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# A SocioCybernetic Approach to Pedagogical Systems

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# Abstract

The ways in which information and communication technologies are influencing educational systems is the subject of discussion from a number of directions including educational practice, education theory and educational technology, as well as from general commentators. Underlying any discussion is the question of the level of change that is being engendered by these technologies. It is argued here that whatever changes have occurred constitute qualitative shifts in the nature of educational delivery and pedagogy *per se*. These significant qualitative changes are generating debate and are influencing theory development on a scale that is unprecedented in education. The conventional thinking about education had its beginnings in the traditional classroom and yet there is a tendency for this conventional thinking to form the backbone of explanation within the changing environment. It is further argued that an alternative approach to educational thinking is needed that is able to deal with change in a coherent way. An approach is outlined that is derived from Sociotechnical Systems Theory and is called SocioCybernetic in recognition of the fundamental role of ICT rather than technology *per se*. All of these factors are seen to be important in defining the way in which education and information technology should combine in order to maximise developmental potential rather than following along behind technology. A thorough analysis of this changing educational system also points to the need to formally evolve a new class of education-ICT professional who have the professional skills allowing them to cover ICT and education at significant depth.

### *A reflection*

In primary and high school of the 1950's, and the university of the 1960's, a project was an exercise in planning. In my final year of primary school (year 6 in K12) I did a project on Chinese characters. This involved using the local municipal library because the school library had nothing useful on this topic. Time had to be organised to bicycle into the Newcastle City Library and to search for relevant information. The information had to be brought together, without a photocopier, and a physical display created with coloured pencils and water colour. For example, showing the Chinese character for Mountain as a pictogram associated with the classical Chinese painting of a mountain.

In 2003 I wanted information on the Korean characters for 'abacus'. A search on the Web gave me a starting point, particularly when I downloaded software that allowed the presentation of Korean and Chinese characters. Then I checked, using the Intranet, out the University's language staff and found we taught Korean. An email gave me a quick response and the laser printer gave me a basic output.

Over those 50 years my skills had improved but it is technology that has inexorably changed the research and presentation processes.

# Introduction

Rushby (2005), in an editorial in the British Journal of Educational Technology, asks where the new paradigms for technology-based learning environments are to be found. He suggests that the complexity of changing learning environments have no parallel in the development of appropriate learning paradigms and in methodologies that support appropriate innovations in instructional design. This paper is an exploration of possible ways of looking at this issue, recognising the narrative that pervades this period of educational history: a narrative about change and its impact.

The integration of Information and Communication Technologies (ICT) systems, into the management and the functioning of educational institutions is changing the teaching and learning environment and leading to questions like those asked by Rushby. The changes in the learner's view range from the capacity of to enrol and obtain results transcripts on-line, through

to the ability of the learner to access self-directed and self-managed learning environments. From the teacher's view we can begin with real-time on-line course management systems through to highly flexible delivery platforms that transcend the classroom. Much of the traditional thinking about educational systems was premised on delimited physical environments where a set of traditional roles defined interactions and many of the models used to describe educational environments continue to work from these types of assumptions.

## *A Reflection*

> In a reminiscence on language, Paul Johnson (The Spectator, Nov.11 2006), when discussing learning Latin and Greek at school said:
>
> > *We all spent a long time over Virgil – did we not? – in those cold, mote-filled classrooms smelling of chalk and ink.(p32)*
>
> The 'we' is the generation that was still using a steel knib and an ink-well on the desk. This was before the acceptance of the technology of the fountain pen and, subsequently, the ball-point pen.
>
> This technology transition is only about 50 years old.
>
> Some 15 years on from the 'chalk and ink' I was using a Hewlett-Packard min-computer – with about 16k of memory on board - to mark multiple choice tests. The beginnings of the current revolution. But, notably, the editor of an Australian educational technology journal, in 1970, rejected a paper on the work being done, saying the ideas were fanciful in that computers would never become central to educational tasks.

Little of the discussion of the way in which educational systems have changed has moved to the level of questioning the depth of this change. The various positions developed on learning systems in Jonassen and Land (2000) are primarily about various pedagogies and technologies while recognising that there is a need for review, but they do not address fundamentals. When Galbraith (2004), Gunter (2004) and Sullivan (2003) debate chaos theory versus system dynamics theory in education, they are not addressing issues central to the nature of educational organisations, rather they are focusing on models that may or may not be relevant. That is, they are discussing change at a conceptual and philosophical level and are not referencing the research that looks at organisational behaviour in educational systems.

Evaluation of functional educational activities adds insight but often fail to question the fundamentals such as the work of de Kock, Sleegers & Voeten (2004) where they recognise issues of change but reformulate it within existing thinking.

The writers who are opening up new ideas do not appear to come from the core areas of educational theory, rather they come from outside educational theory or from the fringe of educational theory. For example, the various papers written by Heylighen over the past decade come from with the Cybernetics community (eg Heylighen, 1993) and generate challenging ideas, albeit ideas that are at times difficult to integrate into conventional thinking. Such ideas may not permeate into the general education community but warrant responses. Similarly, the work of Voithofer (2002) on nomadic epistemologies develops a particular view of education that is outside the mainstream but, again, needs to be considered. But when Jonassen (2004) talks about Activity Theory and learning environments he is not restructuring his constructivist models; he is not re-working any of the core theory and asking how well it works when you add in a new element.

While we have some reorganisation of thinking there has also been concepts generated that can be seen as situational. For instance, as mobile computing and communication devices were seen to be becoming important there was the idea of mLearning (eg Turunen, Syvänen & Ahonen, 2003). Broader discussion of eLearning has generated research and discussion on e-pedagogy (eg Mehanna, 2004). In 1999, Newson introduced the term techno-pedagogy to cover the interaction between information technologies, educational technologies and the teaching environment. In the intervening period there has been little published that references this term and its implications, although there is the Bryn Mawr workshop of this name[1] that

1 http://serendip.brynmawr.edu/talking/

makes no reference to Newson. Spodarg (2005) took up the basic concept and then talked in terms of technoconstructivism.

The idea that information technologies are changing the education system is not without its critics. Robertson (2003) questions the claims about the impact of technology and suggests that contructivism has been hijacked in the name of technology. Her position is partly correct because few of the system developers appear to have a great interest in pedagogy, if their literature is indicative. For example, within the whole of the specification systems for interoperability for e-learning systems, there is no material on educational process and pedagogy (e.g. ADL, 2004). Unfortunately, Robertson's position lacks scope by not seeing many aspects of technology as components in a changing world and by focussing upon constructivism as if it were sacrosanct.

Newsom (2007), in stating the technopedagogy position, was making critical comment on the way in which technology was impinging upon the practice of education. She later developed this more extensively when formally researching the way staff work practices had been influenced by technology. This paper is uncommon in that it is interested in the practice of the university teacher with all of the implications that has for pedagogy.

Superimposed upon all of this, is an element in the changing structure of education that appears to have generated minimal discussion: the socio-cultural implications. Most of the distributed delivery systems are based upon western culture, as have been the teaching models of the imperialist educators and missionaries. It cannot be said that the Anglo-Scottish educational model or any of the educational models from continental Europe were designed to accommodate cultural difference. And little appears to have been done to update these and the USA-based educational thinking for other cultures yet they are being distributed as default models. The technology is carrying along cultural issues that will have effects and that may or may not be beneficial. There appears to have been limited research (eg. Chang and Lim, 2002) into ways in which this might effect pedagogical practice.

