Computing at School

International comparisons

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Executive summary

This briefing note summarises how computing (i.e. computer science) is taught at (high) school in other countries. We focus especially on what computer science qualifications are available to students.

By "computer science" we mean the rigorous, knowledge-based discipline of computer science. Other aspects of digital technology are also important in education, including basic digital literacy (the ability to use a computer and the internet confidently); and the application of digital technology to support learning in other disciplines. However, in many countries around the world there is a growing recognition that

- Computer Science is a subject discipline, quite distinct from the more technology-focused skills of the use and application of computers
- Computer Science has both enormous *educational* benefits (thinking and problem solving skills, understanding a world suffused with digital technology), and *economic* benefits (as companies struggle to recruit well-educated students). It can and should be part of every student's education, just as chemistry is.

The way in which different countries are addressing this realisation, and what they are doing about it, is the focus of this note. Such comparisons are not straightforward, because of the diversity of educational systems. Nevertheless, there are some lessons we can learn from the international experience:

- It is vital to make a clear distinction between Computer Science as a rigorous subject discipline on the one hand, and IT applications and/or digital literacy on the other.
- Many countries, from the USA to India, routinely make Computer Science available to young people at school from an early age.
- There is increasing clarity that "Computer Science" means a lot more than "Learn to program in Java or C++". Programming is central to computing, but the underlying principles of algorithms, data structures, and computational thinking skills are both more fundamental and more durable.
- The confusion between Computer Science and ICT skills means that ICT is often delivered by non-specialists. Meanwhile, the continuing strong employer demand for IT professionals reduces the supply of well-qualified potential teachers. These factors conspire to mean that ICT/Computing teachers are under-valued and under-qualified. There is a desperate need for teacher training in Computer Science.

In the sections that follow we give a country-by-country summary.

The document is best read online: all the links are "live" and can be followed by clicking them.

England and Wales

The UK National Curriculum requires that every student study Information and Communication Technology (ICT). The statutory National Curriculum for ICT is a broad, high-level specification, but the reality as delivered on the ground is often little more than exposure to office productivity software. Computer Science is not excluded by the National Curriculum, but in practice Computing is not recognised as a subject discipline, and is rarely taught.

The Department for Education is running a major review of the National Curriculum (2011).

The Computing at School Working Group aims to make the case for Computing as a rigorous subject discipline that every pupil should encounter, and some should have the opportunity to specialise in. The "Documents" link points to many policy papers giving more background.

GCSEs and A levels

The currently available menu of GCSEs and A levels in Computing is sparse:

- **GCSE**. Until 2010 there was no GCSE in Computing (for comparison, there are over a dozen ICT qualifications at KS4)

  In 2010 OCR launched a pilot GCSE in Computing. OCR have recently (2011) decided to remove the pilot status, thereby making the GCSE available to all schools for the first time.

- **A Level**. Two awarding bodies offer an A level in Computing:
  - AQA Computing
  - WJEC Computing

The International GCSE in Computer Studies

The University of Cambridge International Examinations runs an International GCSE in Computer Studies.

- This course is taken by around 14,000 students worldwide, with a steady 15% year on year increase.
- In the UK, around ten private schools offer the IGCSE.
- In June 2010 the DfE announced that IGCSEs would be available to UK state schools. For reasons that are not clear, the Computer Studies IGCSE is not in the approved list.
- The syllabus covers applications of computers, and their social and economic implications; the system life cycle; algorithm design, programming, and logic gates; generic software and the organisation of data; hardware, systems, and communications. One might debate some of the details (there could be a greater focus on principles) but it is clearly a computer science qualification.

The International Baccalaureate

The International Baccalaureate is taken by UK students instead of A levels. Students take six courses. Of these, two are:

- **Information Technology in a Global Society**; the curriculum can be found here
- **Computer Science**.

The Computer Science course is largely a course in Java programming, and a completely new revision of the course is under way, due for launch in August 2012. It is much less tied to programming, or to a specific programming language, and instead lays greater emphasis on the principles underlying

Computer Science, much along the lines of the Computer Science Principles course under development in the USA (see "The United States of America" below).

