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Smart morning in an African village: Diversifying technologies within a Tanzanian context

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Abstract

Information technology (IT) can make a difference in a developing country only if it is designed in close collaboration with its users. The experiences from an ethnocomputing-based IT education initiative at Tumaini University, located in the rural area of Southern Tanzania, indicates promising opportunities for engaging children and students as creative co-designers and users for diversifying, novel information technologies. The local context with its needs was taken into account when using robotics (I-Blocks) and culture-based learning materials and implementing students' village outreach projects in local schools and hospitals. The CATI model suggests the steps Contextualize, Apply, Transfer, and Import for sustainable, inductive IT design. Together with the concept of ethnocomputing, the CATI model proved useful for building and starting a new needs-based, contextualized IT undergraduate program at Tumaini University in Tanzania in 2007.

Keywords: contextualization, concretizing, visualization, ICT4D, IT education, Tanzania, localization

Introduction

The vision of the World Summit on the Information Society (WSIS, 2003) offers all people the opportunity to use information technologies. Schools and other educational institutions – whether rural or urban, rich or poor – should not be excluded from such opportunities. What inspired the WSIS to enunciate such a vision in the first place is an evident worldwide inequality in accessibility to and use of new technologies. This inequality, which has many ramifications, has become a central issue in the world today. Ancillary to this

the WSIS encourages the development of the content and technical conditions that will enable all the languages of the world to be used on the Internet. Part of our work has been to identify and describe ways in which information technologies and IT education can support local development, especially in higher-education institutions, without any sacrifice of local identity.

The risk is that the globalization especially creates new needs and opportunities that benefit the Western societies, but more seldom the developing countries. One of the challenges is to integrate new Information Technologies (ITs) to support and respect the local community and development. There is an threat that the increased use of IT will create even a bigger gap between the innovators of Western countries and the end users of western products in developing countries. The forms of technology can enrich rather than diminish local knowledge and culture.

The net-generation phenomenon is widely discussed internationally. This generation has grown up with technology and is typically media literate. The people of this generation are also socially active in online networks (Oblinger & Oblinger, 2005). Prensky (2001) suggests that the whole educational system ought to be changed based on needs, action cultures and skills of this generation. On the other hand, there are also critical views on the issue; how prepared are the students for this kind of change (Bennett, Maton & Kervin, 2008; Valtonen et al., 2009)? Further, considering the developing world the starting points and needs for the changes are likely to be different because the technological and cultural background of the students differs from that of the typical Western net-generation students. Today's students in the developing countries might not have any IT experience from their childhood, but they are being surrounded by information technology in an increasing speed (Sutinen & Vesisenaho 2006; see Tabscott, 2008).

Despite the qualitatively essential differences between the context of Western and developing countries, the expectations from IT are too easily equaled in these two different kinds of environments. This is seen in almost all the perspectives of IT: technologies, applications, information systems, and curricula. Individual, not even to mention cultural, characteristics of users have been mostly ignored.

Our research initiative called for a novel perspective to the design of IT that would facilitate everyday life based on people's identified needs. This starting point, as we hoped, would distinguish both the research process as well as its results from conventional approaches that mainly aim at reusing existing technology for new needs. Contrary to this, we wanted *new technologies* designed and developed to meet *existing needs, contexts, and cultures*. The idea of smart morning in our title refers not only to the attribute of novel technologies but also the continuity from yesterday with respect to the needs.

Context of development

The necessary national infrastructure for the support of IT in Tanzania is largely lacking, but under rapid development (Table I). The number of Internet users in proportion to the general population was ten per 1000 in 2007, and the ratio of personal computers to the general population was nine per 1000 in 2007. Statistically, there was one subscriber per 1000 persons in 2007, which shows the general state of broadband connections' availability (World Bank, 2009). The East Africa Submarine System Project was designed to meet this urgent need for supplying a reasonable amount of bandwidth in the future. It looks promising, reaching Tanzania in 2009 or 2010.

