Ethnocomputing
a Multicultural View on Computer Science

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Abstract

Despite all the hype around the dream of global society, the borders of the world have not disappeared. Rather, they have sharpened and changed their form from geographical to electronic frontiers. The prevailing Westernness of Computer Science is a major problem with the Computer Science education in developing countries. The students not only face a new subject, but also a fundamentally different philosophy and problem solving methods. In this article, we shall present a new member to the family of ethnosciences: ethnocomputing.

Ethnocomputing challenges the prevailing way of thinking that in order to keep up with the West, other cultures have to adapt to Western ways of thinking. Relying on constructivist theories, we argue that the universal theories of computing take different forms in different cultures, and that the European view on abstract ideas of computing is culturally bound, too. Studying ethnocomputing – i.e. the computational ideas within a culture – may lead to new findings that can be used both in developing the Western view of Computer Science and in improving Computer Science education in foreign cultures.

1. Introduction

The very notion that there could be a "universal civilization" is a Western idea, and directly at odds with the particularism of most Asian societies [1]. Still, the Western countries are imposing the Eurocentric philosophy of science on non-Western cultures in the name of globalization and fairness. Most of the literature, teaching material, problem solving methods, and even the question of which problems are legitimate at all, are based on the traditions of science written by white Western males. Throughout the history, people have explored other cultures and shared the knowledge often veiled behind the traditions, practices and customs. We see that the exchange of the cultural diversity has enriched and equalized the cultures, including ours. Yet now, there seems to exist a global consensus of the supremacy of Western logic. Our concern is that the currently ongoing cultural imperialism in Computer Science may accelerate the digital divide, the division process of countries.

In this article, we present a field of research that studies the phenomena and applications of computing in different cultural settings. The study of ethnocomputing is based on a constructivist claim that the universal theory of computing takes different forms in different cultures, and that the European view on abstract ideas of computing is culturally bound, too. From this on, *ethnocomputing* refers to a cultural perspective in the problem solving methods, conceptual categories, structures, and models used to represent data or other computational practices. Our view is not historical by nature, but we will try to present how our view on understanding the foundations of Computer Science differs from the traditional view on it as constant, universal and final.

2. The roots of Computer Science

Computer Science is a young discipline, and its boundaries are still unclear. Just a glance at the list of ACM special interest groups is enough to convince one of the diversity of the science. That most of these special interest groups are interdisciplinary by nature, leads to the conclusion that the value and use of Computer Science is mostly instrumental. This multidisciplinarity also problematizes the philosophy of Computer Science. The roots of Computer Science are in mathematics, and are positivist by nature. Still, falsification –a postpositivist method– is widely used in several areas. For example, proving a program correct is often impossible in the real world, and thus the program is supposed to be "correct enough" if extensive testing does not reveal more errors – but certainty is never achieved.

Constructivism, on the other hand, can be seen, for example, in the area of human-computer interaction. Realities are understood to be multiple, and they are all constructed individually. There are no absolute realities, e.g. universally usable user interfaces, but just local, experientally constructed and fluctuating interpretations. This

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variety of paradigms causes uncertainty among both students and researchers. Still, this diversity of paradigms also holds strength in it. Because the discipline is intrinsically open to many differing paradigms, certain openness and adaptability is preserved.

Computer Science was born and raised to meet the needs of the Western society. The army (e.g. ballistic calculations, code breaking and ciphering), sciences (e.g. chemistry, biology, meteorology) and other sectors of society (economy, communications, arts etc.) have adopted Computer Science as a tool. It has developed concurrently with the society, responding to the varying needs of the society. Due to this –and to the values of the Western society– the science is Western, middle or upper class and male in origin [2]. Because of the history, almost all the teaching material, problem solving methods, and concepts are dominantly Western. This causes problems to non-Western students who need to start with learning a whole new philosophy when studying Computer Science. This Western philosophy may be directly in odds with their perceptions of time and space, society, logic, values, or problem solving methods. When the poor resource situation of the developing countries is added to this, the chances for crossing the digital divide are not too promising.

Not only is the eurocentricism in Computer Science fueling itself, it is also a growing burden for the science. That only a small fraction of the brains of the world are invited to develop this science slows down the progress, locking the compass to one bearing. It is almost as if explorers –both the Western and non-Western– would all unanimously agree on leaving northeast to southwest unexplored, determining that all the interesting discoveries can be found in north and west. This kind of attitude can nothing but broaden the digital divide. The clashes between civilizations can be expected to grow in frequency and severity in the future.

