Working for a leap in the general perception of computing

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The name "informatics" is often associated with the set of skills necessary to use specific software applications and not to the discipline itself. We believe it is urgent to change this misperception, as it has negative impacts. To this end, we started a project aimed at spreading the discipline of informatics among school children through a game-contest called *Kangourou*, that has a successful tradition in the field of mathematics. This paper reports the first steps of this initiative: we present a concrete proposal, providing some examples of the content and the formulation of the questions proposed and reporting the initial feedback obtained by testing them in pilot classes.

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Computing principles, game-contest, primary education.

1. Computer science and informatics

The debate about the role of computers in the science of informatics is an ancient one. The popular expression *computer science* has upset several scholars: Dijkstra [1] compared its use to naming surgery the knife science or astronomy the telescope science; others accept the idiom just as a relic of its historical roots, as descriptive as the etymology of the word *geometry* (Greek *γεωμετρία*: geo = earth, metria = measure). All in all, among the experts of the field the question is almost settled: even those who use the term *computer science* – as common in the US – are normally quite convinced that the topic concerns the computation process, rather than the computational devices that have made it possible and convenient. Actually, the design of efficient computational devices remains an exciting research issue, but it is more in the scope of computer engineering than informatics. Also, informatics should be distinguished from the study of computer systems and their deployment, a subject that should be more precisely called *information systems*.

Although well established in the field, these distinctions are much less clear to the general public. Furthermore, the three areas of informatics, computer engineering, and information systems, obviously connected with one another, have little to do with the skilled use of a bunch of specific applications: in fact, being fluent in using a given computer application is largely independent from the knowledge one may have in the aforementioned disciplines. In other words: to be able to read a clock one needs virtually no knowledge about the laws of pendulum.

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Another interesting remark about the various interpretations of the term informatics is due to Claudio Mirolo [3], one of the promoters of the Task Force for the Research on Teaching of Informatics at the University of Udine, who identifies at least three possible acceptations, corresponding to different cultural approaches:

1. informatics as a s*cience,* providing its own peculiar key to interpret reality and its specific approach to problem solving;
2. informatics as a t*echnology*, concerning the characteristics, structure and working principles of the now ubiquitous hardware and software devices;
3. informatics as an *instrument,* providing practical tools to manage information in many different contexts.

For the sake of clarity, in the following we will adopt the term *applimatics* to denote the use of specific applications and *computing* to denote the field of computer engineering, informatics, and information systems. While the latter term is widely accepted, the former is coined ad-hoc: we actually think that the use of a distinct term may help in reducing the ambiguity affecting the subject.

Getting some skills in applimatics can be very useful. For example, the "European Computer Driving Licence" (ECDL) [6] initiative has successfully contributed to the spreading the basic literacy of office automation tools among millions of people, who certainly took advantage of that knowledge. ECDL is a certification program based on seven different modules:

1. *Concepts of Information Technology*
2. *Using the Computer & Managing files*
3. *Word Processing*
4. *Spreadsheets*
5. *Databases*
6. *Presentations*
7. *Information & Communication*

As a matter of fact ECDL teaches very little about sheer computing (virtually only the first module concerns what we consider computing) and the acquisition of basic computing concepts is often perceived as an unwanted overhead by ECDL candidates.

This is the symptom of a general misperception: whereas everybody feels it is important to have a basic knowledge about word-processors and web browsers, an understanding of computing is often considered a special domain knowledge to be acquired only by experts of the field, since it is believed to have no immediate interest or usefulness in the real world. This opinion is supported also by many educated people, as shown by the fact that the conceptual contribution of the science of computing to other disciplines (such as cognitive science, economics, mathematics, physics, and linguistics) is seldom acknowledged. However, we believe some peculiar aspects of computing are sufficiently basic to be taught as a fundamental formative subject. For instance, consider:

- the focus on the precise description of objects, processes, and protocols;
- the management of complexity through encapsulation and reuse;
- the synthetic power introduced by the constructs of formal languages;
- the flexible use of abstractions, that can be dynamically coerced to what is more useful in any given moment, as in the case of data used as instructions and vice versa.

As it is clear to all the people working in computing, the misperception of informatics has negative impacts: brilliant students tend to be attracted by other sciences because they are not familiar with the challenges of our discipline, freshmen in computing courses sometimes have distorted expectations, public funding of basic computing research is hard to raise, etc. What can be done to change this matter of fact?

