Implementing Pedagogy Technology Integration In Teacher Education

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Abstract

Paradigm shifts in education in recent years envisions a new type of learning culture that demands ICT integration with pedagogy in Teacher Education Programme. Implementing the pedagogy-technology integration in teacher education and managing the changes are highly complex and possibly one of the most challenging tasks for any teacher education institution. ICT has to be infused into pedagogy in such a way that its uses can improve learning. The proposed model is derived from international and national studies on ICT development that has identified a series of broad stages that educational system and institutions typically proceed through in the adoption and the use of ICT. These broad stages have been termed as Emerging, Applying, Infusing and Transforming stages of ICT development (UNESCO, 2005). The model is then mapped on the basis of: (a) stages of ICT usage and (b) pedagogical usages of ICT. At the heart of good teaching with technology there are three core components: content, pedagogy, and technology, along with the relationships among and between them. The interactions among the three components, account for the wide variations seen in the extent and quality of pedagogy technology integration. These three knowledge bases (content, pedagogy, and technology) form the core of the technology, pedagogy, and content knowledge (TPACK) framework (Koehler & Mishra, 2008; Mishra & Koehler, 2006). The framework describes how teachers' understandings of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies. In this framework, there are three interdependent components of teachers' knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). In view of this, here an attempt has been made to discuss various issues and strategies for implementation of pedagogy-technology integration in teacher education for teacher development.

Information and communication technologies have revolutionized our society. In last two decades, technology has dramatically penetrated into every area of society and, every aspect of social and cultural lives. Television was the initiator. Television rediscovered and recast the world as a direct experience. Computers made it possible for vast amount of information to be made instantly available and modified with a keystroke. The very nature of work has changed, with an increasing demand for workers who could master the new technologies and use them to conduct business that formerly did not require computer at all. Our children have been raised in a world of instant access to knowledge. They are used to create an environment where they control information flow and access with the press of a button, in which geographic mobility, intellectual flexibility, and the synthesis of work and learning are the norms in the work place.

Although schools are embedded in our culture and reflect its values, the technological changes that have swept through society at large have left the educational system largely unchanged. In last two decades a dramatic rift has opened between the process of teaching and learning in the school and the way of obtaining knowledge in society at large. There have been no wholesale revisions in the curriculum and no substantial change in the process of teaching. The result is an estrangement of the schools from society, and from the children who live in it.

This estrangement has a negative effect. The institutions responsible for educating our children are locked in the past. In the classroom knowledge is presented to them in a linear, didactic manner that differs dramatically from the children's previous experience outside the school. For the children, school is rigid, uninteresting and ultimately alienating. This divergence between our children and our educational practice needs a drastic educational reform so that it will bring the classroom and the society into one line. The National Curriculum Framework 2005 is an attempt to minimize the estrangement between the school and community.

We are entering a world that is changing in all spheres: scientific and technological, political, economic, social, and cultural. The emergence of the 'knowledge-based' society is changing the global economy and the status of education. There is growing awareness among policy-makers, political leaders and educators that the educational system designed to prepare learners for an agrarian or industry-based economy will not provide students with the knowledge and skills they will need to thrive in the 21st century's knowledge-based economy and society. The new knowledge-based global society is one in which:

the world's knowledge base doubles every 2–3 years;

7,000 scientific and technical articles are published each day;

data sent from satellites orbiting the earth transmit enough data to fill

19 million volumes every two weeks;

graduates of secondary schools in industrialized nations have been exposed to more information than their grandparents were in a life-time;

there will be as much change in the next three decades as there was in the last three centuries (National School Board Association,USA,2002).

The challenge confronting our educational systems is how to transform the curriculum and teaching-learning process to provide students with the skills to function effectively in this dynamic, information-rich, and continuously changing environment.

The UNESCO Information and Communication Technologies in Teacher Education (2002) notes that the technology-based global economy also poses challenges to countries as national economies become more internationalized, with the increasing flow of information, technology, products, capital, and people between nations. This new economic environment is creating a new era of global competition for goods, services, and expertise. All of these changes are producing dramatic shifts in the political, economic and social structures of many countries around the world. These trends pose new challenges to educational systems to prepare students with the knowledge and skills needed to thrive in a new and dynamic environment of continuous technological change and accelerating growth in knowledge production.

The UNESCO World Education Report (1998) notes that the new technologies challenge traditional conceptions of both teaching and learning and, by reconfiguring how teachers and learners gain access to knowledge, have the potential to transform teaching and learning processes. ICTs provide an array of powerful tools that may help in transforming the present isolated, teacher-centred and text-bound classrooms into rich, student-focused, interactive knowledge environments. To meet these challenges, schools must embrace the new technologies and appropriate the new ICT tools for learning. They must also move toward the goal of transforming the traditional paradigm of learning.

In the modern society one of the major changes in education can be described as a general shift from teaching to learning. The teacher's role is increasingly to assist students to become good learners. At the same time, teachers must help create stronger relationships between the subjects of study and concrete reality, putting them in a more relevant context for students. In many cases, this implies integration of disciplines and cooperation among teachers of different subject areas.