Scotland

Scotland has supported formal computing education in secondary schools since the 1980s, typically starting at the Standard Grade level, the equivalent of GCSE, and progressing up to Advanced Higher, the equivalent of A-level. Over the years, the focus has shifted from mainly software development and computer systems to a two strand approach at Intermediate 2, Higher and Advanced Higher: Computing, and Information Systems. The former has a significant software development component; the latter centres on relational databases for the practical activity. The two strands have been an issue for university CS departments who have thus far been unable to rate the school qualifications as useful prior learning. This has been a source of frustration for both schools and universities.

In the early years of computing qualifications, uptake was high. The majority of pupils took computing at the Standard grade level. However, the prevalence of IT in pupils' lives and the Scottish 5-14 ICT curriculum has meant that pupils equate computing with the use of Office applications . A survey run in Scotland in 2004, Computer Science: What do pupils think?, discovered that most students found the ICT training boring, thus explaining the steadily reducing numbers in computing classes. Furthermore, the range of computing qualifications requires too high an element of fact-based, and now rather dated, learning rather than fostering improved computationally oriented thinking skills. As a result, there has been steady negative trend in the number of students taking, and centres offering, these qualifications[1]:

Qualification	% change in number of students, 2005-2011	% change in number of centres, 2005-2011
Standard grade Computing Studies	-19%	-19%
Higher Computing	-3%	-8%
Advanced Higher Computing	-4%	-4%
Higher Information Systems	-17%	-30%
Advanced Higher Information Systems	-21%	-35%

Scotland's new Curriculum for Excellence, currently (2011) being rolled out in schools, offers some hope:

- Curriculum for Excellence Key Documents
- The technologies experiences and outcomes

CfE aims to shift teaching focus from facts to skills / competencies / abilities. Computing science is firmly in the curriculum, and all students must be exposed to, at least, the level 3 outcomes and experiences prior to age 14. It is uncertain exactly what this exposure will amount to, but one of the requirements is that they should be able to create a computational artefact. This could easily be satisfied with the wide range of new introductory programming environments, like Scratch or Alice, or using some of the game engines. The key will be to see whether the computational elements are brought to the fore in the teaching, or whether the focus will be simply on getting something working.

The Scottish Qualifications Agency is currently developing the 14-16 and 17-18 computing qualifications that will complete the Curriculum for Excellence. There will be a single qualification stream, currently called Computing and Information Science at Access 3, National 4, National 5,

[1] Source SQA Statistics Reports and Information

Higher and Advanced Higher level. This contains a strong software development focus, drawing on recent research in programming education, and a second strand that will focus on core elements in Computer Science like information, databases, networks and so on.

The Royal Society of Edinburgh has formed an exemplification group, with funding from industry and universities, to provide exemplar materials for teachers, particularly at the pre-14 age level. This is the stage at which all pupils will be exposed to computing and computational thinking, and highlighting these key aspects with teachers will be crucial.

The United States of America

There is a great deal of activity in the USA aimed at improving the state of high school education in Computer Science, most of it coordinated by the Computer Science Teachers Association. Here are some key pointers:

- Computer Science Principles, a new first course in Computing is a major new Advanced Placement (explanation below) course under development, endorsed by over 80 universities. The course aims to convey these "big ideas" in computer science:
    - Computing is a creative human activity that engenders innovation and promotes exploration.
    - Abstraction reduces information and detail to focus on concepts relevant to understanding and solving problems.
    - Data and information facilitate the creation of knowledge.
    - Algorithms are tools for developing and expressing solutions to computational problems.
    - Programming is a creative process that produces computational artifacts.
    - Digital devices, systems and the networks that interconnect them enable and foster computational approaches to solving problems.
    - Computing enables innovation in other fields including mathematics, science, social science, humanities, arts, medicine, engineering and business.
- Exploring Computer Science is a significant new introductory level computer science course developed in Los Angeles, with a particular concern being lack of access to rigorous computer science courses in schools with high populations of underrepresented minorities. The curriculum is given in detail on the above web site, and covers: human computer interaction; problem solving; web design; introduction to programming; computing and data analysis; and robotics.
- New CS Curriculum Standards . 2011. CSTA is revising its ACM K-12 Computer Science model curriculum, 2nd edition, 2006 with the goal of providing a comprehensive set of learning standards for computer science for students from the beginning of their formal school experience to graduation. A vision for computing at school, not just a boring standards document.
- Running on empty: the failure to teach K-12 computer science in the digital age. October 2010.
- The New Educational Imperative: improving high school computer science education, CSTA, Feb 2005.
- Computer Science Education Week, an annual focus week, mandated by Congress

The situation in the USA is complicated by the fact that each state sets and administers its own educational policy, including mandating curriculum and setting certification requirements for teachers.

