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The power in digital literacy and algorithmic skill

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Abstract

We argue that in educational contexts ICT (Information and Communications Technology) and CS (Computer Sciences) should not be separated. To support our ideas, we present methods related to the minimalist principle with which students with different interests would develop algorithmic skills even in an ICT environment, and this introductory phase would lead the students on to more serious CS studies. The core of these methods is that from the very beginning of CSI education algorithms should be looked for in every computer-related problem. Deep-approach metacognitive methods should be applied, instead of uncontrolled sequences of surface-approach metacognitive activities such as aimless clicking, unplanned wandering, and relying on the newest features in graphical user interfaces (GUI). Our team has developed a deep-approach metacognitive method for teaching spreadsheet to novices, which is in accordance with the concept of building algorithms to solve computer-related problems. The three cornerstones of the method are (1) introducing as simple and as few functions as possible, (2) building multilevel formulas based on these functions, and (3) focusing on the problem instead of the features of the software. As the students make progress, the number of functions would be increased, but general purpose functions would still be focused on. Testing our deep-approach method has proved that it is a lot more effective in teaching spreadsheet than the classical surface-approach, wizard-based metacognitive methods, since all the basic elements are in accordance with the minimalist theory, which advises teaching as simple a language as possible for beginners to develop basic algorithmic skills. Beyond the direct advantages of the method, spreadsheet would serve as an introductory language to high level programming languages, which is our ultimate goal.

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Keywords: deep- and surface-approach metacognitive processes; developing algorithmic skill; teaching spreadsheet

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1. Introduction

Digital competency and digital literacy have been among the most popular expressions featuring in the curricula of the last few years, and the effect of both of these on different generations – the Y and Z generations of digital natives (the bit-generations) and the X generation of digital immigrants (Dani, 2013; Jukes, McCain & Crockett, 2010) – is one of societies' main concerns. We must give some consideration to these newly coined expressions and some background information related to them. First of all, the most important point is to emphasize that in order to develop digital competency effectively and efficiently, and to achieve digital literacy, formal education is needed. For formal education, teachers are needed, and for teachers, teacher education is needed. At this point the loop is closed, and we face the chicken and the egg problem: who teaches the teachers if there are no teachers? In Computer Science/Informatics (CSI) education this is one of the most crucial questions and for an answer we have to look back in time to the emergence of the subject. The contradictions, both of the science itself, and of the developing commercialized world as it interacted with the science, have affected both teachers and teacher education and consequently the development of digital literacy.

The pioneer teachers were self-educated, in most cases not supervised, and if so, certainly not by experts in the methodology of the subject, because it did not exist. These first teachers mainly taught programming languages, algorithms, binary arithmetic, and computer architecture. Over time they became accepted in their local environment, whether they were qualified or not; they used methods they had developed themselves, without proving their efficiency or effectiveness, due to a lack of time and methods.

In the meantime, computer science developed at an incredible speed, and the new mouse-based graphical user interfaces (GUI) increased the number of users and changed the approach and attitude towards computers. Everyone started to use computers regardless of whether they had any background knowledge, and software developers encouraged them to do so. These companies claimed that by using the GUI and its accompanying wizards the users would be able to solve problems. Users need do nothing more than click here and there and they will find the solution.

Even teachers fell for this, and giving up the teaching of algorithms, switched to aimless clicking, not looking for the algorithms in these new programs; consequently they stopped developing their own and the students' algorithmic skills.

Nomenclature

A	ICT: Information Communication Technologies
B	CS: Computer Sciences
C	CSI: Computer Science/Informatics, including both ICT and CS
D	CAAD-based (Computer-Algorithmic And Debugging-based): deep-approach metacognitive processes of computer related activities with an emphasis on building algorithms and debugging results
E	TAEW-based (Trial-And-Error Wizard-based): surface-approach metacognitive processes of computer related activities highly dependent on the graphical interface

1.1. Fiasco

1.1.1. Facts and results

Recent studies have found that more than 90% of e-documents have errors (Panko & Aurigemma, 2010; Tort, Blondel & Bruillard, 2008; Tort, 2010, Csernoch & Bujdosó, 2009; Csernoch 2010), and uneducated computer users cause serious financial losses by providing unreliable data and by taking much more time than problems require (van Deursen & van Dijk, 2012). Along with these findings, other publications have provided evidence that these mistakes are due to a lack of algorithmic skills and thinking (Angeli 2013; Panko & Aurigemma, 2010; Biró & Csernoch, 2013a, 2013b). However, the Students On Line session of the PISA 2009 survey proved that computer usage in schools does not necessarily increase the level of digital competency (OECD, 2011). This ambiguity clearly indicates that we have serious problems with the methods employed to teach CSI in most countries. Faced with these problems, countries have reacted in different ways. In the United Kingdom in 2012 the number of computer