Paradigm shifts in education in recent years envisions a new type of learning culture that demands ICT integration with pedagogy. Implementing the pedagogy-technology integration in teacher development and managing the changes are highly complex and possibly one of the most challenging tasks for any teacher education institution.

Stages of ICT Development

ICT has to be infused into pedagogy in such a way that its uses can improve learning. The proposed model is derived from international and national studies on ICT development that have identified a series of broad stages that educational system and institutions typically proceed through in the adoption and the use of ICT. These broad stages have been termed as Emerging, Applying, Infusing and Transforming stages of ICT development (UNESCO, 2005). The model is then mapped on the basis of: (a) stages of ICT usage and (b) pedagogical usages of ICT.

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. However, 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,

(SOURCE: UNESCO, 2005)

Emerging Stage

Institutions at the initial stages of ICT development demonstrate the emerging approach. Such institutions have just started their journey in the ICT field with a skeleton computing infrastructure either donated or purchased by the institution authority. To start with, administrators and teachers just begin to explore the possibilities and consequences of using ICT for institutional management and adding ICT to the curriculum. Institutions at this emerging phase are still firmly grounded in traditional, teacher-centred practice. The curriculum reflects an increase in learning how to acquire ICT basic skills such as office automation, e-mail and basic operation of computers, so that it prepares the ground for moving to the applying stage. In the emerging approach to ICT development, the focus is on the technical functions and uses of ICT and on the need for some knowledge and representation of the impacts of ICT on the system as a whole.

This approach often involves teachers' personal use of ICT, such as, the use of word processing to prepare documents and spreadsheet to prepare a database, locating information on CD-ROMs or on the Internet, or communicating with friends and family by e-mail. Here, teachers are developing their ICT literacy and learning how to apply ICT to a range of personal and professional tasks. The emphasis is on training in a range of tools and applications, and increasing teachers' awareness of the opportunities for applying ICT to their teaching in the future.

Applying Stage

In this second stage ICT tools are integrated into various school subjects. Administrators and teachers use ICT for tasks already carried out in institutional management and in the curriculum. Teachers largely dominate the learning environment. Institutions at the applying stage adapt the curriculum in order to increase the use of ICT in various school subjects with specific tools and software such as drawing, designing, modeling and application of specific tools. This curriculum assists the institutions to move to the next stage.

In the applying stage, teachers use ICT for professional purposes, focusing on improving their subject teaching in order to enrich how they teach with a range of ICT applications. This stage often involves teachers in integrating ICT to acquire specific subject skills and knowledge, help teachers to change their teaching methodology in the classroom, and use ICT to support their professional development.

Teachers gain confidence in a number of ICT tools that can be applied to the teaching of their subject area. The opportunity to apply ICT in all their teaching is often limited only by a lack of ready access to ICT facilities and resources.

Infusing Stage

At the third stage, the infusing approach involves integrating or embedding ICT across the curriculum, and is seen in those institutions that now employ a range of computer-based technologies in laboratories, classrooms, and administrative offices. Teachers explore new ways which changes their personal productivity and professional practice.

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merge subject areas to reflect real-world applications. In this infusing stage, ICT infuses all aspects of teachers' professional lives to improve student learning and the management of learning processes. The approach supports active and creative teachers who are able to stimulate and manage the learning of students, integrating a range of ICT tools in achieving their goals. The infusing stage often involves teachers easily integrating different knowledge and skills from other subjects into project-based curricula.

In this approach, teachers fully integrate ICT in all aspects of their professional lives to improve their own learning, as well as, the learning of their students. Thus, they use ICT to manage not only the learning of their students but also their own learning. They use ICT to assist all students to assess their own learning in achieving specific personal projects. In this approach, it becomes quite natural to collaborate with other teachers in solving common problems and in sharing their teaching experiences with others.

Transforming Stage

In this stage, 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. ICT is taught as a separate subject at the professional level and is incorporated into all areas. Institutions have become centres of learning for their communities.

In the transforming approach to ICT development, teachers and other staff members regard ICT as a natural part of the everyday life of the institutions that they begin to look at the process of teaching and learning in new ways. The emphasis changes from teacher-centred to learner centred. Teachers, together with their students, expect a continuously changing teaching methodology designed to meet individual learning objectives.

Mapping the Model

The continuum model can be mapped onto two interwoven tracks for the development of teachers' capacity in harnessing ICT with regard to (a) stages of ICT usage and (b) pedagogical usages of ICT.

Stages of ICT usage

Studies of teaching and learning in schools around the world identify four broad stages in the use of ICT. These four stages give rise to the mapping depicted in terms of awareness, learning how, understanding how and when, and specializing in the use of ICT tools.

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 or subject areas. 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 to understand 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 involve specializing in the use of ICT tools which occurs when one creates and transforms the learning environment 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.

Pedagogical usages of ICT

Adoption of ICT in the classroom generally proceeds in 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 that have been broadly classified as supporting work performance, enhancing traditional teaching, facilitating learning and creating innovative learning environments, according to the stages of the proposed model.

More than three decades ago, computers and related information technology were introduced to educators for direct teaching and learning purposes. ICT started its journey primarily with productivity tools, proceeded to self-learning courseware and multi-modal instruction, and finally progressed to web-based learning management system.

