Building Basic Competences for Culturally Diverse ICT Professionals

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Helsinki Metropolia University of Applied Sciences, Finland
jaana.holvikivi@metropolia.fi

Abstract. The ICT profession is extremely international, and so are ICT students. University students in one study group in Europe may represent ten or twenty nationalities with varied cultural and educational backgrounds. Selection of appropriate teaching methods for diverse students is challenging. This paper describes cognitive differences in multinational study groups, and explores ways to overcome some of the differences through offering online programming courses to support classroom instruction. Currently, online programming tools are widely used in schools and outside formal institutions. This paper shows that they can be efficient also when building professional competencies.

Keywords: ICT education; programming; cultural diversity; online courses; professional competences

1 Introduction

The student body in ICT departments is extremely international in European universities that offer tuition in English. Students come from many continents with diverse educational backgrounds. The diversity of students poses a number of challenges, simultaneously offering a number of advantages that the universities need to address. The situation has evoked much research and discussion among universities nationally and worldwide, generating a substantial literature on these issues [1]. The main research approach has centered on a limited number of questions: how to recruit efficiently, how to generate income for the institution, how to help students adapt to the new environment, how to teach the correct behavior, and how to provide supporting studies. On the other hand, the contribution of the international student body to universities has been more or less ignored in research. Thus far, only few universities have attempted to modify their core curricula to accommodate a diverse student population [2].

This paper presents a summary of long-term case studies of the capabilities and backgrounds of international ICT students in the Helsinki Metropolia University of Applied Sciences [3], and aims at describing new strategies for developing competences in a diverse group. Moreover, it explores the impact of the emerging trend of global online education. The offering of high profile MOOC's (massive open online courses) by top universities, as well as other online programming and science courses, reaches students in many parts of the world.

First, some characteristics of western academic culture are discussed, focusing on specific cognitive requirements of technology studies. The gap in primary and secondary education between economically developed and less developed countries is exemplified. In the research section, some consequences of the educational disparity for international ICT education are presented. Finally, one solution to improve the current unsatisfying situation by strengthening competencies by online programming courses is discussed.

2 Western Science and Educational Practices

The academic world has largely functioned on the assumption of universality of western science, and the universal nature of human cognition [4]. Accordingly, most of the research that has been published in psychology journals has been conducted by western researchers (96%), using university students as test subjects (in 67% of the cases in American samples). However, the western sample of study subjects has been shown to deviate from other cultural samples in certain cognitive skills such as spatial reasoning and thinking styles, especially analytical thinking.

Similarly, brain studies [5] have been conducted mainly in rich Western countries, partially because of the high cost of the equipment and the high skill level required for research teams. Only in Japan, Korea and China has the technology been advanced enough to conduct brain scans on the local population [6]. The inclusion of eastern populations has revealed interesting results such as brain differences in reading: the use of Chinese characters employs brain areas differently from using alphabetic characters [7], [8]. Moreover, basic mathematical operations are influenced by the language and writing system [9]. Additionally, decision-making and perception seem to be influenced by culture [4].

The dependence of cognitive variation on culture has also been discussed by Margaret Wilson [10] who introduced a theory of cognitive retooling based on the current neuro-scientific knowledge. She argued that culture exercises a profound effect on the cognitive system of perceiving and thinking, and even more importantly, on the functioning of the cognitive system. Cognitive tools are culturally transmitted through education, and the use of cognitive tools shapes neuro-cognitive architecture. In this paper, comparisons of cognitive and study practices of international students are presented.

The situation in Africa illustrates how weak connections to the practical life the education might have [11]. The curricula in African schools are based on western models, as well as most books and materials. Students hardly have access to computers [12]. The content of textbooks might be very remote from the everyday experience of students, adding an extra level of abstraction to the content to be learned. Therefore, students need to operate from two worldviews and often have two or more cultures to contend with, which results for them in rote learning without reaching a de-contextualization of knowledge.

3 Research and Results

The Helsinki Metropolia University of Applied Sciences has educated international students in English since 1994. Our experience has revealed various kinds of challenges that students with developing country background confront when entering the western engineering education system. Our research has extended over ten years, indicating certain changes that have occurred during this period [3]. In the beginning, students mainly came from Russia and China, later increasingly from Africa and South Asia. However, all continents are still represented among the student body. The variety of students ranges from monolingual Chinese and British students to multilingual South-Asian and African students.

