

CONTENTS

Executive Summary	2
1. Preamble	3
2. Why is ICT Special?	4
3. ICT Watch Outs!	5
4. Current Developments In Education Technology	6
4.1. GLOBAL PERSPECTIVE.....	6
4.1.1. <i>The Internet</i>	6
4.1.2. <i>Multi-Media Technology</i>	6
4.1.3. <i>Wireless Communications</i>	7
4.1.4. <i>Electronics and Embedded Systems</i>	7
4.2. LOCAL PERSPECTIVE	7
4.2.1. <i>Social-Economic Situation</i>	8
4.2.2. <i>Co-ordination Problem</i>	8
4.2.3. <i>Connectivity Restrictions</i>	8
4.2.4. <i>Lack of Impact</i>	9
5. Future Development in Technology and Implications	9
5.1. FUTURE DEVELOPMENT IN TECHNOLOGY	9
5.1.1. <i>Multi-Media Applications</i>	10
5.1.2. <i>The Next Generation Internet</i>	10
5.1.3. <i>Ubiquitous Learning Environment</i>	11
5.2. CHANGES AND IMPLICATIONS	11
6. Goals and Measures to be Adopted in the Education Sector.....	13
6.1. A NATIONAL POLICY AND PLAN	16
6.2. DEVELOPING ICT HUMAN RESOURCES	18
6.3 BUILDING NECESSARY INFRASTRUCTURE	23
6.4. HARDWARE AND SOFTWARE	26
6.5. CURRICULUM DEVELOPMENT AND COURSE MATERIAL	28
6. 6. OTHER ASPECTS	30
7. Concluding Remarks.....	31
8. References.....	32

Executive Summary

The importance of education technology in the process of transforming the education to cater to the needs of the 21st century is undoubted. Sri Lanka is yet to harness the benefits of education technology to shape up its education system to face the new challenges in the education sector in the new millennium. It is clear that major part of the education technology is based upon the developments in Information and Communication technology.

ICT is not without its own merits and demerits. In particular, relatively short life-span of most hardware and software and rapidly evolving communication technologies have made decision making on ICT investment quite challenging.

There are several aspects of ICT such as the Internet, multimedia technology, wireless communication, electronics and embedded systems that have greatly influenced education technology. However, in Sri Lanka, due to its poor socio-economic situation, shortcomings of co-ordination, lack of connectivity and failure to make an impact by the developments in this area so far have made the incorporation of education technology to progress at snail pace.

The process of transforming a conventional education system to technology enhanced education system, could be looked at as taking place through three main phases.

The first phase, Limited Technology Phase, is characterized by the using of audio-visual equipment such as audio cassette recorder, VCRs, TVs, VCDs etc., low speed dial-up connections, digital content on CDs, very high student to computer ratio, no or very limited usage of computers in school administration, very limited number of teachers with necessary skills to work in computerized environments, etc.

In the second phase, Moderate Technology Phase usage of more sophisticated equipment such as multi-media projectors, higher speed links, maintaining of relatively low student to computer ratio, computerized school administration to moderate extent, a reasonable number of teachers with necessary skills to work in computerized environments, etc. would be visible.

The final phase, Complete Technology Phase, would enable anytime anywhere learning model. Learning would be a process student-pull rather than teacher-push.

Sri Lanka is yet to go through the initial phase. It requires a lot of efforts to push the education system through the first phase itself. However with a clear plan, dedicated workforce and necessary funding it would be possible to push the system through first phase and the secondary education through the second phase with in ten years. Therefore it is set as the goal for next ten years and necessary recommendations to achieve these goals are addressed here.

1. Preamble

Ever rising population and the ballooning reliance on knowledge in the society has increased the importance of education and with them the student population. The need to scale the education to cater to these rising demands has posed, to our education system, a great challenge that has been made further difficult by the exponentially growing volume of knowledge. As the traditional classroom approach is becoming less fit to face this challenge, the need to look for alternatives has begun to rise rapidly. This has made educationists world over to turn to modern technologies to develop suitable alternatives. Among the variety of alternatives emerged, enhancing educational environments through the introduction of technology, especially Information and Communication Technology (ICT), has caught the attention the most.

The Technology has tremendous potential to transform education. Nevertheless there had been occasions in the past where “educational transformation” hype emerged around certain technologies has failed to deliver any significant results other than excitement among educationists. For instance, the printing press has succeeded while motion pictures and radio have failed to deliver expected results in transforming education:

“I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks.” (Thomas Edison, 1913).

“Radio may come as a vibrant and challenging textbook of the air”. (Benjamin Darrow, 1932, Founder and first director of the Ohio School of the Air).

The purpose of this document is to discuss the educational technologies for the next decade. The role of technology in shaping educational technologies is very significant. As it is reasoned out below, ICT stands

out as the key technology that could significantly contribute to the development of educational technologies. Therefore in this report the roles of ICT in education from global and local perspectives are looked into. Furthermore, future trends in a technology enhanced educational environments (TEEE) are explored. Finally recommendations for the establishment of a TEEE in Sri Lanka to face educational challenges of the next decade successfully are proposed by identifying appropriate technologies and methodologies.