The one area of national coherence for computer science education is the **Advanced Placement** exams (AP's). The AP courses and exams are developed and administered by a national organisation called The College Board with individual schools making decisions about which AP courses they will offer. These courses are intended to expose university-bound school students to rigorous college courses before they graduate from high school. The primary attraction for students is that many universities and colleges offer either a university credit or placement in an advanced university course for a student who successfully completes the AP exam in a given subject. Universities use these exams to evaluate the academic abilities of applicants; students use them to save the cost of a university course; and governments like them because they are well-respected standardized tests. A university-bound student would typically take at least 6 AP exams in various subjects, at some time between age 14 and 18.

The current AP "A" Computer Science exam is a rather narrow course in Java programming, and the National Science Foundation and The College Board (in partnership with CSTA) are engaged in a major initiative to develop a new AP Computer Science exam called Computer Science Principles. The background and motivation for the course are an exact fit for the UK situation:

- "By 2018 computing related occupations will account for 57% of all new STEM jobs."
- "Most high school courses cover only basic literacy, are taught as vocational courses, and aren't eligible for college credit."
- "Most high school students lack awareness of computer science. They think it's programming."

This new CS Principles course is still rigorous, but has a broader focus on computational thinking rather than merely on programming. Although not directly comparable to GCSE or A level, the course is a major comparison point for UK school qualifications in Computing.

Israel

Israel undertook a major review of computing at school around the turn of the century, and now has the most rigorous Computer Science high school program in the world. Here are some key documents:

- A model for high school computer science education: the four key elements that make it, Gal Ezer et al, SIGCSE, 2008. This paper and a collection of others, lay particular stress on teacher education.
- Curriculum and course material for a high school program in Computer Science, Gal-Ezer and Harel, around 1998
- A high school program in Computer Science, Gal-Ezer, Beeri, Harel, and Yehudai, around 1997. More background motivation, but less detailed than the previous one

Again, the motivations (taken from the last document above) are an exact fit with the UK context:

- "Computer science is a full-fledged scientific subject. It should be taught in high school on a par with other scientific subjects"
- "The program should concentrate on the key concepts and foundations in the field"

The Computer Science curriculum has been actively deployed since 1995. It is taken by students as an elective in high school. The program has two versions: a three unit version and a five unit version. Both are electives.

- The three-unit version is taken by approximately 13,000 students, compared to more than 30,000 who take the compulsory three unit Math program.
- The five-unit program is taken by approximately 7,000 students. This is similar to the number of students who take Physics which is also an elective.

Only about 30% of the students who take CS are female, students. At the end of their studies the students have to take a comprehensive exam, the same exam for all students whatever school they attended. This is part of the centralised educational system in Israel.

The curriculum, has been updated continuously, and has gone through a profound change two years ago, unfortunately there is no document in English that describes the change.

The new model was valued by the universities until recently, when a decision has been taken to cease to treat Computer Science like the other sciences. The reason is not clear and there is an active debate right now to get Computer Science back on a par with physics, biology and chemistry.

Teachers who teach have at least a bachelor degree in Computer Science, have to take a teacher training program, and have to be certified by the Ministry of Education. More about this can be found in the following papers:

- J. Gal-Ezer & E. Zur, "Reaching Out to CS Teachers: Certification via Distance Learning," *Mathematics and Computer Education*, 2007, 41, 3, pp. 250-265.
- O. Hazzan, J. Gal-Ezer, & N. Ragonis, How to establish a Computer Science Teacher Preparation Program at your University, The ECSTPP Workshop, *ACM Inroads Magazine*, 2010, 1, 1, pp. 35-39.

New Zealand

Following two influential reports in 2008 (Grimsey and Phillipps, Carrell et al), New Zealand has revamped its school curriculum in Digital Technologies, and from 2011 has an explicit strand entitled "Programming and computer science".

Here are some of the key background papers

Report of the Digital Technologies Expert Panel, May 2009

Computer science in New Zealand High Schools, Bell et al, 2010. This paper gives the background to the project, and
A review of computer science resources to support NCEA, Murgesh et al, 2010. The NCEA is the National Certificate of Educational Achievement.

