Schools for the Future

The Impact of ICT on Schools: Classroom Design and Curriculum Delivery

A Study of Schools in Australia, USA, England and Hong Kong, 2000.

Gillian M Eadie, M.Ed., BA., Dip Tchg, LTCL, MCSNZ
PRINCIPAL, Samuel Marsden Collegiate School, Wellington, New Zealand
Winston Churchill Millennium Fellow

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[1] Education Network of Australia, www.edna.edu.au
[2] Los Angeles Unified School District
[3] Apple Educator of the Year, 2000

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[4] British Educational communications and Technology agency
[5] Qualifications and Curriculum Authority

Introduction

Two major influences have impacted upon education for students in primary and secondary schools in New Zealand and world-wide. Firstly, the rapid development of information and communication technologies and secondly, the deep questioning taking place regarding what a student will be required to know and be able to do to succeed in the twenty-first century.

School responses to each of these influences have inevitably brought about changes: changes in the curriculum, in the way teachers redesign and present the curriculum, in the uses made of resources and the way current classrooms and buildings are being reconfigured. These specific aspects were researched in selected schools recommended by administrators and educators in each of the four countries visited.

This paper pre-supposes that readers will already be well aware of the desirability of integrating computer use seamlessly into the school curriculum and will be familiar with widely accepted classroom practice involving computer use. Empowering learners to engage in meaningful, challenging and enlightening tasks is the aim of all educators and ICT has a powerful role to play in this in every school classroom and beyond. This research moves beyond current practice and seeks to determine future trends.

Scarcity of resources, both physical and financial, make it imperative that best practice guide decision-making in schools regarding both planning for the advanced use of ICT and the way in which buildings are changing to meet identified needs of students.

Often school strategic plans are based on extensions of what is currently known rather than on best practice models and ideas. It is my hope that this research will make available to interested schools, knowledge of trends in UK, USA, Hong Kong and Australia, allowing school administrators to include further innovative thinking into planning for "Schools of the Future".

Research Objectives

1. To determine current and possible future ICT trends in creating *the schools of the future.*

2. To explore the ways in which schools are changing their timetables, curricula and their methods of teaching in response to the use of information and communication technologies (ICT).

3. To examine changing use of established buildings and to explore future plans for the development of existing facilities.

4. To highlight innovative practices in schools in Australia, USA, UK and Hong Kong of value to New Zealand schools and to share the gathered information with participants and education groups in New Zealand to enable effective planning for students of the future.

5. To facilitate communication between New Zealand schools and best practice schools in Australia, USA, UK and Hong Kong.

Scope Of The Study

In gathering data for this research, in 2000, I attended the Navigator Schools' Conference, Bendigo, Australian Computers in Education Conference, Melbourne and the Pacific Basin Consortium Conference in Hawaii (where I presented a paper: *What Every 21st Century Student Needs to Know).* I visited schools, district technology facilities, administrators and government departments in Australia, Hawaii, California, Nevada, Wisconsin, Illinois, England and Hong Kong. Inevitably, only a sampling of views and organisations could be included in my study and in California and England, only some schools were open at the time of my visit. Prior investigations and discussions, however, enabled me to identify a cross-section of sources where I was likely to find answers relevant to my research questions.

Investigating these questions revealed a variety of philosophical approaches to the integration of ICT as well as a range of practical solutions in overcoming the universal problems of staff and student access to computers, professional development for educators, security, maintenance, networks and internet access, funding and health and safety issues. The scope of this paper obviously does not allow me to comment on all of these although some will be explored in the context of describing classroom configurations.

It is also recognised that rapid advances in technology will inevitably "age" observations made in 2000. For this reason, I have endeavoured to focus on categories of change, rather than describe projects in great detail. I am very willing to elaborate any areas of particular interest to educators[6] and have digital pictures of most schools and facilities mentioned.

Findings have been organised and reported under the heading of each of two research questions.