2. Why is ICT Special?

In education information is manipulated and exchanged to create and use knowledge. As such, there isn't any modern technology comparable to information and communication technology (ICT) that has tremendous implications on education. In fact ICT has enabled undreamed possibilities for interactions between students, schools, teachers and parents over any distance. As a result ICT has become one of the most attractive and potential technologies that could be used to transform education today.

In such background, Sri Lanka too needs to reassess and revamp its strategies for the development of education sector. In such exercise, ICT becomes an effective tool due to the following reasons:

- (i). Information and communications become one of the main resources and the vehicle of delivery respectively in the process education. Therefore developments taking place in ICT at breakneck speed based have started to revolutionize the way the education system works.
- (ii). The increased value of time that requires shortening the development cycle of educational products.
- (iii). Assistance of ICT is vital to maintain the competitiveness of the education system in global arena. Moreover possessing skills and competencies to work with ICT is essential to become productive in modern knowledge based societies. Possessing the same skills is

inevitable for our graduates to compete in the national and international job markets too.

- (iv). With ever tightening budgetary situations, education too has to operate in an environment of increased demands for doing more with less. ICT tools, if used productively, could help to bring the cost down and push the quality up.
- (v). Technology, especially ICT, continues to introduce rapid and major change in organizations all over. Education system too should be prepared to accommodate such changes to remain competitive.
- (vi). ICT is capable of mimicking the effects of other technologies of importance in pedagogical environments

3. ICT Watch Outs!

Recognizing appropriate technologies for the development of educational technology is community/country dependent. This is so because in assessing the appropriateness of a technology for educational activities, one has to take into consideration the socio-economic status, pressing national needs, long and short term development strategies, etc. of the country. Specially economical and technological status of a country will be key-determining factors of the country's capabilities to use various technologies for the enhancement of educational activities successfully.

*There won't be schools in the future.... I think the computer will blow up the school. ... but this will happen only in communities of children who have access to computers on a sufficient scale.”
(Seymour Papert, MIT, “Trying to Predict the Future”, Popular Computing, October 1984)*

The highlighted component of Papert's assertion has a great significance to us. It has indicated his concerns about the availability of facilities for learners of different communities to access ICT facilities with equal opportunity. Even today, nearly after two decades, the same concern remains valid due to ever widening economic disparity among developed

and developing nations. The so-called digital divide is also an outcome of this disparity.

Aforementioned discussion highlights the importance of including all significant parameters into the equation of decision-making. This requires our readiness to clearly recognize our needs and capabilities and then to identify and adopt technologies to match them.

4. Current Developments in Education Technology

4.1. Global Perspective

Several trends in ICT have contributed to the current developments in educational technologies world over with varying degree of success. Among many, technologies such as the Internet, Multi-media technology, wireless communications and electronic and software built together: embedded systems are at the forefront in this respect. The following is a brief summary of their potential contributions to enhance the educational activities

4.1.1. The Internet

The role of the Internet in education is numerous. It could be a source of information, converter of computers to teaching/learning machines, very effective means of communication, helper to teachers and students, tool for distance learning, etc. However its effectiveness heavily depends upon its degree of penetration into schools and the availability of appropriate content and resources.

4.1.2. Multi-Media Technology

Developments in speech processing and synthesis technology have made interactions between computers and users simpler and natural. Video, animation, text, and graphics are all available to simulate real life phenomena with close resemblance in computers. The digital media technology has made storage compact enough for many applications. It has enabled to embark on new applications that were earlier unthinkable due to then prohibitively large volume of data involved with them. Digital

cameras are revolutionizing visual experiences in all sectors. As a result new avenues have been opened up to use computers in education effectively.

4.1.3. Wireless Communications

Wireless LANs present a number of interesting new teaching possibilities because they allow computers to be used wherever required. For instance wireless cart, a rolling cabinet with twenty or so portable computers and a wireless bridge, enable to convert every classroom to a computer laboratory as and when required. The advantages of wireless carts are both pedagogic and economic. The computers can be used wherever it is most suitable - in a classroom, laboratory, seminar room or even outdoors. This means that computers can be incorporated into education rather than education fitting around computers.

4.1.4. Electronics and Embedded Systems

The Moore's law has remained valid for almost after four decades. This indicates that the cost/performance index of hardware is going to come down rapidly for a foreseeable future too. Devices such as notebook computers and personal digital assistants (PDAs) packed with computing power provide the right platform for ubiquitous computing to open up many new possibilities for education. Embedded systems technology has enabled manufacturers to create a devices loaded with software intelligent enough to talk, to turn itself on/off, to record information about a student, to remember what a child has done.

4.2. Local Perspective

Unfortunately, Sri Lanka has a poor record on introducing technology in educational environments systematically. Mostly due to economic reasons, ICT too has made a very restricted way into the Sri Lankan society. Furthermore failure to place right emphasize, during planning, on the importance of TEEE to cope with pedagogical needs of the country in the 21st century too is another significant reason for this.

