Modelling ICT Development in Education

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1.0 Introduction

Information and Communication Technology (ICT) [1] is a generic term, which is being used for collecting, storing, editing and passing on information in various forms. Increasingly rapid advances in ICT will have profound impact on way teachers teach and how learners learn in near future. The development of new broadband communication services, convergence of telecommunication with computers, recent developments in the field of communication protocol have fostered numerous proposals for the uses of ICT to support the teaching and learning environment. The integration of computers and communications offer unprecedented opportunities to the education system with its capacity to integrate and interact with each other over a wide geographic distance in a meaningful way to achieve the instructional objectives. The growth of these communication and computer systems, their ease of use, the power and diversity of information transfer allow teachers and students to have access to a world beyond the classroom. It has the potential to transform the nature and process of the learning environment. Interactivity, flexibility and convenience has become the order of the day in the ICT supported environment. Knowing how to use and integrate ICT in teaching and learning is of utmost importance for teachers in their role of creators of pedagogical environments. While literature provides some evidence of the effectiveness of using ICT in education, little is known about which learning strategies should be used for education and training. The present paper illustrates ICT development in education as a continuum approach along which an educational system or institution can be mapped depending on the stages of ICT development. These broad stages have been termed as Emerging, Applying, Infusing and Transforming stages of ICT development. The model is then mapped on the basis of pedagogical usages of ICT along with the stages of ICT development.

2.0 The Proposed Model

Countries in the various region of the world are at different stages of ICT development, in terms of both infrastructure and application of ICT in teaching and learning. Within any such country, there may be uneven development from region to region, area to area, and even from institution to institution. The Arab region has a wide range of ICT development stages in education.

In view of the above considerations, it is useful to have a model for ICT development for developing competency standards for teacher development. Such a model can be a representation of the essential characteristics of ICT development to provide a scaffold or a framework. It can also be useful to show the inter-relationship of various components within a system and thus helping to locate its position in the whole framework. Models and frameworks can be useful in portraying how complex systems operate. Usually in visual form, they depict the major components in a system and the way these relate to each other. A framework for the integration of pedagogy and ICT in teacher education programs,

for instance, can show the major parts and the inter-relationship of these parts. To the extent that such a framework reflects all that occurs, it may then serve as a blueprint that curriculum developers can take as a starting point in determining content, sequencing, and pedagogical process. Based on the UNESCO publication [2], a model has been presented that can be useful in determining the stage of ICT development reached by a country, a district, or even an individual institution. As mentioned earlier, this model is derived from international and national studies of ICT development that have identified a series of broad stages that educational system and institutions typically proceed through, in the adoption and use of ICT. The model [3] is presented here to provide a framework for stages of pedagogy-technology integration.

Studies of ICT development in both developed and developing countries identify at least four broad approaches through which educational systems and individual institutions typically proceed in their adoption and use of ICT. Sometimes, the number of stages identified varies, though there is a general consensus that the introduction and use of ICT in education proceeds in broad stages that may be conceived as a continuum or series of steps. These steps, termed Emerging, Applying, Infusing, and Transforming, are elaborated in Figure 1.