Year	Computers/ 1000 persons	Internet users/ 1000 persons	Broadband subscribers/ 1000 persons	International Internet bandwidth (bits/second/ person)	Population covered by mobile telephones
2000	3	1	0	0	- *
2004	6	7	0	0	25%
2007	9	10	1	3	65%

Note: * no data available

Table I. IT infrastructure statistics in Tanzania (World Bank, 2004 & 2009)

Our Tanzanian partner, Tumaini University, Iringa University College, is located in the town of Iringa, the capital of a rural region. A population of 350,000 lives within its municipal boundaries, whereas the region's population is 1.5 million, and most inhabitants live in rural areas. The town of Iringa is located in the southern highlands of Tanzania. Agriculture is the main source of income and livelihood in the municipality, although there has been a gradual increase in small-scale industries. The Iringa municipality area is home to several primary and secondary schools, some vocational education centres and four private-owned universities. The number of higher level educational institutions has been growing lately.

Tumaini University, Iringa University College, was established in 1994. Tumaini university comprises five faculties: Faculty of Arts and Social Science, Faculty of Business and Economics, Faculty of Law, Faculty of Science and Education, and Faculty of Theology. The student body in 1999 was 200 but has been increasing quickly, even reaching 3,000 in 2009.

Tumaini University has offered IT-application courses since the mid-1990s. The focus of the IT courses has been in the use of office software. Because of the lack of infrastructure and educational opportunities, a specific project in 2000-2004 sought to implement modern IT infrastructure and better access to information. The key areas were (1) human resource development, (2) institutional capacity building, and (3) infrastructural development (Ashford, 1999; Kemppainen 2006). An essential part of the project was to establish Internet connection to the campus. The local area network was installed and Internet connection was finally obtained in 2002 after two years of delay. Accessing information still remained a problem in 2004 because the bandwidth of the university was as limited as 128/64 kilobits per second for the whole university campus and even in 2009 the capacity was about 704/128 kilobits per second for a university that possessed over 300 Windows XP P4-P5 computers. The fee for using such a connection was as high as 4,000 USD per month. Over and above the cost, there are practical problems, such as frequent incidences of power cuts in Tanzania, which impacts the use of IT. Apart from these, the basic infrastructure of the university is good by local standards, and it offers a solid foundation for educational development.

A new B.Ed. program specializing in the teaching of mathematics and computer applications as a minor started in 2002. This new program eventually offered a whole range of new IT courses including a programming course – the development of which is the focus of this research.

Finally in 2004 there were eight courses that focused mostly on computer applications. The four foundational courses, Information Technology I, Information Technology II, Information Technology (Journalism), and Information Technology (Business). The new B.Ed. program offered four new courses: Instructional Technology in Mathematics Teaching, System Support and Administration, Introduction to Computer Networks, and Computer Programming. While most of the courses were quite traditional in design and intent, the System Support and Administration course was designed for student teachers who might in the future need to work with an inadequate IT infrastructure such as that which is powered by current generated by solar panels for laboratory electricity.

Computer programming, the course that is the only one typical of a computer science degree syllabus. The method of teaching the course before 2004 was strongly based on the kind of teaching method one would find in Western universities where most of the students have already had extensive experience of ICTs of one kind or another even before their university studies commence. The course content was also partly out of date. Thus, for instance, programming was being taught by means of Qbasic. A more recent pedagogical strategy has been to teach a large number of difficult concepts such as trees and stacks by using C language One cannot help noticing that because students were being taught data structures and algorithms even before they had any knowledge of even basic programming concepts, the chance of their having learned anything beyond what they could memorize by rote without any real understanding was unfortunately minimal.

Tumaini University was interested in continuing to develop IT education on the basis of the program outlined by infrastructural project and extension of IT courses. We jointly decided to start from a concrete case of a particular university course. Because of the students' very limited background in IT, we decided to support comprehension and innovation by using concretizing technologies, such as visualization and robotics, creating context-related learning material, and having the students apply their IT skills in village outreach projects. Finally, we expected to be able to extend accumulated expertise capacity locally and internationally beyond the original context.

First we worked for the background and continued with practice, model, and theory development. We organized several experimental workshops in 2003-2004 for the feasibility analysis of supporting technology (Lund & Vesisenaho, 2004), and the first whole Contextualized introduction to programming courses for B.Ed. (math education) students at Tumaini University was organized in 2004-2005 with the new supportive learning technologies. Later in 2007 a whole contextualized IT degree program began.

Diversifying IT: toward viable models for sustainable technology

In order to support and evaluate sustainable design, education, and use of IT in Tanzania and developing countries at large, it is essential to come up with models and approaches which help in this effort. The models introduced below are based on the empirical participation described above.

