. The paper addresses these differences, considering them from the perspective of the subject and its variations, the subjects contribution to general educational aims, as well as from a meta-cognitive perspective concerning economic and social aspects.

Keywords

informatics in school, curriculum design, CS-for-All, ICT, computational thinking, social and ethical aspects of education.

MOTIVATION

A key motivation for reflecting on meta-cognitive aspects of informatics in school stems from the fact that concepts related to informatics enter instructional programs at progressively lower grades. The author's role as scientific lead of a regional center for improving informatics instruction and raising pupils' interest in informatics provided further motivation to reflect on curricular prescriptions for the different age groups concerned. As this center is to be run under the supervision four heterogeneous parties (local university, local university for teacher education, a regional and a federal government office responsible for schools), different approaches were proposed. Arbitration required a discussion about basic principles of aims and constraints of informatics education.

Pursuing its charter, the team representing those four institutions set out to develop a place to familiarize specifically pupils from primary and lower secondary schools with concepts provided by informatics. The issues in this venture are what these concepts are and how to motivate youngsters to get interested in them.

Apparently, establishing such a lab differs from curriculum design. But given the spectrum of age groups to be serviced (age: 6 to 13 years) and the clear aim not to focus on any particular type of school within the widely stratified Austrian school-system, the curricula of the group in focus had to be considered and set in relation to recent recommendations for teaching computational aspects (c.f. Wing (2006), Hromkovič (2006), Sysło (2013), Wilson et al (2010), Furber et al (2012)). Further, the issue of how "modern" equipment in the training-lab required decisions. Most contemporary recommendations treat Informatics education from an inner-disciplinary perspective. For traditional school-subjects this seems legitimate. However, for a subject still in its formative stage, the contribution of general educational aims (CS-for-All) requires, as pointed out by Mittermeir (2010), Sentence et al (2013), or Tort and Drot-Delange (2013) a broader vantage point.

In designing an informatics-lab, the key question became whether this necessitates using most recent gadgets or whether “computer science for all” requires pupils to experiment with durable concepts provided by informatics.

This paper will not add to the arguments concerning fundamental issues of CS raised in the papers mentioned above or in Schwill (1993) and Denning (2003, 2004). It rather points out, that behind this decision there are also socio-ethical issues. Those become progressively important the younger the pupils addressed by informatics instruction become. The next section discusses the forces influencing curriculum design and the importance of values and other meta-cognitive issues especially for young pupils. The final section discusses consequences of curricular orientation and attempts to draw a line between modern and modernistic instruction. Some approaches to introduce fundamental principles even to young children are mentioned.

INFORMATICS CURRICULA NEED A BROADER PERSPECTIVE

Who influences curricular decisions for different school-subjects?

Curricular decisions vary among subjects. While traditional school-subjects show rather an evolutionary change pattern, leaping changes are common in more recent subjects as well as in those experiencing noticeable influence from outside the school system. There are several causes for these differences.

Curricula of traditional school-subjects matured over an extensive period of time. This causes stability. A further stabilizing factor is a coalition between teachers and representatives of society. Both are relatively change resistant. Politicians, if interested in school, set rather high level goals driven by economic and social issues considering the labor market or competitiveness of the national economy. Individual companies, even big or multinational ones, show only limited interest in specifics of classical school subjects. They might, collectively though, exercise influence via the political system. Consequently, stepwise changes in subject-related aspects of the overall curriculum are rather proposed by expert teams knowledgeable in both, the subject and education.

History seems to be an exception to this case. Political changes, especially if they are radical, might force rewriting of history books. Expert teams might change in their composition in order to furnish the politically desired results. However, the contributors to those books and instructors of history teachers are still historians. Thus, the external intervention remains indirect.

Informatics education is different. Taking Austria as a demonstrative case, Reiter (2005) gives an account of introducing informatics as a compulsory subject in 1984. The two credit hours obligatory in the 9th grade in general academic secondary schools still exists. Further, the option of choosing informatics out of a list of other subjects till the final school-leaving exam (maturity) was and still is offered. The contents changed though. In practice, informatics instruction focused initially on programming. Teachers were briefed in special courses at computer vendors or colleges for in-service teacher education. The expert team leading this curricular innovation consisted of officers of the Ministry for Education, several of them former teachers, and representatives of the “Social Partners”, i.e., of the Trade Union(s) and the Chamber of Workers, the Chamber of Commerce, and the Association of Industry.