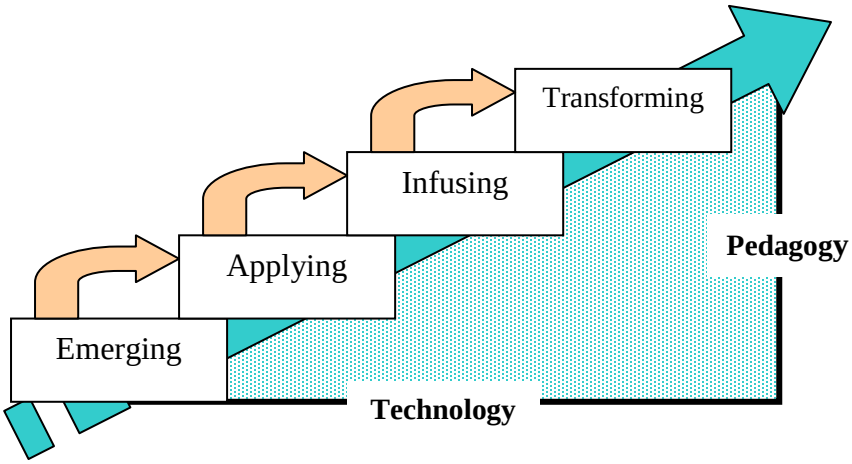

Figure 1: Stages of ICT development

2.1 Emerging Stage

Schools at the beginning stages of ICT development demonstrate the emerging approach. Such schools have just started on their journey in the ICT field with a skeleton computing infrastructure either donated or purchased by the school authority. In this initial phase, administrators and teachers just start to explore the possibilities and consequences of using ICT for school management and adding ICT to the curriculum.

2.2 Applying Stage

Those schools, in which a new understanding of the contribution of ICT to learning has developed, exemplify the applying approach. In this secondary phase, administrators and teachers use ICT for tasks already carried out in school management and in the curriculum. Teachers largely dominate the learning

environment. Schools at the applying approach phase adapt the curriculum in order to increase the use of ICT in various subject areas with specific tools and software such as drawing, designing, modelling and application specific tools.

2.3 Infusing Stage

At the third stage, the infusing approach involves integrating or embedding ICT across the curriculum, and is seen in those schools that now employ a range of computer-based technologies in laboratories, classrooms, and administrative offices. The curriculum begins to merge subject areas to reflect real-world applications. In the infusing approach to ICT development, ICT infuses all aspects of teachers' professional lives in such ways as to improve student learning and the management of learning processes.

2.4 Transforming Stage

Schools that use ICT to rethink and renew school organization in creative ways are at the transforming approach. ICT becomes an integral though invisible part of daily personal productivity and professional practice. The focus of the curriculum is now learner-centred that integrates subject areas in real-world applications.

3.0 Mapping the Model

The continuum model, as discussed in the previous section, can be mapped onto two interwoven tracks for the development of teachers' capacity in harnessing information and communication technology with regard to (a) Stages of ICT usages (b) Pedagogical usages of ICT.

3.1 Stages of ICT Usages

Studies of teaching and learning in schools around the world identify four broad stages in the way that teachers and students learn about and gain confidence in the use of ICT. These four stages give rise to the mapping depicted in Figure 2 that shows the stages in terms of awareness, learning how, understanding how and when, and specializing in the use of ICT tools according to the stages of the proposed model.

Becoming aware of ICT

In the initial phase, teachers and learners become aware of ICT tools and their general functions and uses. In this stage, there is usually an emphasis on ICT literacy and basic skills. This stage of discovering ICT tools is linked with the *emerging stage* in ICT development.

Learning how to use ICT

Following on and from the first stage comes the stage of learning how to use ICT tools, and beginning to make use of them in different disciplines. This stage involves the use of general or particular applications of ICT, and is linked with the *applying stage* in the ICT development model.

Understanding how and when to use ICT

The next stage is understanding how and when to use ICT tools to achieve a particular purpose, such as in completing a given project. This stage implies the ability to recognize situations where ICT will be helpful, choosing the most appropriate tools for a particular task, and using these tools in combination to solve real problems. This stage is linked with the *infusing stage* in the ICT development model.

Specializing in the use of ICT

The fourth and the last stage involves specializing in the use of ICT tools which occurs when one enters more deeply into the learning environment that creates and transforms the learning situation with the help of ICT. This is a new way of approaching teaching and learning situation with specialized ICT tools and is linked with the *transforming stage* in the ICT development model.