The motivations for the change again echo the UK situation:

- "In recent times, New Zealand schools have rarely taught Computer Science – at best there have been courses on programming at some schools, but often computing education has been focused on general purpose applications and skills. Even worse, sometimes courses that teach "computing as a tool" have given students the impression that CS must be an extension of these topics. Of course, it is important for students to be able to use computers effectively, but often this has been a distraction from getting students involved in 'computing as a discipline'."
- "Computing in school curricula is often diluted because it has to cover three quite different directions: (1) using computers as a tool for teaching (e.g. e-learning), (2) using computers as a tool for general purpose applications (sometimes called ICT), and (3) computing as a discipline in its own right (including programming and CS). Sometimes administrators and leaders confuse these roles, and this can make it difficult for Computer Science to be visible as a discipline in its own right."

For various reasons Digital Technologies (and Computer Science in particular) are embedded as a component within a generic "Technology" curriculum; opinions differ about whether this is a good idea in the medium term. In its first year this Computer Science strand is being taken by about 1,500 students in Year 11 (age 15), the first year in which national assessment takes place.

The course designers are now shifting their focus from making the case for computing at school to the challenge of implementation: materials, teacher training, and so on. All seven major Computer Science departments have been involved in this course redesign, and in supporting teacher training.

Germany

Each of Germany's 16 federal states has its own Department for Education. Furthermore, Germany's school system in secondary education offers up to five tracks only two of which cover the full range of grade 5-12 education and thus lead to tertiary education (two of the remaining three cover the grade 5-10 range and lead to a vocational education, the third covers the grade 11-12 range *or* is parallel to vocational education). Grade X means roughly age X+5, so Grade 5 = age 10.

Despite this variety, there is a national consensus on what needs to be taught in higher secondary Computer Science education. In 1989 (most recently updated in 2004), Germany's Standing Conference of Ministers of Education and Cultural Affairs (KMK) passed a document that unified the topics to be covered in grades 11-13 (as of today: 10-12).

> http://www.kmk.org/fileadmin/veroeffentlichungen_beschluesse/1989/1989_12_01-EPA-Informatik.pdf

The topics include Object Oriented Modelling (including programming), Entity-Relationship-Modelling, Automata, Algorithmic Modelling, Functional Modelling (optional), Rule-Based Modelling (optional), Formal Languages, Computer-Human-Interaction, Privacy, Security, Computer Architecture, Computability, (Practical) Efficiency, and Societal Issues.

Computer Science is not a mandatory subject, and it can only be taken in addition and not as a substitute for other Science subjects, but – if taken – the credits earned fully count towards the graduation requirements and grade. Take-up is on the order of 20% in Grade 11, and 10% in Grades 12 and 13.

More recently, in 2008, Germany's Computer Science Association (*Gesellschaft für Informatik*) published *Standards for Computer Science Education in Secondary Schools*, covering grades 5-10. These standards are the result of a multi-year collaborative effort of more than 70 educators, researchers, and administrators.

> Arbeitskreis Bildungsstandards, Ed., Grundsätze und Standards für die Informatik in der Schule: Bildungsstandards Informatik für die Sekundarstufe I: Empfehlungen der Gesellschaft für Informatik e.V. erarbeitet vom Arbeitskreis Bildungsstandards, 2008.

The document is in German but this paper gives an English-language summary:

> Torsten Brinda, Hermann Puhlmann, and Carsten Schulte. 2009. Bridging ICT and CS: educational standards for computer science in lower secondary education. *SIGCSE Bull.* 41, 3 (July 2009), 288-292.

The motivations are similar to those in other countries

It is the aim to foster a contemporary and professionally substantial CS education in high schools. Nowadays CS is important in more and more areas of everyday life. The IT industry needs qualified employees, and learners need professional orientation to relate CS to their personal environments and also to acquire knowledge to be able to consider subsequent CS-related educational phases on a more realistic perspective. The best way towards this aim is to acquire competences in a CS subject of its own in lower secondary education as early as possible. That is, to teach CS instead of teaching ICT, computer literacy, or "computer driving licences" with focus on computer usage only.

The standards are modelled following the NCTM' standards for K-12 Mathematics and are organized along a "contents" dimension and a "process" dimension, each subdivided in five categories. The description is detailed for grades 5-7 and 8-10 and lists learning objectives and indicators for each of the resulting 20 categories.