Indirectly, the computer industry had its chance to contribute to the discussion even beyond this early phase. Equipping schools with computers requires investments. Here, budgetary interests of the buyer and marketing interests of the sellers met. Consequently, schools were equipped with PCs from various vendors and continuous education of in-service-teachers focused on programming. Didactical aspects were rather lacking or underdeveloped at these courses. Thus, at least one important aspect of the educational triangle subject – child – circumstances (here: equipment) was missing in those early days.

It might be interesting to compare the influence structure and the focal points of informatics curricula when they were introduced to schools in developed countries with challenges developing countries are facing. Tendre, Bangu and Nyagava (2009) argue that the scope of IT education in developing countries has to be broader than the scope of IT education in industrialized countries. Ayalew et al. (2012) implemented such an approach at the BA-studies in Information Systems in Botswana. In defining their curriculum, these authors performed a complete survey of their former graduates; a study of the needs of the local IS industry and compared the results of these surveys with international and regional (sub-saharan) recommendations and model curricula. Finally this list was checked against the resources of the authors' university.

Obviously, there is a substantial difference between the relatively autonomous design of a university's BA-program and the design of a curriculum for schools. However, the difference shrinks when the curriculum focuses just on secondary schools as in Austria. In both cases, orientation on industries needs plays an important role. So does teacher qualification (Tort and Drot-Delange, 2013). This had also its bearing on the content of informatics in school. Its focus shifted in many western industrialized countries from topics such as programming or other concepts dealing with fundamental ideas such as computational thinking towards ICT-instruction, featuring application skills for certain software tools, especially those encompassed by the ECDL. Ensuing was a shift from technical competences towards skills of how to use technology.

Shifting to younger age groups requires a broader perspective

At the university level one may assume that students are mature people, firmly rooted in the principles of the community they stem from and/or live in. The same might be postulated to post-adolescent students in higher grades of secondary school; but this cannot be postulated for pre-adolescent pupils. Therefore, with informatics instruction moving down to lower secondary school, effects of instruction on meta-cognitive aspects and on the value-system need to be considered. This holds in particular when informatics instruction reaches primary school or kindergarten.

Given the forces defining curricular aspects of informatics instruction, one might question whether they are prepared to consider meta-cognitive issues and related values in an adequate manner. Computer scientists, projecting the future of the discipline are rather focusing on inner-disciplinary aspects. Practicing teachers experience the didactical problems they face in class when presenting material in an adequate manner to the age group they have to work with. A relative shallow background in CS-basics and lack of didactical advice causes underestimating kids' capabilities. Experiments by Mittermeir, Bischof and Hodnigg (2010) have shown pre-schoolers capability to deduce simple algorithms. Even before they are able to write they can report their algorithm verbally.

The labor market is demanding graduates capable of fluently using current computing technology and the computing industry sees long-term marketing opportunities via children familiar with their equipment. Consequently, vendors are ready to offer selected schools or school-financing authorities good conditions if their equipment or licenses are bought in substantial quantities. This indirectly influences the conduct of education. It obviously focusses on the discipline informatics without addressing meta-cognitive aspects.

This applies also to e-learning and thus outside informatics. The value of using information technology to enhance conventional education is uncontested. However, the role of the informatics teacher too often becomes dominant in comparison with person's teaching the proper subject and it is not sufficiently reflected what is given up for the added value obtained.

Meta-cognitive aspects: implicit maturing and learning, reward system

Considering the differences in the school systems of various countries, it seems safe to claim that none focusses only on an aggregation of skills across subjects. Often, meta-cognitive aims are stated in introductory sections of laws regulating school-education. As pointed out by Rodríguez-Roselló (2002), even if alphabetization of the population is the key challenge, education should also lead to competences on a meta-level.

Individual school-subjects contribute to meta-cognitive educational aims to a different degree throughout (compulsory) education. Their operationalization at the level of curricula for the various types of schools and grades do exist for some subjects. Many of them remain implicit. This is justified since most meta-cognitive capabilities are emergent properties.

As a consequence, however, meta-cognitive goals are easily lost in curriculum design. This holds especially, if curricular contents are shifted from higher to lower grades. Considering them is also endangered if industry attempts to overload the educational system with issues that are better learned in a work environment past formal education. Nevertheless school should prepare the basis upon which such skills can be built.