Research questions

Is ICT use changing schools? No educator involved in schools during the past decade could be oblivious to the expanding body of literature surrounding the introduction of computers into classrooms. During the 1990's, many took only an academic interest because computer access and

[6] Contact Gillian.Eadie@marsden.school.nz

their own knowledge of this new tool was limited, and teaching styles and expected educational outcomes seldom included using computers. For those who were early excited about the possibilities of information and communication technologies, frequent opportunities arose to meet and discuss ways computers could be used to enhance classroom activities.

The advent of the Internet has rapidly advanced the numbers of teachers using computers as an information source, but it is taking much longer for schools to respond significantly to this new medium than it has in the business world. Computer use has the potential to transform the education process for both learners and teachers. But has it? How fundamentally has computer use changed the way schools operate? . The experience of those in other schools can often help prevent wasting money and teacher time on resources that have elsewhere proved of little use.

Two specific areas of change were the focus of my research:

1. How is the availability and use of ICT changing the use of existing classroom spaces?

2. How is ICT use changing the way teachers and administrators approach curriculum delivery?

Research Question One

How is the availability and use of ICT changing the use of existing classroom spaces?

Introduction:

Most schools in New Zealand are over fifty years old with some, like my own, having existed for over a century. The classroom spaces we operate in were designed to reflect the traditional, transmissive style of curriculum delivery with little, if any thought being given to investigation-based, group learning, let alone fibre-optic cabling. While some funding is available for renovation and rebuilding, the reality for most schools is that existing spaces must, in the short term anyway, be adapted to accommodate new learning technologies.

Thinking differently about teaching spaces

The arrival of even one computer in the classroom can have a profound effect on the way students learn and the way the classroom operates. Teachers integrating computer use into the curriculum, soon modify their classrooms to reflect the changes in student learning behaviour that inevitably emerge. Creating space in the classroom for computers and peripherals such as a printer, network connection and large monitor initiates a rethinking process by the teacher, leading to re-evaluating how classroom activities and learning experiences work best.

Early responses to ICT often involved creating a technology centre, or dedicated building to house computers and peripherals, with students being taken to these facilities when work with computers was needed. Computer laboratories were developed with classes being booked in for whole class use of the technologies; this arrangement still exists in most schools visited. Alongside the laboratories, however, a variety of solutions has developed, enabling in-class access to computer facilities and it was these arrangements that were of interest in this research.

Little research has been carried out into the effects of room arrangement on children's learning. Stephen Heppell[7], at the ACEC conference in July 2000 asked: What do we know about the placement of tables in classrooms? What are the relationships of children inside the classroom to the outside world? Are we creating barriers to the outside and adults with

[7] Professor, Anglia University, UK, originator of *UltraLab, NotSchool.com*

our classrooms? Where should the computers be?[8] This paper reflects some answers found by educators.

The anytime, anywhere access to information sources, "ubiquitous" computing, enables students to engage directly with expert sources when they are needed and the *sight, sound, touch* experience becomes a powerful motivator in learning. Bernard Hollkner[9] says, "The Cast of Players in a student's learning experiences has increased dramatically. Convergent technologies now allow experts, peers and collaborators to join the student's world, enriching learning experiences."

Professor Hedley Beare in 1998[10] saw the role of the teacher becoming more fluid and covered by "a range of professional educators – tutors, instructors, mentors, learning theorists, curriculum planners and experts, assessors, curriculum writers, assignment markers, editors and student counsellors". A mix of on-site and distance programmes seems a likely mix for the student of the future.

What is the Ideal Classroom?

Brett Hunter[11] believes today's classrooms need Internet access for research, distributed multimedia curriculum on line, access to digital libraries, distance education courses and remote collaborative tools. Information on demand for students also includes video, live video broadcast, desktop videoconferencing and 3D modelling. "The use of voice (for activities such as interviews, speeches, background music, explanations) and Video (for live conferences within and between schools) will change the way schools operate".