3. Social construction of science

Constructivists believe that what we take to be objective knowledge and truth is a result of perspective [3]. Knowledge and truth are created, not discovered by the mind. In the constructivist paradigm, the realities are socially and experientally based [3]. The phenomena in the world can be expressed in a variety of symbol and language systems, and the reality is stretched and shaped to fit the needs of the people [4]. In a sense we all are constructivists if we believe that learning and knowing are not just passive storing of data in a high-capacity device, the brain – but that mind processes the information somehow; at least forming abstractions and concepts from the data [4]. We invent concepts, models and schemes to make sense of experiences, and, further, we continually test and modify these constructions in the light of new experience [4].

Our hypothesis is that Berger and Luckmann's [5] theory of social construction of reality holds also in Computer Science. Their idea is that any form of knowledge is a human product, evolved socially and individually. The institutional world, however massive and objective it may appear to the individual, is actually a humanly produced, constructed world. This humanly produced world affects the individual mind. The relationship between man, the producer, and the world, his product, is and remains a dialectical one. If this holds also in science, it leads to a realization that man is capable of producing science that he then experiences as something other than human product.

Science, if anything, is popularly thought to be some sort of an extreme form of knowledge, albeit only a small fraction of people can express their thoughts in theoretical form. Still, scientific paradigms are nothing else than social constructs, since they are essentially the result of an agreement among a scientific community [6]. Because the paradigms deal with first principles, or ultimates, there is no way to establish their truthfulness, so they must be accepted simply on faith [7]. Apparently arbitrary elements, compounded of historical and personal accidents are always forming the beliefs of the scientific communities [6]. Successful science, even those projects that aim to paradigm articulation, does not aim at *unexpected* novelty – and when successful, finds none [6]. If we agree that a paradigm is a result of a consensus among scientists, then we can argue that debates on knowledge claims are valid only within a restricted community in a certain era.

Ethnosciences have evoked lots of discussion, raising fervent arguments for and against them. The concept is defined in numerous, divergent ways, one of which is Ubiratan D'Ambrosio's use of the term as "the study of scientific and, by extension, technological phenomena in direct relation to their social, economic, and cultural backgrounds" [8]. Ethnosciences rely on the idea that each community has developed its own ways, styles, and techniques of doing certain tasks, and responses to the search of explanations, understanding, and learning. These are called the *systems of knowledge* [9].

All the different systems of knowledge use inference, quantification, comparison, classification, representation, and measuring [9]. Western science is such system of knowledge, but other systems of knowledge with the same aims have also developed. The other systems use other ways of inferring, quantifying, comparing, classifying, representing, and measuring, but should not be classified as simpleminded or childlike [9]. The term has sometimes been restricted to concern only the scientific ideas of non-literate people [10], but a broad definition suits our idea better. We think that technologically advanced cultures can contribute to the study of ethnocomputing as much as less advanced ones.

4. Culturally sensitive learning

Computers and Computer Science are definitely among the most significant factors widening the regional income gap. Development without the Internet would be the equivalent of industrialization without electricity in the industrial era[11]. The inherently vague concept of "West" eases the broadening of the division even further. The only way to slow down the separation process between computer-literate and –illiterate people is to give everyone an equal possibility to computer education. In the United States, there have lately been cries for ethnically fair education also in science, not only humanities [12]. Studying ethnocomputing offers a tool for developing a multicultural approach in Computer Science education, recognizing the influence of societal and cultural background on both learning and understanding Computer Science.

Like many other disciplines [2], the education of Computer Science has been "canonized", too. The canon assumes that the only worthy knowledge is already in place in the curriculum. Knowledge in this context is inevitably European, male and upper class in origin and conception [2]. In Computer Science the canonization has actually gone as far as assigning particular courses distinct universal codes, and stating the right order of taking them. This is especially questionable in an interdisciplinary subject such as Computer Science, since the canon decides the "appropriate" curriculum now and in the future. People who are taught a certain canon will most probably pass that canon to next generations. Problems with the possible canonization include also the narrow view, the inflexibility and the cultural insensitivity of the canon.