Our first and most fundamental suggestion is that our research community has to undertake a cultural battle to clarify the difference between computing and applimatics, and to disseminate the root principles of computing, starting from children education.

As far as education is concerned, we complete the picture by reporting some simple facts about the teaching of informatics in Italy. Recently, in its "Curriculum directions for K-12 education" [2], the Italian Department of Education (MPI) has indicated "Information Technology" as a means to increase the communicative power of students. Thus, the introduction of information technology tools is encouraged in all subjects (from arts to science) in order to "expand the space, the time, and the mode of social interaction and experience". Even technology teachers seem to be often predominantly interested in the fact that computers may be used to process texts, images, and other multimedia content, or to provide communication facilities. And, although MPI mentions that most of today technological artifacts have to be operated by signals and instructions, the mastering of this kind of issues seems to be suggested more as a service to higher level tasks than as an intellectual challenge in itself.

The actual implementation of MPI's directions is even conceptually poorer, since schools lack resources to acquire information technology means and teachers are rarely competent in computing. In the practice of teaching, at least in Italy, the scientific aspect of computing is virtually absent and the term “Informatica” refers prevalently to what we have called applimatics. Paradoxically enough, in the '80s, the rare pioneers that experienced the teaching of “Informatica” intended it in the sense of computing, by proposing didactic initiatives mostly connected with programming (for instance through the *Logo* language, cf. e.g. [4]). Such initiatives are today considered outdated by most teachers, more attracted by many appealing and user-friendly applications. However, these applications convey very little about computing, indeed they might even obscure the interesting computational and algorithmic aspects of such tools. We are convinced, on the contrary, that the awareness of these intrinsic features may be essential to a critical, profitable and mature use of computing. Vice versa, by overlooking these features, there is a danger that these tools, which are by now ubiquitous and pervasive, may be perceived in some sense as mysterious and indistinguishable from magic.

To cope with this situation, we started a project to introduce children to computing through a game-contest called *Kangourou* that has a successful tradition and a well-established experience in the field of mathematics. This paper reports about the first steps of this initiative and is organized as follows: in Section 2 we briefly present the Kangourou, in Section 3 we describe our current proposal for a Kangourou of informatics, and in Section 4 we draw some conclusions stemming from our first experiences.

2. The Kangourou game-contest

A game-contest, the *Kangourou des Mathématiques*, was created in 1991 in France by André Deledicq on the model of the *Australian Mathematics Competition*, with the goal of contributing to the popularisation and the promotion of mathematics among young people.

The success was immediate also thanks to the associated distribution of a massive and pleasant documentation on mathematics to the participating pupils and their teachers.

The French experience was exported abroad, first to Europe and then to other continents through an international association, *Kangourou sans frontières*, founded in France in 1995.

The association's aim is to promote the spreading of a basic mathematical culture by all means and, in particular, by organising the annual game-contest to be held on the same day in all participating countries. The game, whose intent is to attract the maximum number of pupils without aiming at any national selection nor at a comparison between countries, has had a great success and it now counts millions of participants among elementary and secondary school kids (47,000 in Italy in 2008).

In conjunction with the contest, and under the trademark *Kangourou*, books on mathematical games, brochures on mathematical dissemination to the general public, documents and software are realised and widely spread, meetings and exchanges between children and between teachers, colloquia, and training periods are organised.

In Italy, which joined the association in 1999, the game is organised in cooperation with the Mathematics Department of the Università degli Studi di Milano [5].

As a consequence of the effectiveness of the event, the game-contest was extended to other disciplines. In Italy, in cooperation with the British Institutes and the patronage of the Università degli Studi di Milano and La Sapienza of Rome, the Kangourou for English as a second language was created two years ago, which saw 11,500 participants in 2008. A team of members from two Informatics Departments of the University of Milan, AICA and SDA-Bocconi is now studying a formula for an informatics game-contest. In particular the following issues must be defined:

- the cultural goals,
- the way the game-context should be carried out,
- the content and formulation of the questions,
- the ages of the participants.

3. The ambitions of the Kangourou of informatics

The Kangourou of informatics might offer, to both pupils and teachers, a correct view of informatics and the oppurtunity to face the actual nature of computing, with particular regard to scientific aspects of informatics, often unstressed in school syllabi. The main tool is, of course, play. In fact, in primary schools play may have a strong educational valence, while the competitive feature is utterly subordinate.