4.2.1. Social-Economic Situation

Our society has been relying heavily on state sponsored education system and has a significant percentage of the population receiving education up to year 11 level^[1]. However with the economy that has been ravaged by two decades long ethnic conflict, Sri Lanka has to put a valiant effort to maintain the free education system with tighten belts. As such there was hardly any room for governments past two decades to seriously concentrate on quality improvement of our education system. As a result penetration of technology into education has been seriously restricted. All remedial actions taken to match the education with contemporary needs of the society and the economy of the country were in the form of cost cutting rather than modernizing.

4.2.2. Co-ordination Problem

There are a few stakeholders whose direct involvement has a great significance for the creation of ICT enhanced educational system. Ministries of Education, Tertiary Education and Science and Technology, Telecommunication Operators, Internet Service Providers, Telecom Regulatory Commission, Hardware Vendors, Software Industry, National Education Commission, National Institute of Education, University Grants Commission (UGC) and Universities are main stakeholders. The coordination among these institutes is vital for the success of any serious attempt to achieve aforesaid goal. Unfortunately, except the attempt made in the past: a few years ago; by then ministry of Information Technology Development along these lines, no major coordinated effort has been put to address this issue.

4.2.3. Connectivity Restrictions

For universities, a network called LEARN has been in operation for several years now. However full set of services of LEARN is yet to be extended to all universities. The Ministry of Education started development of its ICT infrastructure a couple of years ago with the assistance of the World Bank funding. However such infrastructure is yet to reach provinces, zones and schools. One of the most serious challenges

in this respect is addressing the issue of wide area connectivity that has to be dealt with Telecom operator, ISPs and Telecom Regulatory Commission. Lack of infrastructure and unaffordable cost are key factors for the delay in reaching modern communication service to a majority of the country.

4.2.4. Lack of Impact

Sri Lanka is already experiencing a significant delay in introducing ICT related developments effectively into education. The mix-up between the objectives of ICT for education and ICT education has also become a barrier in achieving fruitful results in the past. The practice of dumping high-end computers to educational institutes without assessing real ICT needs has so far failed to produce results that can match investments. The reality is that no reasonable impact assessment has been done since the first computer was introduced into our education system. Furthermore relatively short life span of computer hardware, lack of focus on our actual needs and inadequate attention paid to the importance of necessary human resources have also contributed with varying degree to the ICT's failure to display any significant impact within our education system.

5. Future development in technology and implications

Predicting future developments especially in a rapidly developing field such as ICT is quite challenging. Nevertheless, by observing past and present trends, certain major areas of ICT, which are most likely to have significant effect on shaping future education, could be identified. In the following discussion we take a look at several such areas.

5.1. Future Development in Technology

New developments and improvements in ICT will continue to appear frequently. Availability of more and more power packed hardware, flexible and intelligent software, broadband connectivity, smart storage, ubiquitous computing, multi-media applications etc. at an ever reducing cost would be a result of them. In education, emerging applications developed around communication and multi-media technologies would

receive widespread attention. Some of such applications are, tele-immersion, virtual laboratories and digital libraries.

5.1.1. Multi-Media Applications

Tele-immersion enables users at geographically distributed sites to collaborate in real time in a shared, simulated, hybrid environment as if they were in the same physical room

A Virtual Laboratory is a heterogeneous, distributed problem solving environment that enables a group of researchers located around the world to work together on a common set of projects.

Images, audio and video can, at least from a delivery point of view, move into the mainstream currently occupied almost exclusively by textual materials.

5.1.2. The Next Generation Internet

The next generation Internet, expected to play a key role in transforming education, would focus more on security issues such as:

- a) Identity - unique markers of who you (person, machine, service group) are
- b) Directories - where an identity's basic characteristics are
- c) Authentication - how you prove or establish that you are you
- d) Authorization - what an identity is permitted to do
- e) Public-key infrastructure (PKI) – A combination of software, encryption technologies, and services that enables enterprises to protect the security of their communications and transactions on the Internet.

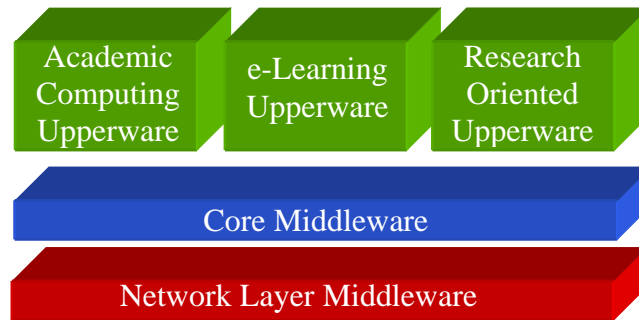


Fig. 1. A Map of Middleware Land

These features of the Internet would make application upperware less bulky and complex. Hence development of upperware will be easy and less time consuming. Many new applications such as distance learning and testing, real-time collaboration in teaching and learning and on-line teacher-parent meetings would be possible with high level of privacy.

A set of middleware in network level is expected to take care of these security functions as shown in the Fig. 1.

5.1.3. Ubiquitous Learning Environment

Learning would be able to come out of the traditional student-classroom model to become a process of anytime, anywhere, anything and anyone's creating an ubiquitous learning environments. Wireless communication and the Internet technologies would be a key to this paradigm shift. As a result of this development, learning and teaching is going to be an entirely new experience of very high flexibility.