SPECIFICS OF INFORMATICS INSTRUCTION

The background of this discussion is that informatics education is made available for ALL pupils in order to prepare them for a productive life in the information society and to address some meta-cognitive ethical aspects.

Ethical aspects related to preparing young people for a life tightly interwoven with IT cover a broad spectrum. Hence, here only aspects relevant for the way informatics is taught are addressed. Other aspects such as effects of IT and automation on the labor market are also important in the context of informatics instruction. But those are independent of whether informatics is presented as ICT-application or as an aid to comprehend this field as constructive technical discipline. The focus chosen, modernism versus fundamental principles, bears on a meta-cognitive level beyond informatics. Specifically addressed are issues influencing pupils' value system concerning social competences and sustainability; both to the extent they are implicitly engrained by curricular choices.

Considering meta-cognitive aspects is particularly important when designing educational programs for pre-adolescent children. At this age a substantial part of the value system is shaped and lines of interest for future engagements (and ignorance) are laid.

Social aspects directly related to an ICT-based community

Initial curricular prescriptions in Austria contained already "social implications" as part of the informatics curriculum (Reiter, 2005). The topics considered were basically the effects of automation, notably automation in white collar branches. Further, the role of commuting versus work at home and to a minor degree shifts in the portfolio of workers' skills were (to be) addressed within informatics lessons.

However, depending on personal interests and qualifications, teachers concentrated predominantly either on programming and the computing equipment itself or followed a strategy focusing almost exclusively on social issues. By now the situation has changed. Teachers are aware that the internet, notably the social web, is attractive for their students but used in a naive credulous a manner. Hence, privacy issues became part of the actively practiced instruction. Hence, at least those aspects that are under the specific individual's control are adequately addressed. Other aspects addressed in the eighties as "social consequences" play only a minor role.

Secondary effects of teaching ICT

Obviously, ICT-instruction needs computing equipment as basic prerequisite. E-learning initiatives lead to the propagation of laptop-classes and, nowadays, tablet-PCs, i-books, or i-phones are used as instructional devices. This is justified to some extent. Whether the most modern equipment is needed might be questioned though. Especially if informatics is to be considered as technical discipline it seems important to show pupils that this discipline is not re-invented in a cycle of 18 months but has emerged from historical roots and rests on a set of stable principles. If this point is missed, school not only becomes an advocate for a throw-away-society, it also follows a self-defeating strategy demonstrating – quite incorrectly – the non-sustainability of knowledge.

In order to be fair to the various school subjects relevant for all pupils, motivation for informatics should not stem from using the fanciest equipment. Project based cooperation between subjects might be a good compromise. An example would be developing apps for smart phones based on a simple data base designed in an informatics course. Later, this app can be used as vocabulary trainer in a foreign language course.

Another effect should worry curriculum designers though. Even if teachers report that basically 100 % of the pupils have a cell-phone (not all of them with internet access though) and that almost 100 % of secondary school students have their own private PC (not all, but a marked majority with internet access), it does make a difference whether a particular type of equipment is offered by the family to the kids or whether school requires such investments.

Compared to the situation 30 years ago, computing equipment became inexpensive. However, for some households buying a laptop or tablet-PC still consumes a substantial portion of the family's income. This applies for industrial as well as for developing countries and it applies specifically in situations where, due to some problems, the situation of the family is precarious.

Consequently, curriculum designers and designers of ventures to foster interest in informatics need to ask themselves about the role of most current hard- and software in school. Certainly, motivation of children gets lost if a subject's challenges boil down to learn which function key, pull-down menu, or keyword is to be used in a particular situation. But regaining the motivation of these students by just using most modern equipment is neither the cure nor is it compatible with the overall aims school has to follow. For parents, it is already difficult enough to convince the young one that he or she does not need to wear the most fashionable garment, even if "all my friends have it". Telling them that they don't need the most recent smart-phone or the most recent tablet is almost impossible if "we need this in class". Using only equipment bought by the school provides only a partial answer for this issue. It might even lead to further stratification.

Thus, insisting on using state-of-the-industry equipment contributes to the race of economic competition among pupils and their parents and defies arguments for sustainability. Whether this race is conducted within a class or within different schools is immaterial. Among the aims of a modern school system is to reduce socio-economic differences. Deepening them by technical segregation and petrifying them by engraining them into the value system of the yet maturing generation runs against meta-cognitive educational goals.

