Impact of Digital Technology on Education

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ABSTRACT

Traditionally education is centred on sources such as schools, teachers and print media. The learners reached the information sources by enrolling with schools, teachers and libraries. Prior to the digital era, information was not accessible by the majority of people, and even those accessed were unable to obtain current information with respect to today's context. The modern society wants to know the information as it happens and when it happens, and the world is moving from an information society to a knowledge society. Thus education is given the highest priority and brainpower is becoming the most valuable asset of an organisation.

Advances in digital technology have opened up many avenues of learning. Technology has made information accessible / transmittable from anywhere and by / to all groups of people. Education has reached most parts of the world and ICT has become an integral part of human life.

This paper describes the process of generation, creation and acquisition of knowledge through the technology. The use of ICT to manage and organise explicit knowledge is highlighted. The paper also describes how technology is used to access and apply such knowledge. The paper relates how these technologies have been used in education and its impact in general. Using examples the paper highlights some of the changes that has taken placed in the Sri Lankan education sector.

1. TRADITIONAL EDUCATION

In Sri Lankan context, formal education was traditionally centred on schools and pirivenas at village level while non-formal education was centred in libraries at central places in the form of newspapers and books. Teachers delivered the formal education either following a textbook or notes prepared using books and their experiences. The learners enrolled and visited the places that offered formal education. The libraries offered supplementary reading material to enhance their learning as well as reference facilities.

A teacher has to be well educated and knowledgeable to be able to educate others. Also they have to acquire the skills of retaining student's attention and deliver content in an effective way. Thus teaching is an important profession and people respected them as they guided and assisted the learners to be useful citizens of the country. Due to the respect earned by the society teaching was one of the social service activities. Also most activities people then used to do were centred at village level and teaching too was carried out at villages where small populations used to live.

With emerge of industrial and commercial cities people have moved out of villages to these cities for various forms of employment. When the population increased the demand for learning also goes up and thus the traditional schools or pirivenas could not cope with the demand. Thus new schools had to be created and existing schools had to be expanded, and new teachers were required to deliver education. To meet the demand inexperienced, under qualified and under trained personnel were used and thus the profession has changed from a social service to a commercial business. Business is governed by remuneration and when it is lower the capable people tends to seek other employment offering higher remunerations. Past governments used this sector as an employment creation section thus contributing towards the deterioration of the sector.

1.1 Electronic and Digital Era

Electronic era commenced with the use of wireless electronic communication over 100 years ago. Transmitting telegraph messages and the radio are among the important applications of this technology. The messages were passed through the air, invisibly, on radio waves. Since then the technology use has moved from radio, to recordings, to movies, to television, to computers, to CDs, CD ROMs & the Internet [11].

This technology was very useful to convey instant urgent messages and well as to make people be aware current local and international news. This has become an informal but effective form of education.

The transformation of analogue signals to digital emerged a new technology that was capable of eliminating transmission errors and performing the same task some efficiently. Digital technology has been around for over 50 years with the wide use of the technology for computers and other electronic equipment. Since early 1960s educators and computer scientist began using computers for teaching purposes. Initially it was used as reading and typing text to provide instructions of how to use the computer due to its low-level interaction with users and later to solve some time consuming problems. However with the invention of affordable microcomputers and the integration of text, graphics and colour there was a rapid spread of computers in business, educational institutes and homes [1].

Computers first came to Sri Lanka in the late 1960's and around the same time computing was introduced to the curriculum of University of Colombo. Learning about computers grew from understanding how computer works, to programming it perform specific tasks, to use of it to perform daily activities.

Computers also evolved from manipulation of text and numbers to interaction via text, graphics, voice and pointing devices. The ability to network many computers to share information and resources was another step forward. With all these advances there has been a steady and dramatic decrease in cost of a computer. Along with these courseware and better integration of text, graphics and colour appeared making education material more effective.

