

Enhancing Learning with Information & Communication Technology

Promises, pitfalls & practicalities

Dr Julia Atkin
Education & Learning Consultant
The Learning Collective
"Bumgum"
Harden-Murrumburrah 2587
61 2 63863342 Ph
61 2 63863317 Fax
bumgum@ava.com.au

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Promises, pitfalls and practicalities

Julia Atkin

How can we ensure that information technology lives up to its promises? The history of educational practice is littered with discarded 'fads'. To avoid yet another wild, de-energising swing, we need:

- *clarity about the nature of learning we value*
- *clarity about the nature of learning appropriate to the particular context*
- *the capacity to critically judge the worth of particular learning events., and*
- *imagination and open-mindedness about what information and communication technology now makes it possible to achieve.*

This paper is designed to engage you, the reader, in a process of looking at the promises, pitfalls and new practicalities associated with information and communication technology—looking at them through a lens which is framed in terms of principles of effective learning.

Technology and communication

As I sit pondering the threads I wish to weave in this paper I am struck by the paucity of this medium—one composed of text and line graphics—to convey the fullness of what I want to communicate!

Those of you who know me, or who have heard me speak, will no doubt add other dimensions—you may hear my voice, inject my personal tone and even heave a sigh of relief that you have control over the pace with which you process what I am saying.

For those of you who don't know me, my communication with you is totally dependent on my skill in using verbal language to convey meaning in a linear string. My 'knowing' of what I wish to communicate, however, is not linear. It is multi-layered and multi-modal—visual, emotional, anecdotal, factual, propositional, conceptual—and it does not translate easily to a verbal linear thread.

This morning I received my first html email message that contained photographic images and sound. As I listened and looked with amazement, I marvelled at the powers of new information and communication technologies that enable almost instantaneous communication, across the boundaries of time and space, in multi-modal form. My mind reels at what these new technologies make accessible at the click of a few buttons, not to mention some frustrating time delays. I ponder on the new and different demands—new practicalities— that these new information technologies place on educators.

Then I turn my attention to the nature of my ongoing work on understanding what stimulates, supports and enhances learning and I am struck by the fact that many educators are still not skilled users of learning technology let alone information technology. Nor are they well versed in the science of learning. Which brings me to some clarification of terms . . .

Learning technology and information technology

If we think of technology as 'the applied science of . . .', then *information technology* is application of the science of information and information systems and results in the development of tools for managing information. *Learning technology*, on the other hand, is the applied science of learning. It is the application of all that we know about human learning to develop strategies and tools for enhancing and managing learning. Following this line of thought, *education technology* includes learning technology and information technology. Technologies for education will include a focus on the 'soft systems' (mind processes and collaborative processes), the 'hard systems' (computers) and the interactions and interfaces between the different systems—Figure 1, below.

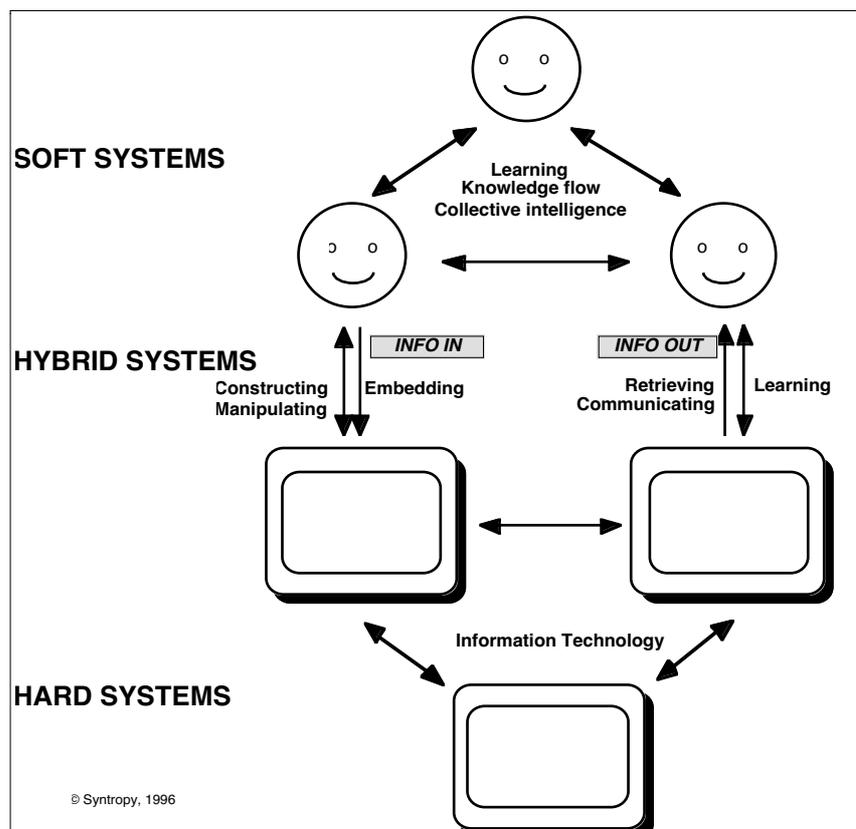


Figure 1 Education technology consists of information technology, learning technology and the interactions and interfaces between elements of the systems¹

¹ Did you look at Figure 1 and expect the meaning to emerge, or did you 'read' Figure 1 to comprehend its meaning? (Perhaps you have not yet even looked at the Figure!) I raise this issue here because associated with the reintegration of multiple languages into our modes of communication there are new literacies. Many of us brought up in a text based, verbal language have not developed these literacy skills and as a result some people arrogantly dismiss these forms of communication as unintelligible to them. To be sure, there is a responsibility on the part of the communicator to ensure that the other language forms are well 'written' but there is also a responsibility on the part of the reader to learn to 'read' the new languages of communication.

The capacity of tools of information technology—computers and electronic storage of data; computer networks and the internet; software programs ranging from word processing to spreadsheets to multi-media—to process, transfer and store information moves the emphasis away from the teacher as being the holder of the information and frees the teacher to act more as a *learning technologist*

In a world rich in information technology, the authority of the teacher no longer lies in being the one who knows. Rather it is in being the one who knows about knowing and learning and in being the one who has deep understanding of aspects of the powerful ideas and processes captured in collective human wisdom.

So what does a learning technologist do?

In a classroom sense, the teacher as learning technologist does what good teachers have always done but with added consciousness. A teacher, as learning technologist. . .