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. During this 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 traditional teaching

From the productivity software, comes the stage of learning how to use and develop computer-assisted learning 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 ICT tools 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 and specialized 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 ICT to create an innovative learning environment that transforms the learning situation. This is possible by incorporating emerging trends in pedagogy and learning principles in teaching and learning.

For this purpose, specialized software including modeling and simulation, expert systems, semantic networking etc., are employed to support pedagogical innovation. It helps to develop, deliver and manage open and flexible learning programme. This stage is linked with the transforming stage in the ICT continuum model.

Scenario of Indian Schools

India is emerging as the fastest-growing economy in the world. Several international reviews predicted that 21st century belongs to India and China as much as 20th century belonged to the USA, and 19th century to Europe. Such international reviews also warn lot of pitfalls and landmines on the way. The success depends largely upon human resource development. But it is observed that the education being imparted in our schools and higher education institutions, including the vast majority of our best schools and colleges, is sub-standard.

As reported in Times of India, 15th January, 2012, titled "India at the bottom of education pile", India ranked second last among i.e. 72 out of 73 countries that participated in the programme for International Student Assessment (PISA), conducted annually to evaluate education systems worldwide by the OECD (Organisation for Economic Cooperation and Development) Secretariat. PISA assesses the skill and knowledge (reading, mathematical, problem solving and scientific literacy) students have acquired at the end of their compulsory education. The PISA sample is drawn from a population of students between 15 years and the three months and 16 years and two months who attend educational institutions and are in the equivalent to grade 7 or above. A minimum of 150 schools were selected in each country; India participated in PISA for the first time. In all, 143 schools from Tamil Nadu and 66 schools from Himachal Pradesh were covered in the PISA assessment. The two states were considered as one entity. The province of Shanghai, which participated in PISA for the first time scored the highest in reading. It also topped in mathematics and science.

As reported by Kurrien (2007) the results of a large-scale study conducted last year from the best 142 English-medium schools in five metro cities - Bangalore, Chennai, Kolkata, Mumbai and New Delhi - 32,000 students were selected from classes 4, 6 and 8. They were administered tests to evaluate their understanding of mathematics science and English. Students fared poorly in questions testing understanding or application of knowledge to new situations. They were only able to do answer questions based on recall or standard procedures. They were simply unable to answer questions that appeared to be different from what they typically encountered in their textbooks. Whatever else our best schools may claim to be teaching, clearly most of them are failing miserably in one of their principal goals - to help students understand what is learnt, relate it to the world outside the classroom and to think critically.

Are schools in other countries doing a better job of teaching their children?

We have no objective basis to make any comparative judgments, as India does not participate in international studies of student achievement. However, the study on our best schools did include 11 questions on mathematics and science that were taken from an international study of 43 participating countries. The results are indicative. Class 4 students from our best schools scored lower than even the average performance of class 3 students from these 43 countries on the same 11 questions. Even though this evidence is limited, it surely indicates that there is something rotten in the state of our top English-medium schools if our best students are performing worse than average students in other countries.

A similar false consciousness exists about the quality of our elite institutions of higher education. In the recently published 2007 Times Higher Education World University rankings, not a single Indian institution featured in the top 200. Of the 26 Asian universities in this list, Japan had 11 and China 6. Hong Kong, which has less than half the population of Mumbai, had 4 universities in the top 200. (Kurrien,2007)

As reported in the editorials of Times of India (18 December 2007) Elementary school must necessarily be viewed as a training ground for young minds. Unfortunately, in India, it is a battleground where children are forced to cram and learn by rote. It is proven that the development of cognitive abilities is not uniform among children. Their needs, interests, responsiveness necessarily differ. It is, therefore, crucial that teachers are equipped to address the specific needs of young children. It is imperative that the present one-dimensional and merely instructive flow of information — from tutor to the taught — is replaced by a more interactive system where learning is made meaningful. To that end, it does not matter if an elementary schoolteacher is a graduate or not. All that matters is that she is competent and up to the job. (It is Elementary, Editorial, Times of India, 18 December 2007)

In current scenario, institutions like NCERT, CBSE, Board of Secondary Education and SCERT of different states design the curricula, instructional methods, textbooks and other materials, which, after having a stamp of approval from ministries of education, are distributed to schools and teachers. A teacher’s duty is to read and follow closely the body of these materials in order to deliver it piecemeal to students, who are expected to memorize the content one chunk after another, and checking in to see if they succeed. The basic, though rarely announced, assumption is that teachers need not add a word to what has been given from higher authorities. Teacher-to-student communication is predominantly oral. Visual aids are usually illustrations taken from books.

There is little hands-on activity with physical materials and tools on workbenches. The teacher is a lecturer, not a master of a craft. Little communication exists between teachers of different subjects on how to collaborate in making the educational process truly involving and effective. There is rigid timing; monologue lecturing and schools are considered as teaching institutions. The curriculum: a sum of disparate subjects.

The Traditional View of the Learning Process

The existing view of the learning process emerged out of the factory model of education at the turn of the 20th century and was highly effective in preparing large numbers of individuals with skills needed for low-skilled positions in industry and agriculture. The UNESCO Information and Communication Technologies in Teacher Education (2002) notes that the traditional educational paradigm is often characterized by the following views of learning:

Learning is hard

. Many view learning as a difficult and often tedious process. According to this view, if students are having fun or enjoying what they are doing in a learning activity, they probably are not learning.