We shall now introduce an ethnocomputing approach and a pragmatic CATI (Contextualize, Apply, Transfer, and Import) model to support the needs-based IT education. Of these two approaches, the concept of ethnocomputing emphasizes the idea of several alternative entry points to IT, whereas the pragmatic CATI model provides its users with concrete guidelines for building sustainable IT solutions for real needs.

Ethnocomputing approach

Our approach for designing an IT course is based on the concept of ethnocomputing – finding culturally suitable entry points for understanding, utilizing, and producing IT in a relevant way (Sutinen & Vesisenaho, 2006; Tedre, Sutinen, Kähkönen & Kommers, 2006). This often means that education should be more community-needs-based instead of theory-driven.

Ethnocomputing in any given socio-cultural setting can be analyzed from the point of view of representation, utilization, and appropriation. *Representation* refers to conceptual models, mental models, and methods of teaching. *Utilization* deals with the various uses of technologies, diffusion patterns, and social attitudes toward technology. *Appropriation* refers to creative initiatives that challenge our mainstream ideas about what should be happening. These include the use of technology for nonstandard purposes, job creation that is stimulated by innovative business ideas, and the creation of effective ad hoc solutions to technological problems (Vesisenaho, Kemppainen, Islas Sedano, Tedre & Sutinen, 2006; Vesisenaho, 2009).

This kind of approach can be deeply related to long-term design and development research. The dual objectives of the research were to develop creative approaches that would solve a variety of problems in teaching, learning, and performance while constructing a body of design principles that could be used to guide future development. Such an objective requires a pragmatic and collaborative approach to the application of learning theories as they are applied by researchers, practitioners, and other participants in the process. At the same time, development research provides information that can be used in making future decisions (Reeves, 2000).

In this case the process can be summarized as preparations, including background inquiries, consultations, theoretical studies, and technological development; pre-testing and re-testing; experimental parts; analyses; and reinventions. The development process is often cyclic or spiral, which takes time, but it can lead to sustainable development (see Reeves, Herrington & Oliver, 2005; Vesisenaho, 2009).

CATI model

During the years of the collaboration we have developed a CATI model (Vesisenaho et al., 2006; Vesisenaho, 2009) which can be used for developing sustainable IT in developing countries, for analyzing the planning and implementation processes of IT, for IT education, and for evaluating the ability of a person to apply previously acquired knowledge. The basic levels of the model are contextualize, apply, transfer, and import. Each of these focuses on the level of localized efforts in different phases of action (see Figure 1).

Each *level* of this model refers to a particular aspect or phase of development, and we briefly explain them from the technology and knowledge-transfer standpoint. In regard to implementation, the levels can be defined in the following way:

Import Import refers to any situation where a technology or knowledge, or both, is imported without prior-needs analysis of the local conditions. While it is relatively easy to make the technology locally available in the physical sense, disregard for the specific local conditions and needs may make the technology completely opaque, alien, and unusable for local operators.

Transfer Transferred technology, innovations, knowledge, and skills have been made accessible to their users and may thus hold *some* potential for application in a local context. This may occur even if the local-needs analysis has been deficient or somehow inadequate and incomplete.

Apply Application means that the potential of transferred assets such as innovation or technology has been realized. A local IT operative has been successful in making his or her technology and skills relevant, useful, and affirmative to some extent in practice in the local environment.

Contextualize Contextualizing means that local users and developers have become capable of integrating IT with the needs, conditions, and concerns of their local communities. Local and immediate conditions and innovations form the basis for the contextualized use of IT.

When the planning starts with the local, contextual needs, the output implementation has a solid base, and has good opportunities to be applied in a context-required way (bottom-up). This type of approach can lead to local innovations and long-term sustainability with respect to development and, for example, maintenance. If the project is only based on non-local-needs analyses and, say, donor-driven ideas, the output can be very mechanical and short-lived, and unsustainable in educational sector (top-down).