- recognises that effective learning requires active construction of meaning by the learner and is active in designing and negotiating appropriate learning experiences;
- is mindful of the learning styles and needs of each individual learner and promotes and affirms their individual ways of knowing;
- intervenes where necessary to help the learner use strategies and processes which take them beyond their style to enhance and maximise their learning;
- teaches the learners about their own learning.

The teacher as learning technologist is 'the guide by the side' rather than 'the sage on the stage'.

The role of learning technologist is not limited to school situations. The general role of a learning technologist is outlined in Figure 2. A recent project in which I have been involved in Indonesia illustrates the elements of the diagram. My brief was to help develop learning systems and approaches which would help the British, Canadian and Australian engineers ensure that the Indonesian engineers learnt the necessary skills and understandings to enable them to manage the mine. In their language my brief was to help them design systems which maximised 'technology transfer'.

Starting from a base of generic understanding of how we learn and think (RESEARCH), the challenge was then to ANALYSE the learning needs of this context. This involved application of generic learning principles and it involved coming to understand cultural differences— differences between Indonesian cultures and sub-cultures and Western cultures and sub-cultures; differences between the Indonesian education culture and Western education culture.

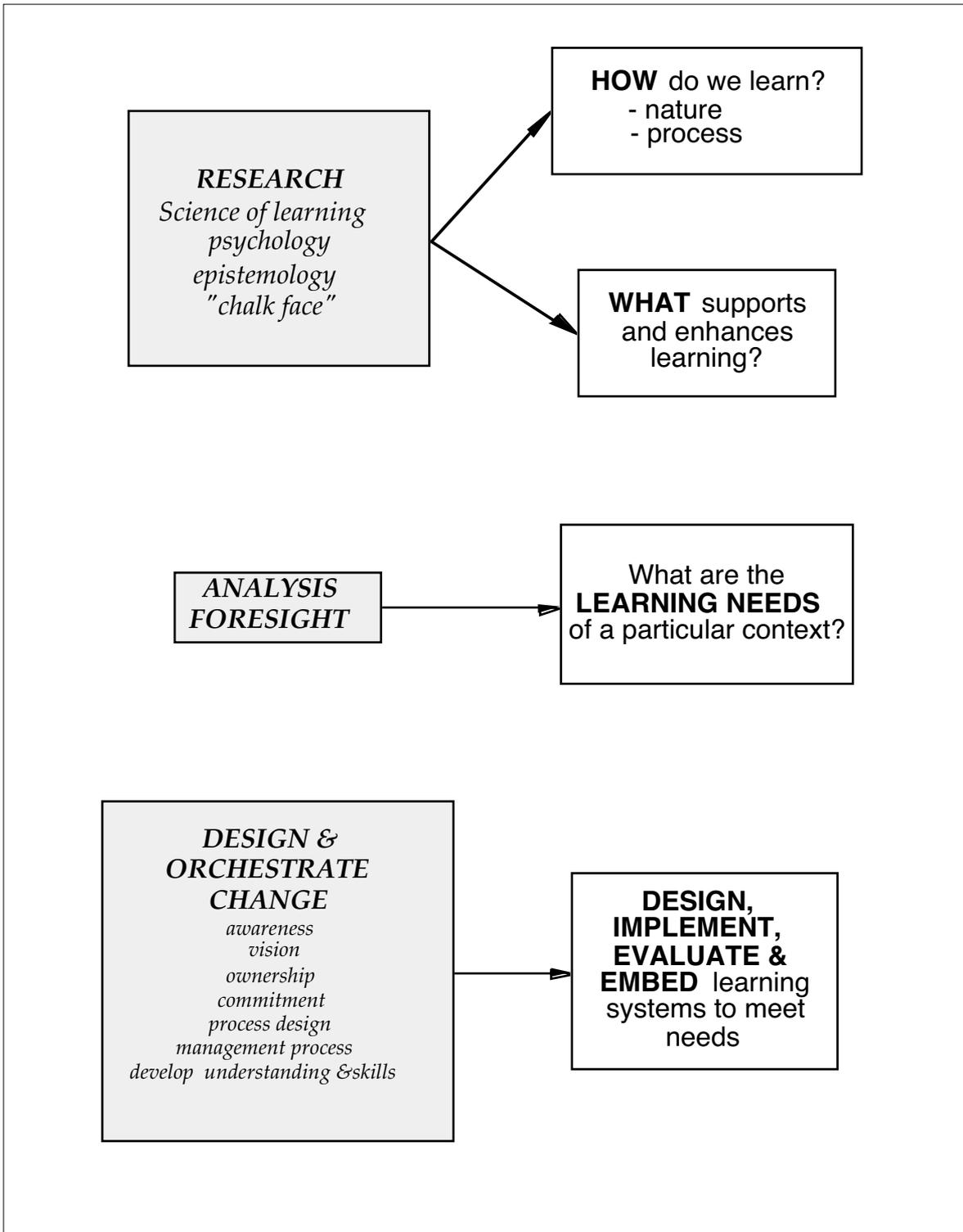


Figure 2 The role of learning technologist

Once processes and approaches were DESIGNED, based on principles of effective learning, it was then necessary to IMPLEMENT, EVALUATE and EMBED the learning systems.

The skills of educators as learning technologists—who will know how to apply, perform, interpret and facilitate in these terms, for varied audiences and in a wide variety of contexts— will be in increasingly in high demand across all sectors in the future, as learning and knowledge become the most valuable assets for individuals and organisations in the emerging knowledge economy.

Just because it's possible, is it really what we want?

<p>Promise 1: <i>Information technology relieves teachers of the burden of being the information source and redefines their role as 'learning technologists'.</i></p>
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Do we really want the teacher to move from being the 'sage on the stage to the guide by the side'?

If we are to avoid empty promises and yet another wild de-energising pendulum swing in educational practice, being able to articulate a thoughtful and clear response to this question is vital. Educators mostly judge the worth of learning events intuitively. *Intuitive responses combined with critical analysis, critical decisions and intentional action, are essential to improved professional practice.*

From the point of view of a learning technologist, how would I answer whether we really want teachers to move from 'sage on the stage to guide by the side'? What do we know about learning which would suggest that changing the role of teacher from information source to learning guide or facilitator would be a step in the right direction?

