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Implementing Information and Communication Technology in Higher Education in Tanzania

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Abstract: Technologies are neither developed nor used in a sociocultural vacuum. They always embody and make use of some kind of tacit knowledge. The gulf between the knowledge that designers possess and the knowledge that users have increases when ICTs are distributed in non-Western developing countries. If an ICT project is ignorant about how to effect local implementation, progress will probably be negligible, and if the planning of an ICT project is irrelevant to local needs and conditions, what may seem like progress may actually not improve anything at all. In this paper we outline our ICT education development project for a Tanzanian college, introduce a model for analysing ICT projects in cultural contexts, and analyse our Tanzanian project in terms of that model. We argue that successful contextualisation takes cognizance of at least four levels (or phases) of projects. These are import, transfer, apply, and contextualise.

Keywords: ICT Education, Computer Science education, contextualization of technologies, ethnocomputing

1. Introduction

The vision that emerged from the World Summit on the Information Society (WSIS) [1] is that everyone in the world should be in a position to make use of information and communication technologies (ICTs). 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 is a WSIS plan of action [2] that 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 ICT education can support local development, especially in higher education institutions, without any sacrifice of local identity.

Rather than support the prevalent linear process of importing technology and education from industrialized to developing countries, we are currently engaged in looking for, identifying and promoting a new balance between technology, education, and culture, a balance that will encourage conditions for the emergence of creative learning communities in non-Western settings. Such learning communities will not be restricted to classrooms alone, but will seamlessly overlap with the everyday lives and concerns of learners.

Our analysis of current conditions included the realisation that although globalization has created a commonalty of technological assumptions as well as attitudes and skills that enable us to live in an internationalized culture with its own internal rules and expectations, cultural differences between or within countries have not been eradicated. Instead of giving uncritical and automatic assent to processes of cultural homogenization [3], we endorse whatever efforts users of technology may make to incorporate elements and features of their local culture into a world of shared international assumptions. Technological change does not always have to be inimical to local identity. If understood in the right way, it can augment rather than undermine local content, knowledge and culture. Our contextualized approach [4] emphasizes the use of such local content, knowledge and culture in building ICT infrastructure.

As we see it, ICTs play two roles in higher education. Their first role is that they constitute the infrastructure that permits an institution to perform effectively (here one thinks particularly of how ICTs enable teaching and research). Their second role is to function as a discipline that can be taught and learned in itself. Table 1 shows whether each listed WSIS principle can be addressed by ICT support or ICT education or not. Functional ICT support, for example, is a prerequisite for building capacity in an efficient library system. We also regard the WSIS principles as context sensitive. This means that the cultural context of the user community needs to be considered when these principles are implemented. Successful access to information and knowledge depends, for example, on the skills, attitudes, and values of the people who need the information.

Table 1: The roles of ICT Education in WSIS key principles

Key WSIS principles	**ICT support**	**ICT education**	**Context sensitive**
1.That governments and all stakeholders should play a part in the promotion of ICTs for development	√	√	√
2.That information and communication infrastructure should be developed	√		√
3.That there should be free access to information and knowledge	√	√	√
4.That capacity building should be a feature of ICTs	√		√
5.That confidence and security in the use of ICTs should be promoted		√	√
6.That an enabling environment should be created	√		√
7.That ICT applications should benefit all aspects of life		√	√
8.That cultural diversity and identity, linguistic diversity and local content should be promoted and encouraged		√	√
9. That freedom of press and information are actualized.		√	√
10.That the ethical dimensions of the Information Society should be investigated		√	√
11.That international and regional cooperation should be encouraged	√	√	√

Although a number of well-designed and constructed theories about ICTs already exist, the real challenge is how to put them into practice. How can we introduce and integrate globally accepted and sanctioned concepts into a society in such a way that they harmonise with local culture? Our particular understanding requires us to create conditions in which local initiatives can evolve harmoniously with existing foreign concepts, attitudes and practices. In this article, we (1) analyse reports on our work in ICT education in developing countries, (2) offer a real-world case study that demonstrates our practical and theoretical

concerns and that gives an example of what we mean by contextualization, and (3) introduce a conceptual model in which contextualization is the central to the argument.

2. The Role of ICT in Tanzanian Higher Education System

Mkude et al. [5] write that in the *Progress and Financial Reports of University of Dar es Salaam*, it is stated that because globalisation will gather momentum in the 21st century, new and more rigorous strategies will have to be devised to initiate and manage change in African universities. African universities, they assert, will also have to make even greater efforts to improve the quality of their output if they are to continue to maintain even their current share of the local and international labour market.