Learning is based on a deficit model of the student

. The system strives to identify deficiencies and weaknesses of the student. Based on noted deficiencies, students are tracked, categorized, remediated or failed. The impact of the deficit model of student learning is most obvious in compensatory education programmes. Bruer, in his book, *Schools for Thought*, notes that research overwhelmingly concentrates on the weaknesses of poor children. Very little research has been done on their strengths. In addition, the weaknesses identified are often deficiencies in terms of the traditional organization and content of schooling. Very little thought has been given to the idea of changing schooling to accommodate new kinds of students; all the effort has gone to changing the students so that they will fit into the schools (Bruer, 1993).

Learning is a process of information transfer and reception

. Much of our present learning enterprise remains "information-oriented," emphasizing students *reproducing knowledge* rather than *producing their own knowledge*. It also remains teacher-centered. Many still see the role of the teacher as a dispenser of information and the role of the student as a passive receiver, storer and repeater of the transmitted information.

Learning is an individual/solitary process

. In a study of schools in the United States, the National Assessment of Educational Progress noted that most students spend long hours working alone at their desks completing worksheets or repetitive tasks. A London Times survey of English school children indicated that students almost unanimously rejected this daily ordeal of dull and ritualistically solitary classroom activity and called for a broader and more exciting curriculum. Above all, they wanted more work allowing them to *think for themselves*. They wanted to design and make things, to experiment and to engage in first-hand observation. The Times reported, however, that there was little evidence of changes in the curriculum that would respond to the students' wishes. (Resta, 1996)

Learning is facilitated by breaking content/instruction into small isolated units

. The educational system is often geared more to categorizing and analyzing patches of knowledge than to sewing them together. Bruer (1993) notes that the technology of mass education is quite adept at "breaking knowledge and skills into thousands of little standardized, decontextualized pieces, which could be taught and tested one at a time." Neil Postman in his book, *Teaching as a Subversive Activity*, states that our educational systems break knowledge and experience into "subjects, relentlessly turning wholes into parts, history into events without restoring continuity." (Postman, 1969)

Learning is a linear process

. Frequently, the textbook or teacher provides only one linear path through a narrowly bounded content area or sequence of standardized instructional units. For example, in a mathematics text only one correct problem solution trail may be offered for a specific subclass of problems. However, the problems encountered in daily life (or in mathematics) seldom have only one solution path or sequence.

New Paradigm of the Learning Process

The UNESCO Information and Communication Technologies in Teacher Education (2002) notes that in contrast to the traditional teaching-learning paradigm, a new paradigm of the teaching-learning process is emerging, based on three decades of research in human learning, that encompasses the following views of the human learning process:

Learning is a natural process

. The natural state of the brain is to learn, however, not everyone learns in the same way. There are different learning, perceptual and personality styles that must be considered in the design of learning experiences for the individual student. Given interesting and rich learning environments, and supportive and stimulating teachers, students will learn. Teachers have often noted that children who appear disruptive or to have short attention spans when confronted with typical classroom instruction, may spend long periods engaged in meaningful and interesting computer-related activities.

Learning is a social process

. The communal context of knowledge and learning is beginning to be rediscovered, as evidenced by the rapid growth of quality circles and computer-supported collaborative work in business, government, medicine, and higher education. As Vygotsky (1978) noted long ago, students learn best in collaboration with peers, teachers, parents, and others when they are actively engaged in meaningful, interesting tasks. ICTs provide opportunities for teachers and students to collaborate with others across the country and across the globe. They also provide new tools to support this collaborative learning in the classroom and online.

Learning is an active and not a passive process

. In most fields, people are faced with the challenge of *producing knowledge* rather than simply *reproducing knowledge*. To allow students to move toward competence, they must be actively engaged in the learning process, in activities such as solving real problems, producing original writing, completing scientific research projects (rather than simply studying about science), dialoguing with others on important issues, providing artistic and musical performances, and constructing physical objects.

Learning may either be linear or non-linear

. Much of what now happens in schools appears based on the notion that the mind works like a serial processor that is designed to process only one piece of information at a time in sequential order. But the mind is a wonderful parallel processor that may attend to and process many different types of information simultaneously.

Learning is integrative and contextualized

. Pribram's holistic brain theory suggests that information presented globally is more easily assimilated than information presented only in a sequence of information elements (Pribram, 1991). It is also easier for students to see relations and to make connections.

Learning is based on a strength model of student abilities, interest, and culture

. Based on the work of Howard Gardner and others, schools are beginning to consider the specific strengths and interests that students bring to the learning environment, and are designing learning activities that build on student strengths rather than focusing only upon remediating weaknesses. In addition, schools increasingly recognize diversity as a resource rather than a problem in the classroom.

Learning is assessed through task completion, products, and real problem solving of both individual and group efforts

. Rather than simply evaluating students through paper and pencil tests, assessments are made using portfolios of actual performances and work in both collaborative and individual learning tasks. As noted by Driscoll (1994), we no longer can view learners as "empty vessels waiting to be filled, but rather as active organisms seeking meaning." Don Tapscott, in his book *Growing Up Digital: The Rise of the Net Generation* (1998), notes that we are entering a new era of digital learning in which we are in the process of transitioning from "broadcast" learning to "interactive" learning. Today's students no longer want to be passive recipients in the information transfer model of learning. Rather they want to be active participants in the learning process. There is growing recognition that today's world requires that students be able to work collaboratively with others, think critically and creatively, and reflect on their own learning processes.