Contents	Processes
1. Information and Data	A. Modelling and implementing
2. Algorithms	B. Reasoning and evaluating
3. Languages and Automata	C. Structuring and interrelating
4. Informatics Systems	D. Communicating and cooperating
5. Informatics, Man, and Society	E. Representing and interpreting

The overall goal is secondary Computer Science education that:

- enables students to cope with the widespread use of digital artefacts and information technology (IT) in everyday life, and
- provides a foundation for learning Computer Science at more advanced levels (upper secondary; vocational training or university education).

The standards clearly separate Computer Science education from Media education or ICT education. Due to the fact that the standards have been published only very recently, the implementation (and thus the evaluation) is still in progress. However, the broad acceptance of the standards – which to a significant part can be attributed to the consensus reached by the abovementioned bottom-up process – has already influenced new state-wide curricula for Computer Science in lower secondary education, e.g. in the states of Berlin/Brandenburg/Mecklenburg-Vorpommern, Schleswig-Holstein, or Thüringen (currently at work).

An important factor contributing to the consolidation of Computer Science in Secondary Education is the availability of fully qualified Computer Science teachers. The German system of teacher training consists of a five-year double-major course of study (e.g. Computer Science and Mathematics) including the domain-specific didactics / educational theory augmented by a course of study in general didactics / educational theory. Afterwards a two-year practical in-service training is required before teacher may join an institution. All courses offered at universities have to be accredited. A central requirement for accreditation is to demonstrate that the standards and contents (matching the abovementioned requirements) set forth by the Standing Conference of Ministers of Education and Cultural Affairs are covered in each curriculum:

> http://www.kmk.org/fileadmin/veroeffentlichungen_beschluesse/2008/2008_10_16-Fachprofile-Lehrerbildung.pdf

India

Computing education is not yet mandatory in schools in India. It is an elective (ie optional) subject from the 9th grade (age 14) onwards, for which the various boards have prescribed syllabi. It is often left to the school to decide when they want to start this subject, or what to teach until 8th grade. However, this scenario is changing and computing education is likely to get standardized in the next couple of years.

Also, there are two electives offered under computing education:

- "Computer Applications" (some boards call it Information Technology) deals with use of computing tools for various purposes.
- "Computer Science" deals with programming, algorithms and such aspects.

The curriculum is specified by an exam board, of which there are several. For Computer Science, two relevant ones are:

- Council for the Indian Certificate Examinations. Their Class X (= 10th grade = age 15) syllabi are here, and Class XII (12th grade, age 17) here.
- Central Board of Secondary Education. The Senior School Curriculum has a Computer Science strand.

The International GCSE in Computer Science and International Baccalaureate are gaining popularity in India.

A group of academics is working on a new Computer Science curriculum for schools:

> Model Computer Science Curriculum for School, 2010, Iyer et al.

South Korea

South Korea has a highly digital society and a long tradition of teaching computing in schools. At all levels of school in South Korea the curriculum contains a substantial amount on the use of computers (ICT). It includes a strong emphasis on ethics and cybercrime which seem to be a significant issue there.

In addition, many middle and high schools teach introductory material from Computer Science. There is a current curriculum that includes some computer science (including object-oriented programming, simple algorithms and logic circuits), but a new draft curriculum has been proposed for introduction in 2013 (approximately). The current curriculum information can be found via the National Curriculum Information Centre (in Korean): http://ncic.kice.re.kr/nation.dwn.ogf.inventoryList.do

The draft new curriculum includes programming (but no longer expects it to be object-oriented), and CS topics include sorting and searching algorithms, binary trees, and graph traversal. The programming includes arrays, linked lists, and non-linear structures. The programme starts from middle school, which begins at Grade 7 (roughly equivalent to US Grade 7), and goes through to high school.

All schools teach the material on the basic use of computers ("ICT", as in most countries). Something like a third of middle and high schools choose to pick up the specialised technology curriculum that includes computer science; in those schools, usually all students would have to take those courses, or in some cases there may be an alternative offered.

There is no formal test or qualification for the new curriculum. Teachers who teach information science are required to have an appropriate teacher licence.

Greece

Primary school

Information and Communication Technologies (ICT) and Computer Science (CS) were recently introduced in primary schools as a pilot.

- **Ages 6-10**. The curriculum of the first four grades (ages 6--10) consists of three subject units, dealing more with “what is a computer” and “how to use a computer” rather than “how a computer works”: acquaintance with computer parts and everyday uses of computers ; playing and learning with computers using simple applications ; and communicating with computers using the web.