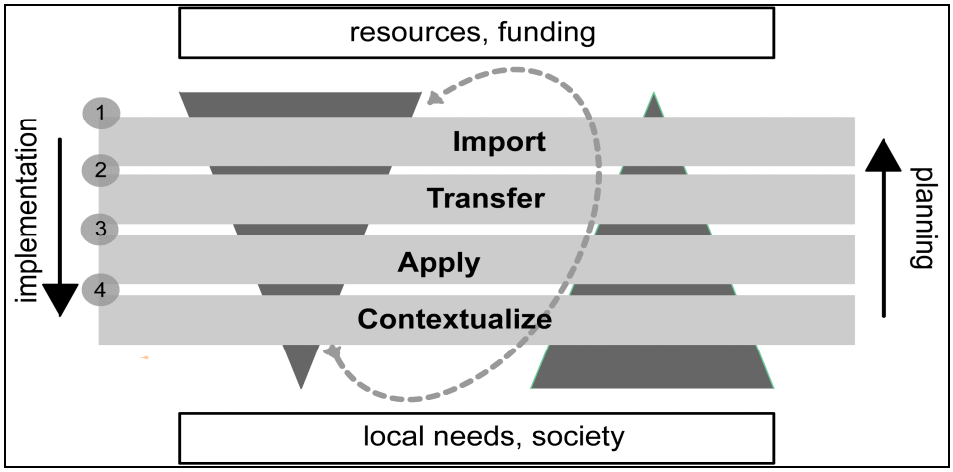

Figure 1. CATI model for contextual IT development (Vesisenaho et al., 2006; Vesisenaho, 2009)

Ethnocomputing and the CATI model for IT-education development

The approaches presented – the concept of ethnocomputing and the CATI model – bring induction and empirical participation into the core of the

contextualized design, education, and use of information technology. This is maybe easiest to see when comparing the approaches to their opposites.

Much of IT training aims at conveying the conceptual understanding of IT experts into the mindsets of novice IT professionals. While relevant and to some extent even advisable in an IT-mature environment, the approach might produce theory-mastering professionals who have limitations when brainstorming with their customers about new solutions. A professional conceptualizing technology from only a given viewpoint might not be helpful with customers representing alternative or even contradicting mindsets. An ethnocomputing perspective might also be more viable when learning new, not-yet-existing technologies and computing paradigms.

Following the ideas of IT as an agent of change is much too often equated to its direct application for immediate benefits, although this might not have been the essence of the concept of "agent of change". Retail chains, for example, might use IT just to cut their personnel costs while reinforcing their existing core business model, whereas they could rethink and enrich their overall service concept by designing more innovative, context-based IT solutions. The same tradition-conserving principle can be seen in the current trend of replacing small schools with more efficient mass schools, equipped with modern IT laboratories, and the accompanying discussion in several Western countries as well. The conventional approach to IT is deductive: take an existing technology and transfer it directly to several, possibly completely different situations. Rethinking a service concept – according to the CATI model – requires a profound analysis of the context, which has been done over years with Tanzanian academic faculty members, and using all this data combined with various technologies to design inductively a novel solution for existing needs.

Implementation based on Ethnocomputing and the CATI model

In the academic year 2004-2005, our research group offered a course called *Contextualized introduction to programming* for 27 second-year teacher students studying in the Bachelor of Education program at Tumaini University. The main goal of the course was to encourage the students to use IT in their future school work, especially from the aspect of making their own students more aware of novel IT uses for existing needs. That is why the community outreach project of the course was essential for reaching the learning objectives.

Because Tanzania lacks well qualified teachers, the students had enrolled in the program from all over Tanzania to upgrade their degrees to university level. They had nine years of teaching experience in average, which offered us an excellent opportunity to discuss and elaborate with them realistic possibilities of IT uses at schools. There were 11 females and 16 males in the group and their average age was 35. Their previous experience of using computers was to a large extent based on the IT-literacy courses that they had completed at Tumaini University.

Together with our Tanzanian colleagues at Tumaini University at Iringa, we started the project in a very pragmatic way, by arranging pre-workshops for some students and analyzing how activating technologies could change learning of introductory information technologies. Based on the promising experiences and feedback from the events, we have carried out a carefully analyzed project of running a whole course on Contextualized introduction to programming, including their field work at local schools and even hospitals. In particular, the students used, for example, I-Blocks (Lund, 2003) as concretizing tools that were later modified according to feedback, to fit better into the context.

I-Blocks

I-Blocks, short for Intelligent Building Blocks, are physical artifacts to support learning by construction and, more specifically, to support *programming by building*. By attaching a number of basic building blocks, each containing a microprocessor and communication channels, together, the user constructs an artifact that can perceive input, process the input data, and produce output. The I-Blocks also introduce an idea of distributed intelligence, which can be linked to a structure of a functional society (Vesisenaho & Lund, 2004). The form of the blocks is a Lego Duplo brick. I-Blocks are developed by the Adaptronics Group, at the University of Southern Denmark (Lund, 2003).