Tanzania, for instance, has its *Development Vision 2025* [6], in terms of which the country proposes to have created a well-educated society by 2025. This document states that information and communication technologies will be a major driving force in the realization of this vision. By stating this, this document reveals the part that ICTs are intended to play in the development process of the country. Tanzania in fact has its own ICT policy [7] that pinpoints key areas marked out for development in ICT.

Tanzania's ICT policy document of 2003 [7] explains that that country possesses neither well-established ICT professional profiles nor standardised processes for the evaluation and certification for ICT courses. Access to online and distance learning by means of ICT is limited, and opportunities for ICT training are confined mostly to a few urban centres. While an official Secondary School Computer Studies Syllabus exists, it is already out of date. No programme for training ICT teachers in the country exists. Only a few urban and private schools offer opportunities for realistic ICT education. Universities and other higher-level institutions are hamstrung by a lack of computers, and Internet access bandwidth operated at a speed of less than 512 kbps shared by the whole institution.

According to the Higher Education Accreditation Council [8], there are four higher level education institutions that offer degree education in ICT: the Institute of Accountancy in Arusha, the Institute of Finance Management, Mzumbe University, and the University of Dar es Salaam (the largest university in the country).

Table 2: ICT Degree Programmes in Tanzania (May 2005) [8]

Higher Education Institution	**Degree**	**Student enrolment/ academic year**
Institute of Accountancy, Arusha	Advanced Diploma in CS	41 / 2004-05
Institute of Finance Management, Dar es Salaam	Advanced Diploma in IT	378 / 2004-05
Mzumbe University, Morogoro	B.Sc. in ICT Management	33 / 2003-04
University of Dar es Salaam	Bachelor in CS, M.Sc. in CS	400 / 2004-05

Computers and Internet connections in Tanzania are concentrated in the urban areas. According to World Bank dates from 2003 [9], the population of Tanzania is 35.9 million, there are about 5.7 computers per thousand people, and 7.1 Internet users per thousand people. Computer illiteracy is widespread and people have very limited access to ICT facilities. One of the functions of the universities is to educate future ICT professionals so that they can operate at local and international standards.

3. Case study: ICT at Iringa University College, Tumaini University

The Evangelical Lutheran Church of Tanzania (**ELCT**) established the Tumaini University in 1996 as a contribution to the cause of higher education in the country after the government had signalled its intention to liberalize Tanzania's education system by passing the Education Act No. 10 of 1995. Iringa University College (**IUCO**) is the largest constituent college of Tumaini University. It is situated on the northern side of Iringa, the

capital of the Iringa region, which had a population of about 110,000 in 2003. In 2004 the college consisted of four faculties: Arts and Social Sciences (including the Department of Journalism and the Department of Education), Business and Economics, and Law and Theology.

The number of student enrolments in the college has increased by about 30% per annum between 2000 and 2004, with 670 students enrolling in the academic year 2004-2005. Students have come from every region of Tanzania, as well as from other African countries such as Botswana, Burundi, Kenya and Malawi, to enrol at the university. The percentage of female students in the student body is approximately 40%. This is a significantly higher proportion than the proportion of female students at the other public universities of Tanzania such as the University of Dar es Salaam, where only one quarter of students in 2000 were women [5].

3.1 Strategies

Since 2000, IUCO has been implementing a plan called ***Internet Project Strategic Plan*** (**IPSP**). This plan defines the vision, goals and objectives for all the ICT activities that IUCO undertakes with the aim of creating a more effective learning environment [10]. The underlying purpose of the plan is a clearly stated technological vision. This vision is that the Internet and computers should be incorporated and consistently used in learning and teaching environments. The key task was therefore to connect IUCO to the Internet as quickly as possible.

With this in mind, IPSP was divided into three areas: *human resource development*, *institutional capacity building*, and *infrastructure development*. The goal of human resource development was that all members of IUCO, faculty, staff, and students, should be empowered and trained to use ICT facilities as effectively as possible in the course of their duties. Institutional capacity building was predicated on development in five areas. These were the *library, curricular exchange, internet-assisted courses, the Computer Science Department,* and *language skills*. The third area, infrastructure development, focused on five initiatives. These were *local linkage, regional linkage, disciplinary consortium, African studies and local service*.