The effect of sustainability of artifacts versus the sustainability of knowledge and competences is also deeply involved with the value system of the new generation. With current computing devices, one has to expect a replacement cycle of less than five years. Is this compatible with the aim of guiding pupils to become responsible citizens in a world that recognizes the finiteness of its resources and is consequently aiming for sustainability of investments and reduced resource consumption?

Of course, considering sustainability, one must not stop at hardware. Software takes a dual role in this respect. On one hand, "fat" software is eating up a lot of

hardware resources; on the other hand, teaching pupils highly specific application commands of state-of-the-industry software tools provides them with non-sustainable knowledge, knowledge that might already be outdated before pupils leave school.

Modern informatics instead of modernistic IT-glamor

These critical remarks are not to be misunderstood. Of course, informatics instruction has to be modern and motivating and computing equipment plays an important role. But modern does not mean modernistic and free from any relationship to historical aspects. Moreover, motivating does not imply easy. Young people like to compete. In order to improve they are ready to invest time and effort in training. This is uncontested in the context of sports, provided the trainers are well educated in their discipline and provided they are motivating role models. Why not applying this experience to “thinking sports”?

Without aiming for completeness, below some aspects are mentioned that avoid the problems addressed above.

- *Computational thinking* as proposed by Wing (2006) and others familiarizes students with fundamental ideas of computer science. The approach is neutral with respect to meta-cognitive aspects.
- *Computers unplugged* (Bell, Witten, Fellows, 2010) and similar initiatives achieve similar aims without using computers at all.
- *History of Informatics* (Böszörményi, 2008) on its own is apparently not a school-subject. However, it is an important topic in teacher-education. Showing young people that some fundamental ideas are much older than they are themselves will point them to the fact that informatics is not a throw-away-science, where every generation of new products out wipes everything deemed to be valid so far. Occasionally, reaching back to even ancient history (Bitto and Mirolo, 2013) will create curiosity and insight.
- *Competitions* such as the International Olympiad on Informatics (IOI) or the Bebras contest certainly do not belong to issues focused at when designing curricula. However, considering such contests one finds quite a number of tasks where problems are embedded in a context that does indeed contribute to meta-cognitive attention of contestants. Hence, considering examples as instructional training material seems worthwhile (Diks and Madey, 2008; Dagienė and Futschek, 2008).
- *Scoping* is an issue that is best explained and experienced by pupils in the context of programming. Even if CS must not be reduced to programming (Denning, 2003) and wrestling with overly complex syntax is no starting point, identifying the scope of validity of some recommendation or assessing the scope of an action is definitely one of the prerequisites of making young people fit for their life in a complex, tightly interwoven society.

A possible way out

There is no silver bullet for solving the curricular problem between ICT-instruction and teaching CS-principles. As ethical issues are involved, each stakeholder has to find her or his way to cope with the issue. However, an amalgam of whatever is considered local standard in informatics education with concepts mentioned above might mark a way to good solutions. Taking extreme positions between teaching ICT use and principles of computing is not fruitful. In interdisciplinary projects those extremes can be easily avoided. Using applications serves well to offer students a chance to be creative using computers. Projects can be conducted in such a way that students become curious about how this equipment can achieve what it does. This forms a good basis for stepwise progressing towards informatics as a technical discipline providing concepts for pupils and students who will otherwise shy away from attempts comprehending technology.

SUMMARY

Departing from the international trend to introduce informatics instruction for all pupils into their school system as well as from the fact that informatics instruction moves down to lower level grades, one has to reflect on whether expertise from computer scientists and from experts working in the computing industry or in branches where computer applications play an important role suffice for curriculum design.

The paper analyzes the influence structure on curriculum design and shows that this leaves gaps especially concerning meta-cognitive ethical aspects. It also shows topics, including but exceeding computational thinking, that meet pupils interest in an ethical neutral manner and without deepening social differences.

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Biography



Roland T. Mittermeir is professor of Informatics at Klagenfurt University, Austria, where he served as founding chair of the Institute of Informatics Didactics. He has been instrumental in defining the first Informatics curriculum for educating Austrian secondary-school teachers. Currently he leads a competence-centre focussing on improving the professional background of in service informatics teachers.

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