Figure 2. Students building with I-Blocks in the field school

I-Blocks (Figure 2) allow users to build a program by connecting blocks of the following three types:

- input blocks with a sensor or mechanism to set a value;
- output blocks to produce, for instance, a tone, light or signal and to display a value; and
- operator blocks for arithmetical or logical operations.

There is also an interface that allows students to program I-Blocks for different functions in an easy way. The QEL Micropro program was used to download programs to the microchip inside each I-Block.

We started to use the first version of I-Blocks in 2003. The analysis of their use in programming by building workshops in 2003 and 2004 had indicated clear potential in their usefulness for leaning IT (Vesisenaho & Lund, 2004). The whole Contextualized introduction to programming course started by a similar hands-on IT workshop. The aims of the workshop were to understand the basic idea behind robotics, programming, and technology and to open students' eyes to identifying IT around them in everyday life (Figure 3; see also Nielsen & Lund. 2006; Nielsen & Lund, 2008).

When we started the use of I-Blocks with students, they were nervous with this kind of experimental "play". This was related to their authoritarian educational tradition, and probably concern on breaking new and expensive tools. But very soon students started to express their ideas and to build new constructs with the I-Blocks. They were inventing, for example, car alarm systems and gadgets to help blind people.

Figure 3. Students working with I-Blocks

Digital learning material

The digital learning material for the Contextualized introduction to programming course was created for learning the Java programming language, and it was based on the metaphor of a learning village, referring to the idea of IT around the students in their everyday lives (see Figure 4). Tanzanian art illustrating different village settings were used to represent each week of the learning material.

Very often IT is thought to be theoretical and alienated from everyday life. However, several IT concepts can be found from normal life; for instance, the ideas of data structures can be found in a village structure (see Eglash, 1999). Students using the site could obtain the information they needed by clicking on the huts and the people in the village. This symbolism was deliberately used to demonstrate that computer programming does not have to be presented in obscure high-tech, Western-specific formats, but that it can be made easy to grasp from imagery and concepts that are entirely derived from the local social and cultural context. Although there were weekly problems to solve, the students would also be encouraged to come up with their own ideas and plans for making programs.

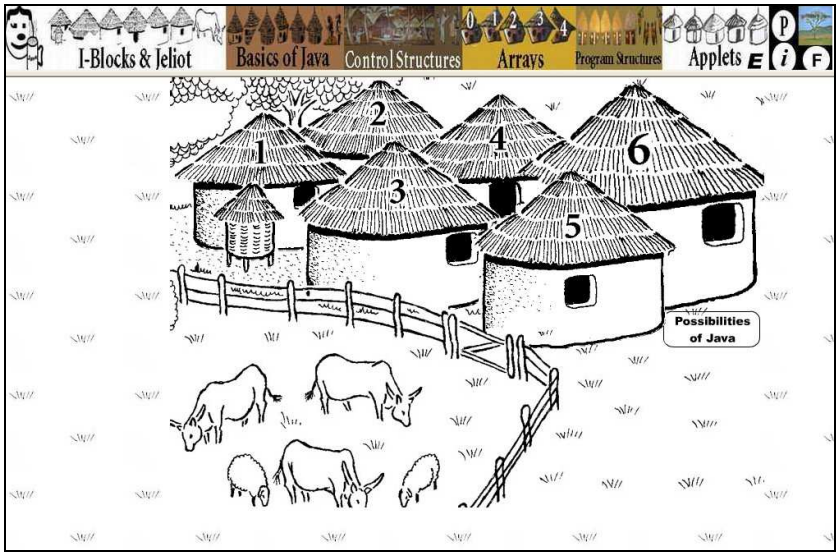

Figure 4. A learning village in the course material of the Contextualized introduction to programming course

Course activities were continuously linked to the local context (as well as the material) and the I-Block concretizing experiences.

One practical example of repetition structure (loops) in the material was to boil water.

"As long as the water is not boiling you need to add firewood to the fire. But as soon as the water is boiling you will stop adding firewood."

The condition was: *"continue while water temperature is less than 100 degrees"*. The work to be done within the loop was "*Add firewood to the fire to increase the temperature"*.