Tomorrow's classroom

Paul Butler, Head of Information Technology at Caulfield Grammar School, Melbourne, believes classrooms will be characterised by:

- access to on-line resources which use a powerful combination of video, multimedia, text and graphics, prepared by specialists in a centralised resource development facility and delivered to individuals or groups by technology

- provision for the teacher to teach the whole class or part of the class, assisted by technology as appropriate

[8] Paraphrased by writer

[9] *Faculty of Education, Monash University, speaking at ACEC Conference, Melbourne, 2000*

[10] IARTV Seminar Series, quoted in *Schools Without Walls,* David Campbell in Independent Education Vol. 30/No 3, October 2000

[11] *Industry Development Manager 3COM. ACEC 2000*

- provision for all students to learn the same way or to choose ways which suit their own individual learning styles, assisted by technology as appropriate
- access to individualised curriculum pathways, managed by technology
- access to individualised diagnostic testing and assessment of progress, managed by technology
- students moving independently between learning areas as necessary, managed by technology
- flexible room layout and furnishing
- large-screen video display
- individualised access to network resources – wireless networking; cheap, light-weight notebook computers; e-books
- continuity of access to network resources away from school

So what is really happening in classrooms?

My research revealed that, although some classrooms remain apparently untouched by technology, many classroom configurations have changed to incorporate easy access to the computer(s) and to facilitate the discussions, problem solving and decision-making that inevitably follow their use.

Schools in my research group made a number of differing responses to ICT. Through grouping these responses, I have created the following list of observed trends in the use of classroom spaces with ICT:

- Rearranging the Classroom
- Creating New Spaces From Old Configurations
- Providing Centralised, Shared Facilities
- Creating Dedicated, Flexible Classroom Space
- Developing Virtual Classrooms And Campuses
- District Networks Creating Learning Communities
- Web Hosting By An External Provider
- Classroom Redesign For Maximum Flexibility
- Wireless Technology Offers New Options
- Changes In Traditional Library Areas

Re-arranging the existing classroom

My most frequently-viewed, changed classroom design involved creating **three main areas for student use**: grouped and networked computer facilities, student desks facing a whiteboard and monitor linked to the teacher's computer and an area designated for group-working space. In some smaller rooms, the latter was created when needed by rearranging the desks to form groups. Adjustable chairs and/or desks enabled safe use of computers for students.

No "front" to the classroom

Classrooms at John Paul College, Brisbane reflected computer use in several ways. The aim is that **old and new spaces are no different in operation**: **flexibility and power** being the keys to successful programmes.[12] Older classrooms have been adapted for use with new technologies[13] by installing more power points and benches. Two rooms with connecting doors have been rearranged to enable more group, presentation and combined class activities. As the teacher explained, "having a board at both ends means there is **no *front* to the classroom, anymore"**. A pervasive air of purposeful activity surrounded the class: groups of desks were placed close to network points (although the growth in wireless technology will soon free up this restriction); a centrally hung screen allowed another group of children to view a data-show presentation. Tables of resources were placed near groups and a printer, scanner and monitor were on a mobile trolley. The two rooms work together and share resources.

Sharing resource spaces

New classrooms are built around **a central, well-equipped, soundproofed wet resource space** which each of the four classrooms used for Art, withdrawal groups, remedial assistance or project work. All of these classrooms used wireless technology, all classrooms have a large TV monitor/display ("couldn't function without this") and classes had a small "sound" room at the rear of classroom for recording in multimedia presentations. Flexibility is important to the operation of the classroom.

Easily-moved desks

Movable desks in classrooms are individual and can be **reconfigured** for the many different functions in the room ("we used to have tables but found them too constraining of activities"). Wireless cards were stored in a wall-hung, individually named organiser, enabling the teacher to see at a glance whose cards (very expensive!) were in use. Each day began with 30 minutes of basics using notebooks – spelling, mathematics facts, journal time and keyboard skills.