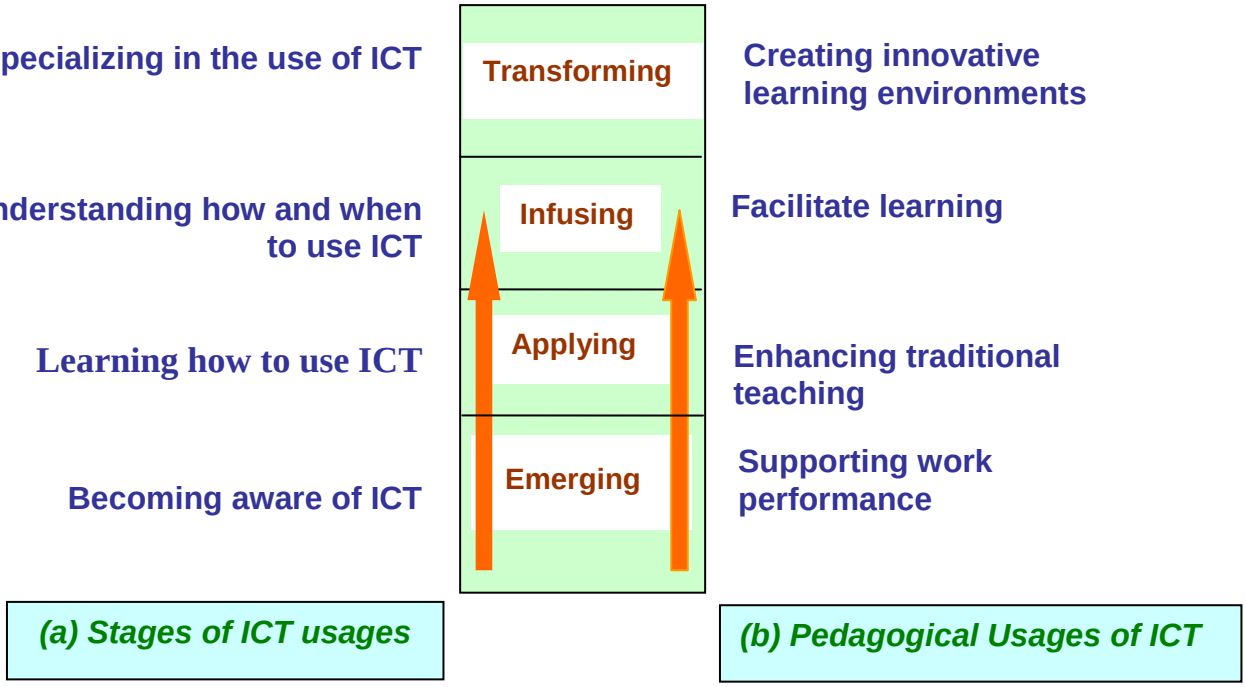

Figure 2: Mapping the Model

3.2 Pedagogical Usages of ICT

Studies of teaching and learning in schools around the world identify four broad stages in the way the teachers and learners use ICT as a support to teaching and learning. These four stages give rise to the mapping depicted in **Figure 2** that have been broadly classified as supporting work performance, enhancing traditional teaching, facilitate learning using multi-modal instruction, and creating innovative environments, according to the stages of the proposed model. More than three decades ago, computers and related information technologies were introduced to educators for direct teaching and learning purposes. It started with presentation

software to CAL/CBT/CAI, then moved to multimedia courseware and finally to learning management system using open and flexible learning.

Supporting work performance

In the initial phase, teachers use productivity tools such as word processor, visual presentation software, spreadsheet, database, email etc. to support their daily work performance. In this initial stage, there is usually an emphasis on basic operations of electronic office software. This stage of using productivity tools for teaching and learning is linked with the *emerging stage* in ICT development.

Enhancing teaching

Following on and from using productivity software, comes the stage of learning how to use and develop computer assisted learning software and beginning to make use of such software in different disciplines. This stage involves the technique of integrating computer-based learning in the traditional instructional process, and is linked with the *applying stage* in the ICT development model. Various instructional packages were selected, developed and used to enhance traditional classroom teaching.

Facilitating learning

The next stage involves using various types of instructional software to facilitate student learning. The key point is that the teachers need to learn how to choose the most appropriate tools for a particular task, and using these tools in combination to solve real life problems. This stage implies the ability to recognize situations where various multimedia, simulation and modelling software can be utilized for teaching and learning. This stage is linked with the *infusing stage* in the ICT development model.