Allied to this is a socio-cultural conundrum that appears when working through the current situation in educational thinking: Brunner worked in the 1960's and 70's in a world that was very different to that we have to-day and if we accept that there are social and cultural contexts in which this research is done, and that learning does involve such contexts (*vide* constructivism), then we have to look at the updating of this research. The learning environment where children have access to a different set of tools, that can both facilitate and hinder learning, must be included in the learning equation. The conundrum expands when we recognise that Vygotsky worked in the USSR in the 1930's where the environment was unusual even when compared to the western European standards of the time. Whatever he wrote, whatever conclusions he drew had to be in tune with Marxist-Leninist-Stalinist thinking, yet Marx produced very little on education and whatever he did produce tended to be polemic rather than explication. This gives even more reason to look at the basics of current pedagogical models.

## *A reflection*

In the 1950's and 60's there were Classic Comics that were drawn to bring out the core of the 'Classics' to the non-reader. Discussions I had with a literature graduate from the 1960's, who studied at a US university, indicated that Classic Comics were used by some students in his university as the reading base for 'Literature 101'.

In this period, there was also the Readers Digest Condensed Books, through which a read an interesting array of novels.

The well-produced historical film was rare. In 1959, Sir Lawrence Olivier's Henry V was officially viewed, at a local cinema, as a part of my matriculation English course.

By the 1980's there were compressed versions of the classics that were/are used by students.

Now we have many of the classics dramatised and available on electronic media. They include comment, deconstruction and alternatives. Literature 101 in 2007 operates in an educational and social setting that is quite distant from that of the 1950's and 60's and parsecs away from the world before WWII.

The position to be argued here is that a paradigm shift is upon us and that this requires a response that produces some integrating approach that accepts the real diversity that distributed, global educational systems imply. This approach must be able to accommodate the

interaction between technology, teaching and learning without reverting to Procrustean methodology. We also must understand that the shift is neither complete nor universal and this is quite understandable given the diversity of educational thinking and pedagogical models that support educational practice across the globe. The most likely approach that can help explicate what is happening is seen as being some variation on open systems theory, such as socio-technical systems theory (Emery & Trist, 1969), and this will lead to a super-ordinate pedagogy that allows for the existence of task-specific pedagogies, such as constructivism. Open systems theory would also allow us to develop an integrated organisational model (eg, Rice, 1952) although this is outside the scope of the current paper.

It is also argued that there are qualitative shifts occurring in education that are having a profound impact upon computers in education and upon computing education. These shifts are moving towards the point where the instructional designer and the educational technologist will be working with the *ICT educator;* with the person who is trained to deal with developing, implementing and evaluating systems that can be distributed, mobile, virtual and learner-directed.

# Defining the Paradigm Shift

### An observation

> The website of the Open University in the UK tells us that in 1971 it began teaching its first students and by 1980 it had 17,000 students as well as having its first entry in *Whose Who* for one of its graduates. The current figures on students and their activities are:
>
> - More than 180,000 students are interacting with the OU online from home
> - Each week, 25,000 students view their academic records online.
> - When exam results were available, 85,000 students viewed them online
> - The student guidance website receives 70,000 page hits per week.
> - The Open Library receives more than 2.5 million page views each year.
> - 110,000 students use the conferencing system.
> - There are 16,000 conferences, of which 2,000 are organised and moderated by students themselves.

A paradigm shift in the basic Kuhnian sense (Kuhn, 1996) occurs when new components enter the area of study and these then seriously disturb the *status quo*. These lead to a qualitative transformation or shift in the way materials are handled and theories are formulated. Additionally, these new elements increase the richness and complexity of the area. Kuhn's interest was in scientific theory but it is reasonable to extend his thinking into more applied areas when it can be shown that what he formulates can have clear explanatory value. But like many other writers on this topic, I will be taking a rather cavalier approach and will use Kuhn's basic concepts as a touchstone rather than building a full Kuhnian analysis. This sees Kuhn's model as a general explanatory process rather than as a detailed analytical model.

One of the conditions for a paradigm shift can be seen to be change that is qualitative rather than linear. That is, the change that is observed shifts into new theory or new methods that differ in kind from what has gone on before. This may also be described as a catastrophe shift from within Catastrophe Theory (Arnol'd, 1992; Zeeman, 1977). The parallel here is that the paradigm shift and the catastrophe change both mark a transition from one state to another; a transition, in our case, from one model of an educational system to another.

Another condition for a paradigm shift is that new ideas disrupt the normal world order of the discipline. New thinking subverts or challenges old thinking. In Kuhn's terms, from a science perspective: '..a scientist's world is qualitatively transformed [and] quantitatively enriched by fundamental novelties of either fact or theory" (Kuhn, 1996:p.7).

Within this process of change, the communication system reflects the fact that there is controversy with the development of communication about the change. In essence, qualitative change will require some shift in the professional media to allow for different positions, partly because new ideas are often seen as radical and subversive. This tends to then encourage the 'old school' to become entrenched in its position.

Taking these generalisations from Kuhn's science-based paradigm shifts, can justify talking about a paradigm shift in education? By exploring the role of ICT systems on specifiable changes that have occurred in the educational environment over at least the last ten years, I will analyse the extent that a shift has occurred. In particular we can look at the changes in the science and art of teaching, in the way administration functions, in the epistemological assumptions underlying the learning environment and in the way specific ICT structures are working in education.

## *ICT in education*

A basic example of what I am referring to is the introduction of the asynchronous chat room as a feedback forum in teaching activities. This can be seen to be a qualitative change in that both the staff and student move from the face-to-face communication methods to the computer-to-computer communication methods. Not only is there are qualitative shift in the mode of communication but there is also a change in the communication process where there is amove from one-to-one to one-to-many-to-one communications.

Broadly I would say that what is generally called distributed computing environments produces new ways of delivering materials and new models of teacher-learner and learner-learner interactions. There are those who see a new epistemologies deriving from this technical capacity such as Voithofer's (2002) nomadic epistemology.

The world of virtual education has had a mixed development (Markham, 2004) particular in the development of the virtual university. But virtual educational environments that are based upon innovative technologies are opening up alternative ways of developing educational activities. For example, the use of so-called software agents in tutorial and management systems radically changes their potential functionality. There are also efforts aimed at utilising advanced technology thinking in the development of intelligent and responsive storage systems (eg. Chhetri et al, 2004; et al, 2004).

Work that has also been carried out to build various intelligent systems to support educational activities. The possibility of various forms of interactive support tools is opening up the question of what constitutes level of support system can be created where such support constitutes more effective versions of the expert system concept. The TILE system (Hong et al, 2000; Kinshuk, et al, 2002) attempted to create a responsive cognitive model of the user but appeared to fail to have the needed conceptual tools.

We must be careful here that we do not fall into the technology error and confuse technology with pedagogy and the teaching and learning processes. Research carried out into the way on-line education was being implemented in the Australian Technical and Further Education sector (Hill, Malone, Markham, Sharma, Sheard & Young, 2003), showed that the introduction of technology into the teaching environment lead to the belief that the teaching environment was somehow turned into an e-learning environment. Simple translations of paper-and-pencil materials into internet accessible materials was being defined as the developing an e-learning environment.