[12] Aidan McCarthy, Director of IT
[13] This is a Laptop school

> *"This gets students into correct habits of unpacking notebook, storing bags, checking for functionality"*[14].

Security needs to be managed

Security is a big issue at JPC; before leaving classrooms, windows, lights and doors must be checked. On-site security checks are made each break and lunchtime and teachers who forget are named. Routines are important.

Shared software

Le Fevre College, Adelaide enables **computer group work** to take place by arranging seven computers in an oval central "island", screens and keyboards outwards, and using **shared software**[15]. Each student in the group can add to the combined project from their individual keyboard and the combined project can be viewed and shared by all.

Configurations evolve with use

A great deal of research went into setting up the classrooms at Advanced Technologies Academy, Las Vegas, a school that is only five years old. The English classes comprise PC's on benches around the walls, large areas of space for movement and other activities and a set of circular tables for students to work at in groups. In Mathematics, the classrooms were originally set up with each student having a PC on the desk, two large monitors at the front of the class and the rear wall of the classroom completely mirrored so that the teacher could see the PC screens from the front of the room. **After two years, that set-up changed as the teachers realised that computers were not used all the time in class**. Now the computers are ranged along each of two walls with a large monitor at the front of each row. Desks are arranged in the middle of the classroom for whole-group teaching and the teacher's demonstration desk (in all classrooms) comprises a computer, video, monitor (connected to the two large monitors) and printer.

Creating a Business Centre Model

Vanguard School, District 214, Illinois is the result of rethinking the needs of students who have not succeeded in the traditional school model. **The rooms have been redesigned to replicate a fully equipped, modern business centre,** complete with a reception foyer. All curriculum subjects are integrated and project-based, so students do not study English, Mathematics, Science …. There is one computer to every two students and no classrooms: they are *conference rooms.* Classes became *workgroups* and appropriate styles of address and appearance are expected when the students undertake work experience in community businesses. A high level

[14] Head Teacher, Jan McNamara
[15] Zing Technologies

of success has been experienced with students although other schools in the district have not taken up the model.

Central "island" in the classroom

At Weydon School, Surrey, the ICT teacher changed the *rows of desks pointing forwards* style of classroom to **creating a central island in the class** with an interactive whiteboard on the end wall. This arrangement enables a more easily monitored, friendlier environment.

Creating new spaces from old configurations

At MLC, Melbourne, in the late 1990's, a long block **of ten "shoe-box" classrooms was rebuilt to form four large, flexible glassed-in teaching spaces with teacher conference rooms in between.** The walls of the conference spaces were also glass, enabling staff to view student activities. The new spaces were designed to allow maximum student space both inside the "classroom" and in the outer corridors, carpeted and stepped to provide student seating. Network access points were arranged in these areas as well as in the classrooms.

In the Oregon School District, Wisconsin, within the old footprint of the building**, a large, flexible space was created where movable walls** separated off teaching spaces while a shared, central resource space contains abundant computer and presentation resources. These are used co-operatively among teachers and collaboratively on cross curricular and class projects.

King George V School, Hong Kong is **developing a shared workspace from two "old" classrooms.** "The layout of the classroom has changed from each student needing a computer on his or her desk, because teachers can now assume that students have all the necessary computer skills so can concentrate instead on teaching Business Studies, using the computers as and when appropriate. The design includes a glassed teacher space between the two classroom areas to reduce teacher isolation, enable supervision of other teachers, ease of movement between classes and opportunity for team teaching and planning."[16]

Both classrooms are set up with computers around the perimeter of the room and work tables grouped in diamond-shaped "islands" in central space. A whiteboard was placed in the teacher's teaching space.