The nature of learning

Humans can learn in a variety of ways. We can learn like parrots, playing back like a tape recorder what we have heard. Humans can learn like robots - a 'monkey see - monkey do' type of learning carrying out actions without thought, or we can assume attitudes and beliefs without questioning them. Human learning has the capacity to be far richer than this. We can learn in a way which transforms; in a way which endows our experience with meaning; in a way which empowers us to perceive differently, to value and appreciate differently; to adapt and to create. The critical questions in designing education for learning, is *what is the nature of learning we value* and *what is the nature of learning which is appropriate to a particular context?*

I find a model of John Holt's (Holt, 1971,p20) very useful for framing and thinking about the sort of learning I value. He develops a wonderful little two page cameo in a chapter of his book *What am I Doing Monday?* . The Chapter is titled *The Worlds I Live In*. John Holt describes his perception of the worlds

we all live in. He says that each of us has four such worlds. The first world is the world inside our skin. The second world is the world the individual knows about from direct experience. The third world is the world the individual knows about, but has not experienced in any direct way through the senses. The fourth world is the infinite world of possibilities which the individual has not as yet heard of or even envisaged - Figure 3.

World One is the world inside my skin, World Two is what I might call "My World", the world I have been in and know, the worlds of my mental model. This world is made up of places, peoples, experiences, events, what I believe, what I expect. While I live, this worlds is part of me, always with me. When I die it will disappear, cease to exist. There will never be another quite like it. I can try to write or talk about it, or express it or part of it in art or music or in other ways. But other people can get from me only what I can express about my world. I cannot share that world directly with anyone.

Worlds Three is something different. . . . It is the world I know of, or know something about, but do not know, have not seen or experienced. It has in it all the places I have heard about, but not been to; all the people I have heard about , but not known; all the things I know men have done, and that I might do, but have not done. It is the world of the possible. World Four is made up of all those things or possibilities that I have not heard of or even imagined.

John Holt (Holt: 1971:20)

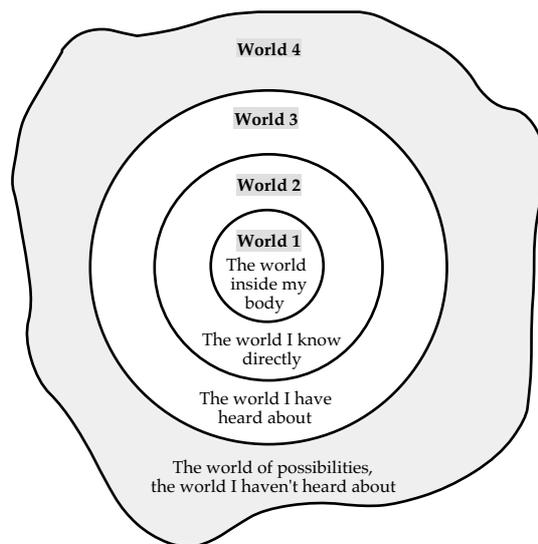


Figure 3 The worlds we live in

Learning is an activity involving the dynamic interaction and growth of all of these worlds. Let me bring the model alive through story. Twelve years ago, in the world I knew about (World three) but had not experienced directly was parenting. Eleven and a half years ago I had my first child and the world I knew directly began to grow out to take in parenting. I can assure you as I experienced it directly it changed my inner world forever—both emotionally and physically! As I experienced it directly I wanted to know more about parenting and what other people knew about parenting and so I read and listened to others' views and knowing about parenting.

In the past twelve years of being a parent I have also selected to engage in experiences which bring some of my 'know about world' into direct experience. I 'knew about' wind surfing but had never experienced it. A love of sailing, an inner drive, meant that when an opportunity arose I chose to experience it directly. And as I experienced it directly I quickly recognised the need to know more about it and what other people knew about it!

Invariably as I experience things directly the impact on my inner world is strong. Natural human learning is a dynamic and integrated interplay of the worlds we live in—Figure 4.

Learning in this fashion tends to integrate our ways of knowing, gradually and naturally our worlds form a coherent whole (see Figure 4).

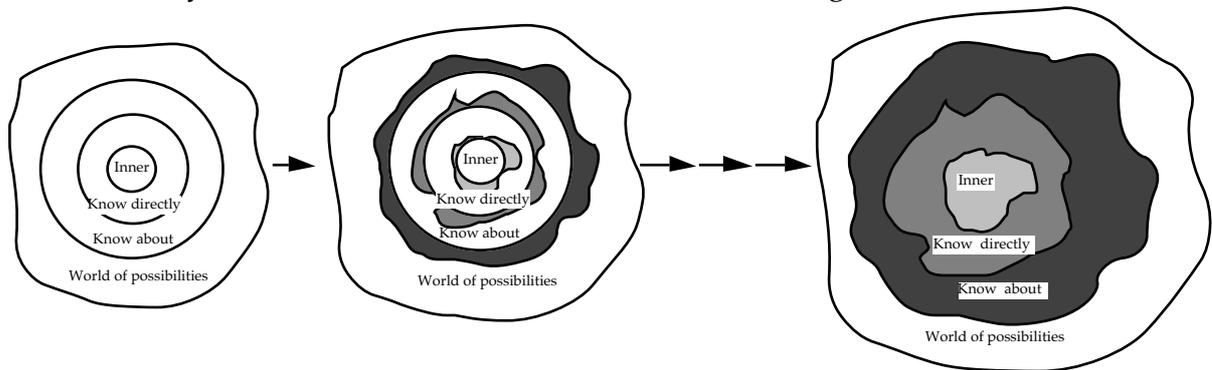


Figure 4 The natural process of learning

What of learning in formal learning settings?

For some learners learning in a formal setting mirrors what happens for them in informal learning settings - these learners are in the minority. For other learners, learning with some teachers mirrors learning in informal settings. However, for most learners, learning in formal settings *rarely* mirrors learning in informal settings. For *most* students learning in formal settings involves the filling up of the world we 'know about', but don't 'know'; the world other people 'know about' but we do not know—Figure 5.

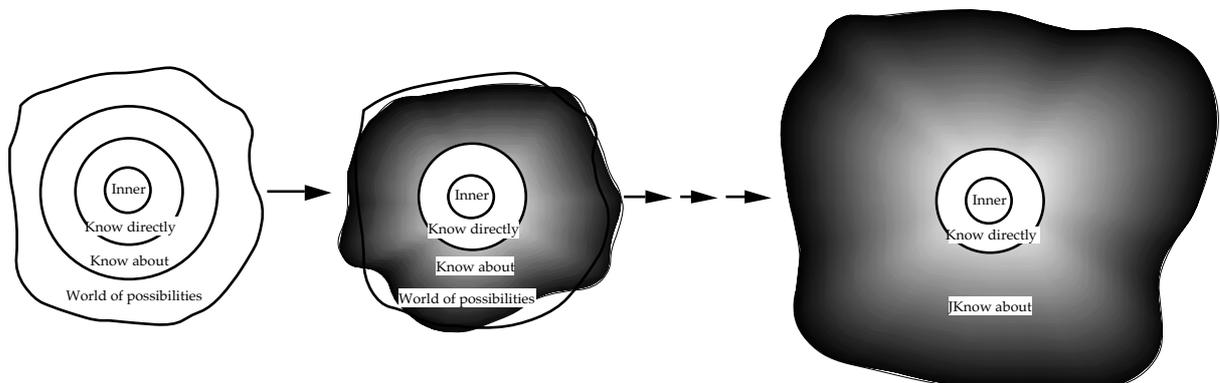


Figure 5 Formal learning as learning to 'know about' and know about what others 'know'

These learners know about World War II but don't know its connection to their own experience of conflict; they know about levers and machines but

don't connect it to their own experience of lifting loaded wheelbarrows; they know about Pythagoras' theorem but don't know how to use it to square a building. They know what they need to know to regurgitate on exams.