The narrow view discourages students from using Computer Science the way it actually should be used: as a powerful tool for a wide range of different fields. It is not a surprise that the main problem of computer industry is the lack of understanding between the programmer and the client, for innovative and creative combinations of Computer Science studies are not encouraged. The inflexibility here means the assumption that the list of the acceptable courses is comprehensive, and good and final as such. The list has been reviewed once every tenth year, and each time some new branches are added, depending on the preferences of the jury.

Cultural insensitivity of the canon manifests as a failure to understand that Computer Science has evolved in response to its surroundings (see, e.g. [13]). Thus, starting from the birth of Computer Science, it has been culturally dependent. The discussion has still centered solely on the social and ethical impact of computing on society, not the other way around. The idea of ethnocomputing includes an assumption of a dialectic process where the society has an impact on Computer Science, too. The dialectic nature of computing is evident in that technical issues are best understood – and most effectively taught – in their social context, and the societal aspects of computing are best understood in the context of the underlying technical detail [14]. The systematic study of ethnocomputing aims at developing skills for observing computational phenomena that have their roots in distinct cultural settings. The results may then lead to new viewpoints into Computer Science, which can be used to improve the cultural sensitivity in teaching computing. Promoting the competence of different social groups goes also hand in hand with creating ethnically fairer science. For example, Ron Eglash's research on fractals in African indigenous design [15] could work as a contact surface for teaching recursion in Computer Science - not necessarily in Africa only, but also in other cultures.

All the main approaches to multicultural education (see, e.g. [12],[16]) fail to bring out the dynamics of Computer Science. Another approach is needed in order to emphasize the radical reformative nature of ethnocomputing: *reformative multiculturalism* [17]. It stresses the diversity and constant change of society (and consequent change in knowledge and science), and underlines the role of the students in this change. Especially in a diverse science that is in constant fluctuation, it is imperative to incorporate the cultural knowledge and the idea of dialectic process into teaching. On one hand, ethnocomputing should be seen as an active force of societal change, on the other hand as a dynamic subject of change. Ethnocomputing arises from the culture and adapts to the changes in the culture [17].

5. Definition of the term

The etymology of the prefix *ethno-* traces back to Greek word *ethnos* meaning "people", "nation" or "foreign people". In the concept of ethnocomputing, though, ethno does not refer only to race or people but to differences in culture. The differences in culture are based on language, history, religion, customs, institutions, and on the subjective self-identification of the people – those social, economic, and cultural backgrounds that define a cultural entity [1]. The different cultures have different views on the relationships between god and man, the individual and the group, the citizen and the state, parents and children, husband and wife, as well as differing views of the relative importance of rights and responsibilities, liberty and authority, and equality and hierarchy. These differences are far more fundamental than political disputes and regimes [1] or scientific paradigms.

After Church's thesis in 1936, computing has been understood as something that Turing machines or similar models could compute [18]. However, this definition of computing is rather limited. Most of the interesting problems are thought to be insolvable, though they are practically solved using different kinds of heuristics [18]. Differently from the traditional constrained view, using Gibbs and Tucker's [19] definition of Computer Science as a basis, computing is here defined as a combination of

(1) the organized structures and models used to represent information (data structures),
(2) the ways of manipulating the organized information (algorithms),
(3) their mechanical and linguistic realizations, and
(4) their applications.

Rather than changing the science itself (the content), the goal of the study of ethnocomputing is to take the form (the outward appearance) of computing under examination. In another words, the aim is not to alter the foundations that underlie computing. It is the way in which the computational concepts are presented that ethnocomputing has particular interest in. Instead of being another paradigm itself, the study of ethnocomputing aims in encouraging new paradigms to be sought, examined and adopted. There is no reason to believe that the idea behind the universal Turing machine, for example, would not be a part of the foundations of Computer Science in any culture. Instead, there is reason to believe that the form the concept of the universal Turing machine takes, or how it is taught best, may differ from one cultural setting to another. The Western notion of the universal Turing machine also represents a subjective view on numeral computing.

The internal contradiction of the term ethnocomputing is intentional. *Ethno* represents particularity and *computing* universality, and a combination of particular and universal leads to computing activity that takes its place within a culture. The concepts of ethnocomputing can manifest as direct applications in real-life situations, or objects among cultural groups, and they reflect the traditional practices of a culture – whether or not technically advanced. It is necessary to understand how computational concepts are born, conceptualized and adapted into the practices in a society.