Attempts to actualize the visionary intentions of the IPSP by introducing ICTs into the zones mentioned above soon ran into trouble because the IPSP had not taken certain existing conditions into account. Thus, for example, the strategy had not given due weight to the fact that, apart from Internet connections, no other ICT facilities were available. There was thus a significant gap between the good intentions outlined in the ISPS and the reality of the situation. In order to cope with this exigency and close the gap between the IPSP strategy and the actual ICT situation at IUCO, a new sub-plan, entitled the ***Four-Point Plan for Internet Project*** (**FPP**), was devised.

According to this FPP [11], the aims for the college were somewhat modified. They were then formulated as follows: that technology should be used to enhance learning; that better facilities should be provided for teaching; that an independent ICT department should be endowed, and that students and faculty members should have access to electronic materials. The plan included a provision that these aims were to be achieved by means of a local network, a dedicated computer classroom, technical support, and library development.

3.2 Implementation: ICT Support and Infrastructure

The implementation plan was devised to reflect the expected lifetime of the installations. The LAN (Local Area Network) wiring was thus expected to last longer than the new computers. The final implementation plan included implementation protocols for three out of the four areas defined in FPP that were scheduled to be put into action between 2001 and 2003 [12]. This plan envisaged the intention:

1. To build a LAN in two buildings. The intention was to build a LAN on the campus similar to the local network, to connect all computers to it, and then to train students and staff in its use so as to realise the long-term goal of creating a solid foundation for Technology Enhanced Learning that had already been introduced in IPSP.
2. To modernize the library by introducing a Library Management System and exploring the possibility of using CD-ROM learning materials. To this end a new library building was constructed at IUCO and opened in 1999. Although the library building could then house its existing 75,000 volumes in excellent conditions, most of the books were outdated or otherwise inadequate and so failed to attract readers. It was for this reason that the Library Facilities Improvement Project was given top priority among the IUCO goals when they were drawn up in the implementation plan in 2000. The result was that each faculty member was presented in 2001-2003 with a list of recommended materials, and funds of 10,000 USD [13] were allocated per annum for this part of the project. Library Development was hindered by three major problems that had been identified at the library: the disappearance of books, a shortage of learning materials on CD-ROM format, and inadequate access to the Internet.
3. To equip an ICT laboratory for teaching. The Computer Classroom referred to this as a "new ICT laboratory for teaching". Although a new room had already been built and opened for ICT teaching, all the computers in it were 486s that had been loaded with Windows 95 and Microsoft Office 95, and these were connected by means of temporary LAN wiring and a second-hand HUB.

The establishment of an ICT Department and drawing up a budget for this department (which was regarded as a goal of FPP Technical Support) was a vitally important sub-project. The Finnish Government defines *sustainability* as: "[A] long-term functionality of developed systems. Sustainability consists of sufficient economic and financial basis for long term operation and maintenance, institutional capacity and capacity to manage the systems, good socio-cultural feasibility, reliable technical operation and maintenance, and acceptable environmental impacts" [14]. Finding a way to guarantee the sustainability of the project had been a key consideration of project implementation since the very beginning.

FPP identified two major obstacles that hindered long-term functionality. These were that IUCO was not allocating any funds for its ICT development and that it did not have an organized ICT department. Ways of solving these problems had been sought from the earliest days of the project. The first problem (funds) was solved when the IUCO administration included provision for maintaining ICT items in the budget for the academic year 2002/2003 [15], and when a computer access fee was made part of the annual fees that students were required to pay. The second problem (how to create an ICT department at IUCO) had been a serious challenge right from the beginning, mainly because of the lack of qualified Tanzanian ICT professionals in the Iringa region. In the academic year 2002/2003 the problem of ICT support and maintenance reached critical proportions when the last volunteer ICT teacher from abroad left the college. (It is worth noting that there was no official ICT organization existed in IUCO before 2003.)

A project to educate Tanzanian ICT professionals in Finland was introduced at IUCO in 1998. A Tanzanian student started his B.Sc. studies in Computer Engineering at the Espoo-Vantaa Institute of Technology in 2000. He went on to accept a post at IUCO after he had graduated in 2004. In addition, two former business students from IUCO completed their M.Sc. degrees in Computer Science at the University of Joensuu in 2002. One of them then accepted a post as head of the ICT department at IUCO in 2003.[16]

It was mentioned above that one of the key tasks defined in the IPSP was to install a reliable and adequate working Internet connection. Once the IPSP had been launched, an analysis of technical development at IUCO was undertaken. This analysis brought to light a number of suggestions about how IUCO might be connected to the Internet. After a series

of challenges during the installation phase, an Internet connection (128/64kbs) was finally installed at IUCO in August 2002 through the landline network of the Tanzania Telecommunications Company Limited.