They work to pass and not to know, alas they pass and do not know!

Bertrand Russell

The focus on 'knowing about' but not 'knowing' has its roots back in the rise of scientific thought when subjective ways of knowing were discounted and discredited and rational modes of thought were reified. It has taken centuries, and the realisations emerging from quantum physics, for western thinkers to reassess our view of what it means 'to know'. In his paper *Science and the Search for Meaning*, Darryl Reaney captures the way quantum mechanics challenged the positivist stance.

The insight stripped of its complexities is this, that the act of observation changes the nature of the thing observed, that the observer and the observed far from being separate are coupled in the most intimate of ways.

Darryl Reaney

And thus we have dared recognise that our reality is constructed internally and that our reality is shaped by the software we bring to bear on the data we receive.

I, and many others, have a strong belief that powerful human learning involves constructing and reconstructing our own meaning in the world. However this does not mean that an individual's learning should be limited by the bounds of the world they experience directly. The open discovery approaches of the seventies were misguided in the sense that they did not recognise that the challenge for educators is to help individuals construct, for themselves, the understandings that other minds have discovered before them. Left to chance, or open discovery, my belief is that you would have to be Einstein, or Einstein-like, to discover what he discovered. In words written a long time ago. . .

The task of the teacher is not to put knowledge where it does not exist, but rather to lead the mind's eye so that it might see for itself.

Plato

In some schools, the swing away from a heavy emphasis on 'knowing about', and 'knowing what others know about', resulted in many students going through school without knowing vital facts—eg maths tables facts. You are limited and constrained in mathematical thinking and problem solving if you have to work it out, look it up, or use a calculator every time you want to process something like seven fours. The challenge for educators is to discern what facts, what procedures, what skills need be automated to ensure that further learning and thinking is not impeded. The learning secret is to ensure that those facts are only automated after deep understanding is in place.

So where does this discussion on the nature of human learning leave us with regard to information technology? In my ongoing research which focuses on identifying principles of effective learning—the natural laws of learning—from

the stories of thousands of learners and educators, I have identified several factors which promote the transformative learning described through John Holt's model and illustrated in Figure 4. These factors are:

- intrinsic motivation
 - need/purpose/perceived challenge
 - curiosity
 - relevance
 - inner drive
- teacher passion
- direct experience
- learning/teaching strategies which stimulate and integrate multiple ways of knowing.²

When the teacher moves from 'sage on the stage to guide by the side' the locus of control moves from teacher-centred to student-centred—motivation for learning moves from extrinsic towards intrinsic. 'Student-centred' learning does not mean totally student directed. In my experience of effective student-centred learning situations the teacher moves in and out of various roles. The teacher fluidly moves between being the expert, the learner, the collaborator, the master craftsman and the motivator. Learning experiences and outcomes are negotiated—learner and teacher work in partnership. The student's intrinsic motivation is a prime, but not sole, factor in directing the learning. Student ownership of their learning is strong.

Information technology makes it possible for teachers to move beyond being the information source to being a true guide to learning—but will it happen?

Making it happen

The *Apple Classrooms of Tomorrow*(ACOT) project is an excellent resource for learning about what is possible when classrooms become information technology rich. Their recent publication, *Teaching with technology: Creating Student-centred Classrooms* (Haymore Sandholtz et al, 1997), documents the experiences of ten years of learning in classrooms richly endowed with information technology. One very clear outcome of the ACOT project is that information technology has facilitated the development of student-centred classrooms and the trend in ACOT schools is for there to be a shift from 'instruction to construction'—Table 1.

Of course you can have learning situations that are based on a learner-centred, constructivist approach that do not use information technology which is any more modern than a book. Similarly, you can have learning situations which have access to all the latest information technology but are very teacher-centred and focus almost solely on 'drill and kill'.

So what enables or disables the shift? What are the practicalities?

² For a more detailed elaboration of the principles of effective learning, and practices congruent with these principles, see Atkin 1993, 1994, 1996.

	Instruction	Construction
Classroom activity	Teacher centered Didactic	Learner centered Interactive
Teacher Role	Fact teller Always expert	Collaborator Sometimes expert
Student role	Listener Always learner	Collaborator Sometimes expert
Instructional emphasis	Facts Memorization	Relationships Inquiry and invention
Concept of knowledge	Accumulation of facts	Transformation of facts
Demonstration of success	Quantity	Quality of understanding
Assessment	Norm referenced Multiple-choice items	Criterion referenced Portfolios and performances
Technology use	Drill and practice	Communication, collaboration, information access, expression

Table 1 Contrasting views of instruction and construction *Source: Haymore Sandholtz, 1997:14*

Consider again, **Promise 1:** *Information technology relieves teachers of the burden of being the information source and redefines their role as 'learning technologists'.*

Practicalities: Students often know more about information technology than teachers. Whether teachers like it or not, students are often the 'expert' while teachers are the learners. And even if the students are not experts, the teachers are generally learners when it comes to information technology. With the rapid rate of change in available information technology it is hard not to be continually a learner. Somehow information technology 'gives permission' for the roles to change. It is okay not to know.³

³ The breakdown of traditional hierarchies is a feature of the emerging knowledge era. A recent front page media story (Sydney Morning Herald, November 15, 1997) tells of a Sydney school boy who has signed a major contract with Telstra involving software he has developed to enable easy access to the Internet. Through his story, and many similar stories, we witness the breakdown of the traditional hierarchies defined by power and experience.

Although teachers generally have a rich experiential knowledge about learning those who have articulated it clearly are in the minority. If teachers are going to be supported in becoming learning technologists, inservice courses, pre-service courses and teacher conversations will need to continue to focus on:

- deepening understanding of learning
- the development of learning strategies
- the development of collaborative, student-centred learning
- developing approaches for learning to learn.

