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A perspective from Poland on the introduction of Informatics[1] into schools

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Introduction

The changes in the informatics education for all grades in K-12 have been the subject of nationwide proposals and discussions in 2014-2016 and finally the new informatics curriculum has been approved by the Ministry of National Education and introduced to K-8 in September 2017 and will be introduced to high schools, including vocational schools, in September 2019.

The curriculum is a separate document for each school level (1-3, 4-6, 7-8, 9-11+ext.) however **Unified aims**, which define five knowledge areas in the form of general requirements, are the same in all curricula. The most important are the first two aims and their order in the curricula: (I) **Understanding and analysis** of problems based on logical and abstract thinking, algorithmic thinking, and information representations; (II) **Programming and problem solving by using computers** and other digital devices – designing algorithms and programs, organizing, searching and sharing information, using computer applications. The content of each aim, defined adequately to the school level, consists of detailed **Attainment targets**. Thus, learning objectives are defined that identify the specific informatics concepts and skills students should learn and achieve in a spiral fashion through the four levels of their education. At each level the implementation of the curriculum varies across three elements – the first element is more important at lower levels and elements 2 and 3 become more important during progression: (1) problem situations, cooperative games, and puzzles that use concrete meaningful objects – discovering concepts, heuristics; (2) computational thinking about the objects and concepts – algorithms, solutions; (3) programming, moving from visual/block to text-based environment, including program testing and debugging. For benefits of such a spiral curriculum see: Chapter Structuring the Curriculum, in M. Web et al., Computer Science in the School Curriculum: Issues and Challenges, in: A. Tatnall and M. Webb (Eds.): WCCE 2017, IFIP AICT 515, pp. 421–431, 2017

Comments on Key Challenges (as listed at the end)

1. Today in Poland, informatics is widely recognized, by the society, politicians, and decision makers as an academic discipline (in science and among technical disciplines); as a result we observe that informatics is the most popular study among high school graduates (twice as many graduates choose informatics than the next popular subject – management).
2. see 1.
3. Computational thinking is a new term/concept for almost all teachers, also for academic teachers, and teachers of teachers. Although our curricula, especially attainment targets, address and focus on abstraction, generalization, decomposition, algorithmic thinking, programming, and program testing and debugging, and problem solving and we want our teachers and students to think computationally, we avoid to use this term mainly in the curricula for initial school levels. Most teachers, especially in lower levels of education, are afraid of new ideas/terms in pedagogy, even if a new name is used to describe what they

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[1] Informatics = computer science in Poland.

have been doing so far as happens with using computers. We hope teachers and students will develop the meaning and their understanding of computational thinking through properly chosen problems and environments, but without losing time on non-productive discussions about its meaning

Informatics *versus* **programming**. In the new curriculum and especially in its implementation we avoid ‘the equation’: informatics = programming, which in effect may kill interest in informatics among school students. Informatics should be taught independently of specific application software and programming languages and environments. Programming is a tool in the process of developing concepts and computational thinking while approaching and solving problems from various areas and school subjects. We convince our teachers and students to: “First think computationally then program”, and as a counterpart of “The purpose of computing is insight not numbers (R.W. Hamming, 1959) we declare that: “The purpose of programming is abstraction not programs” since every program is an effect of mainly abstract thinking on problem situation to be solved.

Recently, the “Hour of code” and code.org initiatives became very popular among children and young students. We are very happy that hundreds of thousands of students in Poland each month spend some time practising coding in the environments they know from games they used to play. It is a fantastic introduction to programming but many teachers do not go any further with their students and are satisfied with the codes students produce in these environments. Unfortunately, most of our teachers cannot read educational materials available in these environments. We are now working on providing them with versions in Polish, which additionally will put coding in the context of informatics education.

Programming is not only the way to communicate with computers. Programming can enhance students’ problem solving skills in a constructivist way by constructing programs as ‘real objects’ and then using them in learning by doing (solving problems, making experiments with data, verifying hypothesis, proving statements).

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5. The new curriculum has been proposed by a team of school and academic teachers and also discussed in academic circles to meet their expectations concerning preparation of graduates for higher education. Moreover, the curriculum team also supervised versions of the informatics curriculum for various specializations in vocational high schools.
6. Integrating ICT (informatics) across other subjects in school has been ineffective in practice. Our study shows that this is mainly due to: (1) the lack of integration of informatics with other subjects in the subjects’ curricula and (2) the lack of basic informatics knowledge among teachers of other subjects.

   There are a number of steps we undertake to change and improve this situation: (1) students learn informatics by solving, with computers, problems coming from various disciplines (subjects)while , at the same time, developing their knowledge of those subjects and this also contributes to integration of informatics with other subjects; (2) in supporting this integration students may use their informatics knowledge and skills when learning other subjects; (3) we plan to provide teachers with guide books on integrating informatics with mathematics, physics, biology, etc. demonstrating contribution of informatics to other disciplines (school subjects in the curriculum) – such books could be used in project based learning (PBL) across informatics and other subjects curricula.
7. We have published education standards for informatics teacher preparation which include modules on subject, pedagogy, and technology competences. Moreover, the standards focus also on teachers’ engagement in professional development – candidate teachers come from various pedagogical and subject areas and they need personalized professional development and training. We have also developed a certification procedure,

which evaluates the classroom teacher's preparation for effective and successful managing of learning informatics by her/his students.

Special efforts are put to prepare teachers of initial education (in 1-3) who usually graduate in pedagogy and have only little background in ICT: (1) a new module on informatics will be proposed for future teachers in 1-3 and (2) the government devoted 124 ml. PLZL (30 ml. Euro) for in-service training of 5000-7000 teachers from small cities and rural areas.

8. Happily, the education system in Poland is in some sense "ready" for the new informatics curriculum. In particular, (1) informatics has been taught in schools in Poland (under various names) for more than 30 years and recently as a separate subject on each level of education in K-12; (2) the previous curriculum approved in 2008 included computer related subjects on each level, therefore schools employ teachers who teach such subjects – they only need now extra in-service training to meet the requirements of the new curriculum, especially on algorithmics and programming; (3) all schools have been equipped with basic hardware and software and are connected to the Internet; more and more software systems and packages are open and free for education, in particular, almost all programming environments can be freely accessed from school and home equipment; (4) the most important and encouraging is the enthusiasm and readiness of school students on all education levels to learn how to program and use programming skills in various subjects and environments, such as robotics, games, informatics and ICT competitions, and to enhance competencies in informatics.

Key Challenges (see Task Force TC 3/EDUSummIT Report)

1. Lack of clear understanding of Computer science/Informatics as an academic discipline.
2. Need for Computer Science/Informatics as a distinct subject in school curricula is controversial and poorly understood.
3. Computational thinking, a core component of Computer Science/Informatics this considered to be important in 21st century skills, but due to its complexity, it is difficult to implement in schools.
4. The development of Computer Science/Informatics school curricula is impeded by insufficient empirical evidence of student learning in order to support content definition and sequencing.
5. Previous ICT curricula deliveries poorly prepared students for Computer Science/Informatics in further/higher education or professional employment.
6. Integrating Computer Science/Informatics across other subjects in school curricula has been ineffective.
7. Teacher professional development in a newly introduced Computer Science/Informatics subject is a challenge in quality and quantity.
8. Identifying and allocating the additional resources for teaching Computer Science/Informatics is a challenge.