Workshop spaces, formerly assigned to industrial arts education, have proved to be **excellent in housing ICT facilities**. At Pacoima Middle School, San Fernando, a visionary teacher, to offer students experiences in applied computer technology, has transformed a former workshop. The room comprises sixteen bays, large enough to allow adequate working space for two students and the equipment involved in e.g. Virtual

[16] Head of Department, Economics

Architecture, Aerodynamics, Robotics, Digital Music, Computer-Aided Drafting, Telecommunications, Health and Fitness or other activity. Students apply the skills they are learning to a real task and spend two weeks of their allotted time on each activity. A similar concept, produced by a different company, was successfully being implemented in previous workshop space at higher secondary level at King George V School, Hong Kong. Tasks here included: Industrial Control Technology, Electronics Technology, Robotics and Automation Technology, Mechanisms, Materials and Processes, Aerodynamics (wind tunnel), Pneumatics, Multimedia, Graphics and animation.

At Elk Grove, District 214, Chicago, Illinois, the Applied Technology Laboratory has been created through the combined effort of industrial arts and science staff. Again, **two-student booths have been created in a large space** and students work through a series of applied technology models.

San Fernando Senior High School has been successful in gaining funding for a huge computer facility, the design resulting from school research. Housed in a disused industrial arts space, the **Community Inspiration Centre** will house sixty–four IMacs, videoconferencing room, digital imaging and editing facilities, blue filming room, Think Rooms and a huge **video wall for image projection**.[17]

> *"There was a "huge battle to get this room for IT; the Board wanted to build an auto shop so that graduates would get jobs in the automotive industry – but Ford downsizing had a huge impact on this community and I finally convinced them that IT is the way of the future".*[18]

Providing centralised, shared facilities

Providing leading-edge facilities and ICT equipment in a centralised environment has enabled students from many schools access to learning technologies that would otherwise not be available to them. This is the solution chosen in Adelaide where the DETE[19] has established the **Technology School of the Future**[20], a spectacular district **technology centre**. TSoF is a highly sophisticated project with 11 specially set up labs with the latest technology in every curriculum area. State of the art in Music, production and editing; CAD, pneumatics, and other technologies. Music suite has presentation area with smart lighting, curtains, sound operated from footpad sensors; smart workstations with cabling and special effects mounted under the centre of elevating tables. It is a teacher and student training facility with skilled ICT trainers where teachers can book to bring classes for short or long term projects.

[17] Plan available
[18] Marco Torres, IT Coordinator
[19] Department of Education, Training and Employment South Australia
[20] www.tsof.edu.sa.au

Creating a dedicated, flexible classroom space

Keeping one**, fully equipped classroom space to be shared by a block of six or so classrooms** has enabled teachers at Caulfield Grammar in Melbourne access to computers for a whole class. The room can be configured to suit an individual teacher's needs with 16+ network outlets, PC's on trolleys that can be placed to suit and a set of laptops permanently available (stored in a security locker in the room).

Creating virtual classrooms and campuses

Creating a virtual classroom space where students can log in and find course notes, resources, worksheets and teaching tips enables students who are home-bound, out of school for sport or cultural activities or on fieldtrips, to maintain contact with their coursework and teacher. Many schools are now pursuing this method of improving services to students and their families. Caulfield Grammar, Melbourne **links all five campuses (one in China) through their Virtual Campus**.

> *"One of the school's aims is to establish a network of learning institutions around the world, linked together through strategic alliances and sharing best practice through the exchange of staff and students and the use of learning technologies."*[21]

See also Denbigh OnLine, UK.[22]

At John Paul College, Queensland, where each student has a laptop computer, course outlines, assignments, key teaching points and research suggestions are all available on the **school intranet. Remote access** enables student, parents and school community members to access these "anytime, anywhere". This individualised learning capability has allowed for individual differences in learning while clearly delineating the learning outcomes required at each level.[23]

Using Oracle software, (Think.com) Netherhall, UK[24] have created an **on-line community of students, most staff and parents with Internet access at home or work.** This has "torn down the classroom walls" and enables teachers to utilise the home computers to extend the school's capabilities. On-line communications are enabled and students can work on projects from both school and home. Students who are ill or absent for other reasons can maintain contact.