Creating innovative learning environments

The fourth and last stage involves specializing in the use of network based resources to create meaningful environment with rich affordable for innovative learning models so that it occurs when one enters more deeply into the shared learning environment that creates and transforms the learning situation. This is a completely new way of approaching teaching and learning using technology. It helps to develop, deliver and manage open & flexible learning program. This stage is linked with the *transforming stage* in the ICT continuum model.

4.0 A Frame Work Based on Functional Approach of ICT Usage

Several attempts have been made to classify the functions of ICT in education in the literature, However, the most comprehensive and well defined classification [4] describes the following functions of the use of ICT in education: (a) ICT as Object (b) ICT as Assisting Tools (c) ICT as Management of Learning and (d) ICT as Medium of Teaching & Learning.

ICT as Object

It refers to learning about ICT. Mostly organized in a specific course. What is being learned depends on the type of education and the level of the students. ICT curriculum prepares students for the future occupation and social life. There are various types of short term, long term and modular courses being offered in this area to satisfy the ever growing demand of skill personnel in the software industry.

ICT as an Assisting Tool

ICT is used as a tool, for example while making assignments, collecting data and documentation, communicating and conducting research. It is independent from subject content. Generic assisting tools may be **general or specialised** in their application. Some of the examples of generic tools have been described below:

Word Processing and Publishing Tools—*preparing, editing and producing written, tabular and graphical material;*
Freehand and Geometric Drawing Tools—*devising and producing pictorial representations of events, ideas and artefacts;*
Database Tools—*searching, storing, categorising and arranging data and information;*
Statistical Analysis and Modelling Tools—*deducing trends and patterns, organising and synthesising information;*
Multimedia and Authoring Tools—*capturing, editing, modifying integrating text, graphics, audio & video information;*
Simulation Tools—*devising and testing ideas and hypotheses, and projecting future consequences;*
Animation Tools-*creating editing and modifying 2D and 3D animation.*

ICT as Management of Learning

This refers to the application software used for organizing and management of institutions broadly refer as educational management information system. Use of ICT for record keeping and database, examination and other administrative purposes are some few applications of this category.

ICT as Medium of Teaching and Learning

This refers to ICT as a tool for the purpose of teaching and learning itself. More than three decades ago, computers and related information technologies were introduced to educators for direct teaching and learning purpose. It started with CAL/CBT/CAI, then moved to Multimedia courseware and finally to Web Based instruction & Computer Mediated Communication (CMC) system. Using CAI for drill and practice of basic skills can be highly effective according to a large body of data and a long history of use [5]. Students usually learn more, and learn more rapidly, in courses that use computer assisted instruction (CAI). This has been shown to be the case across all subject areas, from preschool to higher education, and in both regular and special education classes. Effective instruction requires presenting information, guiding the learner, practice, and assessment of student learning. The use of a computer to provide any combination of these factors may be termed computer-assisted instruction. It should be noted that there is no requirement that

the computer provides all of these elements. Rather, any combination of these can be appropriate computer intervention in the learning process. Interactivity, flexibility and learner control is the hallmark of these technologies. The application of educational technologies to instruction has progressed beyond the use of basic drill and practice software, and now includes the use of complex multimedia products and advanced networking technologies. Today, students use multimedia to learn interactively and work on class projects. They use the Internet to do research, engage in projects, and to communicate. The new technologies allow students to have more control over their own learning, to think analytically and critically, and to work collaboratively. An increasing body of evidence [6] suggests positive results of the ICT integration with teaching and learning. The type, features, styles, usage and pedagogical base of these transformations [7] from CAL to WBI has been described below.

Type: Computer Assisted Learning (CAL)
Features: Interactivity, Flexibility and Learner Centered
Styles: Drill & Practice, Tutorials, Simulation and Instructional Games
Usage: Self Paced Instruction
Pedagogical Base: Primarily Behavioral Objectives

Type: Multimedia Based Instructional Software
Features: Interactivity & Multi model Instruction
Styles: Drill & Practice, Tutorials and Simulation & Modeling
Usage: Self-Paced Instruction
Pedagogical Base: Primarily Behavioral Objectives & Constructivism