Another example was relating Tanzanian life to modern technology by mobile phones. According to the students, mobile phones are the everyday modern technology they have most experience of. With this in mind, we used an approach of programming mobile phone functionalities by Java, which effectively unfolded the mysteries of IT and programming.

The students reflected their learning experiences with their work and society weekly in their learning diaries, for example, "Contextualization means applying new skills and knowledge to your own life or community. Give at least one example on how to contextualize your learning of this week?"

Finally, the connection to context was concretized especially in the field projects which concluded the course (see Section Outreach projects).

Outreach projects and results

We started the course with the I-Block programming workshop and continued on to programming language (Java), but had all the time linkages back to the surrounding environment and ideas introduced in the starting workshop. Finally, we completed the course with the village outreach projects to connect students' experiences to the society and their profession. Three groups of students from the year 2004-2005 had their village outreach projects in secondary schools, teaching the basics of robotics and information technology. The remaining groups were required to use Java programming to develop programs that would be beneficial to secondary-school teachers or students. The Java groups programmed a calculator, made graphic representations of

polynomial functions, created a program for a simplified Bao game, and coded three different mathematical presentation programs for educational purposes. All of the project outcomes were immediately applicable and relevant to future subject teachers of mathematics and science (see Figure 5).

The village-school experience was good for the teachers in a sense that they needed to apply their skills in an environment with very limited resources. For instance one of the village schools had a solar-panel system for producing a limited amount of electricity and there was no Internet connection. Still, the pupils were active and very happy for the opportunity to work with technology.

Figure 5. Young patients at the Ilembula Hospital in rural area Tanzania playing with the I-Blocks and the next prototype-version, A-BLOCKs.

Also, some of the students applied the technology in special circumstances as a part of Bachelor project. They had outreach projects at the Ilembula Hospital with hospitalized children who, for example, had leg fractures and were normally bedridden for six to eight weeks (see Figure 5). This process highly activated the patients, who able to attend school, but also reached the relatives who were with them in the hospital. The next step of this process could be modifying this kind of robotics to physiotherapy.

An example of the use of CATI model is the evaluation of students' ability to apply IT in their work after the programming course. Most of the students from the year 2004-2005 reached the application level of the knowledge in the final interviews of the course. And even though the responses of some of the students show that they remain on the transfer level, various contextual elements are discernible in many of their answers. While it takes time for a student to make the move completely to the contextual level, it was nevertheless gratifying to note that even this short intervention inspired a number of impressive application ideas in the university setting and in the local society. There were also several students who thought that they would be able to teach programming or to support their schools in this way, or both, in the future. Several students felt that they could even start their own business in the field, and share in that way their knowledge. This is one way how contextualized IT education can lead into locally meaningful development and innovations (for more details see Vesisenaho, 2009).

A cross between needs and models: design of a contextualized IT degree program

As this Tanzanian case indicates, the needs of local communities in East Africa are quite different from those of Western or industrialized countries. In relation to the term "net generation", the phenomenon appears different in East Africa. There are limited facilities and infrastructure, which account for the lack of ubiquitous IT that in the Western world seems self-evident. The environmental issues are demanding and financial issues challenging. However, the development is fast despite the huge gap between the rural and urban areas. These were the main motivators for us to start thinking of an alternative, comprehensive pattern suitable for a Tanzanian degree program in IT. The inductive, empirical starting points of ethnocomputing and the CATI model helped to scaffold the new program and to distinguish it from most, if not all, other IT curricula in Tanzania.

The undergraduate IT program started in September 2007 at the Iringa University College of Tumaini University is based on the following principles:

- IT education should be *contextualized*, that is,, the whole learning process should be linked to the culture, concepts, practices, needs, infrastructure, resources, and potential of the Tanzanian society at large and the Iringa region in particular;
- most of the IT education should be organized around *projects* where students need to identify *problems* and to solve them;
- IT education should be *practical* so that the graduates are able to take a comprehensive responsibility of IT in their future jobs from technical details to IT management and planning, in a bottom-up rather than top-down style; and
- in an *interdisciplinary* way, IT education should consist of elements from both Computer Science and Engineering.