Bendigo Senior Secondary College, Victoria**,** host of the Navigator Schools' Conference in July 2000, has a highly developed intranet enabling each student and staff member to access course information readily**. Aiding individualised learning** has been a key goal for BSSC

[21] Caulfield Grammar spokesperson, quoted in *Educare News*, May 2000
[22] www.denbigh.net
[23] Also www.kingscollege.school.nz , www.kgv.edu.hk
[24] www.netherhall.cambs.sch.uk

and the school provides an impressive role model for others in ICT provision for staff and students.

Starship School, created by Edventions in Skokie, Illinois, is an example of a **commercially developed virtual school which existing schools can adopt to supplement the resources and administration services they already have in place**. Starship School provides validated, "kid-safe" databases of on-line resources, teaching plans, self-marking modules and the provision is expanding all the time. Web-based administration systems save schools time and staffing and a fully developed, on-line fundraising service has been well received.[25]

Schools linked to share classrooms and teachers

A **District Interactive Classroom** comprising classrooms replicated in four or eight schools was viewed at Edgewood College, Madison and Oregon, Wisconsin. These **distance learning facilities** operated not on the videoconferencing principle but were **interactive** so that what was happening in each classroom could be seen and participated in by each of the connected classrooms. Each room was equipped with a bank of monitors at the front and rear of the room, each monitor showing a different participating class. A roving video camera in each classroom automatically focussed on the person speaking. Each student in each participating classroom had a microphone mounted on their desk and when he or she asked a question, the camera moved in to film the speaker and the image was displayed on the screen.

One classroom led proceedings and the teacher had a document camera, video, data-show and other presentation equipment to use in the course of a lesson.

Although resource intensive, these classrooms offered an excellent **opportunity for schools to share scarce experts and to bring distant classes together for research projects**. In Oregon, a community Book Discussion Group used the facilities to excellent effect.[26]

District networks creating on-line learning communities

Developing the *virtual classroom* concept even further, school districts in the USA are using **highly developed networks to bring all public schools in the district together in a collaborative way**. Each teacher, student and administrator becomes a participant in the Learning Community. The Clark County school district, Nevada is an excellent model of this approach. Their *Technology Development Services* division, through the network InterAct, "concentrates on fast-tracking innovation".[27] InterAct hosts web pages for all schools, provides Internet access for teachers

[25] www.starship.com
[26] Pictures of this facility available
[27] Bruce Daley, Technology Development Services, Clark County School District, Nevada

and students (8000+ accounts) and provides a platform for collaborative resources. Teachers pay $12.50 for a lifetime account, students are paid for by the District. Students have to qualify for their computer *Driver's Licence* before getting their account (computer, e-mail and Internet training)

> *"The network provides space where teachers get used to working together – they collaborate and come up with inventive solutions. They use the contacts to teach each other and share resources. They get to know each other across 8000 square miles* ***- the network is creating*** **technological capital."** *Bruce Daley*

Areas on the CCSD Network include:

Exchange – where a person who can be a "shared resource" e.g. US Senator or a Native American storyteller, is available for asynchronous chat and some real-time questions and answers. These programs are cached and can be video-streamed to all schools.

Policies and Regulations, District documents with a search facility included.

lnformation for subject teachers, elementary and secondary; FOSS (Science on line), teacher tips, **Classroom Connect** (four scientists in the area attached to projects)**; Special events** e.g. the Treasures of Russia exhibition, are used as a basis for digitised resources for the TV station and picture videos on the network, printed resources are available for teachers to extend the knowledge gained on the trip to the museum.; **Concert series** (bands from schools in district).

QUEST – additional resources are made available for teachers through KLVX, the public broadcast station – videos and broadcasts supplement classroom teaching; field trips available in schools, requests for pictures sent out and these requests allow sharing of resources and planning.