Instructional design has its own technical issues when we look at what is changing in the educational system. The way in which computers and software have affected the profession of instructional design would constitute a separate paper. What we are interested in is the way instructional design has come to see its role in this changing world and the relative depth of the changes that have taken place. There is always the issue of whether technology is being used for the sake of technology or whether it has a pedagogical purpose. Few papers on the application of educational technologies establish a meaningful educational position to justify the introduction of that technology (eg. Lid & Suthers, 2003; Blum & Baumann, 2003). Against this trend, Segrave and Holt (2003) discuss the issues of developing courses in the e-learning environment, recognising the changing world:

> This broader contemporary view challenges education designers to begin with current conceptions of not only the rationales and practices of e-learning, but more fundamentally the meaning of desired forms of teaching and learning, enacted increasingly through more complex and diverse technology-enhanced environments and aimed at a more diverse range of learner cohorts. (p.22)

In 1995 Thornburg was suggesting that we had moved from the information age to the communication age. Critical in this was the way in which information had become an infinite resource rather than something under the control of a limited number of people – usually teachers and librarians. This was an early statement about some of the core ingredients in the paradigm shift.

### *A reflection*

My personal archive has wet-method photocopies obtained during the period I did my PhD (1973-1977). Some of these have the imprint of the inter-library loan service where the source libraries were all over the country.

Not long after this, the librarian gained a new power base with the search of the international databases. This was done via the mainframe through international telephone connections. This cost money so my academic department only ever allowed a limited number searches.

In 1992, while working in Indonesia, I saw the use of a portable computer plus a dial-up modem as a data access tool – albeit fairly inefficient in a low grade telecoms system.

In 1994 I watched a colleague's computer go into a massive download as he did a search on the internet – a completely new entity to me.

In 1996 I gained access to the WWW on a dial-up network and discovered the time-based cost of accessing anything of any size.

Now I access information and data bases within what Thornburg was talking – a seemingly infinite resource with few 'controllers'.

A more recent change in the way educational material is delivered has come through increased 'connectivity' of the computer. The realisation of McLuhan's global village (McLuhan & Powers, 1989) is upon us and this is changing the way in which learners can cooperate on learning tasks. The growth of models of cooperative learning environments is one of the major transformations in educational thinking over the past ten years. For example, Rovai and Lucking (2003) look at the application of television technology in creating a distributed learning community while Russell, Calvey & Banks (2003) look at the development of learning communities as means of enhancing e-learning. Järvelä and Salovaara (2004) report on the changes in high school student responses based upon exposure to computer supported learning. Added to this is the whole of the Computer Supported Cooperative Work movement (CSCW: eg. Karsten, 2003) that is, in effect, premised on the ability to work together via connected computers.

The world of the learning community, unrestrained by physical meeting schedules, now takes on a completely different perspective. Lifelong learning in unconstrained learning environments is almost a reality. What has happened here is not simply a quantitative shift along a linear scale defining personal control versus external control. Rather it is a change from others defining the content and outcomes of knowledge acquisition to the learner defining his/her own learning environment. This is best illustrated by the enormous array of special interest areas that are available on the Web.

## *Pedagogy*

Pedagogy, defined as the science and art of teaching, has experienced changes that are quite complex and these changes cover a number of aspects of what the teacher, at all levels of the education system, is doing. The first of these concerns the impact of information technologies on teaching where the teacher can now control and manipulate information at an extremely complex level. The teacher is not constrained by the four walls of the classroom. She is, for example, able to utilise complex simulations to develop student thinking and understanding; to work with the student outside the classroom via the computer. In addition the teacher is able to traverse traditional pedagogies and tailor materials to fit student needs. And all of this can be done "on the fly". Education can be seen as shifting from a delivery paradigm that is focussed on the classroom to one that is multidimensional and flexible from both the teacher and the student view.

The pedagogical changes that are engendered by tools such as asynchronous communication are profound. The teacher can now carry out real-time teaching across physical boundaries, where the information can be controlled and generated live. Perhaps the best example of the size of the change can be shown through the way in which the Australian *School of the Air* which began in the early 1950's. The *School of the Air* provided wireless-based teaching to children in remote areas of the country – such as children on isolated cattle stations. The teacher communicated in real-time with a number of children with switchable two-way radio. That is, only one person could talk to the rest at any one time. The children used printed materials that were posted to them on a regular basis. This same group of students will now be using a satellite linked internet connection with various forms of real-time communication that

can be modified and developed as the class session is in progress. The methodology of teaching into distance education has changed radically with the major changes in internet communication systems.

Similarly, technology/software systems can build distributed systems that move outside the concept of the classroom. When this is coupled with electronic access to information that eliminates the basic need for the library (without becoming involved in the issue of the veracity of such information) then the world of the self-managed or self-directed learner becomes a reality and the science and art of teaching takes on new parameters.

Within this, the role of the teacher is becoming more varied and flexible. A practical example of this shift is outlined by Young (2004) in discussing the functioning of the *School for All* program in Taiwan.

In a similar vein to the discussion in the previous section, on information access via the internet, pedagogy is being effected by the way the storage of learning materials is shifting from passive, well defined systems into dynamic, open-ended access systems (Krishnaswamy et al, 2004). Even the formalism of SCORM (Sharable Content Object Reference Model e.g. ADL, 2004) and related definitions for electronic storage and retrieval, is accepting that there needs to be some dynamic element. With the introduction of SCORM2004 some capacity has been included for establishing associations between search elements and consequent user patterns. As repositories develop and provide effective educational materials, the teacher and learner will have access to a qualitatively different level of learning materials.

Pedagogy has been transformed through the level of accessible information that the Internet provides. The Web user can search for almost any topic and find information that is not restricted to the formalisation of the encyclopaedia or the indexing of the library. In recognising that the veracity of the data from the web can be in doubt, a new element in the teaching and learning environment has also been introduced, namely the development of a search validation expertise. Once this was the prerogative of the researcher but now every student has to learn the processes needed to weigh up the content extracted from a search. A component of this qualitative shift is that teaching moves more and more towards teaching students the skills that help them become independent learners.

What best defines the change in pedagogy as a consequence of ICT is that the teaching and learning environment is becoming dependant upon technology rather than having technology as an adjunct to the teaching and learning process. The change has been one where the teacher could use technology is he/she wished to one where the teacher is unable to escape the use of technology – and this is being partly driven by the experience of the learner.

## *Epistemology*

Epistemology, as the theory of how we come to know things, is a less clearly definable component in the changing educational environment. This is not to suggest that epistemology is unimportant in any analysis of the changing structure of learning systems. The problem is that the issues around epistemology are very difficult to explore without delving into the core philosophical concepts underlying it.

An under-researched area of education is the relationship between changing media, changing learning environments and epistemology. Voithofer (2002), from a theoretical perspective, made a series of important points when talking about nomadic epistemology, particularly the idea that the learner who is able to study in a distributed mode is displaced from face-to-face learning environment and is not, in the conventional sense, a part of the geographic physical institution. He sees the knowledge acquisition under these conditions has being influenced by multiple knowledge sources being available at a click. If Voithofer's conceptualisation translates into learning action, then there are important epistemological issues to be researched – how effective is a nomadic epistemology in education?

We may also move from general epistemological issues to the shift that has occurred in the way the electronic media are changing the requirements for learners. Even by 1997 people were beginning to question the veracity of the Internet. Ulfelder (1997) was one of the first writers to point to the problems of misinformation and disinformation on the Web. Since then this has become a topic of core interest. Borsook(2000) records some of the influences that she believes created the relatively libertarian philosophy that has influenced the openness of the Web while Mintz (2002) has brought together examples that illustrate the difficulties with the Web. Anecdotal evidence coupled with research into student work practices (Sheard, Markham & Dick, 2003) shows that university student have some trouble defining the way in which the web should be ethically used. The epistemological structure surrounding the Web has

transformed the way in which students approach learning, and that is probably the most obvious qualitative shift within education.