The average age of teachers in Australia is in the mid forties. Many teachers have had their attitudes and perceptions of their role, and their sense of self, shaped by a bygone era in which the authority vested in the teacher was based on them being the 'knower' of the vital information. The move to embrace a new role will be uncomfortable for many. What is more, it is unlikely that they will have many, if any, models of how to do it differently. Naming the situation and deliberately creating supportive, collaborative environments are essential to teachers learning to be comfortable in a new role as is identifying role models.

The ACOT research indicates that the *role shift is likely to be evolutionary rather than revolutionary*. Those of you who made a shift from being strongly teacher-centred to student-centred will no doubt identify with this.

Interestingly, as I reflect on Table 1—*From instruction to construction*, in terms of my own experience, I am aware that as a teacher I have always valued 'construction' but in my early days of teaching I was orchestrating this in a strongly teacher-directed but learner-centred way. The learning was learner-centred in that the meaning construction was happening in the learners' minds but there was little student self-direction. For me, the intellectual and emotional commitment to a learner-centred approach which had a strong element of learner self-direction, was close to a 'revolution' and was brought on by the crisis of facing totally disengaged learners in my second year of secondary school teaching. The change in my actual practice, however, was 'evolutionary' and it took years before it was transformed to the point that I found it uncomfortable to do what had been comfortable many years before.

Another useful model from the ACOT research, *Support for instructional evolution in technology-rich classrooms*, is reproduced in Table 2. Understanding that people will most likely move through the phases of *Entry, Adoption, Adaptation, Appropriation and Invention* helps individuals understand and reflect on their own professional growth and it helps those in the support role in knowing how to support and what to expect.

Learning design for schools

The second question that begs an answer, in designing schools for learning, is *what is the nature of learning that is appropriate to a particular context?* As learning technologists, our approach requires a thorough analysis of the LEARNING NEEDS of a particular context—Figure 2.

The contemporary context

What learning and educational experiences will help prepare our current youth to live in the emerging world - an increasingly complex and uncertain world; a world in transition; a world with a global & local focus; a multicultural world.

The emerging learning culture is one of:

- lifelong learners
- learning to learn
- learner directed learning
- customised
- collaborative/cooperative
- contextualised
- transformative
- just in time

Peter Ellyard, Barbara Lepani, Julia Atkin

This learning culture is in stark contrast to the learning culture of my youth. In my younger days learning, work, leisure and retirement were compartmentalised phases or aspects of life. Now they are interwoven.

Most of my learning was not ‘just in time’ learning. Rather it was ‘just in case’. We learned how to solve quadratic equations in Year 9 *in case* we went on with maths. We learned minute detail about mitosis and meiosis in case we became geneticists. In the days when access to information was limited to libraries, educational institutions and experts, and education was limited to certain years of your life, ‘just in case’ learning may have had a place. However, in these days of learning anywhere, any time, ‘just in case’ learning is an anachronism.

<p>Promise 2 <i>Information technology enables access to information anywhere, anytime. The emerging learning culture of lifelong learning promises to free the curriculum for the school years from having ‘to cover’ everything. The opportunity now is to discover and uncover things.</i></p>

Phase	Expectation	Support
Entry	<p>Volunteer team</p> <p>Critical mass of technology present for teachers and students</p>	<p>Provide routine planning time to develop shared vision and practice</p> <p>Excuse staff from as many district requirements as possible</p> <p>Create opportunities for staff to share experiences with nonparticipant colleagues</p>
Adoption	<p>Keyboarding</p> <p>Use of word processors for writing</p> <p>Use of CAI(computer assisted instruction) software for drill and practice of basic skills</p>	<p>Provide nuts-and-bolts technical support to develop teacher's confidence and ability to maintain hardware and facilitate children's use.</p> <p>Provide CAI, keyboarding, and word processing software and training</p>
Adaptation	<p>Many basic instructional activities individualized and self-paced</p> <p>Students composing on computers</p> <p>Course of study evolving as a result of student productivity and changing expectations of teachers</p>	<p>Develop flexible schedule to permit peer observation and team teaching</p> <p>Introduce and discuss alternative pedagogies</p> <p>Train staff in use of tool software: spreadsheets, databases, graphics, hypermedia, communications</p> <p>introduce video disc and scanner technology</p>
Appropriation	<p>Increased focus on higher order skills</p> <p>Experimentation with interdisciplinary project-based instruction</p> <p>Experimentation with team teaching</p> <p>Experimentation with student grouping</p> <p>Conflict with traditional schedules and assessment techniques</p> <p>Experimentation with scheduling and assessment strategies</p>	<p>Routinize peer observations and group discussions of events and consequences</p> <p>Re-examine project mission and goals</p> <p>Build awareness of alternative student assessment strategies ie. performance-based assessment and portfolio assessment strategies</p> <p>Encourage and support conference attendance and teacher presentations</p>
Invention	<p>Establishment of higher learning standards</p> <p>Implementation of integrated curriculum</p> <p>Balanced and strategic use of direct teaching and project-based teaching</p> <p>Integration of alternative modes of student assessment</p>	<p>Encourage collaboration between teachers and researchers</p> <p>Encourage teachers to write about and publish their experiences</p> <p>Explore telecommunications as way to keep teachers in contact with innovators outside of district</p> <p>Create opportunities for teachers to mentor other teachers</p>

Table 2 Support for instructional evolution in technology-rich classrooms

Source: Haymore Sandholtz, 1997:52

Practicalities: A 'just-in-time' learning culture demands a revisioning of an essential curriculum for the school years of learning,⁴ and a national endeavour to build and provide for a lifelong learning culture.

Whereas thirty years ago it was critical for all young people to learn to read and write, it is now critical that all students learn:

- to 'read' print **and** visual media
- to communicate in multiple language forms: written, oral, body, visual and electronic
- to work independently and interdependently
- to think critically as well as imaginatively
- to be reliable
- to be effective problem solvers
- to be flexible and adaptable - to deal with uncertainties and shades of grey
- to use new tools of information and knowledge management technologies, and to **learn how to learn**.

Learning, and learning to be autonomous, self directed learners, have never before been so vital to functioning as part of society.⁵

Learning to compute and computing to learn

Whereas machine technology gradually took over routine and repetitive physical labour, information technology is gradually taking over routine and repetitive mental labour.