3.1 A concrete proposal

At present our proposal is conceived as follows.

1. The organization should be similar to that of the Kangourou of Mathematics. An individual competition to take place in the classes, followed by a national final for the best competitors. The questions of the first stage will involve multiple choice answers, in the style of the other Kangourous, without using computers, since that would severely complicate this stage. In the final competition, however, we expect to propose open questions which might require the use of computers or specific programs.
2. For the first edition of this Kangourou we only expect to involve classes in secondary schools (11-14 year old pupils), but the idea is to extend the competition to primary schools (6-11 year old pupils) as soon as possible.
3. The subject of study of informatics is actually such a vast one that it is not easy to determine which contents and levels of deepening should be suitable for young pupils. Moreover, no definite programs exist for the subject and the choice of topics is left to the teacher. For this reason a first set of test questions has been proposed to pilot groups of pupils and teachers with the aim to collect their feedback and reactions.

3.2 Contents and formulation of the questions

The aim is to present the questions in a playful form, by creating fanciful contexts, and to make topics and problems accessible even without previous experience with informatics. One has to tackle technical terminology, reference to computer components, codes and specific representations of information, jargon from signal processing, cryptography, data structures (trees, graphs and so on), primitives and composition rules, algorithm representation, execution and complexity, recursion, sorting and searching, automata, languages and grammars.

Presently, only a few classes have already experienced our proposal but we can testify the first reactions of teachers and pupils were quite different. Teachers often appeared worried: the questions proposed often dealt with completely unknown topics and they felt they would not have been able to answer; on the other hand, even if students considered many questions difficult too, they appeared to be less scared and more curious.

As an example let us consider a couple of the questions proposed in the test set.

> *Santa Claus has prepared a few gift parcels having different colors: red, yellow, blue, and he has put them in two stores, mixing colors. Now he needs to know how many red parcels he has stored. He has got some elves to help him, but each elf only knows how to perform one operation and moreover Santa can choose only three of the following elves.*
>
> ***Arvo** moves blue parcels from a store to the other.*
>
> ***Bjork** moves red parcels from a store to the other.*
>
> ***Ceula** moves parcels from a store to the other but he is color-blind.*
>
> ***Dino** counts the parcels in a store.*
>
> *Which elf will Santa NOT choose?*

In this specific case, answering the question requires the ability to realize a complex plan by composing a few basic operations. These abilities may be considered of a logical or mathematical type, however the existence of explicit constraints endows the problem with some typical computer science features. We estimated such a question to be quite difficult for the audience, however, surprisingly enough, students declared it to be quite easy. Actually, it turned out that very few of them were able to answer correctly, recognizing that the unneeded elf is Arvo; on the contrary, almost all of them excluded Ceula. Clearly, this means they did not build a complete solution to deduce their answer, but probably followed this wrong shortcut: keeping the more specialized elves and exclude the more generalist one.

Another example is the following.

> *Philip needs to choose a password to protect his e-mail. Which of the following passwords ensures greater security?*
>
> 1. *Philip1995* [adding his birth year].
> 2. *Ph1l1p* [changing a few letters into numbers].
> 3. *PhiLiP* [using some capital letters].
> 4. *Philipemail* [to remember what the password is for].
> 5. *TpitfIto!* [the initials in the sentence “This password is the first I thought of!”].

In this case the aim is to convey attention to a basic operation common to most computer activities – the choice of reliable credentials – which much too often is made with dangerous superficiality. According to the first feedbacks, this question actually seems to be quite easy for young students, probably more acquainted with such issues and less naïve than we would think.

4. Conclusions

Notwithstanding the ubiquity and pervasiveness of the results of the science and craft of computing in everyday life, the impact of its conceptual roots on modern thinking is still unclear to the general public. The success of the computational approach is often confused with the popularity of successful applications and the need for mastering computing principles is mixed up with the skills needed to use a given system proficiently. To cope with this situation we think it is urgent to change the misperception of computing, by introducing children to its root principles as soon as possible. To this end we started to study how a game-contest as the Kangourou could help in fostering the interest about computing through amusement and play. Our first experiments are promising, although, as expected, the major obstacles seem to stem more from the misunderstanding of the multiple facets of computing on the side of adults rather than from a lack of interest in informatics on the side of school pupils.

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6 http://www.ecdl.org