Graphical power and use of mouse on a par with keyboard made the most impact with respect to attracting laypeople to use computers. The growth of the Internet from a small group of academics and government officials exchanging textual material into a world wide resource, with millions of people using it for diverse activities such as shopping, banking, researching, forums, exchanging and sharing information, access to digital libraries and of course e-learning have already made an impact to the society. This has and will transform everything we do.

2. SUPPORTING TECHNOLOGIES AND APPLICATIONS

There are a number of technology components available to built knowledge management systems [2]. Local area networks, Internet and Intranets are the backbones. They provide transparent speedy transfer of knowledge among people and applications. Internet applications built using software and tools allow collaborative intelligent access to knowledge. Appropriate access and authentication layers ensure the security aspect of such systems. Data and document bases act as the repositories to generate the knowledge.

2.1 Organisation of Explicit Knowledge

Organisation and managing explicit knowledge includes generation, creation or acquisition of knowledge. Such activities could be performed through tools such as RDBMS and EDMS.

2.1.1 RDBMS

One of the most commonly used tools to manage information is a relational database management system (RDBMS). RDBMS have been used by IT applications to manage operational data. The same technology is now been used for knowledge management. RDBMS traditionally managed text and primitive data types such as numbers and date. Knowledge has to be represented using beyond the traditional data types such as character strings and numbers. Thus other forms of representations such as images and videos are required. Multimedia databases have immerged to manage such data.

Operational data of educational management system are managed using this technology. Student registration data, evaluation results and their performances are recorded using student information systems. In Sri Lanka use of such systems is restricted to a handful and they too do not fully exploit the facilities on offer. In most cases only few ad hock activities involving a handful of employees are performed using technology. Lack of capable and willingness employees at operational level have hampered the use of information systems for daily activities. Also the inability to take necessary actions at the management level has contributed towards this fallback.

2.1.2 EDMS

Electronic Document Management System (EDMS) is a rapidly developing technology and is considered as the solution for organizations that needs a way to manage the information efficiently. EDMS applications focus on the control of electronic documents

throughout their entire life cycle, from creation to eventual archiving. Its functions include document creation, storage and retrieval, management, version control, workflow and multiple-delivery formats [7].

EDMS allows managing the documentation of an entire process. With respect to education this task is achieved through an enhanced and more effective process called e-learning. Although some organisation in Sri Lanka uses systems for their daily activities, most are not looking at these possibilities. When considering educational institutes in Sri Lanka the use of e-learning has been around for the last two years. The BIT external degree programme of University of Colombo School of Computing (UCSC) has allowed private institutes to expose their students to e-learning.

2.2 Media for Explicit Knowledge

Explicit knowledge could be represented using different media. Text, graphics, animation, sound and video are the media to represent them [3]. Unlike the traditional media in forms of books information stored digitally can be preserved without any forms of distortion and they can be accessed easily and quickly from any part of the world.

2.2.1 Text

Text is one of the most effective components of representing knowledge. The words embodied as text, convey a powerful message and this has been widely used in handwritten and print media. Most data and information is represented through this medium. It is impossible to convey an unambiguous message without text. To convey a message effectively the message should be specific, definite, concrete and precise. Selection of suitable fonts and size is important for legibility and aesthetic effects.

Learning is concerned, summarised text is used to identify the important points and detailed descriptions are for explanations and subsequent supplementary reading.

2.2.2 Graphics

Text and graphics are the basic components of multimedia systems. Text without graphics will fail to retain person's attention as well as long-term retention.

Bitmaps (paint) graphics and vector (draw) graphics are two basic forms of still graphics. Each type has its own characteristics and satisfies different needs. Bitmaps stores the graphics as seen on screen while vector graphics stores the instructions of how the graphics is created.

Colour is an important component of a picture. However when producing graphics colours should be chosen carefully to ensure effective and pleasing displays. Human eye react to light intensity and to the three colours red, green and blue. Like in the case of fonts and sizes of text, the choice of colour composition has immediate aesthetic impact.