A search through the articles and papers associated with the issues being addressed here, shows that epistemology *qua* epistemology is rarely talked by authors who are researching teaching and learning. At times there are some interesting new meanings added to epistemology such as the epistemic keys of Banerjee (2001) but rarely is there coherent discussion of epistemology and changing learning environments.

Associated with the formal questions about how students come to learn is that of the motivation to learn. I would suggest that there is a change in the factors that might motivate learners, particularly those factors associated with self-driven or intrinsic motivation. That is, the student no longer has to establish a structure where he/she works on the tasks. Information can be trawled at will. The development of a sense of involvement is, possibly, minimised and outcomes may be tied to the localised, short-term world of the web search. This may seem to contradict the argument that pedagogy is moving towards primarily supporting the independent learner. What appears to be the case is that it is the need to generate appropriate pedagogies that help students develop the skills of an independent learner that is critical. The passive-dependent interaction with the Web has to be transformed into a new type of involvement, encouraging significant intrinsic rewards.

Within the context of paradigm shifts, we are being forced into a position in education where we cannot simply assume some general epistemological position as the foundation for pedagogical models. The generalised epistemologies do not clearly reflect what is now happening in education. Bruner's theories are likely to be good representations of the way in which children learn and even Vygostky is probably representative of some aspects of children's learning. The work that is potentially more important in developing a clearer understanding of learner behaviour is that on the beliefs learners have about how they acquire knowledge (eg Sommer, 1998; Cano, 2005). The origins of this work lies in the idea of metacognition as one of the meta or superordinate processes in human cognitive activity (eg. Flavell, 1992). This became a common theme within the epistemologically related work of developmental psychology where theorists such as Bruner became interested in the question of reflective learning. How we come to know and learn moved from passive exposure to active participation in the process of acquiring knowledge.

## *Administration & Management*

Over and above the teaching-learning component, educational administration has experienced substantial changes. Educational institutions are utilising ICT-based administrative tools that allow the student to have direct access to the administrative structure ranging from enrolment (including paying fees) to assessment results and transcripts. No longer does the administration system function *deus ex machina,* rather it is a real-time component in the student's and the teacher's educational life.

This particular change has occurred gradually and varies in its level of implementation. There appears to be no research into its influence upon the teaching practices and upon the relationship between teaching and administrative staff although Segrave and Holt (2003) include it in their discussion of effective design of e-learning environments. Even though the shift has been gradual, its meaning in terms of the work requirements of academic staff is quite clear, in particular its effect upon the teacher becoming a quasi-administrator. The teachers then takes on a role that moves beyond the normal pedagogical structures. Now the teacher must deal with problems such as the content of institutions filing systems, a process that has been legendary in education institutions.

Where the student is able to control his/her entry into, and the progression through, the institution there is a distinct change in the student's relationship with institution. When a student was required to utilise admissions staff for the enrolment process the student was in a particular power relationship. Once the student is the position to enrol online he/she is taking responsibility for the process that has no particular power relationship to "admissions". Similarly, a student access his/her transcript without making formal requests also means that the student is being forced to take responsibility for his/her educational progression. All these things constitute a clear qualitative change in the role the student has in the educational.

The formal management of the educational environment is also changing as a consequence of the forces that are influencing the teaching and learning environment. Management has, for example, had to respond to the speed with which ICT has influenced overall organisational functioning. The Open University in the UK produced a limited electronic delivery at its inception

in 1970, but it had been seen as a 'University of the Air' in its gestation. Some 30 years later other educational systems and individual universities were fighting to find an identity in the virtual learning world (Markham, 2004), partly because university management has had difficulty in redefining its organisation within the changing structures. It might be argues that the formalist structure of the university, at least as seen in Australia, militates against effective response to change. The extremely hierachical system starting with a Council and then having a vice-chancellory level followed by Faculties and departments with Deans and Heads is not conducive to handling change.

## *Other factors*

Writers on changes in distance learning tend to accept that a fundamental shift has occurred. Harper, Chen and Yen (2005) give a useful summary of the history of distance education and the importance of the current changes. But what is being argued here is that the shift is functional across all educational modes, not just distance education.

Another indicator of the qualitative shift is the development of counselling and related services using the Internet (eg. Mallen, Day, Susan & Green, 2003). This will effect the way education is functioning because it allows for student support services to parallel those that exist on the physical campus. The significance of this shift lies in the basic definitions that existed for effective counselling where body language and total listening were seen to need face-to-face interaction. Even the use of telephone counselling was seen as an inadequate approach except in crisis interactions. To accept that counselling can be carried out over the internet requires the creation of a new model of counselling that is qualitatively different from the old. Hence the work by Mallen et.al. (2003) and others on ways to develop counselling communication processes over electronic media are having a profound effect on how we define the teaching-learning environment.

## *The Technologies of Education*

The previous sections have focused upon structural changes in the teaching and learning environment but there is a more basic level at which change has taken place – the technologies that are a part of the teaching and learning process.

Table 1 is structured around the idea that we can talk about the classroom technologies, the learner technologies and the support technologies. Other divisions would be possible but this one provides sufficient information to illustrate the point. The lines of the table represent an approximate chronological sequence of the entries although establishing when a given technology seriously entered the classroom at different levels in different cultural contexts is impossible to determine objectively.

*Table 1 Technological change over time*

| **Classroom Technology** | **Learner technology** | **Support technology** |
|---|---|---|
| Black Board and chalk | Pen and Ink | |
| | | *Spirit duplicator* |
| ***Radio*** & Film | Fountain & Ball point pen | |
| OHP | | |
| Television | | *Photocopier* |
| Whiteboard and Marker pen | | *Apple & PC* |
| | Portable Computer | |
| *Data Display* | | Scanner |
| | *Notebook Computer* | |
| Electronic Whiteboard | PDA | Digital Camera |
| *Synchronous Video* | Tablet Computer | Mobile Phone |

| | | |
|---|---|---|
| | *Computer Network* | |
| | | |

The division in the table at the double line represents a significant transition during the mid 1980's where the computer began to have a clear effect. This was driven by the Apple II and then the IBM PC. The second division given by the triple line is when the electronic revolution began at about the turn of this century. Each of the italicised technologies represents a significant influence upon educational practice in its own right.

'Radio' has been differentiated from the rest because it generated the first clear conceptual shift in education when it was used as an educational delivery medium. Some stations in the USA delivered educational materials as early as the 1930's but it was in 1951 that the Australia *School of the Air* was started[2]. This was revolutionary in that the teacher was in a studio in Alice Springs and the students were on cattle stations and outposts across outback Australia. In the early days, the remote students communicated using a pedal wireless unit. That is, a wireless unit that had an electrical generator driven by a pedal mechanism. The wireless communication created a one-to-many-to-one synchronous communication system as a student could respond to the teacher and the other students would be listening in.

It should be noted that Table 1 stops at about 2008 without introducing likely influences over the next couple of years. What is to come might be seen as even more radical than what has happened to date – ubiquitous computing, fast local wireless technology and the like, but the definitional problems associated with what has happened up to now creates a large enough task without introducing prognostication.