Type: Web Based Instruction
Features: Interactivity, Just in time & On demand Instruction
Styles: Computer Supported Collaborative Learning Environment
Usage: Asynchronous & Synchronous Virtual Class Room
Pedagogical Base: Primarily Constructivism

5.0 A 3-D Representation of Varying Instructional Approaches Using ICT

Adoption of ICT for varying instructional approaches with respect to complexity and authenticity of learning poses a complex inter-relationship. An attempt has been made for a 3-D representation of this complex inter-relationship between various instructional approaches (vide Figure 3) [8]. The figure shows one of the ways of understanding the range and diversity of the model discussed above with regard to instructional approaches to complexity and authenticity of learning from emerging to transformation stages. Such a representation may be useful in defining ICT usage that might extend the learning potential of learners. The three axes shown therein may be used to answer three important questions, as discussed below.

X What instructional approaches work most effectively with various ICT applications?
The X-axis represents *Instructional Approach to Learning,* ranging from didactic to constructivist.

Y Which ICT applications can be a springboard for student learning in a real-world context?
The Y-axis represents *Authenticity of Learning*, ranging from Artificial to real-world problem solving.

Z What types of ICT uses support thinking and learning?
The Z-axis represents *Complexity of Learning*, ranging from simple (Basic Skills) to complex (Higher Order Thinking).