2.2.3 Animation

Animation adds impact to a presentation. Unlike text and graphics these are dynamic time based media. The visual impact of animation is to harness the learning process. Animations usually take forms like moving an object across the screen, user-controlled movement of an object, bitmap flipping and full animation files. Authoring tools are used to create such objects.

2.2.4 Sound

All forms of verbal communication use sound. Technology has been used to transmit sound across the universe. Teacher's voice has been the primary focus in delivering knowledge. Sound could be represented using computers, and MIDI (Musical Instrument Digital Interface) and digital audio are the two basic file types used in multimedia systems. A multimedia system requires the use of speech, music or special sound effects. When used for education, speech should be short, manageable and integrated with other media. It should be used as a complementary to text.

2.2.5 Video

Video occupies the most disk space and bandwidth when used over the network. Hence video can be integrated with other media only through use of edited segmented video clips each conveying a specific message.

2.3 Accessing Explicit Knowledge

RDBMS and EDMS manage the explicit knowledge. They are accessed using various

technologies such as Internet, Intranet, Search Engines and workflow tools [2].

2.3.1 Internet

Internet provides a cost effective global network backbone. It connects users from anywhere, as long as they have access to the web. This has allowed users to host information on their computers and make them available for others. Such computers need to be dedicated for that purpose as users will be searching for information at different times. These sites are called web sites and they are connected to the web on 7x24. This technology intends to provide unrestricted access to information. An educational institute will publish all information relevant to the public through their web sites. This technology has made information accessible as it happens and people access them at any time they want to do so.

2.3.2 Intranet

Intranet is used only within an organisation, thus restrict access to information from outside the organisation. The appropriate security measures (e.g. firewalls) implements such requirements. These web sites allow employees and authorised users to access information while protecting the same from others. This technology is used to share confidential information within an organisation. Teachers and administrators could monitor the overall status of a student and hence take appropriate actions promptly. Teachers can also make their learning material and exercises available through them. Some e-learning systems runs on these networks with login accounts created for its users.

2.3.3 Search Engines

Search Engines are very effective powerful tools that allow text based information retrieval. Web based search engines deploy different types of navigation strategies. Meta searching, hierarchical searching, attribute searching and content searching are among them. This facility is now widely used by most users of the Internet. This has helped researchers, teachers and students to reach the required information and acquire the knowledge.

2.3.4 Workflow

Workflow Tools allow documents and other forms of information to be routed among individuals and applications according to predefined processes. Workflow tools allow setting up the workflow environment in terms of users, types of information, processes, timing constraints and alternatives. These tools are used in some organizations, but not yet exploited by the education sector. Teachers could use these tools to effectively communicate with their students. We see e-learning systems gradually incorporating some of these characteristics.

2.4 Using Explicit Knowledge

The explicit knowledge that was accessed should be able to use effectively. For this it is necessary to ensure that the information gathered is presented in a useful manner. Tools such as Decision Support Systems (DSS), data mining and data warehousing are available for such purposes. These tools are just lying around for use by most users and education sector is no exception.

2.4.1 Decision Support System (DSS)

DSS are software products that transform operational data into useful information such as statistical models and trend analysis for used by the management for decision-making. They summarise internal and external data into graphs, charts and simple reports.

2.4.2 Data Mining

Data mining is a process to discover new knowledge from existing databases. Here, sophisticated data searching techniques and statistical algorithms are used to discover patterns and correlations in vast quantities of data.

2.4.4 Data Warehousing

Many organisations have several databases existing within their organisation. A data warehouse attempts to unify all these databases. The technology aggregates the data from different databases and cleans the data in the process of attempting to increase the quantity of the data. Effective data mining could then be performed. The paper in [5] described one such an attempt with respect to the education sector in Sri Lanka.

2.5 Sharing Knowledge

Knowledge sharing is done among a network of people. Communication among people could be done through paper mail, fax and telephone. However these techniques are synchronous and less effective across geographical boundaries. IT provides more effective solutions through the use of e-mail, video conferencing, virtual meeting, and document collaboration [1, 2].

Combined use of knowledge sharing techniques will allow reaching them beyond geographical boundaries and performing businesses and services more effectively.