Professional Development opportunities offered on-line

Virtual Art Gallery is not a *real* art gallery at all. The digital art works change every nine weeks and the lighting in the roof of the gallery changes depending upon time the computer accesses the site. A library could be made in the same way, with orchestral concerts for the schools,[28] Digital Art Exhibition published on CD for the district.[29]

It will soon be possible for students to place music auditions on the network so music colleges all over the world can access them for scholarships.

Virtual School tour – so that residents can see what the planned school is like when voting to have it in the neighbourhood. (55 new schools are to be built in the next 10 years).

[28] Comment by Bruce Daley
[29] CD of Art Exhibition available on loan from the author

After-school tutorial programme meets twice a week and all sorts of topics are covered: health, nutrition, hygiene, music, arts, fine arts (this was a student idea).

Ask the Experts Students submit questions; research teams of high school students try to answer: if they cannot, university personnel work on the question. Each month there is a special focus e.g. in September/October there was a Mock Election, prior to the USA elections.

Junior Web Fifth Graders did not like some of the sites the adults recommended so came up with their own grading criteria – when they find sites they like, they submit their evaluation for inclusion on the network. The site of the week is featured. There are plans to do the same with Book Talks. Preparing items for the network develops children's analytical skills.

Global Village Students and teachers from schools from different countries form this. Schools from England, Scotland, Canada, Germany, Sweden, and New Zealand connect at night to discuss issues – e.g. arming Police and they get to know each other and their views.

Private contact areas available for teachers or discussion groups.

Global moderators offer customised conferences for new teachers. This concept would be very useful in New Zealand for those in their first five years of teaching.

> "Social networks are very important in building the human capital of the district"[30].

Other areas visited offered district-wide services to schools. Los Angeles Unified School District has created a **virtual museum,**[31] offers district information, professional development and has 2000 plus videos which they make available on demand via network and, using high band width via cable, download educational programmes in "off hours"; schedules sent to schools and selections recorded on demand. (The Internet will soon supersede this technology.)

District 214, Chicago, Illinois,[32] where the entire curriculum is available on the website, offers data support, all **registrations are on-line**, cataloguing of all **district databases** (60+) on web. **Livetext allows teachers to put up content on a webpage and enables them to offer on-line classes.** Conferencing, calendar, fostering collaboration, conferences, students will have email addresses throughout district. BadgerNet, Wisconsin links all schools that have suitable connections.

[30] Bruce Daley, Technology Development Services, Clark County School District
[31] www.lausd.net
[32] www.dist214.K12.il.us

The BECTA site, England[33], *Connecting the Learning Community*, offers a range of national services including the National Grid for Learning site, a Virtual Teacher Centre providing information and resources for educators using ICT.

The DETE network in South Australia **DESCtech2001** (Department of Education and Children's Services technology plan) **has set up LAN's in all schools with Internet connections. A state-wide LAN connects all schools with ISDN**.

New Zealand's Ministry of Education website[34] offers national information and Te Kete Ipurangi[35] is the portal for on-line resources for the New Zealand education community.

The concept of on-line learning communities is fast developing and has the potential to transform the way teachers connect, collaborate and achieve professional development.

Web hosting by an external provider

In Hawaii, the Maui High Performance Computing Centre (MHCCP, to be renamed SuperComputer) is the largest Internet service provider (connected to over 600 ISP's) and offers service hosting and can store programmes for schools. There is an **E-School with virtual spaces where students log-on for real-time interactivity "like a sandbox"**[36] where they meet, discuss, share ideas and co-operate. Bill Wiecking believes that **Chat and instant messaging** will be important communication media in the future.

MHPCC also offers:

ASP – **Application Service Provider**– e.g. allowing schools or companies to go to a page and do wages every Friday so there is no need to buy licences, or maintain software in workstations. Also they provide AutoCAD, a high cost application beyond the means of most schools, hosted by SuperComputer (MHPCC); students can log on, take the course at their level, work and then save to the web. Students can log on at school or at home.