3.1 Previous research and findings

Most conspicuous difference between developing country students and western students is their capability to combine theory and practice. An overly theoretical approach by developing country students has been revealed in laboratory assignments in nearly all ICT engineering courses that require hands-on work with the equipment, accurate measurements, or program coding. As students themselves report, these tasks are completely new to them, and they have not been trained in laboratory procedures [13]. The early life experience in western countries includes interaction with technical objects whereas children in developing countries tend to have more social interactions. According to a study by Agiobu-Kemmer in 1984, Nigerian Yoruba children spent more time with human beings than with physical objects. The reverse was true with Scottish children who spent more time with physical objects than with human beings. This comparative study indicated that cultural factors influence the way how the early upbringing introduces the physical world [14].

Student basic cognitive abilities also seem to differ in certain respects, in particular in the reaction times and working memory functioning [15]. A simple working memory test was given to groups of different nationalities, and the western and Chinese students performed significantly better in memorizing and in reaction times than African students. Van de Vijver [16] has previously reached somewhat similar results on reaction times. The working memory capacity of international students has not been studied previously, and even though the results of the study were unambiguous and significant, further studies would be needed to understand the phenomenon better.

The teaching methods in many affluent countries consist of little lecturing, and a range of possibilities for project and team work. Engineering study includes lots of practical work in laboratories. Even though students from developing countries find these new study methods appealing, the methods are perceived demanding as they call for more individual effort and need for self-regulation. Team working practices are usually taught in western schools and therefore university students are expected to have some previous knowledge of them. International students are in a less advantageous position in this regard compared to home students. These findings at our university are very similar to findings from other western institutions [13]. However, universities that primarily apply project based learning and team working methods are aware of the effort that is needed to become a productive project member, and try to address it [17]. Developing country students need to alter attitudes in studying and reflection to match teaching methods where individual knowledge building is encouraged, and questioning and criticizing are allowed and even expected.

Students who are accustomed to a lecturing type of teaching and straightforward drilling practice, find also mathematics teaching different. They might be competent in mathematical operations but when they need to concentrate on problem-solving instead of mechanical operations they encounter a new challenge. Their previous education has been concerned with acquiring a fluency in operations, which have been adopted as separate skills. The phase of deep learning has to be achieved next, and construction of sense-making units of knowledge needs still to be developed [18], [19]. The knowledge and competences that have been acquired in home country education are less useful in the pragmatic engineering field where application of knowledge is required. To become a competent professional, the student has to reach the level of de-contextualizing knowledge, where she is able to apply skills in new situations.

3.2 Current research

One beginning study group consisting of 56 information technology and media students answered an online questionnaire of their study experiences and previous practices in their first study term in October 2013. The survey included questions on the experience of computer use, earlier use of computers in studies, familiarity with various study methods, and cognitive preferences.

The survey was given as an optional task in a study module; however, all students decided to participate. Moreover, they answered nearly all questions though none was indicated as compulsory. The ages of participants ranged from 18 to 34, with an average of 23 years. Nine of the respondents were women. They came from several regions: 8 from Africa (Af), 9 from Eastern Europe (EE), 9 from Western Europe (WE), 15 from South Asia (mainly Nepal, SA), 10 from East Asia (Vietnam, China, EA), and 5 from Middle Eastern (ME) countries. They reported being fluent in 26 different languages.

The survey consisted of multiple choice questions on technology use and understanding, questions on study modes and use of technology in the studies, questions on career aspirations and cognitive practices, and some open questions on the current studies. Respondents were given a link to the online form, which was implemented at Google drive. The form could be filled in at any time. Duplicate submissions were eliminated from the results.

3.3 Results

A few questions explored the time and place where the student started using computer. The background diversity was reflected strongly in the usage of computers before studies. About one third of the respondents had become familiar with computers already before age 10, 24% started using computers at age 11-15, 28 % at age 15-20, and 16% were older than 20 when they started using computers regularly. As could be expected, Africans had a shorter exposure to computers than the other nationalities, whereas western students had been using computers already very young.

Use of computers in school (fig. 1) gave a similar profile as the starting age. Only one African student had used a computer in high school, all others had started computer use at the university level, whereas 67% of European students learnt using computers in primary school and the remaining 33% in secondary school. Among Asian and East European students the distribution was more even.