2.5.1 E-mail

E-mail allows sharing knowledge asynchronously. An individual could share knowledge with a community by sending a message to a group of people. Distribution list eliminate the need for everyone to remember the names of the community and also ensure everyone gets the message.

Creating student groups, teachers and well as students share knowledge and this is practised to some extent in Sri Lanka as well. At UCSC we use distribution lists to communicate with current and past students.

2.5.2 Video Conferencing

Telephone allowed voice communication among distant personnel. This has evolved not only to view a live video of the person but also to connect to a number of people. Although the technology is costly it is been used for scheduled meetings involving people internationally. Universities having campuses spread over a larger geographical locations have their staff meetings through such technology. This saves travel time of individual. If the time saved and it is used effectively the organisation and society will benefit in the long run.

Some universities use this technology for teaching as well. Students ask questions by posting them to the teacher using the technology. Such systems require each student to have their individual computer with the ability receive and interact with the system. We witnessed use of such technology at the Multimedia University in Malaysia. Although the facility to use video conferencing is available among universities such as Colombo, Moratuwa, Peradeniya and Ruhuna it is yet to be used on regular basis. However, many events involving these universities and well as some local and overseas institutions have already made use of this facility. Video conferencing facilities are also available in other places such as distant learning centre.

2.5.3 Virtual Meeting

Virtual meetings allow people from different locations connect with each other to conduct meetings and share knowledge as if everyone were in the same room. Applications such as presentation graphics, spreadsheets and word processing can be shared in real time. Such activities are being used in Sri Lanka and the extent of it varies among users.

Stock exchange has reached beyond Colombo due to use of technology and the same is required for education. We see many students from Galle, Kandy, Kegalle, Kurunegala, Ratnapura districts coming to Colombo on daily basis in search of good education. Such needs could be reduced if similar facilities could be made available in these districts. Good resource personnel are reluctant to travel out of Colombo due to the long travel hours. However if through Vishwa Grame Kendra project [4] access to technology is made available people from Colombo could reach them remotely and country will benefit in the long run. Officials from public services including education, travel to Colombo for regular meetings. Planned organised virtual meetings could save time and effort of these people.

Educational Institutions created to deliver knowledge have yet to adopt technology for this purpose. Universities, technical education centres should use them on regular basis. In developed countries computers has become a day-to-day tool like a radio and a television. However developing countries such as Sri Lanka are way behind in order to provide the required technology, as the infrastructure does not support an affordable solution beyond the city of Colombo.

2.5.4 Document Collaboration

Document collaboration lets team members' work together with many other participants with documents or information in real time. Everyone can manage and use information in real time.

Documents in digitised form can be transmitted to a remote place in the exact form and reproduced any number of times. Digital

information leads to tremendous saving of space, time and maintenance, while providing easy access, storage, management and retrieval of information. Chances of non-availability, losing or misplacing of documents is rare and documents that fall under this category are accessible even after many years of isolation.

Those who use technology have been able to reduce their printing and postal cost dramatically. At UCSC we no longer post notices and application forms to our external students. They access / download them at any time they want.

3. CHANGES TAKEN PLACED

Availability of vast amount of information on the web has provided access to all types of learning material. The teacher's lecture notes are no longer the primary focus of a learning process, and the teacher's role and the student's learning process is changing [10].

3.1 Paradigm Shift

Paradigm shifts in today's world have identified the Machine / Industrial era being replaced by Technology / Information era. Similarly production process has moved from Products to Knowledge, Workplace has moved from Physical to Virtual and its focus has changed from Worker to Customer [8].

In terms of education this means we should create Knowledge that is accessible virtually with the focus on the student. Virtual access is achieved through Internet / Intranets. Techniques such as e-mail, web notices, discussion forums and video conferencing allow a student to access information without visiting the physical location of delivery. A typical interactive e-learning system will have these characteristics and thus demonstrates the paradigm shift.