5.2. Changes and Implications

The penetration of technology, especially ICT, into education is going to make the process of learning to be dramatically extended from "teacher push" to "learner pull." Learning systems will be built from a set of powerful tools allowing instructional designers to go from concept to operational systems quickly. Robust simulations will make possible assignments in which learners learn and test their expertise in addressing compelling assignments and problems. Teachers and learners will be able to call on a variety of human tutors, counselors and experts and access a

variety of automated help systems for addressing routine questions. A combination of automated monitoring tools, tutors and other specialists will make it possible to continuously adjust the pace, nature and style of the learning process to ensure a learning experience optimized for each learner. This combination of automated and human observers will enable continuous measures of competence integral to the learning process that can help teachers work more effectively with individuals and leave a record of competence that is useful and informative to learners, future teachers and employers.

There could be a multitude of implications of the changes mentioned above. Most importantly, teaching will become much more personalized and teachers will find more time to have dialogues with individuals and small groups.

Today's teachers are generally playing the roles of lecturer, tutor, counselor, subject-matter expert, administrator, disciplinarian, record keeper, evaluator, and curriculum designer. With many tasks performed by experts mostly through online collaborations or by using automated systems with specialized expertise, the roles of teachers are likely to be redefined.

Educational activities, presently confine to traditional institutes, are likely to move out of them to form new industries. These new industries will generate an enormous number of new occupational opportunities related to education. Many of these will be in firms that produce tools for education at various levels.

Professionals in education at all levels will need to continuously upgrade their skills and use an array of tools for professional development throughout their careers. This can include keeping abreast of developments in the field being taught, understanding advances in the theory of cognition, pedagogy and assessment, and understanding innovations in software design, standards and communications.

Life-long learning is going to become a more customary activity than ever before due to the opportunities created by ubiquitous learning facilities. Educational institutes are most likely to place great attention to this aspect of education too since knowledge-based societies would place greater emphasis on educational standard of their citizens.

6. Goals and Measures to be adopted in the education sector

Importance of reforming the education system to keep abreast of global developments in education sector is beyond doubts. In order to bring in necessary reforms, inevitability and importance of ICT are clearly understood. However, in Sri Lanka, amid weak economic situation, inadequate social awareness & preparedness and lacking implementation capacity, introducing reforms would be a challenging task that should be under taken according to a properly done plan.

In the processes of incorporating technology in education, it could be considered that an education system has to go through a transformation consisting of the phases shown in Fig. 2.

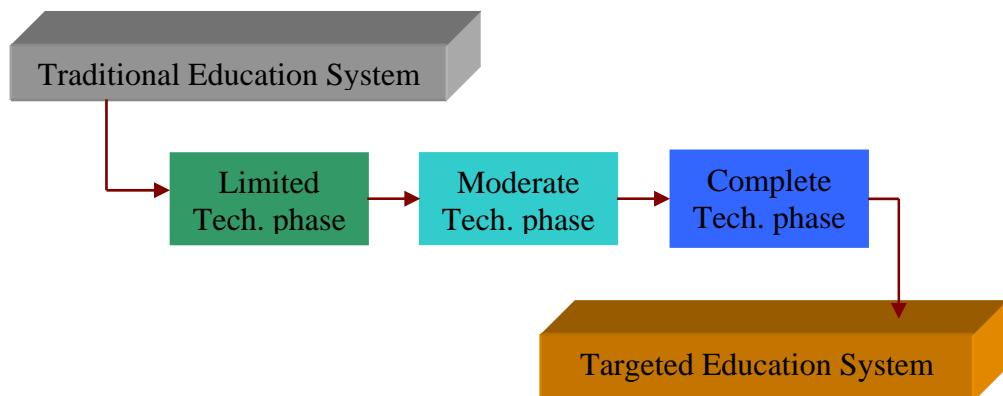


Fig. 2. Transitional Phases of an Education System in Incorporating Technology

The first phase, Limited Technology Phase, is characterized by the using of audio-visual equipment such as audio cassette recorder, VCRs, TVs, VCDs etc., dial-up connections at speeds below 56 kbps to the Internet, digital content on CDs, very high student to computer ratio (around 50 students per computer), no or very limited usage of computers in school administration, very limited number of teachers with necessary skills to work in computerized environments, etc.

The penetration of technology into the education system more intensively than that in the first phase leads the system to the second phase, Moderate Technology Phase. After going through this phase, the usage of equipment such as multi-media projectors in addition to audio-visual equipment, higher speed links such as leased circuits, ADSL etc, to get the connectivity to the Internet and on-line digital content, maintaining of relatively low student to computer ratio (around 20-25 students per computer), computerized school administration to moderate extent, a reasonable number of teachers with necessary skills to work in computerized environments, etc. would be visible.

The final phase, Complete Technology Phase, would enable anytime anywhere learning model. Each student will have a computer with a broadband connection to the Internet. Decision-making would be 100% data-driven since all necessary information would be available on-line due to the availability of broadband connectivity to all locations. Learning would be a process student-pull rather than teacher-push.