A Paradigm Shift: From Teaching to Learning

As technology has created change in all aspects of society, it is also changing our expectations of what students must learn in order to function in the new world economy. Students will have to learn to navigate through large amounts of information, to analyze and make decisions, and to master new knowledge domains in an increasingly technological society. They will need to be lifelong learners, collaborating with others in accomplishing complex tasks, and effectively using different systems for representing and communicating knowledge to others. A shift from teacher-centred instruction to learner-centered instruction is needed to enable students to acquire the new 21st century knowledge and skills. The following table (Sandholtz, Ringstaff, and Dwyer, 1997) identifies the shift that will take place in changing from a focus on teaching to a focus on learning.

Table 1.1

Teacher-Centered and Learner-Centered Learning Environments

	Teacher Centered learning environments	*Learner centered learning environment*
Classroom activity	Teacher-centered, Didactic	Learner-centered, Interactive
Teacher role	Fact teller, Always expert	Collaborator, Sometimes learner
Instructional emphasis	Facts' memorization	Relationships, Inquiry and invention
Concepts of knowledge	Accumulation of facts, Quantity	Transformation of facts
Demonstration of success	Norm referenced	Quality of understanding
Assessment	Multiple choice items	Criterion referenced, Portfolios and performances

Technology use	Drill and practice	Communication, access, collaboration, expression

Shifting the emphasis from teaching to learning can create a more interactive and engaging learning environment for teachers and learners. This new environment also involves a change in the roles of both teachers and students. As shown in Table 1.2 (adapted from Newby et al., 2000), the role of the teacher will change from knowledge transmitter to that of learning facilitator, knowledge guide, knowledge navigator and co-learner with the student. The new role does not diminish the importance of the teacher but requires new knowledge and skills. Students will have greater responsibility for their own learning in this environment as they seek out, find, synthesize, and share their knowledge with others. ICTs provide powerful tools to support the shift to learning centered education and the new roles of teachers and students.

Table 1.2

Changes in Student and Teacher Roles in Learner-Centered Environments

A shift from:	***A shift to:***
Changes in Teacher's Role	
Knowledge transmitter, primary source of information, content expert, and source of all answers	Learning facilitator, collaborator, coach, mentor, knowledge navigator, and co-learner
Teacher controls and directs all aspects of learning	Teacher gives students more options and responsibilities for their own learning
Changes in Student Role	
A shift from:	***A shift to:***
Passive recipient of information	Active participant in the learning process
Reproducing knowledge	Producing and sharing knowledge, participating at times as expert
Learning as a solitary activity	Learning collaboratively with others

(Table adapted from one developed by Newby et al., 2000).

Instructional Role of Information and Communication Technologies

Information and Communication Technology alone, of course, does not produce learning; technology is a tool that can be used in many ways, to enhance learning. The literature generally describes three major categories of instructional use for computer-based technologies; these are: learning from the technology, learning about the technology and learning with the technology.

Learning from the technology

When technology is used to convey specific information or skills, Zucchermaglia (1991) describes it as "full" technology--full of information to be conveyed to the student. Maddux, Johnson, and Willis (1997) label applications that support this use as Type I applications, which are "designed to make it easier, quicker, or otherwise more efficient to continue teaching the same things in the same ways we have always taught them" (p. 18). Use of technology in this case mirrors traditional classroom practice: users are relatively passive, the content and interaction between the user and the software are predetermined, and there is a limited repertoire of acceptable responses. The acquisition of facts through repeated practice and rote memory, or learning from the technology (Jonassen, 1996), is the goal of instruction. This use of technology was the most prevalent one in the 1970s and 1980s (Jonassen, 1996).

"Full" or Type I technologies include computer assisted instruction, integrated learning systems, computer-based tutoring systems, assessment software, and administrative software, such as electronic grade books or attendance record- keeping software. Computer-assisted instruction and integrated learning systems have been readily adopted in many schools as they closely match the traditional routine of classroom life. McClintock (1992) points out that technology has often been used as a replacement for existing tools, such as books, rather than as an alternative medium through which different tasks might be performed and different objectives might be achieved. Some researchers (Vockell and Schwartz, 1992; Merrill, Tolman, Christensen, Hammons, Vincent, and Reynolds, 1986) suggest that computer-assisted instruction can increase achievement because it leads to automaticity of lower-level skills through extended practice. A computer that is endlessly patient with the learner monitors this practice. In the tutorial form of computer-assisted instruction, the computer provides additional information to the learner if an incorrect answer is supplied. This continues until the learner is successful.

Hundreds of research studies have been conducted regarding the effects of computer-assisted instruction (CAI). From his analysis of twelve meta-analyses of the effectiveness of computer-based instruction programs developed primarily prior to 1990, Kulik (1994) concludes that students usually learn more and in less time with computer-based instruction. Becker (1992), however, found numerous methodological problems with many studies that have demonstrated positive effects of using CAI. In his meta-analysis of 100 studies, he concludes that differences in CAI users and non-users are too small to have educational significance.