The implementation of ICT support and infrastructure was thus based on the prioritised key areas of FPP. Even though the number of computers did not increase between 1999 and 2004, existing computers were better utilized, and servers, the LAN, Internet connection and ICTs were increasingly seen to support administration, teaching and learning in various ways.

3.3 Implementation: ICT Education and Training

The prospectuses of the college [15] show how IUCO organized its ICT education, which consisted of curricular courses for students (Table 3). The only new courses after 1998 were those of the new Department of Education in the Faculty of Arts and Social Sciences at the beginning of the academic year 2002/2003. Real classroom conditions at IUCO also improved in many ways other than through an increase in enrolments. Teaching facilities, for example, became significantly better than they had been in 1999. At that time, for example, 486-level computers were running Windows 95 and Microsoft Office 95 and attempts were being made to teach students how to use Internet features such as search engines and the email system without any viable sustained connection to the Internet. Teachers in 1999 had to save all instructions to a file and print them out for students because there were no data projectors. All these limitations had disappeared by 2004. The ICT laboratory was connected to the Internet, both software and hardware had been updated, and a data projector had become available. And the need for ICT training was being met by ICT courses with a strong practical component that were organized on an annual basis for members of staff [16].

Table 3: ICT Courses at IUCO (1994-2004)

Course	**For curriculum in year:**	**Who attends (students):**
Information Technology I	1994*	All
Information Technology II	1994*	All
Information Technology – Journalism	1998*	Journalism
Information Technology – Business	1998*	Business
Instructional Technology in Mathematics Teaching	2002	Education
System Support and Administration	2002	Education
Introduction to Computer Networks	2002	Education
Computer Programming / Contextualized Programming Course**	2002 / 2004	Education

* Revised 1999
** Research project

Since IUCO offers no degree programme in ICT, few courses in programming were available. Those that were available were isolated courses that had been developed before 2004. These were based on models that were taken from Western universities and were designed for students who had already been exposed to a lot of ICTs before they arrived at university. An analysis of these courses shows that their pedagogical intention was to teach a very large number of concepts to students.

IUCO therefore introduced a new kind of programming course at IUCO to a class of B.Ed. students in 2004. This new course was constructed in terms of a contextualized

model in collaboration together with the University of Southern Denmark and University Joensuu, Finland [4]. The course that was developed featured local course materials, problem-based learning, project work, interaction between the university and school students, and an extensive use of activating tools such as robotics and visualization. The aim of this course was to encourage students to apply creative problem-solving techniques to their studies, and to contextualize their emerging ICT skills and knowledge in the everyday context of their lives. [17]

4. Case Description and Analysis

The contextualized approach to ICT in higher education can be represented as two parallel but opposite processes: planning and implementation (Figure 1). Our contextualized approach has four levels (import, transfer, apply, and contextualize) that may be used to analyse processes when troubleshooting and *constraints* emerge in any situation. The planning process proceeds from contextualization to import, and the implementation process from import to contextualization. It is important to note, however, that the two processes can interact with each other on all levels, and that the model also makes allowance for sub-processes. Thus, for example, a scheme of apply → transfer → apply would make sense in a situation where planning starts from the identified need of a particular application, and where the application needs to be transferred to a user who needs to learn to use the application

This simple four-level model gives users a way of identifying ICT-related difficulties that occur in developing countries and a method for analysing why they happen. The two processes of planning and implementation apply to both ICT roles in a higher education institution: to ICT support and infrastructure and to ICT education and training.