It is clear that the cost involved in the transformation goes up exponentially as the system progresses through different phases. As a developing country with a state sponsored (mostly) education system, the cost of complete transformation in a shorter period such as 10 years is going to be prohibitively high. Moreover the rate at which country is achieving readiness to accommodate new technologies suggests that a gradual approach would be more appropriate in introducing technology in education. *Thus pushing whole education system through Limited Technology Phase initially and then getting the secondary education*

through Moderate Technology Phase during next 10 years are pragmatic goals for Sri Lanka. Setting this goal could be further justified by the present and possible future socio-economic situation. In addition such a gradual approach would enable the evaluation of the impact of the early phases of the transformation before moving on to the final phase of the transformation which is tightly linked to the country's (per capita GDP) economic situation.

The above goal could be interpreted in terms of pedagogical quantities summarized as shown below.

Table 1. Targets for Next 10 Years

No	Level	Aspect of Learning	Target	
			In 5 years	In 10 Years
1	Primary (Years 1-5)	Availability of Digital Contents	60% of total contents	60% of total contents
		Non-interactive Audio Visual component	50% of total instruction	10% of total instruction
		Interactive Learning	10% of the total instruction	50% of total instructions
		Learning anywhere	20% of course material	60% of course material
		Learning anytime	60% of course material	60% of course material
		Connectivity to education Network and the internet	30% schools	100% of schools
		Data-driven decision making	30% of instances	100% of instances
2	Secondary (Years 6-13)	Availability of Digital Contents*	80% of total contents	80% of total contents
		Non-interactive Audio Visual component	60% of total instruction	20% of total instruction
		Interactive Learning	20% of the total instruction	60% of total instructions
		Learning anywhere	20% of course material	60% of course material
		Learning anytime	80% of course material	80% of course material
		Connectivity to education Network and the internet	50% schools	100% of schools
		Data-driven decision making	50% of instances	100% of instances

* Audio, Video and Web contents

The education system in Sri Lanka, in general, is going through the first phase presently with a high degree of heterogeneity in the implementation. Under the World Bank and Asian Development Bank assistances, about 1000 schools are just getting Computer Learning Centers and Information and Communication Technology Centers. These centers are equipped with 10–20 computers. Most of these schools are without proper resources persons to make use these resources. Hardly any content is available for education purposes. In terms of getting support from sources other than the state urban school are having better opportunities while schools in rural areas are poorly placed in this regard. With regard to a policy of providing equal access to technology, this situation suggests that corrective measures are needed immediately. At the present rate, it could take many more years for the whole system in this country to go through the first phase itself.

Pushing the education system through Limited Technology phase and the secondary education through Moderate Technology Phase requires quick actions in many areas, which could include providing very basic services such as electricity and telecommunications. The following actions are recommended to reach the expected goals.

6.1. A national policy and plan

A national policy for technology-enhanced education and an implementation plan for the same is an important need of the country for the survival in a highly competitive global arena. In absence of such policy attempts to reform the education sector is most likely to be a farce.

- 6.1.1. **Goal:** *Assessing the suitability of current learning objectives and models to cater to our educational and national needs in next ten years in the context of present and probable future socio-economic backgrounds and recommending modifications and technology integrations required.*

Knowledge about the strengths and weaknesses of current learning objectives is useful in developing new policies and planning future activities in right direction.

Recommended action: *Employ a team of experts as consultants who are knowledgeable about education reforms, national planning and economic reforms in Sri Lanka, ICT application in education for a period of 4 months to achieve the goal mentioned 6.1.1. They shall work as a team.*

6.1.2. ***Goal:*** *Preparing a national policy for technology-enhanced education and a detail plan to implement the same.*

The need of a national policy and an implementation plan are obvious. A detail plan should contain the process re-engineering aspects for the entire system.

In fact we are already experiencing consequences of not having such national policy and plan. Among many a few of them are worthwhile highlighting here.

Hardware is available but necessary software is not available.

Both hardware and software are available but no resource persons are available to undertake teaching programs

Hardware, software and resource persons are available but no appropriate curriculum is available.

Hardware, software, resources persons and curriculum are available. However curriculum is no match to the computing power of hardware. As a result investment is under utilized.

Resources are given with the objective of computerizing administration. No proper training, software and information systems are provided for any useful work.

The list could be very long. Therefore these situations have to be corrected without any further delay. Thus a study should be done to assess the present status and to propose necessary modifications on fast track basis.

***Recommended action:** Employ a team of experts as consultants who are knowledgeable about education planning and ICT application in education for a period of 3 months to achieve the goal mentioned under 6.1.2. They shall work as a team in coordination with the team working to achieve goal mentioned under 6.1.1. This team may start its activities after findings and recommendations of the team mentioned under 6.1.1 are made available.*

6.2. Developing ICT human resources

The success of implementing technology enhanced learning paradigms would greatly depend upon the competence of people involved in related activities. As indicated previously, in technology enhanced environments the roles of present day's teachers have to be refined and several new jobs have to come into the picture. Some such new jobs that require ICT capabilities are:

Experts in various fields to advise on new applications of technology in education in respective fields and to give presentations that can motivate and inspire

Counselors sensitive to the individual needs, interests, abilities, and cultural background of each learner. As learning become more personalized the counselors are going to be much more busier than ever before. Communication facilities such as email initially and video-conferencing later are going to provide access to counselors.