### *An Observation*

> In an article in Computerworld on March 2008, Brian Nadel (2008) looked at what the concept designers are doing with the laptop computer. One example he quotes is a design called Siafu based upon using Magneclay which is a material that changes shape in response to patterns of electrical stimulation. This design could radically alter our thinking about the educational environment for the visually impaired and it could change the way we look at the need for illumination in difficult environments.
>
> The overall impact on educational delivery of possible changes in the computing tools is extremely complex. For example, if every laptop included a laser-based projector, the seminar would take on a new meaning. If every laptop had a parallel processing capacity, the complexity and quality of material would change radically.
>
> The ICT+Education future is complex but unclear.

Table 1 can be overlaid with a further set of factors. If we look at the communication process in the teaching and learning environment, it can be said that the base type of communication in education is face-to-face:one-to-many-to-one - the teacher in the classroom, however defined, with a group of students. It was not until the synchronous video and the computer network were effectively applied in education that the type of communication became as complex as that of the School of the Air and then took on further complexity. We now have something like face-to-face+virtual:one-to-many-to-one-to-one. It was not until the turn of the 21st century that the communication system was able to begin to achieve this.

This combination of the changing technology and the changing communication processes indicates that we are dealing with a complex socio-technical system (Emery & Trist, 1969). As will be noted later, this forms the crux of the model I will develop later.

# A shift or not a shift

In 1998, Carter was talking about the issues involved in taking the laptop out into the field and the conflicts this created for nature and technology and at the same time raising the question of the pedagogical implications of computers in education. In the few years since that paper was written, the educational issues around computing have expanded – although this is not to say

[2] The current activities and the history of this unique school can be found at: ttp://www.assoa.nt.edu.au/

that what Carter was concerned about has been resolved. The change over a relatively short time is very large and such levels of change appear to be continuing.

The observations presented in the preceding sections indicate that something is occurring in education, it does not tell us definitively that there has been a paradigm shift. If it was not for the evidence of the way in which technological change and educational communication process have changed, we could simply say that there is change and that a change is influential and that would partly meet with the requirement of Occam's Razor. That is, the simplest explanation for the phenomenon we have observed. Applying Occam's Razor to each area of change one at a time assumes that the changes are not interdependent. Unfortunately, such a simple explanation belies the depth and breadth of the change that is happening in education. We have tried to suggest that many of the changes constitute clear qualitative shifts within the educational system and that they might also be defined as catastrophe shifts.

The key places where there has been a qualitative change in the way education is happening include:

- The availability of information and the opening up of information sources. More generally, information is far less likely to be in the hands of gatekeepers.
- Students taking responsibility for their education through on-line administrative processes constitutes a shift in the way the administration of an educational system functions. The changes that have staff directly interacting with the administration systems is also significant although it may not be quite a dramatic
- There is confusion about the relationship between the medium and the message. The increasing role of ICT in education creates the problem that the electronic media appear to be part of the content of the message that is being transmitted. Because something is on the computer it becomes a new form of content.
- The development of complex software tools that create virtual educational environments such as TILE (Hong et al, 2000; Kinshuk, et al, 2002) and PIAVEE (Krishnaswamy et al, 2004). This has required new thinking on educational practice and the relationships between of ICT educational systems, potential users and the management of the educational system.
- Building various intelligent systems to support educational activities such as the conceptual awareness tools of Morch, Jondhal and Dolonen (2005) that move into user support. The possibility of various forms of interactive support tools is opening up the question of what constitutes pedagogical agent systems.
- The development of on-line student counselling systems. This shows a fundamental change in support for students that emphasises the relationship between the changes in delivery and the changes in individual support
- Asynchronous interaction via ICT tools is changing thinking in various areas of education including the Computer Supported Cooperative Learning movement and those working in student support areas. It is in the latter that major reviews are taking place on how to train on-line counsellors and how to monitor the effectiveness of these activities.
- The proliferation of on-line journals is a clear shift in the scholarly process if not directly in pedagogy and epistemology. An impact of this on educational practice is that ideas and research findings can be quickly distributed to a wide audience. *As change happens, change is reported.*

Each of these changes, taken alone, could be seen as simply linear changes in the way education is practiced but taken together they indicate a complex set of interacting effects that are by no means linear. They have engendered debate and have, if nothing else, created a range of sources for reporting that debate, particularly online journals. The development of online journals is, perhaps, one of the clearest indications of a paradigm shift through the current influence of ICT systems on education.

## *A Caveat*

All of the above discussion must be seen as being a part of a continuing process that is influencing specifiable parts of education systems rather than as being change that has permeated either the national education systems or the global system. Even in the hard sciences, from where Kuhn developed his concept of paradigm shift, change is never universal because theory is theory. Within education, the change we are pointing to is a complex interaction between technology, educational thinking and educational practice. In essence, it is a conceptually noisy place.

A part of this caveat is also that we should not assume that it is only happening in the western developed world. Countries like India are utilising wireless technology at the village level to reduce the need for technology infrastructure, so that local wireless networks can provide low-cost connections to the internet and to the distributed learning systems. The organisational intranet becomes the village communication system. It is well understood that a very small percentage of the world's population has personal access to a telephone, but to focus upon personal rather than communal access is a good example of Western thinking colouring the way we look at this paradigm shift. This is well developed in a note by Mitra (2003) where she reports on work looking at how children learn to use *the village computer* under different models of availability.

A further, critical component of this caveat is to re-emphasise that we must not confuse technology with education. The attempt to distinguish between e-learning, m-learning and any other trend, lacks any educational base. Introducing technologies because they look good, attract attention or earn money for consultants is not good educational practice. For example, the Australian Government's *education.au* released a paper on mlearning (Watson & White, 2006) that lacks any coherent educational justification for using mobile devices as some special or separate entity in educational practice.

# The need for a new model

The nature of the shift that I have described above is such that it presents a fundamentally changed educational environment. We are no longer talking about a well structured organisation where there were the teachers, the students and the administrators – not to mention the community. We are now talking about a multi-skilled organisation that no longer exists in splendid isolation. We are now talking about education that has become learner focussed not just in the educational sense but also in the procedural sense. The learner can take part in the management of his/her educational destiny; can access informational sources that complement (and confuse) the given materials; can exchange information about his/her experience in a boundary-free real-time world.

The learner is being offered the opportunity to be a self-managed, independent learner without the rest of the education system having any control over the process.

The obvious point that can be made here is that Constructivism and its variants deal with the learner as learner. They emphasise the fact that the learner's knowledge is contextually defined to the point in distributed cognition that the context is the knowledge. The difficulty is that they have been developed from within the framework that education is moving away from. There is minimal restructuring of the teaching and learning models that deal with the changing environment. This is compounded by the fact that they are not fully defined pedagogical theories, rather they are limited models of teaching practice. Teaching has always including the organisational context of the classroom but it is difficult to find discussion of the interaction between the elements.

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This is further compounded by the fact that the development of Constructivism was a response to the changing post-war social world but was hardly a major theoretical shift in our view of education. Constructivism, basically, took some interesting ideas in educational psychology and generalised into a broader model of learner behaviour. When we look at the criticisms that have been made of constructivism (Fox, 2004) we find that there are substantial problems in its generalisability and its capacity to deal with the real-world (Simpson, 2002).

The organisational models most likely to be used are those that assume a simple hierarchy. At best they include a participative element but this may be subverted by the reality of conventional educational management thinking.

That conventional model of the educational environment also had a fairly well defined structure for the relationship between teaching methods, educational technology and instructional design. Most current writers who publish on teaching and instructional design (eg. Johnassen, 2004) have not developed structural systems that show how teaching methods, educational technology and instructional design interact within the broader framework of pedagogy qua 'the science and art of teaching'. I would suggest that the domain is changing and the means and the method may be melding into a particular sort of method; melding into a new model for the science and art of teaching.