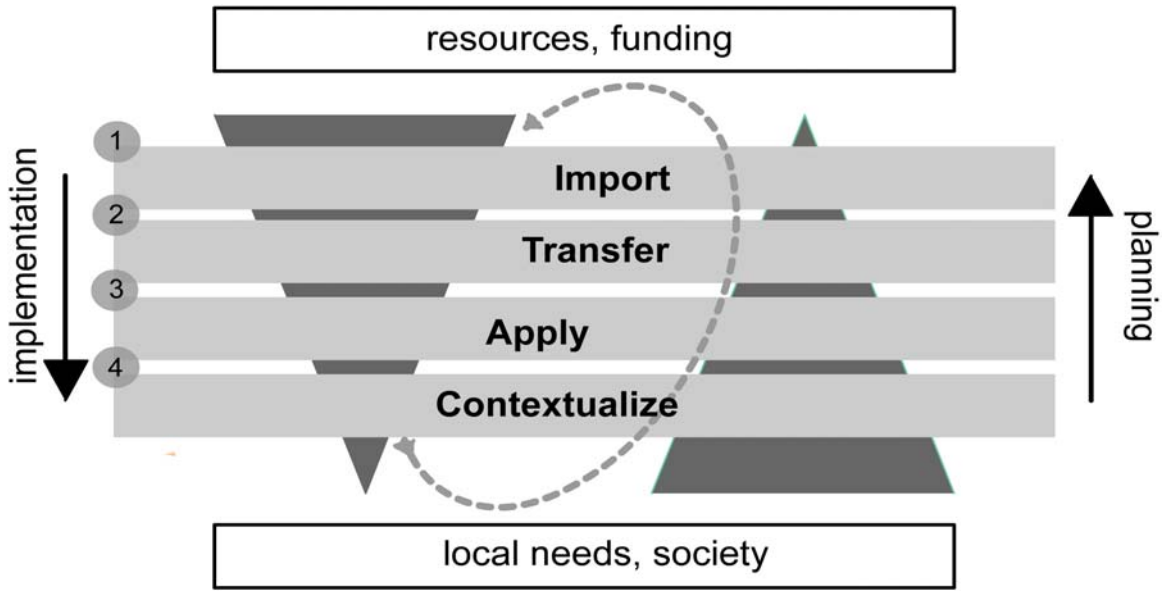

Figure 1: The Four-levels Model of Planning and Implementation Processes of ICT

Let us now define each of the levels in the four-level model by reference to their dictionary meanings. A dictionary [18] provides the following meanings for the four key words:

- Import: *To bring or carry in from an outside source, especially to bring in from a foreign country for trade or scale.*
- Transfer: *To convey or cause to pass from one place, person, or thing to another.*
- Apply: *To bring into nearness or contact with something; put on, upon, or to. To put into action.*

- Contextualize: *to place (word or idea, for example) in a particular context* [where context is] *the set of facts or circumstances that surround a situation or event; that which surrounds and gives meaning to*.

We may now apply these meanings to ICT. (Note that ICT refers to any piece of software, hardware, wiring, service, professional or suchlike.)

- Import: *ICT is on site.*
- Transfer: *ICT is available to whomever needs it*.
- Apply: *A user may apply an ICT to the task* (typically in another cultural context) *for which it has been designed.*
- Contextualize: *ICT also serves the needs of its user community – something that it was not designed to do in the first place.*

We can now characterise these terms from the point of view of *local needs* in the following way.

- Import refers to a situation in which innovations are received from abroad before any local-need analysis is undertaken. Innovations are items such as human capital, technology, books or culture, habits, and so on, that may indeed be both useful and necessary. Import may also indicate a significant possibility for non-sustainable development.
- Transferred innovations are those that are accessible to their users and potentially applicable in a local context. The analysis of local needs in such a case may be relatively weak or incomplete.
- Applied means that the inherent potential of transferred innovations is realized. Such usage is not merely mechanical. It also contains elements that require users to exercise their own initiative. A user may thus apply spreadsheet software for his or her own purposes without such an activity being relevant in any further way to his or her environment.
- Contextualizing means that a deep relation to the needs of a more extended user community exists. Contextualized innovations are necessary and sustainable in certain cultural contexts and environments. Because the active user comes from the region where the innovation was introduced, the analysis is rooted there.

This four-level model (Figure 1) may be utilized for developing sustainable ICT in developing countries, for analysing the planning and implementation processes of ICT, for education, and for evaluating a person's ability to apply previously acquired knowledge. In this case we will concentrate on analysing the project planning and implementation at IUCO, as described in Chapter 3.We will pay particular attention to problems that arise, and especially those that prevent progress from one level to another. The reason why many of these problems arise is that technology-driven implementation is undertaken at the cost of context-based planning.

4.1 Planning and Implementation of FPP in 2000-2004

Figure 2 outlines the FPP strategy as a planning and implementation process in the four-level model at IUCO. In what follows, we will analyse the implementation of two FPP sub-projects by using the model.