Specialist Teachers who have specialized expertise in assisting learners with particular learning difficulties. They are supposed to play a key role in helping weaker students to remain creative and

innovative. At present only private tuition system is available to look after the weaker lot of students. Naturally teachers running tuition classes are catering to weaker students with the intention of attracting students in large numbers. Hardly any room is provided for innovative thinking in tuition class environments. However in absence of any other support all students seek the help of tuition classes. With the provisions available in ICT enhanced learning environments such specialist teachers have a great role to play in handling weaker students. They should be able to provide their services on-line initially as web cast or DVDs/VCDs and later as interactive sessions through video conferencing.

Curriculum designers who work as part of a design team to translate learning objectives into creative courses of instruction. They should be capable of identifying and incorporating potential ICT tools to enable the courses of instruction to achieve objectives efficiently. It is also necessary to ensure that these courses of instruction are suitable for a wider audience than ever before.

Management and ICT Support Personnel provide a variety of services including record keeping, network management, information analysis, EMIS and FMIS systems, etc. Most of the present management staff is involved in providing the same services manually. Retraining them and reassigning them are important activities in education transformation process

Teachers and Tutors gifted in working closely with individual learners. Teacher-student, parent-teacher, teacher-teacher communications are expected to take place through the Internet more frequently than ever before.

Software Engineers, who work in teams to develop and maintain systems that can track individual learner progress, help provide accurate automated answers and summon instructors.

Content Development Engineers who build and maintain the components for synthetic environments, including specialized educational software. e.g. a digital simulation of ancient Anuradhapura to be used for a variety of learning situations

- 6.2.1. **Goal:** *Developing the critical mass of ICT personnel required in the education sector immediately.*

Such program should use the potential of local and foreign institute to train people. Whenever possible, existing staff should be retrained to fit into new paradigm. It is essential to retain the development of local training capacity as an objective of this exercise. Local Universities, National Institute of Education, National Colleges of Education and selected potential private sector organizations are the institutes where the building of training capacity should be undertaken.

Recommended action: *Training the required critical mass of ICT personnel in the following areas.*

- i. Awareness, system administration, usage of basic ICT tools in education (learning and administration)*
- ii. Technology in education at postgraduate diploma level*
- iii. Technology in education at Masters levels*
- iv. Management information systems*
- v. Management information systems at Masters level*

For training teachers, through the coordination of the ministry of education, local public and private sector training institutes such as universities, national institutes and Colleges of Education should be used with priority. These trainings should be planned as a part of the retraining exercise of the existing staff.

It is also necessary to place a greater emphasis on the developments based upon open systems during all these trainings.

- 6.2.2. **Goal:** *Developing a higher level human resources base to support education technology activities at policy level.*

Training of ICT specialists in education at postgraduate level too requires great attention. While building and strengthening the research and postgraduate education capacities of local universities, programs should be launched to get trained an adequate number of persons required at higher skill levels through foreign trainings immediately.

Recommended action: *Scholarship scheme should be established to get people trained at postgraduate level in the following major areas*

- i. Education planning*
- ii. ICT integration into education*
- iii. E-learning and evaluation methods*
- iv. Curriculum development for technology enhanced learning*
- v. Digital content development Education management information systems*
- vi. Computer systems and data communication networks*

It is essential to concentrate on open systems based environments wherever applicable in these trainings.

- 6.2.3. **Goal:** *Establishing an appropriate remuneration structure for ICT specialists in educational institutes in order to retain and encourage them.*

An appropriate remuneration structure should be formulated for ICT specialists to encourage them to retain with the education institutes. This recommendation is particularly important for public sector institutes.

Recommended action: *A mechanism to establish a remuneration structure to match the market values should be*

studied and put in place. Offering performance-based incentives should also be considered in order to motivate people to work towards targets according to the schedule.

- 6.2.4. **Goal:** *Establishing and promoting collaboration with higher education institutes, industry and other relevant entities to use technology across the human resources and professional development continuum.*

It is essential for educators to be knowledgeable of current research and applications of technology in education to work continually to improve their skills

Recommended action: *Links should be established with potential institutes for human resources development. Joint research and development activities with such institutes should be initiated in the area of education technology.*

6.3 Building necessary infrastructure

This is an important aspect of the exercise of developing technology-enhanced environment for education. There are two major unavoidable aspects in the case of ICT:

- a. Connectivity – Local area connectivity isn't critical issue. Therefore we concentrate on long distance and the internet connectivities here.
- b. Hardware and software

Connectivity is a need of almost all other sectors of the country. Telecom operators, especially Sri Lanka Telecom (SLT), are at the forefront in providing connectivity since their businesses are also heavily relying on connectivity. Most long distance links have been established to channel voice data. However the trend is changing rapidly as a result of IP becoming the de facto standard for all type of data communication. SLT has commissioned the first segment of its IP backbone, which would enable the easy establishment of corporate

VPNs that is going to bring the connectivity cost dramatically down. With the possibility of coming many other operators to the market with similar services in the future, the cost could further come down making the cost of connectivity a minor component of technology enhanced education process. Since the telecommunication industry is developing rapidly, it is quite challenging to predict long term future development of this industry. Therefore the following actions are recommended to address the connectivity issues in the present context.