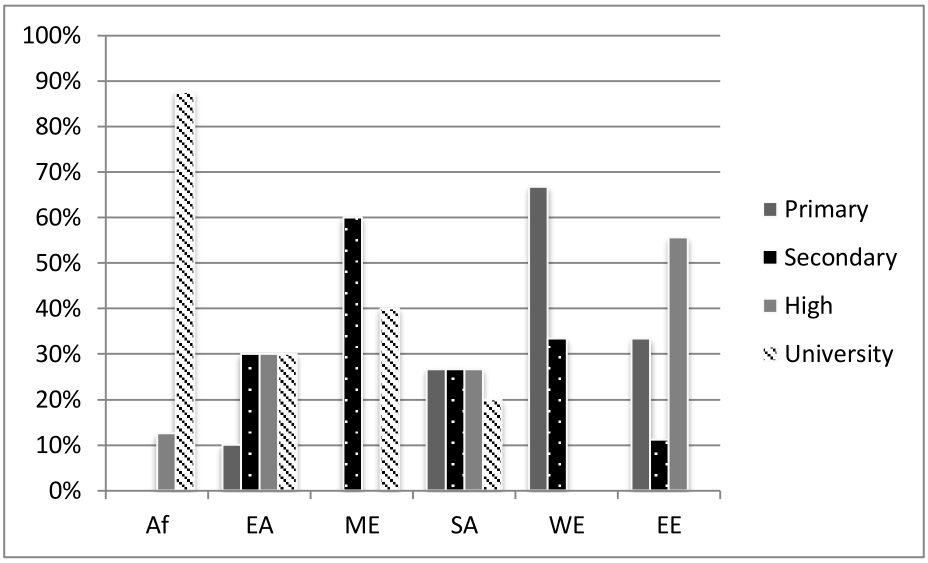

Fig. 1: Use of computers in school by nationality

Previous programming experience or programming studies were not common among the survey population, as half of the students stated that they had not learnt programming before. Only 25% had programming lessons in school, but among East European students this figure was 56%. 30% of respondents had learnt programming on their own; 20% of the students had tried some online courses. (Fig. 2)

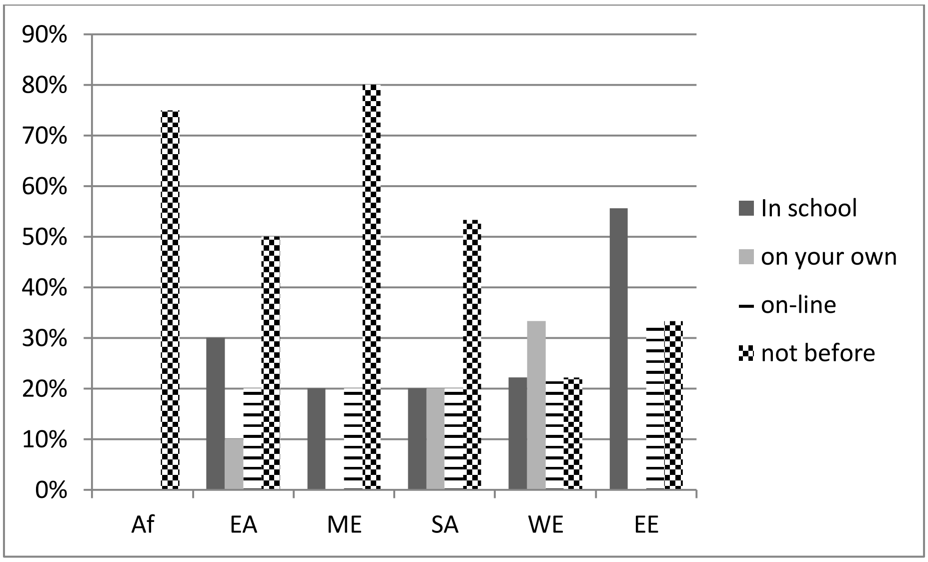

Fig. 2: Previous programming study by nationality

According to this study, East European schools seem more science-oriented than others, but in fact the reason might be that students from there have been better informed when choosing their field of study than students from poor countries. Other interviews of East European students indicate that they often have previous studies in ICT, and come to strengthen their career opportunities by a western degree.

Few other questions explored the professional inclination of students. To the question "What kind of job are you interested in?" 60% responded that they were interested in programming as a job. On the other hand, 70% found working in software development attractive.

According to this survey, East European students also had the most traditional study experience and less exposure to varied study methods such as team work, research report writing or giving presentations. They also indicated little interest in natural world. To the statement: "I enjoy learning the names of birds, trees, animals and plants" they gave the second lowest average score, 2,0 (maximum 5). Middle eastern students indicated no interest at all, their average was 1,0, whereas the average in other nationalities was around 3. African and South Asian students had played only little with Legos, which was a shared experience among other nationalities. The frequency of playing word games varied from 2,4 (ME) to 3,8 (SA). (Fig. 3).