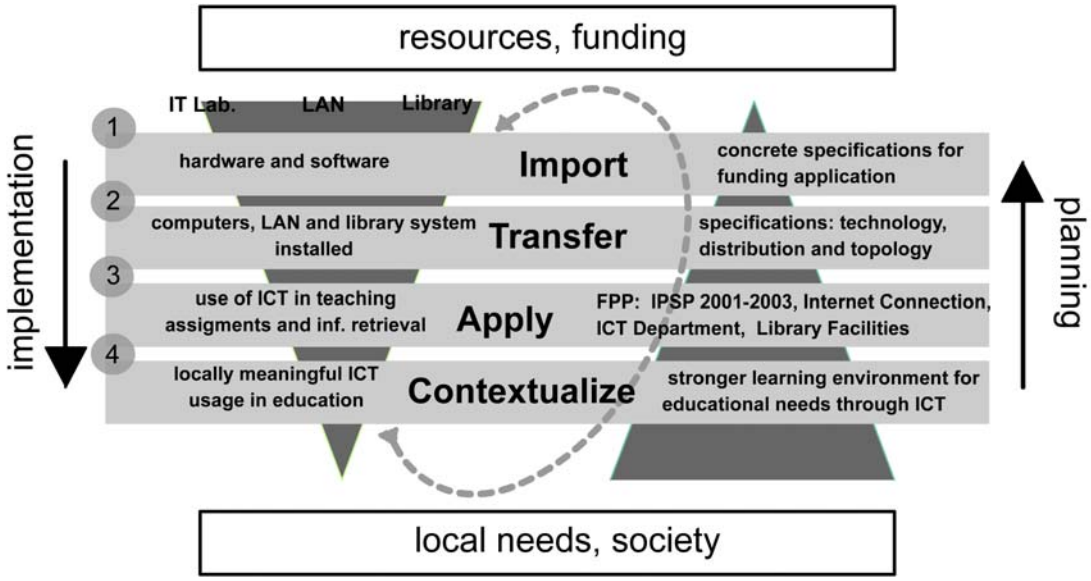

Figure 2: Planning and Implementation of ICT infrastructure

Although the planning for ICT infrastructure in FPP was meticulous, the implementation process revealed several problems. The first problem encountered in accessing the import level (number 1 in Figure 2) occurred when an attempt was made to obtain the right materials and machines. This problem was solved by patience, by new trials and by simply waiting for the right materials to become available. For various practical reasons, however, the received ICT could not be transferred (number 2 in Figure 2): the desks were not strong enough, water flooded into the building, electricity grounding was not working, power cuts were frequent, neither fibre optic cable nor skilled technicians from outside companies were available, the cooling system was inadequate, and so on. These problems are fairly typical of conditions in countries with developing economies. But these problems were also solved by the allocation of extra time and by engaging in further planning exercises. Teachers were duly educated so that the acquired ICT could be applied (number 3 in Figure 2). Contextualization (number 4 in Figure 2) requires an innovative use of local context. This need was at least conceptually conceded when contextualized programming course in 2004/05 was initiated at IUCO as a first step towards a contextualized B.Sc. degree programme in ICT.