- **Ages 10-12**. For the last two grades (ages 10--12) the curriculum consists of seven subject units: deepening of computer literacy; text, image, and file processing ; using and creating graphs; programming a computer with a Logo-like language; finding information using the web and presenting it using simple multimedia applications; communicating with others via Internet (e-mail); and computers' applications in everyday life.

To this day, there hasn't been adequate teacher training. Also, there is no recommended teacher supporting material, nor student textbooks, so the implementation of the curriculum depends on the teachers' own skills and disposition.

Middle school

ICT has been a compulsory discipline in the Greek Gymnasium (middle school) since 1993.

- **Ages 12-14.** At the first two grades (ages 12--14) the curriculum focuses on four areas: more detailed acquaintance with computer hardware; more sophisticated use of a GUI operating system; finding, processing, presenting information using the web and office applications; and the use of computers as professional or everyday life tools.
- **Age 15.** In the third grade (age 15) the curriculum moves to Computer Science and focuses on algorithmic thinking, on programming using a Logo-like language, and on the widespread use of the web and presentation applications for making student projects (in groups or individually).

There is a textbook for students, but educators have the right to use their own material (photocopies, etc.) as long as it does not deviate from the curriculum.

High school

At Lyceum (high school, ages 15--18), ICT is an elective course at the second grade. The curriculum covers the same area as the Gymnasium curriculum with more details. At the third Lyceum grade students are streamed to different directions. Those selecting the Technological Direction have a compulsory Computer Science course, with emphasis on algorithmic thinking, Computer Science principles, and programming concepts. There are also three elective courses on:

- Multimedia/Networks
- Software Applications
- Computers and Operating Systems.

Students are given textbooks, and educators have again the right to use additional material.

Curricula information can be found at http://digitalschool.minedu.gov (the main site of the Ministry of Education for ICT and CS in schools, in Greek).

For the time being, universities do not require any school-level qualifications in Computer Scienc as a prerequisite for a Computer Science degree. This may change pretty soon, as the university entrance exams are being re-designed, and universities will get more say in the selection of students and in the qualifications they will require (right now they are all set centrally by the Ministry of Education).

Currently there is a plan to introduce an ICT skills certification program for the 3rd grade Gymnasium students (age 15).

Teacher qualifications and awareness

Generally speaking, the quality of Computer Science teachers of Greek schools is very high; most of them being Software Engineers and Computer Scientists with high university qualifications, able to bring forth Computer Science as a rigorous subject in schools. At the same time, however, they may not necessarily be familiar with the pedagogical needs and potential of young children, especially those of Primary school, as all teachers are recruited from the same pool, regardless of the level they are teaching each year (so that, for instance, Software Engineers are teaching Primary school kids). Moreover, during the first years of implementing Informatics in the school curriculum, teachers of other disciplines (such as Mathematics and Physics) were hastily trained, and have been appointed to teach the subject. The reality in their teaching was that they practically focused on applied ICT, computers as general purpose tools, and rough programming, without being able to emphasize on fundamental concepts, algorithms, or even data structures. This is a heritage of the past; new teachers are either Computer Scientists or Software Engineers.

In everyday life in schools, Computer Science teachers are often used as technical supporters for school computer labs and school administration issues, and practically they have no time to invest in their own teaching. Another important factor is that the majority of school directors are computer illiterate, and they tend to underestimate the role of Computer Science as a discipline, and their Computer Science teachers.

This is not true for the central ministry administration, however: Computer Science is highly appreciated at the ministry level, in part because of the government commitment to follow the strategic ICT decisions at the European level; also, due to the positive influence from the close and long relationships of the ministry with highly qualified computer scientists and researchers of the Computer Technology Institute (acting as the formal consultant of the ministry for the utilization of ICT in schools for about 15 years).

In addition, although most policy makers confuse ICT with Computer Science, the current effort of the Ministry of Education about the Digital School deserves some credit. It includes a large scale training of teachers in ICT and Computer Science issues, a huge effort on posting all the books in the web in annotated form, together with some actions on advancing the class equipment (e.g., interactive whiteboards, new labs, and most importantly the existence of the Greek Schools Network (www.sch.gr), a huge educational network in the web, connecting all schools, teachers and students with many activities and services.