6.3.1. **Goal:** *Obtaining connectivity to all schools.*

Duplication of resources and prohibitively high initial and recurrent cost could be avoided by sharing resources. This is true for present day communication. The education sector may require exploring the possibilities of sharing resources with other public and private sector organizations. In particular, government's initiatives to provide connectivity to other public institution should be considered as potential opportunities for sharing resources.

Recommended action: *The incorporation of connectivity needs of education sector in national initiatives (e.g. e-Sri Lanka) should be highlighted and promoted. Using the IP backbone of SLT or other operators should also be promoted. An Education-VPN should be established to cover as many parts of the country as possible.*

6.3.2. **Goal:** *Maintaining the cost of communication services required in education at affordable level.*

Proper planning of communication services could bring the cost of communication services down dramatically. With the possibility of handling voice, data, and video etc. over a single network opportunities are there to achieve better return for the investment on network infrastructure

Recommended action: *Education-VPN should be promoted as a multimedia network and provide all possible communication services through it.*

- 6.3.3. **Goal:** *Increasing the opportunities available to access the services of Education Network.*

It is necessary to provide simplified access mechanism to the education network. With learning becoming an anytime-anywhere activity, accessibility to educational resources is going to be in high demand. Dial-up connections are going to be main form of connectivity for many users in many years to come. A unique access method, such as dialing 150 in the case of SLT subscribers, would be preferable for dial-up users. For under privileged institutes/communities where even grid power is not available, cost-effective mechanism to provide connectivity would be a critical need to be looked into.

Recommended action: *A simple, reliable and cost-effective access mechanism to education network should be established.*

- 6.3.4. **Goal:** *Establishing alternative mechanisms to provide network services to institutes away from Education-VPN and networks of other service providers.*

There are many institutes, providing connectivity immediately to which may not be economically viable. In such situations alternative methods have to be considered.

Recommended action: *In case connectivity to a certain institute is a near impossibility, a nearest accessible institute(s) should be identified and provision should be made available in them for learners of the institute without connectivity to access services.*

6.3.5. **Goal (Short-term):** *Ensuring the operational cost of connectivity affordable in short-term until country's telecommunication infrastructure is capable of covering any location in the country at a reasonable cost.*

Recommended action: *If there are several institutes in the close vicinity, providing connectivity to which individually is not feasible, then setting up of a common facility at a suitable location for all these institutes should be promoted.*

6.3.6. **Goal:** *Ensuring an uninterrupted network service.*

Recommended action (Long-term): *A mechanism should be established to earmark funds required to sustain the connectivity at the beginning of every year particularly for public institutions.*

6.3.7. **Goal (Short/long-term):** *Defining and implementing the Internet access policies and maintaining the services reliably.*

Access policies are essential to ensure the proper and efficient use of and stop abusing the Internet services. Connecting through a single gateway to the Internet from the entire system enables the implementation of policies easily.

Recommended action (Short/long-term): *A central authority should be entrusted the responsibility of defining and implementing the Internet access policies. This authority, in addition to the above mentioned activities, should ensure the security of the network services.*

6.4. Hardware and Software

Making recommendation to address hardware and software issues is more complicated since needs could vary with time, purpose, availability of funds, etc. The fact that the life span of investments on them is relatively short, clear utilization plan should be drawn up

before deciding on necessary hardware and software. Purchasing top of the line hardware and commonly used commercial software as a habit may not be the best practice under tight budgetary conditions.

6.4.1. **Goal:** *Maintaining the cost of hardware at an affordable level.*

It is essential to identify and install necessary hardware and software for the delivery of digital content at appropriate locations. For instance, if the objective is just delivery of material, i.e. if the content is in the form of a VHS video, a VCR and a TV are required in the delivery mechanism. On the other hand, if the objective is interactive learning, workstations are essential.

Recommended action: *Specifying hardware according to the exact use of them should be promoted. Low-cost computer clusters based upon client-server architecture and special configurations available for educational purposes should also be promoted.*

6.4.2. **Goal:** *Improving the utilization factor of hardware.*

The utilization factor of hardware resources is one of the key factors that justifies the investment in hardware resources. The pooling of resources could provide access to more people and the utilization factor could be improved greatly. A networked pool of hardware resources (computers, printers, scanners, internet connections etc.) with a file server is capable of creating personalized environments for users of such a pool.

The utilization factor of resources could also be improved by opening up such resources to non-conventional audiences.

Recommended action: *Pooling expensive and short-lived hardware resources should be promoted. Furthermore, innovative and non-conventional utilization patterns should be explored and implemented.*

6.4.3. **Goal:** *Establishing common software platforms.*

Operating systems and application software consumes a substantial portion of any ICT investment. The less expensive option, using open system and open source software, is still not common in the education sector of this country. This is mainly due to unawareness and inadequate opportunity to access the internet.