It was brought home to me recently just how powerfully and efficiently information technology enables us to store and transfer information. I foolishly locked the keys of a hire car in the boot. My old technology of a wire coat hanger was no match for the new electronic door locking system. How was I to get out of this predicament? A phone call to the car company (answered in a city several hundred kilometres away), identification of myself and the vehicle resulted in the code for the key being sent digitally to a locksmith a few kilometres from where I was stranded. He cut a new key and soon let me into the vehicle. Think of the paperwork; think of the difficulty in locating and transferring that information about the key in the days before computers.

As information technology assumes much of the tedious task associated with information management there is a shift in the nature of human work and it correspondingly shifts the skill set we need to learn.

⁴ It was with dismay that I watched the mapping of the national statements and profiles a few years ago. The process was not designed to vision a curriculum for the twenty first century. Rather it was a mapping of what is and thus did not escape the curriculum of 'just in case'.

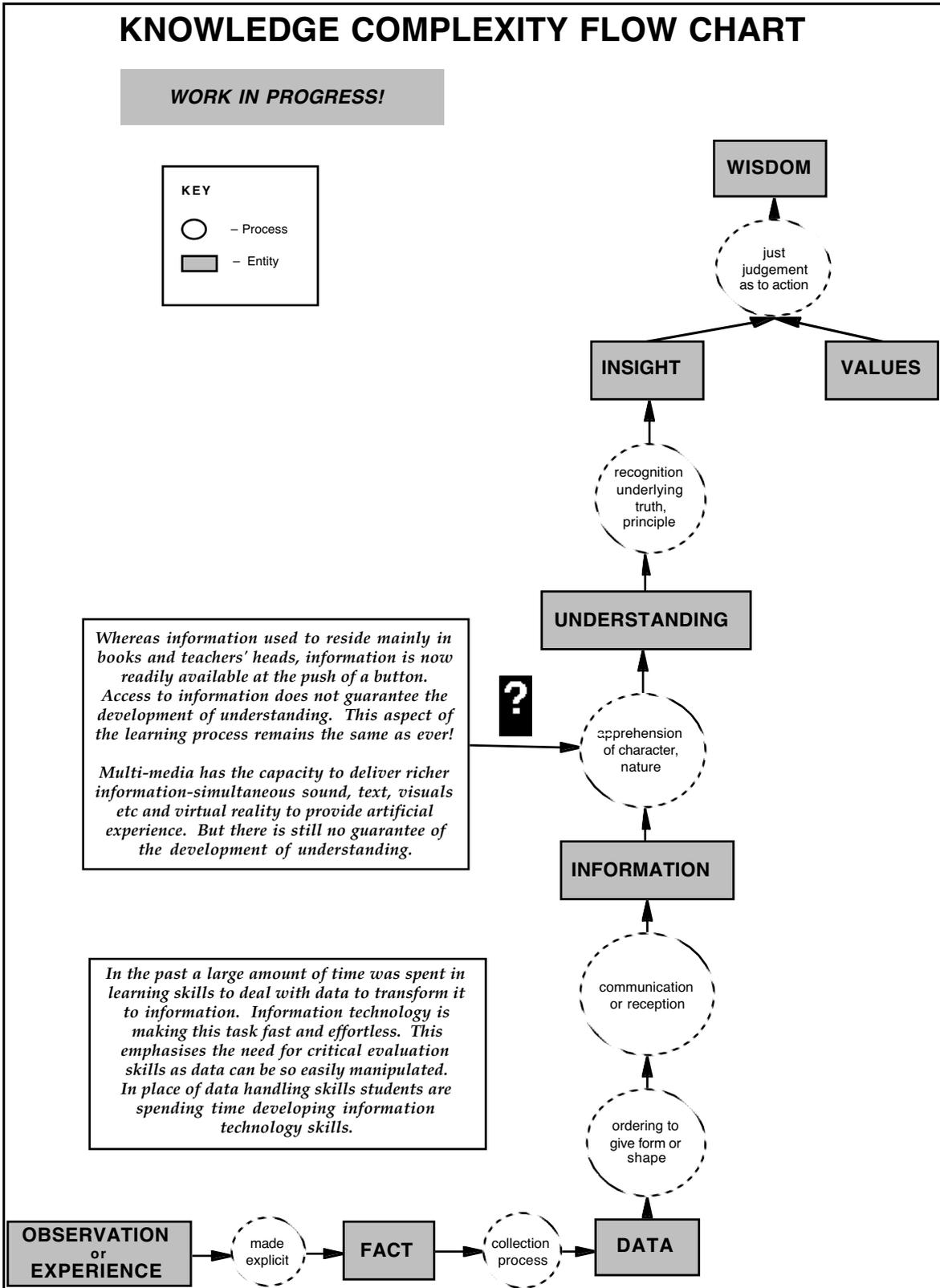


Figure 6 Levels of complexity of knowledge

Figure 6 is my first rough attempt to draw out different levels of complexity of knowledge. It is not intended to describe *how* an individual acquires the knowledge—it is **not** a model of learning. Nor is it intended to convey anything about the ease with which an individual might acquire forms of knowledge, nor how values or past experience might shape an individual's knowledge.

The chart (in its very draft form!) is more akin to a levels of complexity chart, say, for life forms. In a chart of levels of complexity of life forms, you would have single celled animals like amoeba at the bottom, followed by simple multi-cellular life forms while complex organisms like mammals would be much higher up. Figure 6 is a draft attempt to chart the levels of complexity of knowledge. In my terms, facts, data, information, understanding are all forms of knowledge at different levels of complexity.

A vast amount of my time in my school learning years was spent learning:

- the **information** I might need to have accessible in later situations;
- the skills of collating facts **to form data**;
- the skills of '**forming**' data as **information**.

Promise 3 Information technology enables compact and efficient storage, ready access and fast transfer of information freeing the human mind for less routine, more creative mental work.

Practicalities: Information technology may have wiped out the need to learn old skills, such as using log tables or slide rules, but it has created the need to learn new skills—the skills associated with using the technology. We need *to learn to compute as well as compute to learn*.

With the help of the new technologies data is transformed to information readily and speedily. A table of data can be transformed to a pie chart or bar graph with ease. But what do we miss by not handling the data ourselves? By not engaging in the actual manipulation of data our mind does not have a chance to form its own patterns, its own analysis. Where as once we would have had a sense of 'that's not right' when seeing invalid representation of data, now there is the potential to be easily hoodwinked. We may have given up the need to learn the skills of transforming data but in their place we have gained a new need—the development of refined critical evaluation skills.

Sharing information and networking - inclusivity versus exclusivity

The ease with which individuals can publish information, including their thoughts, on the world wide web has turned the world of exclusive publishing on its head. If a refereed journal won't publish it, a writer/communicator can publish it on the internet.