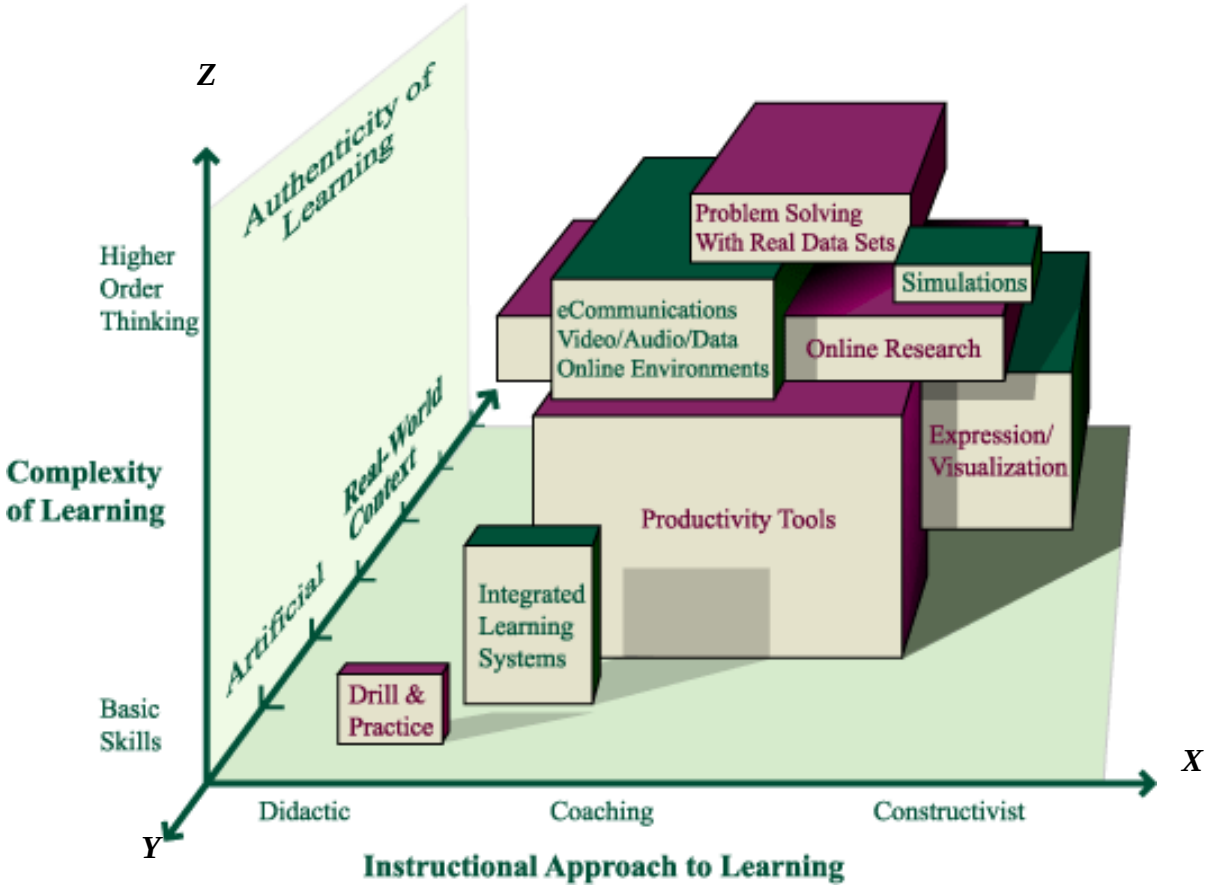

Figure 3: A 3-D representation for gauging which instructional approach with ICT (X-axis) might support students' thinking (Z-axis) in authentic learning situations (Y-axis) [Source NCREL 2003, http://www.ncrel.org/engauge/highlite.htm]

6.0 Conclusion

An attempt has been made in the present paper to illustrate ICT development in education as a continuum approach. For this purpose, a model based on UNESCO publication has been developed and expanded which conceives of four stages viz., Emerging, Applying, Infusing and Transforming. *Emerging stages* mean that teachers are beginning to become aware of the potential of ICT. *Applying stages* imply to that teachers may be learning how to use ICT for teaching & learning. *Infusing* stages mean that a variety of ICT tools are being used for getting integrated into the curriculum. *Transforming stages* involve new ways of approaching teaching and learning situation with specialized ICT tools to be used to explore a variety of real-world problems through innovative learning. The model has been mapped onto two interwoven tracks for the development of teachers' capability in manipulating and using technology. A 3-D representation of the complex inter-relationship between various instructional approaches with respect to complexity and authenticity of learning has been attempted. One of the objectives of the present paper is to provide better understanding and appreciation of the role of ICT in teaching and learning system. Several view points of integrating ICT in teaching and learning system has been discussed. Learning is not a transfer of knowledge, rather an active construction. This paradigm shifts give the learners a completely new role that was not earlier described in the transmission model of teaching. Technology and teacher professional development in its use are best introduced in the context of broader educational reform which embraces a shift away from teacher-centred, lecture oriented towards learner centred, interactive and constructive learning environment.

References

[1] SER (1997) : ICT en arbeid : advies informatic- en communication technology en arbeid. Den Haag : SER Sociaal -Economische Raad

[2] UNESCO. 2002. *Information and Communication Technology in Education: A Curriculum for Schools and Programme of Teacher Development* (Eds J. Anderson and T. van Weert). UNESCO, Paris. [Online]. Available: http://unesdoc.unesco.org/images/ 0012/ 001295/129538e.pdf [Accessed 8 April 2004].

[3] UNESCO. 2005. *Regional Guidelines on Teacher Development for Pedagogy-Technology Integration [Working Draft]* (Ed S. Majumdar). UNESCO, Bangkok.

[4] Jager, A. K. and Lokman A. H. (1999) : "Impacts of ICT in education. The role of the teacher and teacher training", Paper presented at the European Conference on Educational Research, Lahti, Finland 22-25 September, 1999

[5] Kulik, J. A. (1994) : "Meta-analytic studies of findings on computer-based instruction". In E. L. Baker and H. f. O'Neil, Jr.(EDS.), "Technology assessment in education and training" Hillsdale, NJ : Lawrence Erlbaum

[6] Alessi, S. M., and Trollip, S. R. 1985. *Computer-Based Instruction: Methods and Development,* Englewood Cliffs, NJ : Prentice-Hall.

[7] Majumdar, S. 2004. *Integrating ICT in Teaching & Learning: A Functional Approach* Presented at the UNESCO-APEID Writing Workshop for a Guideline and Competency Based Standards for Teachers' Pedagogy-Technology Integration, Hua Hin, Thailand. March 28-31.

[8] North Central Regional Educational Laboratory (NCREL). 2003. Indicator : Range of Use, [online]. Available : www.ncrel.org/engange/framewk/efp/range/efranra.htm [July 15, 2003]