Recommended action: *Standardizing operating systems, application software, and user front-end preferably based on non-proprietary open system and open source software should be promoted.*

6.5. Curriculum Development and Course Material

Ability to extract the best out of the capabilities of technology enhanced learning environments heavily depends upon the way that curricula have been developed. For instance developing course instructions to suit asynchronous learning, or self-paced online learning that allows students do most of their work outside of a standard, shortened lecture or presentation may be required.

6.5.1. **Goal:** *Developing curricula to extract the maximum benefit of education technology.*

In extracting the maximum benefits of education technology, curricula development has to play a major role.

Recommended action: *The development of curriculum should focus sharply on enhancing the quality of course instruction*

and incorporation of enhanced learning objectives by looking at ICT not only as a way of reaching a larger audience, but also an enabler of new learning paradigms.

6.5.2. Goal: Making available educational resources to a widest possible audience.

Contributions to the development of educational resources could come from various sources. The demand for such resources is expected to rise rapidly in the country. Therefore a mechanism to cater to this demand would be necessary.

Recommended action: *National Educational Network should be established and maintained.*

6.5.3. Goal: Producing digital content for education

Undoubtedly, Digital content could facilitate more effective and homogeneous teaching and learning processes. Some parts of digital content may be directly imported. However, major portion is required to be locally developed because of the media of instruction in this country.

Recommended action: *Digital content development should be considered as an urgent need and public and private sector organizations with the capacity to produce such material should be promoted.*

6.5.4. Goal: Ensuring the availability of content in Sinhalese and Tamil

Recommended action: *Developing content in Sinhala and Tamil too should be given priority in the content development.*

6. 6. Other Aspects

6.6.1. *Goal: Introducing data-driven decision making*

For data-driven decision making information management systems are indispensable. Such information management systems could be used to monitor the progress of individual students, adjust learning strategies to suit audience, do timetabling, classroom and laboratory allocation, evaluate teachers' performance, find out resource utilization, decide on teacher transfers, handle student admission, etc.

Recommended action: *Managing student records and functions of school administration should be automated for better management of schools.*

6.6.2. *Goal: Ensuring the interoperability of various information systems used in education*

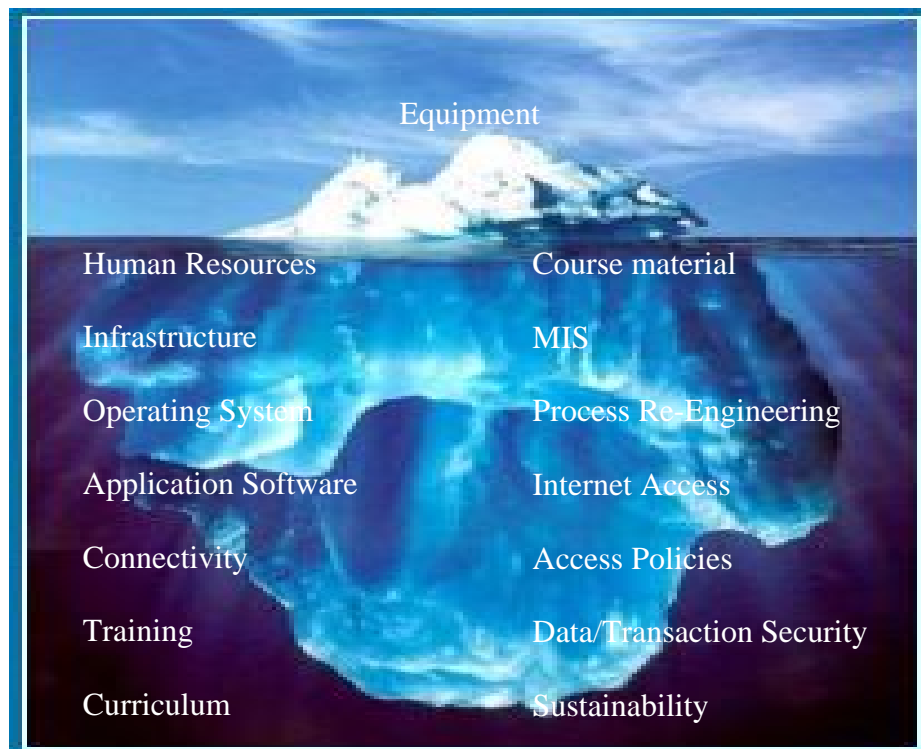
This is essential to ensure interoperability and smooth integration different systems developed for different units with in the system.

Recommended action: *A holistic approach to the development of information systems should promoted.*

7. Concluding Remarks

Incorporation of ICT to create technology enhanced educational environment involves many more than making equipment available. As shown in Fig.5 equipment forms the tip of the iceberg and the rest is hiding beneath the water surface. Addressing all these aspects is crucial for the success of creating a technology enhanced education environment and harnessing the benefits of education technology.

Recommendations made in this document intend to cover all aspects in the picture. A detail plan proposed in recommendation 6.1.2 is expected to provide a detail plan for the implementation of these recommendation.



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