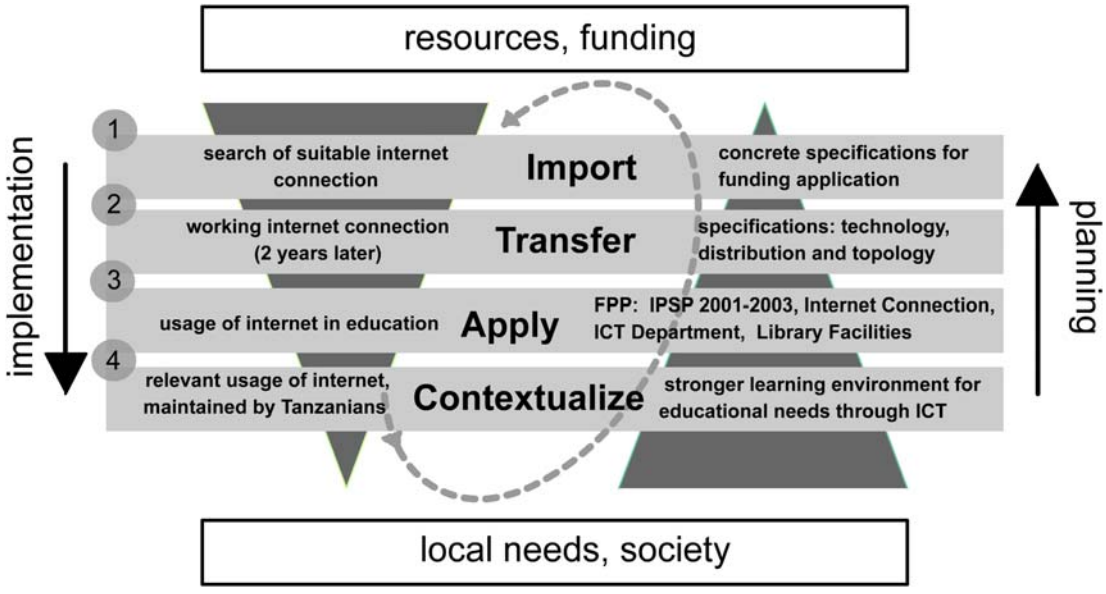

Figure 3: Implementation of the Internet Connection

The first priority of the FPP was to *implement the Internet connection* (Figure 3) within four months in 2000. It soon became evident that this timetable was too optimistic and that it would not work because of a lack of suitable technology providers in Tanzania at that time (number 1 in Figure 3). This caused a two-year delay at the import level. After two years had elapsed, suitable providers who that offered more reliable ADSL connections at reasonable prices in Iringa, became available. What then prevented a movement to the transfer level was the slow speed and low reliability (stability) index of available connections (number 2 in Figure 3). Reliability was anyway becoming better all the time and in some cases the local server substituted for the Internet. Thus the application level (number 3 in Figure 3) was reached even though the number of the Internet users was growing more quickly than the capacity of the Internet connection could sustain. Nevertheless the Internet connection opened out opportunities for relevant teaching to take place. It also made Internet resources materials available (number 4 in Figure 3). Even the Internet connection was being maintained by local people in 2004.

5. Conclusions

In this paper, we sketched the developmental strands of ICT usage and ICT education at Iringa University College of Tumaini University between 2000 and 2004. During this period, ICT utilization and ICT education evolved from what were relative side shows that attracted only desultory interest into high-profile and eagerly sought-after elements of the college's prospectus. The university has allocated regular funding from its budget for ICT and has also succeeded in obtaining sustained external funding for maintenance and development. The functional, practical ICT-related know-how with which these students are currently equipped therefore prepares them not only for the Tanzanian labour markets, but also for global information sources and global markets.

The most important lesson we learned from this project relates to the indispensability of local knowledge. Much of the knowledge that enabled the success of this research was knowledge that is both tacit and unspoken. It was the knowledge that researchers and the community possessed, knowledge that has been distilled from many years of living within their communities. Yet there was also a great deal of overt knowledge, knowledge of the kind that can be transferred to other similar projects. Examples of this sort of overt knowledge are, for example, firstly, the necessity and difficulty of finding even poorly qualified support and maintenance people, let alone ICT teachers; secondly, the importance of getting a firm commitment from different levels of the university, and, thirdly, locally engendered sustainability for the project. If these people wish to make investment in the project worthwhile, most of the development projects need eventually to become autonomous and self-reproductive.

On the basis of our experiences, we have proposed a four-level model for ICT planning, evaluation, and training in developing countries. These four levels comprise the following aspects of ethnocomputing [19] in a particular sociocultural setting: representation, utilization, and appropriation. Representation consists of features such as conceptual models, mental models, and methods of teaching; utilization includes elements such as uses of technologies, diffusion patterns, and social attitudes towards technology, and appropriation embraces aspects that deviate from mainstream mental models such as the use of technology for non-standard purposes, job-creation through innovative business ideas, and the creation of *ad hoc* solutions to technological problems.

We believe that interaction between the implementation and planning components of our model can significantly help projects to achieve results that are both sustainable, relevant, and autonomous as well as effective, productive, and influential. No technology is after all ever used in a sociocultural vacuum: the power and significance of technology is derived from people and from the fact that it can help people in some way or another. If an ICT project is deficient in its implementation phase, progress will be hard to achieve. And if a project is lacking in relevance in its planning, what may *seem* like progress will

probably not improve anything at all. But a discerning combination of adequate implementation and planning will bring about a real, decisive improvement in people's lives.

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