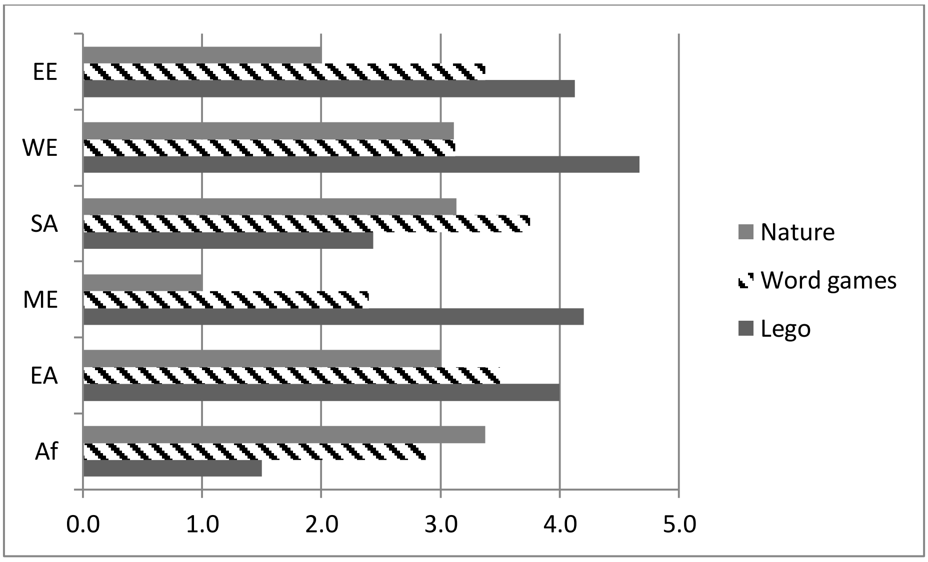

Fig. 3: Childhood hobbies by nationality

3.4 Experiments

All first year students were required to complete an assignment with the online version of MIT's Scratch, at http://scratch.mit.edu/. Scratch is a tool that has been developed for children and it teaches programming structures in an entertaining visual way [20]. The first demo programs show how to create a small animation. When student perceptions of Scratch were inquired in the survey, they were almost exclusively positive. However, approximately 10% failed to grasp the idea and develop anything functional, a couple of students even failed to follow the simple instructions how to start the program. They were among the previously computer illiterate students. In survey responses, two were negative towards Scratch stating that they did not understand it. Student quote: "I think it is useful but I am not being able to use it." On the other hand, there were many enthusiastic comments by programming novices, as well. A student quote: "I've never used Scratch before and I think this program is perfect for those who just doing their first steps in programming. It is clear, funny and easy, I wish I could study it at school." In sum, Scratch was an appropriate tool for beginners also on this level of study, and for a diverse group of students. In fact, it would have been unexpected to get an opposite result, as Scratch is used worldwide in schools, outreach programs, and even at universities. Moreover, experimenting with Scratch seemed to have a positive effect on learning in the C-programming course that followed in the next term.

In our previous research, we tried to replace more demanding programming languages with Javascript as the first language to learn [21]. When the Ville online tool became available, we asked two international groups of third year students to practice Javascript programming in the Ville programming environment. The Ville environment has been developed by University of Turku, at http://ville.cs.utu.fi. In fact, it includes a choice of several programming languages as well as mathematics, language studies, etc. This environment has a visual, user-friendly interface, which allows completely self-guided practice [22]. Most students in our experimental groups had no previous experience with online tools, despite a substantial percentage of Europeans including French and German exchange students. They had taken at least one programming course, though. After the practice, students were asked how they liked the environment for coding practice, and the response was very positive. Around 70 students in two groups completed the required practice that included 60 tasks and took 8 to 20 hours to complete. Only 15 students failed, which was a reasonably good result for these groups.

4 Conclusion

Both Scratch and Ville are based on extensive research on learning and programming. They rely on visualization of programming structures, and automatic interpretation of code. Based on the three experiments conducted in this study, the selected online programming courses can be recommended to any group of international students. The great advantage is the large amount of simple tasks that can be completed on one's own pace. Drilling practice that the online coding systems offer seems to suit almost every student. More advanced students might become bored, but at that point they do not need the practice anymore. On the other hand, if students fail the simple practice, they obviously should not choose programming as a career. Students who come from developing countries, might have a poor idea of ICT profession, and have chosen it based on its importance. Their aptitudes in this regard are checked first when they start university studies. Therefore, some drop-out percentage is natural.

Developing ICT competences in culturally diverse groups requires approaches that allow different starting levels and individual practice times. The online courses in programming that were used in this research have reached a maturity level where they can be considered as a valuable option for all students.

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