One only has to witness the smile of delight as a youngster receives feedback, from a student on the other side of the world, about a poem they have published on the web to realise the motivating power of a learner's work being

celebrated through publication. The fact that accessibility of information and communication transcend land and national boundaries with ease gives an exciting glimpse of the world of possibilities.

No longer is there a need to physically send information to a distribution list of potentially interested people. If you have something to offer it can be put up on the web and people who want it can 'come and get it'—people are empowered to be active about furthering their own interests.

Promise 4 *Whereas the world of exclusive publishing carried with it criteria for acceptance and hence some guarantee of standard, electronic publishing has the power to be totally inclusive.*

Practicalities: There is no shortage of availability of information. Being available is not the same as being accessible. Although web search engines are improving all the time, information on the world wide web is quite chaotic. Frustration levels and time delays can interfere with realisation of the potential.

Being available does not guarantee authenticity nor reliability. As mentioned earlier, critical evaluation skills take on a new level of importance. Although the potential for total inclusivity has been present, there is some evidence to suggest that a rule governed, exclusive environment will emerge on the web.

Potential pitfalls

Information rich but learning poor?

Information technology has provided easy access to information and information in multiples modes. Virtual reality even has the capacity to stimulate senses other than our sense of hearing and sight. But an information rich environment is no guarantee of learning. Although human understanding can be embedded in software (for example accounting packages which guide the accounting ignoramus through processes to complete accounting procedures) humans cannot simply gain understanding by direct transfer from a computer any more that they could gain understanding from direct transfer of notes from the board.

Human understanding requires processing in the individual's mind. You can transfer information but understanding has to be developed. Processing for understanding cannot be left to chance. This is true in every classroom regardless of the presence of technology. Some students' thinking and learning styles lend themselves to search for understanding and connection. Others are less inclined to do so. Unless the teacher probes and nudges for understanding some students will be learning rich, others learning poor.

Let me illustrate my point through an anecdote. In one of my classroom visits while at a school I was enthralled to be an observer to the learning in a

technology-rich classroom. All around me were signs of true collaboration, signs of self-directed learning and some signs of individuals reflecting on their learning. One student, highly engaged in some work on the computer negotiated with the teacher to complete his daily fitness activity at lunch time so he could complete what he was doing. The classroom was busy, active and engaged.

I wandered over to a group of students who were completing a group project and asked them to show me what they had developed. Their group project involved systems of the human body. A hyperstudio stack had been developed along with a paper based folder of materials. As I flicked through the folder I saw colourful and well presented diagrams of many systems of the human body. I came to one on the human ear and asked the students where they had found the diagram. I learnt that they had downloaded it from an online encyclopaedia. I went on to ask them to explain to me how the human ear enabled us to hear sounds. I was greeted with blank faces and mumblings like “I think it’s got something to do with this bit”.

Perhaps understanding the systems had not been an intended learning outcome, I thought and wandered back to the teacher to ask what the intended outcomes had been. It emerged that understanding the functioning of the systems had been a key outcome but that had not really been made explicit in the structure nor criteria for the project.

My sense is that the students who were naturally effective learners sought to develop understanding while others were content to develop visually pleasing presentations. My concern is that information technology can lead to a sophisticated form of cut and paste and a much speedier version of copying slabs from an encyclopaedia.

How can we ensure that information rich is not learning poor?

In another technology classroom in another setting I observed a similar class. The features of this classroom—highly engaged, highly self-directed, interactive learners working on collaborative projects, seemingly similar to the first classroom I spoke of above.

I observed and then probed for understanding. In this second classroom, the understanding of the key concepts, at an appropriate level was clearly evident for all of the students with whom I spoke. I thought that this teacher may have made the requirement for understanding more explicit in the project outline. On viewing the outline I realised that this was not the case—it was written in a similar way to the outline of the other classroom. So what was making the difference?

On closer observation I found that *what had been embedded in the learning approach in this classroom was a systematic and regular focus on metacognition—thinking about thinking and thinking about learning.* Questions such as the list in Table 3, following, were a regular feature of classroom process. Students kept learning logs and tracked their learning

journeys. These logs were an important element of the process by which the children reported to their parents during parent-school visits.

Questions used to stimulate metacognition

What do you know and what do you want to know?

What's the 'big idea'?

What are some of the little ideas?

What can you do now that you could not do before?

How did you learn that?

Compare how you learned it with how others learned it?

What do you understand now that you did not understand before?

What do you want to know now?

What will it look like, feel like and sound like when you have finished?

What questions do you have?

Table 3 Questions used to stimulate a metacognitive approach

As we integrate information technologies into our practice, classrooms will only become **information rich and learning rich** if we attend to all the features which enhance learning in any learning situation. Information technology may have changed things in that it makes more possible, however those possibilities will only result in enhanced learning if we attend to the application and refinement of powerful learning technologies. On that front the scene has not changed.

A curriculum for 21C

The 'just in case' curriculum referred to earlier, is one of the strong forces which impede the transformation of schools into places of learning for the new century.

Promise 5 *As computers relieve us of the tedium of transforming data into information and provide speedy efficient information storage and transfer, and, as lifelong learning becomes a reality, the focus of learning in schools finally has the chance to focus on developing understanding.*

Practicality: The focus in schools, especially secondary schools, has been on what topics had to be covered. A shift in thinking, a change in focus is needed. How do we escape this mind set?

Let me illustrate the nature of the shift required. I am amused and amazed as I listen to adults tell stories of meaningless learning in their youth. In Tasmania, these stories often relate to being required to recite the railway gauges for every state in Australia; in NSW, to being required to recite the rivers down the east coast. My suspicion is that what teachers wanted me to understand, as I learned the rivers down the east coast, was why towns like Grafton, Taree, Maitland and Newcastle had developed where they did. While in Tasmania I presume those who defined the syllabus wanted students to understand and appreciate some of the factors behind the drive towards Federation.

With the power of hindsight we can laugh at these quaint stories. I suspect that the next generation will do just the same in relation to our persistent 'just-in-case' curriculum of the nineties.

Changing the question

Instead of asking 'what topics do we have to cover' we need to develop processes and approaches which ask. . . **'what are the powerful ideas and processes, captured in collective human wisdom, that we believe to be important for young people to learn'.**

In terms of Figure 6, we need to start with our focus on desired understandings, the big ideas, and then ask what information and what experiences do I need to engage the students in, in order for them to develop these understandings. The focus of assessment needs to be 'if students understand this idea, how can they demonstrate it?'