According to these principles, the three years' curriculum is content-wise internationally recognized and constantly evaluated and promoted further by an interlinked research program. Instead of a list of courses, the program is built around four components: (1) use and administration of hardware and software, (2) basic concepts of Computer Science and Engineering, (3) students' application projects that are linked to the local Science Park and other business activities, including a student-run Computer Clinic for local people, and (4) a bachelor project which runs throughout the three years (for more details see Tedre, Bangu & Nyagava, 2009; Vesisenaho, 2009).

The effects of ethnocomputing and the CATI model on the degree program can be seen in Table II. The multidisciplinary studies of the degree focus on entrepreneurship for self-employment and modules can be included from business administration, law, and mathematics.

Component	*Ethnocomputing*	*CATI model*
Use and administration of hardware and software		Hands-on activities with broken hardware and wrongly installed software etc. Real-use cases for office software
Basic concepts of Computer Science and Engineering	Cultural analogues or representations for basic computational concepts, including localized visualization and concretizations	
Applications		Participatory design process follows the steps of scenario development, activity and user analysis, implementation, and test with users. The needs are taken from the areas of agriculture, health care, education, commerce, legislation.
Bachelor Project	The whole process aims at students' being able to represent, utilize, and appropriate the technologies in their own context.	

Table II. Examples of the effects of the concept of ethnocomputing and the CATI model on the components of the contextualized IT undergraduate program.

Concluding remarks and future challenges

The era of globalization has witnessed several economies emerging. However, this extensive phenomenon of new opportunities, especially due to the smart use of information technologies, has hardly touched Africa.

The way that technology has transformed and revitalized life in other parts of the world has not yet completely materialized in East Africa. There are unique challenges but also opportunities regarding the earlier mentioned IT-backgrounds, infrastructure, a gap between rural and urban, environmental, financial, and cultural issues in relation to the "African developing net generation". Also, the local tribe and relative-based networking culture without the "net" offers very interesting viewpoints.

Therefore, Africa needs novel initiatives to promote development and to enrich life by information technology. The concrete examples described above indicate a possible direction. Innovations can be found within a particular context. This requires that researchers and locals combine their efforts to identify and analyze existing needs. In this task, the real users – whether in rural areas or disadvantaged townships – are the best experts to listen to.

Diversification is the key characteristic of an information technology that transforms the conditions of its users. Technology needs to bend – in an inductive way – according to the stream of individual, existing needs; new needs should not be created to fit, deductively, an existing technology. An innovative approach to technology is, therefore, empirical or inductive rather than theoretical or deductive.

Designing and creating diverse, meaningful technology on an experimental, contextual basis needs, however, solid models. Our two approaches to modeling the contextualization process of information technology are the concept of ethnocomputing and the design-implementation-evaluation framework of CATI. Both of these approaches share the same empirical background. On the one hand, ethnocomputing starts from *acknowledging* multiple entry points to information technology, including those that might be alternatives to the mainstream ones used for conceptualizing IT and its conventional uses in a certain society. On the other hand, the CATI model can be applied in a concrete situation for scaffolding the steps for a needs-based intervention by creating appropriate IT solutions.

Information technology cannot be used, not even to mention its contextual design, without proper education and training. A problem-based IT curriculum is a natural consequence of crossing needs as starting points and models as guidelines to building novel technology according to the needs. It is analogous to modern medical education which starts with the patient. In a similar way to a medical practitioner, an IT professional, especially in a situation that is new to IT, needs to learn to listen to the user of IT and, based on the diagnosis, to match the needs with a fit, possibly completely novel, technology.

The examples from a Tanzanian context illustrate the importance of diversifying information technology. The future is, however, what matters. Introducing alternatives proposes threats to the conventional and traditional solutions of importing both technology and its training from the countries that have, thus far, used it successfully. Only efforts between the needs-aware and IT-aware can turn the smart morning of Africa into a day of improvement and progress. Diversifying information technologies requires collaboration that is committed, long-term, and multidisciplinary.

This article widens the scope of an individual research project to that of a more comprehensive collaborative process between our three universities of

Joensuu (Eastern Finland since 2010), Southern Denmark, and Tumaini. The process has helped us, based on empirical participation of concrete IT user scenarios, to model a new approach for designing, learning, and using IT in the context of a developing country. We expect that our experiences will also have a fundamental impact on the way that technology can be used in the Western societies. Despite of all the enthusiasm, the existing experiences merely indicate the first steps of novel opportunities of smart technologies for Africa, and needs-based education for all.

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