At this point I would suggest that a pedagogy is best defined as a 'model' of the teaching/learning environment that allows the participants in the environment to interact and achieve outcomes. To define *pedagogy* as one of the possible sub-models associated with the way people can develop a learning environment, is a distinct category problem in that a part is being confused with the whole. One process within a complex set of process is being defined as that whole set of processes. This applies whether we try to talk about instructivism, constructivism or critical theory as pedagogy. They are each versions of how information can be organised for delivery, none of them having a priori precedence over the others.

An epistemology is a description of, or theory about, how people come to know things. Within education we tend to talk in terms of 'learn' rather than 'know', raising philosophical questions that are outside the scope of this paper. The process of absorbing/acquiring/internalising information is the subject of learning theory in its various forms and it is learning theory that has strongly influenced current pedagogical thinking. Against this, epistemology is concerned with the more abstract aspects of the processes defined by learning theory, exploring, for example, the issues associated with perception in coming to know something. An epistemology is not about how material might be organised for learner utilization and to take an epistemological theory and call it a pedagogy is to confuse process and outcomes. That is, the science and art of teaching is about delivery while those to whom material is delivered may take up and utilize that material in a number of different ways. The process of the delivery will assume *forms* of utilisation but cannot be dependent upon a single form of utilization.

# A SocioCybernetic Model

Much of educational thinking is mired in the conceptual and physical environment that is pre-cyber. The reality of the cyber world is that activities become seriously interwoven with each other; that there are few independent entities living is splendid isolation from each other. There are various ways of viewing a system that is based upon interdependent components but systems thinking (eg. Emery, 1969), in its various forms, is premised upon such an approach. The strength of systems thinking is that it starts from the assumption that things are interdependent.

A systems orientation in education starts from the complexity of the educational environment and attempts to build the well structured model of this complexity and this has been recognised for a number of years (eg Betts, 1992; Miller, 1998). To begin this process all possible components have to be taken seriously. We are not simply talking about the teacher and his/her delivery but also talking about the learner, the administrator and parents, and all this takes place within the formal and informal systems within which educational system is embedded.

One of the keys to understanding the power of systems orientation in education is the idea that any system is embedded in other systems; that systems do not operate in isolation and interfaces between system components have to be understood. Current pedagogical thinking, from constructivism to critical theory, we would say that there is nothing new in this, in that they have been talking about the social context of learning. The difference between what will be developed below as the systems orientation and what has been developed in current pedagogy is that the systems orientation is explicit on both the definition of the various elements, or components, and the ways in which these elements interact.

A variation on open systems theory developed by Emery and Trist () is the sociotechnical system. The core of this is the fact that at least one component of the system is a social subsystem and that social subsystem interacts with a technical subsystem. The task is to define the transactions between the subsystems and to facilitate such transactions. Miller (1998) has discussed the application of this approach to staff development programs in education while the seminal educational work was Rice's overall model for any tertiary education institution (Rice, 1952).

Of direct interest to this paper is the work of Cartelli (2007) who has looked at the implications of sociotechnical systems theory for the development of Management Information Systems (MIS) curriculum. Cartelli provides a context but fails to take the sociotechnical concept seriously as he fails to recognise the total organisational environment in which sociotechnical systems are defined. His definition of a pedagogy focuses upon the teacher and student with added reference to information systems without looking at the overall educational environment. The point I will be making in what follows is that a new model of learning environments has to take account of the real-world complexity of education.

The original applications of sociotechnical systems theory was in the analysis of work environments. For example, the management structure developed at the Volvo car plant in Sweden was based on the definition of the functioning of workers and management in relationship to the production line. Work units were created where a car was produced by a given unit creating a situation where the work unit owned and took responsibility for the quality of each car it produced. The social system of the work group had, then, a set of important transactions with the technical system, the production line, designed to maximise worker satisfaction and plant productivity. In another application, mining practices in the UK were revolutionised again focusing on the importance of the work group in take responsibility for work practices.

The applicability of sociotechnical approach to education comes, in part, from the paradigm shift we have been explicating. There has always been a complex interaction between technology and the teaching environment. For example, the blackboard created its own complexities given the need for the teacher to turn his or her back on the students: this then meant that teachers needed to be trained to handle this relatively trivial social-technical interaction. The probable current electronic parallel to this is the capacity of students to “talk to each other” via their computers and to send messages embedded in graphics. The teacher now has to learn a new set of classroom management skills based upon these technological factors.

Looked at more broadly, the learning environment of the early 2000’s can be unequivocally defined as a sociotechnical system, following Badham, Clegg & Wall (2000):

- An educational institution has interdependent parts that are adapting to external environments and which are pursuing goals associated with that external environment.
- The learning environment has always had interacting social and technical components that are interdependent but which is becoming more obvious.
- The educational organisation can achieve it goals by different means. It is not constrained to a single ‘production’ process and, critically, the learning environment is now very much concerned with jointly optimising the social and technical subsystems in order to achieve its goals.

They have additional more complex, industry-based, criteria these are less easily applied to educational institutions.

In order to distinguish the discussion here from the more general area, the model being developed has been called a SocioCybernetic model. Cybernetics is defined as the process of communication and control but it has already been hijacked and taken on the more general meaning of pertaining to ICT systems. We justify the use of it here by the fact that ICT systems are no longer about computers but have become integral to the communication processes and that they function as intelligent control systems. The 'Socio' component is simply to emphasise that the ICT component must be always seen in terms of the social system in which it is operating.

I will also call this a SocioCybernetic Learning System rather than and Educational System. The latter has the connotation of delivery, of educating someone. It is a part of the changes in the educational environment that learning is becoming the focus both as the self-managed learner and as a life-long learner.

It is not possible within the scope of this paper to look at the application of systems theory to the complete educational environment, although we will provide a broad statement in the following section. Rice (1957) wrote a comprehensive systems structure for Higher Education but its impact has been limited because the difficulties in dealing with the complexity of the task has lead to it being placed in the 'too hard basket' by educationists.

# Building the SocioCybernetic Learning System

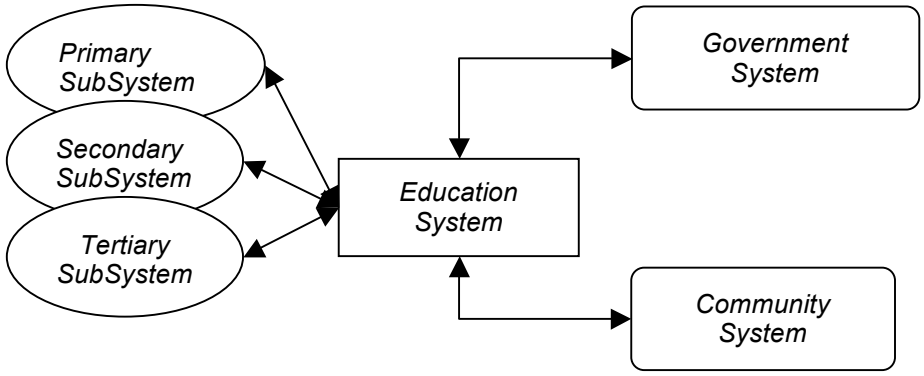
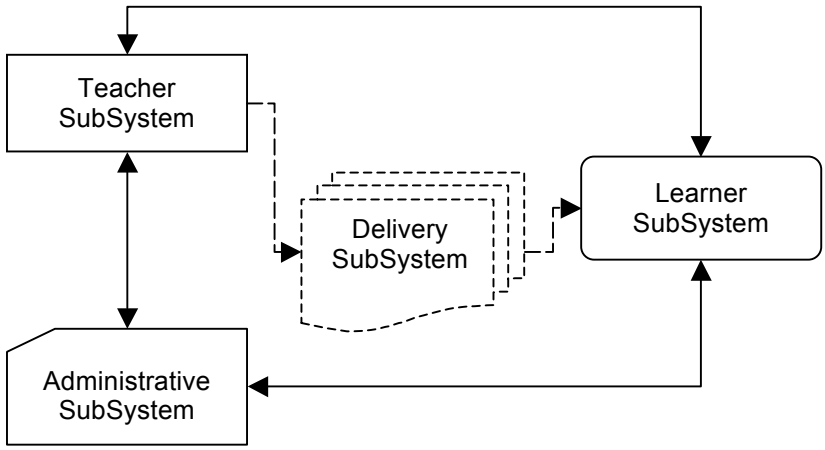