Learning about the technology

Another use of technology in schools that exemplifies traditional learning environments includes learning about the technology itself (Jonassen, 1996). Classes in computer programming and computer literacy are designed to teach students how computers work. Students learn specific skills related to using the computer, such as keyboarding skills, ethical uses of computers, or a particular programming language, but these skills are not tied to other content. These classes were prevalent in the 1980s, but Jonassen (1996) observes that this use of technology is now less emphasized in schools. He attributes the change to:

the increasing availability of computers in society that gives students more experience with them outside of schools;

the understanding that one does not have to know how a computer works to take advantage of it as a tool; and the

emphasis on memorizing vocabulary about computers in computer literacy classes, which had little applicability to educational goals of schools.

Learning with the technology

Learning with technology drives much of the current thinking about the use of technology to support learning (Jonassen, 1996). Bonk, Hay, and Fischler (1996) note, "Currently popular ideas about students using electronic tools to be designers of knowledge are akin to Dewey's arguments that children must actively construct and interrelate knowledge by learning in more authentic ways" (p. 95). According to this perspective, when technology becomes an integral part of the classroom learning environment it provides a tool for both teachers and students that can facilitate new roles and new instructional strategies.

Technology used as a tool can serve as a means to seek and process information, and to reflect on one's understandings, beliefs, and thinking processes. Used in this way, technology is "empty" as it allows the learner to enter information and explore new content relationships (Zucchermaglia, 1991). Ordinary application software such as word-processing, spreadsheet, graphics, presentation, and database software; problem-solving software; simulations; electronic mail; and the Internet are technology tools that fit into this category. These applications, labeled Type II by Maddux et al. (1997), give the user control of almost everything that happens, including the interaction between the user and the machine. An extensive repertoire of acceptable responses is provided for. Rather than rote memorization of facts, Type II applications encourage the accomplishment of creative, higher-level tasks (Maddux et al., 1997).

Because of the interactive nature of technology and the power of its information-processing capabilities, Jonassen (1996) proposes that when students learn with technology, it becomes a "mindtool." He defines mindtools as "computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning" (p. 9). Using commonly available software (databases, spreadsheets, electronic mail, multimedia, hypermedia, and others), learners employ technology to both construct and represent knowledge.

Information and Communication Technologies in Teaching and Learning

The instructional implications of information and communication technologies are mostly based on Constructivist theory -- based on observation and scientific study -- about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences

Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. Always guided by the teacher, students construct their knowledge actively rather than just mechanically acquiring knowledge from the teacher or the textbook. Students become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings.

Changing roles of student, teacher and community

Students as Teachers

The age of the teacher as the primary source of knowledge in the classroom is gone. Today, with the universe of experts and information available through the Internet, students can access new and relevant information not yet discovered by their teacher. Internet-using educators are discovering a new mode of learning that we call "Side-by-side learning." It is becoming a more and more common experience to find students assuming both informal and formal roles as teachers of their peers and younger students, and in many cases of teachers.

Teacher as coaches

Teachers who involve their students in project-based learning activities also find their own role logically and naturally changing. Rather than being simple dispensers of knowledge, they discover their primary tasks are to guide and coach and mentor their students. They teach their students how to question, and how to develop hypotheses and strategies for locating information. They become co-learners as their students embark on a variety of learning projects, which chart unfamiliar territory.

Community as guide and mentor

With the growth of the World Wide Web, more and more of "the community" can be found online, therefore permitting closer relationships between people inside schools and outside in the "real world". Parents, business leaders, scientists, political leaders and administrators, and many other members of the community can play more effective and innovative roles as motivators, role models, sources of information, critics, evaluators, guides, and mentors.

The changing role of teacher in ICTs based interactive learning

In the traditional teaching learning situation, the relation between the teacher and the pupil is frontal –the role of the teacher is to deliver knowledge to the pupil. There is some co-operation among pupils. Teachers do not possess adequate knowledge and skills for the effective exploitation of ICTs. In many cases teachers are less expert than their pupils. Further, teachers find themselves in a situation where they are no longer the principal source and deliverer of information. In this context, teachers need to be properly trained for developing pupils' learning abilities. The skills needed how to use computers as tools for learning i.e. develop a critical mind; how to make lines among different sources and types of information; and how to help pupils to construct their knowledge with ICTs.

Traditional Teacher pupil relationship

Teacher

Knowledge Transmission Knowledge Transmission

Co-operation

Pupil Pupil

Teacher pupil relationship in emerging learning society

Teacher

Information Resource

Knowledge construction

Pupil

Pupil

For effective education, it is essential that there be more opportunities for student participation in the learning process, more team work, more self-study and self-evaluation, as well as more peer evaluation and less examination oriented teaching and learning. It is felt that ICTs can assist in promoting more student centered and interactive learning.

The new technologies have enormous potential to revolutionize education. It is obvious that the monopolies enjoyed by schools as formal education providers will diminish.

What the teacher has to do in a learning centered classroom?