3.2 Classroom Level

Use of technology at classroom level was not possible until the teachers delivery mechanisms were aided with technology. Originally delivery mechanism was through verbal communication and then through the introduction of written media such as blackboards. Later through overhead projectors teachers were able to do the writing in advance and project them directly. Use of overhead transparencies allowed them to reuse written material but without improving them. With the invention of projection through a computer, a teacher can easily update his material as well. The same material can also be printed and the students are able to obtain it without having to copy them. This technology has now evolved not only to project text and figures, but also animations, video clips etc.. Thus the teachers are now equipped with tools to teach effectively. Figure 1 summarises these options.

Method	Teacher	Student
Verbal explanations	Dictate	Listen and copy
Writing during class	Blackboard / whiteboard & Chalk / Pen	Copy notes
Pre-written transparencies	Overhead Projector	Copy notes
Pre-prepared slides	Multimedia projector & computer	Printed material
e-learning	Provide learning material	Learn through participation

Figure 1: Classroom Facilities

3.2.1 Teacher's Role

In the modern global learning environment teacher's role shifts from "dispenser of information" to "facilitator of learning" as he has only to guide the active students who are involved in using the e-learning material. Classrooms have been fully equipped with permanent multimedia projectors and computers and the facilitator needs to access the e-learning system through the Intranet. Teachers should not control the learning process as well as they should allow students to perform collaborative work and make some decisions on their own.

The changes that are happening in teaching and learning were discussed in [10] with the aid of two case studies. The key technologies and practices of e-learning at University of Western Sydney were highlighted there and it was compared with the activities of the external degrees program at UCSC.

3.2.2 Student's Role

Some classrooms are equipped with computer access to all students. In such cases students

interactively participate in the learning process. Now the student's focus is totally on the learning process than on copying note as the learning material can be accessed at a future time.

Teachers should ensure that knowledge and skills are not presented to students directly, but are constructed by them in response to information and learning tasks. Teachers need to consider how these learning experiences could be encouraging to students who are performing this type of mental work.

Thus student who used to learn facts and skills by absorbing the content presented by teachers and media resources should move towards creating personal knowledge by acting on content provided by teachers, media resources, and personal experiences. The focus should be on acquiring higher order skills like problem solving and critical thinking.

3.2.3 Curriculum Characteristics

In order to change the teacher's and student's role the curriculum also needs to be revised. Traditional curriculum would focus on fragmented knowledge and disciplinary separation. However now we should focus on multidisciplinary themes as future generation will need the ability to move through several different jobs. Thus establishment of basic literacy and focusing heavily on job specific skills is pointless, as one has to change jobs or manage many jobs by themselves. Therefore it is important to emphasise on thinking skills, knowledge integration and application. Depth of understanding will be required than breath of knowledge [6].

3.2.4 Assessments

With changes to the learning process the assessment methods should also change. Instead of measuring a student on fact knowledge and discrete skills, assessments should focus on application of knowledge. This will allow testing of problem solving skills of a student. Students should also be given tasks to demonstrate understanding and creativity.

3.3 Language Barriers

Most Sri Lankan learner's first language is not English. Hence some find it difficult grasp the concepts through reading. Hence there is a need for supplementary material in native

languages. This could be supported through Unicode.

Learning computing has now been introduced at schools as well. Currently it is targeted only at advanced level students. However with time this facility should be available for students at the ordinary level like in the western countries.

3.4 Society

Using computers for public services is gradually wide spreading. Although these benefits are currently enjoyed by a small fraction of the population the availability will encourage others to join and enjoy the benefits of technology.

For example, some banks have moved towards providing most of their services through the web. This includes managing their accounts, placing standing orders and settlement of bills. This allows the customer to make a virtual visit to his bank at anytime he wish and obtain the required service. Other services such as withdrawing cash, depositing cheques etc. can be done through the teller machines which are also accessible at anytime.

Wireless local area networks allow users to access shared information without looking for a place to plug in their laptops. This technology is being made available in some public places and organisations. Educational centres such as Universities and Libraries should have such facilities, as future generation will be carrying mobile equipment to access facilities. Information users now carry their laptops, PDA, smart phones, CDs, thumb drives with them for fast and precise access to their day to day material.