*Figure 1 Generalised model of the educational system*

The first component in understanding the SocioCybernetic Learning System is the generalised model of the educational system. Figure 1 shows that the educational system is a component in set of systems that include the general social system and the government system. This is a trivial statement but it provides the general background. Within any particular country this will be expressed in different ways but the interacting systems are those that determine the socio-cultural milieu within which education operates.

It is important to note that the educational system has many different transactions with other systems and that these will range from the formal necessities of government through to the normal local interactions.

*Table 2 Traditional Learning Environment*



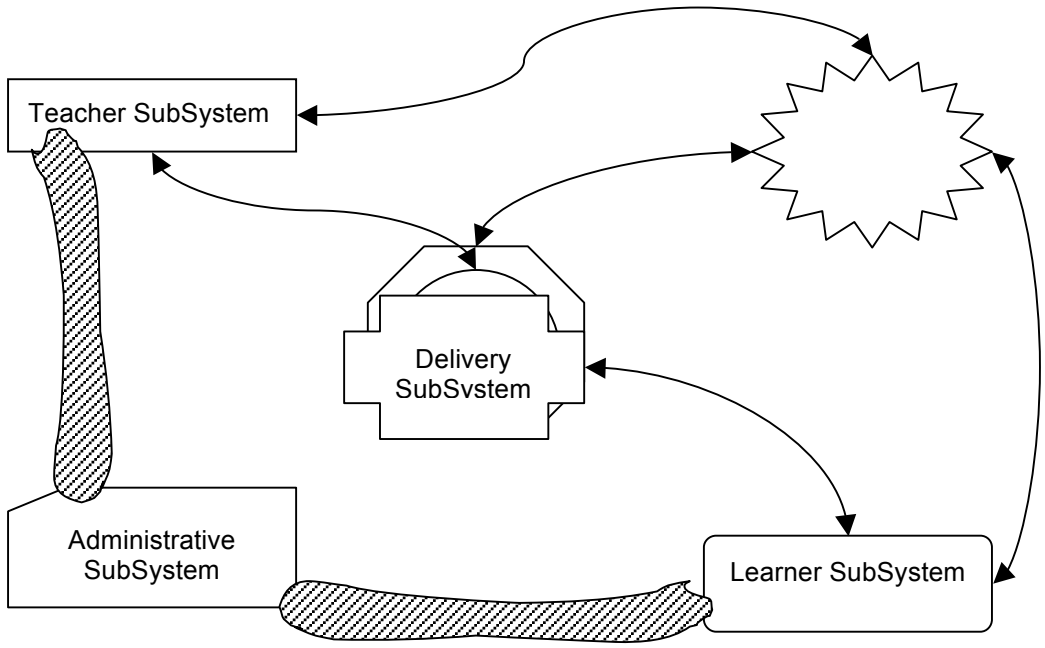

Our primary concern is to look at the teaching and learning environment, or the basic educational environment. The traditional structure is shown in Figure 2 where it has the three obvious component subsystems: Teaching, Administrative and Learner. A Delivery SubSystem has been included as a background element. Within the traditional educational system, delivery has not been a major issue as the options were essentially face-to-face or distance education. If we move into the type of structure that the changing educational environment has, then we need Figure 3.

The SocioCybernetic model has a different approach to the links and transactions between the subsystems than that used in the traditional model. The sun-burst in the top right hand corner represents the range of possible interactions between the teacher and the learner including direct communication and computer mediated communication. The use of this connector

emphasises the growing complexity of the transactions between the teacher and the learner. The days when the primary contact between student and teacher was to find the teacher in her office (and maybe the telephone) has passed and contact may have to be through email, on-line discussion and voice-over telecommunications. We can assume neither simple nor one-to-one/face-to-face modes. The addition of the Delivery Subsystem indicates that delivery no longer has some general functions that need not be defined, rather it is integral to our thinking about the system. It is shown as a multiform connection to emphasise the multiple delivery modes that may apply in any given learning environment. It should also be noted that the relationship between the Delivery SubSystem and the other components is defined as two-way. That is, a given mode of delivery might by formally or informally providing responses or feedback as a part of its structure.

The final general point on Figure 3 is that it shows fluid transactions between the Administration SubSystem and the other two. These fluid transactions are not simple transaction points but reflect a structural continuity; a set of transaction subsystems that allow real-time, two-way information transfer.

*Table 3 SocioCybernetic Learning System*




The connection between the Administrative SubSystem and, say, the Learner SubSystem represents the transactional process that happens there. An empirical analysis of that transactional process would lead us to investigate the physical and electronic transactions that define any given interaction where, for instance, the learner was attempting to find information on his/her current marks in a Subject. A sociotechnical approach assumes that we must understand the transactional processes if we are to have a well-functioning system.

What is particularly important in the sociotechnical approach is that it requires the continual monitoring of the interactions between the social and technical components of the system rather than the limited monitoring that is assumed in other models.

For the sake of simplicity, the Figure 3 does not include the important transactions with the social system that is a part of the educational system and the wider social system with which the educational subsystem has significant transactions as is indicated in Figure 1. A fully developed schematic would show, for example, the fact that the Learner SubSystem has transactions with its Social Subsystem that includes family, recreation and neighbourhood. The learner's transactions within his/her neighbourhood can readily include materials from the school environment. In the traditional environment, if the learner meets up with a friend and talks about the interesting things covered in the last lecture on Programming 201 then he/she would have had to bring along the notes associated with the topic. Within the SocioCybernetic

world, the learner can use the friend's computer, or may even have an appropriate mobile phone, to access the actual learning materials used by the lecturer for his/her friend to see and copy. More than this, the friend will also be able to see the communication generated in the virtual seminar room. In effect, a learner can distribute materials in a way that has not been possible in a conventional environment. This changes the way the transactions occur between the teaching-learning subsystems.

The Delivery Subsystem is particularly susceptible to influences from interaction with the wider social system through, for example, parental perceptions of what type of technology should, and should not, be used in teaching their children becomes more informed because the parent can 'get inside' the teaching environment.

As was said in introducing the open systems thinking, developing this type of model allows us to define complex interacting structures that take into account the processes in the system and transactions between systems. Of particular interest is how the concept of 'pedagogy' fits into the SocioCybernetic model. The model itself is not about pedagogy but is about the learning environment in general but If we take Figure 3 and think about it in terms of the applied subsystem that constitutes the SocioCybernetic classroom then we can see that it can become the bases for a generalised science of teaching model or generalised pedagogy. That is, it gives us the basis for developing ways of viewing what the teaching activity is about because it defines the obvious transactions between the systems that operate in the classroom. But more than this, it also gives the means for defining particular modes of pedagogical practice. We have then a hierachical structure from the generalised system down to particular operations.