Teacher has to use many techniques in the teaching process. For example, he may:

prompt students to formulate their own questions (inquiry)

allow multiple interpretations and expressions of learning (multiple intelligences)

encourage group work and the use of peers as resources (collaborative learning)

The literature suggests that technology can support constructivist learning environments when technology is used as a tool for learning, rather than the object of instruction or as the instructor, it can assist the teacher to uncover students' prior knowledge, understanding and beliefs; base instruction on the posing of problems; increase the complexity of the context; take on the role of the facilitator; increase the ability of students to test multiple scenarios and thus challenge preconceived notions and misconceptions: and, broaden the circle of social interaction to include students' peers and experts beyond the classroom, the school, the community and even their own country.

In a constructivist learning environment technology plays an acknowledged and purposeful role in the day-to-day activities, but does not become the object of instruction (McClintock, 1992). According to its advocates, this environment can provide students with a complex laboratory in which they can observe, question, practice, and validate knowledge. The following discussion examines how technology can be used to support the creation of classroom environments based on the instructional implications of constructivist learning theory. This discussion is based on the premise that it is learning with, not from or about, technology that makes computer-based technologies important tools in a constructivist learning environment.

A Frame Work of Integration

At the heart of good teaching with technology are three core components: content, pedagogy, and technology, along with the relationships among and between them. The interactions among the three components, account for the wide variations seen in the extent and quality of educational technology integration. These three knowledge bases (content, pedagogy, and technology) form the core of the technology, pedagogy, and content knowledge (TPACK) framework (Koehler & Mishra, 2008; Mishra & Koehler, 2006). The framework describes how teachers' understandings of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies. In this framework (see Figure 1), there are three interdependent components of teachers' knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK).

Figure-1

Source: http://tpack.org

Content Knowledge (CK)

Content knowledge (CK) is teachers' knowledge about the subject matter to be learned or taught. As Shulman (1986) noted, this knowledge would include knowledge of concepts, theories, ideas, organizational frameworks, knowledge of evidence and proof as well as established practices and approaches toward developing such knowledge. In the case of art appreciation, such knowledge would include knowledge of art history, famous paintings, sculptures, artists and their historical contexts, as well as knowledge of aesthetic and psychological theories for evaluating art. Not having a comprehensive base of content knowledge can be prohibitive. For example, students can receive incorrect information and develop misconceptions about the content area (National Research Council, 2000).

Pedagogical Knowledge (PK)

Pedagogical knowledge (PK) is teachers' deep knowledge about the processes and practices or methods of teaching and learning. They encompass, among other things, overall educational purposes, values, and aims. A teacher with deep pedagogical knowledge understands how students construct knowledge and acquire skills and how they develop habits of mind and positive dispositions toward learning. Pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in the classroom.

Pedagogical Content Knowledge (PCK)

PCK

is consistent with and similar to Shulman's (1986) idea of knowledge of pedagogy that is applicable to the teaching of specific content. Central to Shulman's conceptualization of PCK is the notion of the transformation of the subject matter for teaching. According to Shulman (1986), this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge. PCK covers the core business of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy.

Technology Knowledge (TK)

Technology knowledge (TK) is always in a state of flux. The definition of TK used in the TPACK framework is close to that of Fluency of Information Technology , as proposed by the Committee of Information Technology Literacy of the National Research Council (NRC, 1999). Fluency of Information Technology, therefore, requires a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem solving than does the traditional definition of computer literacy. Acquiring TK in this manner enables a person to accomplish a variety of different tasks using information technology and to develop different ways of accomplishing a given task.

Technological Content Knowledge (TCK)

TCK is an understanding of the manner in which technology and content influence and constrain one another. Teachers need to master more than the subject matter they teach. They must also have a deep understanding of the manner in which the subject matter (or the kinds of representations that can be constructed) can be changed by the application of particular technologies. Teachers need to understand which specific technologies are best suited for addressing subject-matter learning in their domains and how the content dictates or even changes the technology or vice versa.

Technological Pedagogical Knowledge (TPK)

TPK is an understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. To build TPK, a deeper understanding of the constraints and affordances of technologies and the disciplinary contexts within which they function is needed. For example, consider how whiteboards may be used in classrooms. Because a whiteboard is typically immobile, visible to many, and easily editable, its uses in classrooms are presupposed. Thus, the whiteboard is usually placed at the front of the classroom and is controlled by the teacher. An understanding of the affordances of technology and how they can be leveraged differently according to changes in context and purposes is an important part of understanding TPK.

TPK becomes particularly important because most popular software programs are not designed for educational purposes only. Software programs such as the Microsoft Office Suite (Word, PowerPoint, Excel, and MSN messenger) are usually designed for business environments. Web-based technologies such as blogs or podcasts are designed for purposes of entertainment, communication, and social networking.

Thus, TPK requires a forward-looking, creative, and open-minded seeking of technology use, not for its own sake but for the sake of advancing student learning and understanding.

Technology, Pedagogy, and Content Knowledge

Technological & pedagogical content knowledge is an understanding that emerges from interactions among content, pedagogy, and technology knowledge. Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. Instead, TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones.