A public library is a knowledge centre [9]. To provide services through technology it should not only allow members to view available books, but should also allow viewing of content pages and abstracts. In the case of research papers the facility to download papers, journals and thesis is provided. User must also have a facility to interact with the librarian, suggest procurements, interact with publishers, receive alters on outstanding books, late fees and collection of books reserved.

3.5 Infrastructure Facilities

Educators confront with the issue of equity when they consider introducing technology to learn. To develop a country and provide everybody equal facilities is impossible with

the existing free education system and the policy implementation processors. Trying to solve the equity problem and introduce technology at classroom level will result in the country going backward compared to others as well as encourage migration as people are always looking for better learning opportunities and living standards.

Every student must have computer access to successfully implement above ideas. Thus student to computer ration must increase. It is recommended that all education institutions must have computers with a minimum ratio of 1:5 with those teaching computing with a minimum ratio of 1:3. All teachers must be provided with unlimited computer access so that they could prepare their educational material.

Word processing is the most frequently reported application. The most frequently mentioned categories of use are word processing, Internet research, and CD-ROM research. Thus the percentage of schools with Internet access needs to be raised and ultimately all users should have access to the Internet. Lower Internet bandwidth and high usage cost is a bottleneck.

The education system has been producing graduates without any exposure to computers. When these graduates take teaching assignments they are not equipped to use technology for education. Technology and educational reforms has to be done taking these into consideration.

4. CONCLUSION

Over the last five years computers have been introduced to most educational institutes although its ratio to a student is very high. By making the educators aware of the available technology and some taking initiatives to implement them, some forms of reforms may take place.

Whatever Sri Lanka do with respect technology requirements the world will be flooded with information and some people will use them effectively. They would be the people who have developed their skills to the level of finding problem-relevant information and interpreting and applying them in solving of problems.

5. REFERENCES

1) Alessi S.M. and Trollip S.R. (2001), "Multimedia for Learning: Methos and Development", Ally and Bacon, (3rd Ed.).

2) Biswajit Saha (2005), "Knowledge Management: Strategy, Technology and Application", Proc. of Intl. Conf. on Information Management (ICIM) in a Knowledge Society, pp.684-694.

3) Boyle T. (1997), "Deign for Multimedia Learning", Prentice Hall.

4) De Silva Harsha (2003), "The Vishwa Grama Fund: An Innovative Funding Mechanism to Overcome Rural ICT Infrastructure Bottlenecks, Proc. of 22nd Nat. IT Conf., Computer Society of Sri Lanka.

5) Fernando M.G.N.A.S. and G.N. Wikramanayake (2004), "Application of Data Warehousing & Data Mining to Exploitation for Supporting the Planning of Higher Education System in Sri Lanka", Proc. of 23rd Nat. IT Conf., Computer Society of Sri Lanka, pp. 114-120.

6) Grabe, Mark and Grabe, Cindy (2004), "Integrating Technology for Meaningful Learning", (4th Ed.), Houghton Mifflin Company.

7) Sathiadas Joseph P. and Wikramanayake G.N. (2003), "Document Management Techniques & Technologies", Proc. of 5th Int. IT Conf. (IITC), Infotel Lanka Society Ltd., pp. 40-48.

8) Schwandt, David & Marquardt, Michael (2000), "Organisational Learning: From World-Class Theories to Global Best Practices". London: St. Luis Press.

9) Waydande H.S. (2004), User's Perspective Towards Digital Libraries: A practical approach of Central Library, IIT Bombay, Intl. Conf. on Digital Libraries, Vol. 2, pp. 1081-84.

10) Wikramanayake G.N. (2003), "e-Learning: Changes in Teaching and Learning Styles", Proc. CSSL. Proceedings of 22nd Nat. IT Conf., Computer Society of Sri Lanka, pp. 118-124.

11) www.wsone.com/fecha/electra.htm