# The SocioCybernetic Pedagogy

The SocioCybernetic Learning System is not tied to any particular pedagogy but it does imply a superordinate pedagogy. That is, it implies an overaching, abstract pedagogy that is an application of the components of the learning system model. This is premised on the fact that the teacher operates in a complicated setting where the science and art of teaching includes the technical, social and organisational structures that make up the educational system. That is, this pedagogy takes seriously the total environment in which the teacher operates. It is a superordinate pedagogy in the sense that it provides a basis from which other specific teaching models can be implemented. This derives from it being about the teaching process and not about learning theory. Most current pedagogies have their origin in learning theories and are coloured by a definition of the learner. This, then, extends into the socio-cultural domain so that some pedagogical positions are not appropriate when an attempt is made to apply them to other cultures. In fact, some of the criticism of Constructivism and its variants is that does not provide an appropriate model even for some areas of education within its culture of origin (eg. Simpson, 2002).

Over and above this, the SocioCybernetic pedagogy takes seriously the fact that the teaching and learning environment is becoming embedded in Cyber-based technologies. The paradigm shift tells us that we cannot continue to look at ICT as an adjunct or tool, rather it tells us that we must see its integrating role in the educative process. To do this we must be able to explicate the way in which components of the teaching and learning environment transfer information and then transform that information into its own knowledge system.

The importance of the SocioCybernetic position can be seen by looking at the way that it handles key elements of the teaching-learning environment.

*The role of the teacher as teacher*

The first component of the SocioCybernetic pedagogy is *the role of the teacher as teacher*. What we have to accept is that this role is multi-faceted; that the teacher can teach in a classroom, in a virtual classroom, in an asynchronous structure, as a non-contact teacher and in many combinations of these. The teacher will produce teaching materials that can be used in a variety of modes, using various technologies at various levels of complexity. Within this, the role of the instructional designer may or may not change but clearly the teacher must be trained in multi-mode pedagogical skills because he/she has to be in charge of content and structure if coherent delivery is to take place.

*The interface between the teacher and delivery*

The second component of this pedagogy is *the interface between the teacher and delivery systems*. Critical to the art of teaching has always been the way the teacher uses the primary interface with the learner. A good classroom teacher has been partly defined in terms of blackboard/whiteboard skills and more recently, electronic presentation skills. As the role of the

teacher changes then the teacher must develop the ability to deal with a number of different interfaces with the learner and to manage the transactions associated with each.

*The changing modes of communication*

Associated with the above points is *the changing modes of communication*. The shift from face-to-face communication to include machine mediated communication, including asynchronous methods, means a different set of skills are brought into the science and art of teaching. Within the pedagogy there has to be the definition of skills and abilities that reflect this change. A pedagogy has to have the power to define the transactions that are involved.

*The electronic administrative role*

Next, the SocioCybernetic pedagogy has to take into account *the electronic administrative role that is becoming a part of the general teaching role*. When administration was controlled in "the office", the teacher was distanced from many issues but as the teacher takes on more administrative tasks, he/she has to be more aware of the structure in which his/her organisation works. It might be said that many teachers have been relatively naïve about the way their organisation works, not taking an interest in the basics of enrolment, formal recording and associated activities. The on-line administrative systems are changing this.

As was noted in the general definition of the system, the societal structure surrounding the educational institution is an integral part of the educational system at all levels. A consequence of ICT interfaces is that the teacher is less able to insulate him/herself from the societal pressures. An email message from a parent or employer is less easy to disregard than is a telephone message. We need to look at the impact of this on teaching practice.

This extends into the cross-cultural arena because the SocioCybernetic pedagogy is not contained within a cultural premise. Systems thinking has been used across a number of cultures – India, Jugoslavia, Sweden and Brazil to name a few. In developing a systems orientation there is no fundamental conflict with existing views on the nature of education.

# The ICT Educator

A consequence of the role of Information and Communication Technologies in driving the paradigm shift in education is that computer science, software engineering and information system need to look at their involvement in producing the professional who can drive innovation and change in educational delivery and support systems. At the same time, education has to be aware that it can no longer rely on a generic instructional design function and *ad hoc* teacher ICT skills. The needs for education are based upon an ill-defined mix of skills that cover both Education and ICT because the future of the education/computing mix requires the complex set of skills that can develop for the future rather than simply working in the current technology. This need is emphasised from the review of the Australian technical education sector (Hill et al, 2003) where it was clear that most of the software being used was just current thinking and was certainly not tapping into leading-edge developments in IT. Similarly, an unpublished review carried out on repositories for re-usable learning objects showed that SCORM etc standards industry was not keeping up with software developments such as the use of agents for real-time management tasks.

Computers in education need staff with a strong pedagogical and educational psychological base that is then supported by strong ICT training. Such training would not necessarily make the person an ICT professional but would produce someone who is able to work with ICT and who is able to comprehend the computing future.

Those who do educational computing can no longer be simply ICT professionals: they will need some understanding of educational needs and educational systems. As educational delivery systems adopt technology, the technologists cannot leave it up to the educationalist to sort things out. If the old consulting model continues to be used there will be the problem of system design over-shooting the educational structure.

**Case Study**

> In a recent project, the TELDA system (Schuhmacher & Markham, 2004), a software application was being developed as a data base application from a prior spreadsheet version. The programmer implemented the data base as it was progressively defined by the educationists but the educational component in the design became progressively more difficult. Near the point of producing a pilot version, it was realised that there had been a miscommunication between the educationalists and the programmer and this meant that a basic procedure could no longer be implemented.

This was not the programmer's fault but if he had have had the level of educational training being suggested here, he may have better understood what was being said. From the other direction, if the programmer's immediate supervisor had understood data bases, he might have seen the issue arising.

An added observation on the programmer's behaviour was that he was looking at the surface of the software implementation process and not looking at the underlying rules or processes that drove the educational design of the software. This would, again, have changed if he had have been a SocioCyber Learning specialist.

A SocioCybernetic Learning System cannot be sustained without appropriately trained professionals. Computing education needs to include more education while educational computing needs for ICT.

# Conclusion and Directions

Rushby (2005), with his focus upon educational technology, saw the future for better paradigms in on-line learning systems based upon activities such as the development of more responsiveness metadata systems (eg Mwanza & Engeström, 2005) and more sophisticated portals within a constructivist framework (eg Muthukumar & Hedberg, 2005). Unfortunately, this simply accepts the status quo in the definition of teaching and learning systems in that none of this work challenges the fundamental ways that I see education being influenced by the change role of ICT systems in education.

Electronic, distributed teaching and learning systems may not be universally accessible given their reliance upon distribution systems such as telephones. This is clearly an influence on what happens in distributed education in the short-term but this area needs to think in the longer term in light of change in technologies and software engineering. I noted what had happened in the Australian TAFE system where online learning was dependent upon old technology (Hill et al, 2003). Without the appropriately trained professionals the electronic, distributed teaching and learning systems cannot meet the challenge that this changing environment is setting.

The new professional in the SocioCybernetic learning world must have a mix of skills and knowledge that reflects the interface between technology, teaching, learning the global cultural systems. That professional cannot be locked into simplistic models of teaching and learning that derived from narrow cultural perspectives.

The research that is needed in electronic, distributed teaching and learning environments must challenge the fundamentals, such as the limited models of the learning world provided by Constructivism and its associates.

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