If we truly value learning which is integrative and coherent, described through John Holt's model of the worlds we live in (Figure 4), then we will also be paying attention to ensuring that the learning and assessment is authentic—that it has genuine purpose in the lives of the students.

An example of what is possible for curriculum restructuring

River Oaks Public School, a K-8 school of approximately 750 students, in Ontario, Canada provides a good example of a school which has restructured curriculum along with the integration of information technology.

A focus on curriculum restructuring is essential if we are to effectively utilize information technology in the teaching and learning process. This has certainly been the focus at River Oaks School. If we are successful in restructuring curriculum with an emphasis on preparing students for a global economy, one where individuals have access to information anytime and anywhere, where information technology is used to help us be more productive, efficient and creative in our work, and where information technology provides the opportunity for us to collaborate with others and share our knowledge, computers will become transparent in the teaching learning process. (Smith, 1997p4)

At River Oaks, students study 6-8 week integrated units from three strands for learning:

- *Human Relationships*
- *Science/Technology, and*
- *Global Awareness.*

They have identified seven “BIG” concepts which can be found in all disciplines:

change
energy
diversity,
patterns
relationships
system, and
model

They have developed what they call a communication architecture:

oral language
written language
numbers
concrete representation
sound/music
graphic images
video
interactive media
movement(self expression)
movement(fine/gross motor)
personal skills
interpersonal skills, and
thinking skills.

The school day is organised around the components of *Literacy, Life Skills, the Arts and Creative Applications.*

Practicality: The immediate response of many secondary school teachers, to a model like River Oaks, is to say how they could see that happening in a primary school where the teachers work predominantly with one class but that it would be impractical, if not impossible in a secondary school because of the structures and because of the external demands imposed by universities.

When I cast my eye over the attempts at integrated curriculum in secondary schools in the seventies I can see with clarity the difficulties of integration in a traditional secondary school structure.

The emergence of the team approach in Years 7 and 8 in many schools around Australia is paving the way for an organisational structure which lends itself to genuine integration. Along with the structure, much attention needs to be paid to re-framing the curriculum around the ‘big ideas’ and key processes which we believe are important for young people to learn at that stage of their lives.

What emerged in many secondary schools, in the early days of an integrated approach, was a stilted form of teaching a theme. The theme may have been 'water', for example, and for three or four weeks every subject area 'did water'. Water was done to death! In these attempts, integration was a 'force fit'. The essence of the power of an integrated approach is that it models natural learning in real life situations. Integration is doomed to failure if integration is done for the sake of integration.

Some endeavours to integrate the curriculum are in response to the overcrowded curriculum. Although I am quick to recognise that there is much overlap in curriculum areas, I do not believe that integrating the curriculum to remove overlap is the right focus. The power of integration stems from the natural capacity of the human mind to integrate. Knowledge develops through ever more complex forms by a process of integration—that is the meaning of integration. Simple forms are integrated to form a more complex form, and the form which emerges is more than the sum of the parts. Skills become refined capacities through the integration of information and experience; simple concepts become complex mental models through the integration of reflections on experience. The real power of an integrated approach will be realised when we begin to focus on integrated learning rather than an integrated curriculum; an integrated curriculum is a natural manifestation of integrated learning.

Avoiding the pitfalls

For those of you who have read any of my work previously, my advice here is predictable:

1. Clarify and articulate what you value and believe about learning.
2. How does/can information technology help us achieve what you value and believe?
3. Measure your success in terms of how well you are achieving what you value and believe.
4. Develop frameworks as 'compass bearings'
 - Principles of effective learning
 - Learning to learn
 - Powerful ideas and processes captured in collective human wisdom

Information technology and the 'world of possibilities'

One of the fascinating things about the knowledge era is the transformation of what we have considered to be normal in the late industrial era. For example, in the industrial era if I gave away my key assets I no longer had them; if I gave away my property I no longer had it. In the knowledge era, if I give away my key asset, knowledge, I still have it. What is more, it is likely to have grown in the process of giving it away. Not only has my knowledge been maintained or grown, but the collective knowledge in the particular community of learners has grown.

As indicated earlier in the paper, in the knowledge era traditional hierarchies such as teacher-learner, publisher-writer are being dismantled. Much is made possible in terms of empowering individual learners in an unstratified world of learners.

There are many fascinating transformations and shifts occurring. Recently I was struck by an interesting phenomenon about the emerging knowledge era. Because learning and knowledge are the key assets, learning the skills you need for the era has a compounding effect—learning the skills for a learning society helps you learn the skills you need for the learning society—they are one and the same. The great possibility I see here is that we have the potential at last to bridge the divide between the different traditions in education—academic versus vocational. Learning to learn is a vocational skill just as much as it is a foundation skill for an academic education.

Vignettes from schools

Information technology has the potential to assist us in differentiating the curriculum for different students. A case in point. . .the recent emergence of *the Virtual School for the Gifted* realises a dream that many have had that learning on line would help teachers individualise aspects of the curriculum.

Much as I relish the potential of learning on-line and off-campus, I do not believe that this mode of learning will take over—I believe it will augment and supplement real communities of learners. Why do I believe this? Is it just my wish?

In listening to the themes emerging from the stories of close to a hundred thousand people the factor which emerges as the most powerful influence on an individual's learning is the relationship with the teacher. In the future my hope is that we will all be teachers and we will all be learners as we develop collaborative learning communities which are both real and virtual.

Many of the possibilities emerging were physically possible before but they were clumsy and awkward in the limited media we used. Many curriculum support materials I have written, for example, have been designed in layers, hyper-text like. The linear nature of a folder of materials does not lend itself well to this layered design—digital storage does.

I remember in my youth a communication that went between two friends. It was continuous letter. One wrote, the other added her response and sent it back and over the years the letter grew and grew! The new possibility is speed of interaction, compact storage and quality of presentation that does not deteriorate with age. When I was first involved in helping schools develop student portfolios as a record of their learning journey in the early eighties people were aghast at the thought of the storage space.

Recently I read and interacted with senior secondary students' poetry written in hyper-text and I read a collective piece of writing that had been written interactively by a virtual community of writers who live in several different countries!

The possibilities are endless—we will be limited only by the limits of our imagination and by hanging-on to outdated mind sets. One of the powerful features of mental models is that they give us a sense of order in chaos; a degree of predictability and comfort. They can, however, be our greatest enemy straight-jacketing us in concepts suitable for a different time. In the words of the ancient Hebrew proverb:

Do not confine your children to your own learning, for they were born in a different time.

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