Figure 1 represents the idea of the layers of knowledge [17]. A community is a group of people forming a distinct segment of society, and the members may have their own language and culture. Community A could represent the IT users in the Finnish countryside, whereas B could be the programming elite of Seoul National University. The languages and cultures of different communities may overlap, and a person may belong to many communities. The relationship between language and culture and the communities works in two ways; language and culture also change (and sometimes define) the community. The universal theory of computing consists of computational concepts of which we can only acquire knowledge confined to their appearance, but the noumenal reality (*Dinge an sich*) is beyond our reach. The layer of ethnocomputing represents the appearance of the concepts to us. Different cultures may have different abstractions of the universal concepts, and these abstractions can overlap. It must be noted that all the knowledge attached to the universal phenomena is culturally bound and thus subjective.

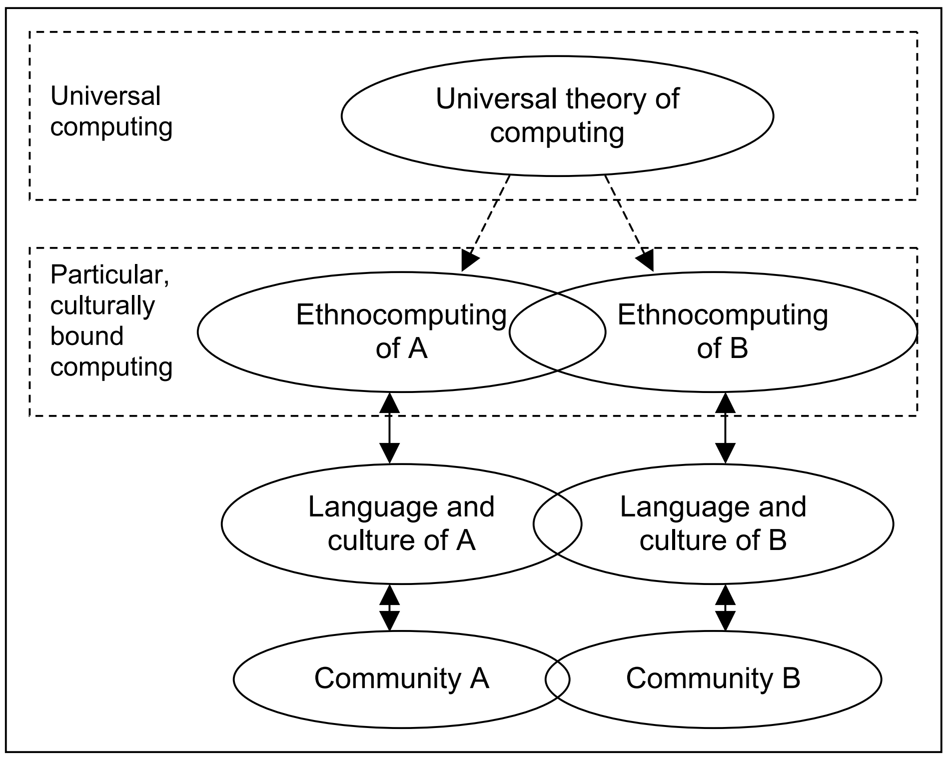

Figure 1: The relationship between particular and universal computing

At the moment, ethnocomputing seems to be important especially in new fields of research such as AI or fuzzy logic. For example, Lofti A. Zadef states that the Hindu, Chinese, and Japanese cultures have greater acceptance of truth that is neither perfect truth nor perfect falsehood

[20]. In our opinion though, ethnocomputing has been given a chance only in the new research – or ethnocomputing has lead to new fields of research. Current normal science does not give ethnocomputing of non-Western cultures much chance to introduce new views into old themes. Our opinion is that different cultures can contribute to the development of concepts and ideas and enrich them – also in the traditional fields of Computer Science.

Lastly, in addition to the development of Computer Science and education, ethnocomputing holds another equally important objective. As Ubiratan D'Ambrosio recognizes, ethnoscience means going back to basics with the common goal of equity and dignity [21]. The Eurocentric conception of science has been imposed globally as the pattern of "rational" human behavior. The results of this intended globalization under the control of imperialist powers are far from acceptable. Study of ethnocomputing can encourage the ethics of respect, solidarity and co-operation across cultures. Eventually, if science would become equally available to all, ethnically fair by nature and if cultural diversity is accepted, the ultimate goal of getting rid of the ethno-prefix shall be accomplished.

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