By simultaneously integrating knowledge of technology, pedagogy and content, expert teachers bring TPACK into play any time they teach. Each situation presented to teachers is a unique combination of these three factors, and accordingly, there is no single technological solution that applies for every teacher, every course, or every view of teaching. Rather, solutions lie in the ability of a teacher to flexibly navigate the spaces defined by the three elements of content, pedagogy, and technology and the complex interactions among these elements in specific contexts.

Thus, teachers need to develop fluency and cognitive flexibility not just in each of the key domains (Technology, Pedagogy, and Content), but also in the manner in which these domains and contextual parameters interrelate, so that they can construct effective solutions.

The TPACK framework suggests that content, pedagogy, technology, and teaching/learning contexts have roles to play individually and together. Teaching successfully with technology requires continually creating, maintaining, and re-establishing a dynamic equilibrium among all components.

Impact of Collaboration in Technology Based Collaborative Learning

The impact of collaboration in technology based collaborative learning environments on study performance and nature and quality of knowledge construction has been studied during four subsequent years (Schellens, 2004; Schellens and Valcke,2000,2002, Schellens, Van Keer, and Valcke, 2004a, 2004b, reported by Valcke, M. *et al.* 2005)

In the first study, 300 of 850 freshman students studying psychology and educational sciences participated. They worked four months in 38 asynchronous discussion groups on authentic task and problems in which they applied the theoretical base of different instructional theories. Group size was manipulated this study. The complete transcripts of nine groups were analyzed to determine levels of knowledge construction reflected in these messages. The results of this study confirm the task related nature of the group communication. Building on the hypothetical hierarchical nature in the levels of knowledge construction, the results further reveal higher proportions of phases of knowledge construction in all groups. As to the group size, smaller groups (8-10 students) reached significantly higher levels of knowledge construction than average size (11-13) and large groups (15-18).

In a subsequent study, 230 freshmen worked in 23 asynchronous discussion groups as a formal part of their curriculum. Group size was constant in this study (10 per group) and the focus was on determining the impact of task structure (Global task versus pre-structured task) and participation levels (three levels, based on the number of observed contributions in the group discussions) on construction. Complete transcripts of eight randomly selected discussion groups were analyzed. The results again confirm the highly task oriented nature of the discussions. Discussions in more actively engaged groups (reflecting the highest participation level) show significantly higher level of knowledge construction. The findings also hint at a significant impact of task structure. More complex tasks foster higher levels of knowledge construction.

In the third study, with 286 students, multi-level analysis was applied to determine the impact of individual student characteristics (i.e., positive attitude towards collaborative learning; deep, surface, or strategic learning style; participation level). And task characteristics (i.e., role assignment, task complexity) on two dependent variables, namely level of knowledge construction and study performance. To determine the level of knowledge construction, the same models were applied to code the transcripts as in the second study. With respect to the in-depth exploration to the task environment, task complexity (availability of conceptual base and availability of a solution procedure) was measured and considered to have a differential impact.

The results of this study point at the impact of task complexity. When tasks are too complex, the levels of knowledge construction are significantly lower. On the other hand, when the tasks are too straightforward, the number and quality of constructions drop significantly. The results confirm the earlier findings that a task should be in the learners' zone of proximal development (Schellens *et al*., 2004a; Quinn, 1997). With respect to the impact of roles, only the role of the 'summarizer' resulted in significantly higher levels of knowledge construction. Considering the results of the multi-level analysis dealing with student, group, and task variables, a large part of the overall variance in students' level of knowledge construction can be attributed to differences between the various discussion themes and tasks. As to the impact of student characteristics, the amount of individual contributions and students' attitude towards the online learning environment are significant predictors of students' mean level of knowledge construction.

The findings of the above studies are largely in line with the results of studies that fit into the long tradition of collaborative and cooperative learning research. The research results reveal that task structure is an important issue to consider for developers of such environments. A careful balance should be respected between open and closed structure of discussion. Along with task structure, task complexity is also a significant factor. Tasks should not be too complex as students' motivation might decline. It implies that students are capable of seeing that they can complete the activity that is within their zone of proximal development. On the other hand, when tasks are too straightforward, we might expect that students experience no challenge and that the quality of contributions also drops. It appears that challenge is an important concept in this context. In order to keep the learning in this zone of proximal development, focus should be laid on structuring of assignment. Another practical implication is that task should be enjoyable.

These strategies are consistent with constructivist approaches to learning and instruction to foster engagement in an online learning environment. Present achievable goals and clear evaluation criteria, organize authentic learning, and set tasks at the appropriate level of complexity.

Conclusion

It may be concluded that it is learning with, not from or about, technology that makes computer based technology an important tool in a new paradigm of learning. In order to capitalize on the potential of new technology, and particularly digital technology as a teaching tool there is an urgent need of the professional development of teachers. Professional development that allows teachers to construct professional knowledge about pedagogy, content, and technology, as well as strategies for managing the changing classroom environments brought about with the creation of constructivist learning environments supported by technology. To achieve this, there is need of providing learning experiences to the teachers. These experiences should be situated in an authentic context for teachers, their school and classroom. It should build on their prior knowledge and provide opportunities for social interaction with colleagues. It should begin with investigation of problems supported by technology that are relevant to teachers. By providing such learning experiences to the teachers, we can enable them to create learning experiences appropriate for the children of the Information Age and take the advantage of Information and Communication Technologies in a new paradigm of learning.

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