Sixty-two schools in the Hawaii Association of Independent Schools through the state are involved in a distance learning project through SuperComputer. **Remote coaching** is also hosted and used as a professional development tool.

One school needed a computing teacher so is now videoconferencing with a school that has a teacher with 8 students. The teacher has on-line hours

[33] www.becta.org.uk and http://futureclass.ngfl.gov.uk
[34] www.minedu.govt.nz
[35] www.tki.org
[36] Bill Wiecking, Manager of Educational Programs

and class hours, but, as Bill Wiecking says, “this is not a total solution because a class needs a “warm body” at times also”. A school has also hired an astronomer in this way for a number of hours.

Videoconferencing chat with a shared whiteboard screen: Snapshots of the participants are represented on each screen connected to each of the nine participating sites – Boston, Hawaii, Maui, New Mexico and others. “Some participants appear in bathrobes to emphasise the time difference”.

Streaming media: Real media (what everyone uses for radio, TV and taping movies for demand viewing) when hosted in a server enables up to 2000 to watch a hosted video at once. For example, people in six or seven continents watched MaryKnoll’s MayDay celebration in Hawaii. (NB: There are only 200 students in this Grade School). Also, personnel from the University of Hawaii at Hilo audiostreamed, in Hawaiian language, interviews of “old” Hawaiians. There is now a database that allows you to select the categories you want to access.

Digital Video – At Hawaii Preparatory Academy[37], students **make and edit digital films**. All the video is recorded and edited at school and uploaded to the Maui server at night. **Relatives in the mainland can hit the server at night and view the films**. Live screening of video is possible also. Another project, *SeeMore Turtles*, involved students placing video cameras in a very secluded reserve, a turtle habitat. Waterproof cameras are aimed at the turtles and from the school, students can control the cameras and pick out the turtles they want to see.

Streaming Server – asynchronous: Because the streaming server catalogues all of the contents, users can choose the item wanted and it will download just that. (“Rather than non-streamed where you used to have to wait a long time and watch the whole thing. You don’t have to have big connection you can use a 28K modem.”)

Classroom redesign for maximum flexibility

The advent of ICT has allowed – many would say, demanded - the classroom teacher to develop more individualised approaches to the learning needs of students. The immediacy brought to classroom experiences by contact with on-line experts, the world’s best libraries and encyclopaedias via the Internet means that curious students can learn far beyond the planned lesson.

Using laptop computers

In the search for flexible teaching styles, schools in more affluent circumstances have invested in, or engaged parents in the purchase of, mobile learning technologies (laptop computers, I-Books) for each student. ***Laptop schools*** proliferate through the countries involved in this research

[37] www.hpa.edu

and much is written to support the success of the **24/7** (twenty-four hours, seven days a week) **access to ICT** and the Internet for students.

District 214, Illinois is conducting **research into the effectiveness of laptop technology in learning** using 90 IBooks with a wireless network. Pre and post research being carried out on both the control and experimental groups for a year at least beginning January 2001. Two identical courses are being taught – one with 24/7 (24 hours, 7 days a week) IBooks, the other without. Three test areas will be involved, English, Social Studies and High-risk students. Testing involves both an attitudinal survey and academic achievement, measured on standardised test. Every week students are given a survey to measure progress and detect problems.

> *"We are trying to measure how student-teacher interaction changes and whether the types of learning activities are different with the application of technology."*[38]

Virtual Learning System (VLS)

At Fenton Charter Elementary School, San Fernando, **a desktop computer has been supplied for each student from Grade Two**, and children younger than this have ready access to computers for appropriate tasks. The school engages in a **Virtual Learning System** whereby **all resources are digitally stored and children pursue individualised learning programmes.** The dynamics of the class were quite different from a traditional classroom and it was interesting to view a classroom of Grade Six students who had been involved in the VLS since Grade Two and whose new computers had not arrived by the end of the first week of the semester. Both teacher and students were finding the adjustment to a whole-class, "whiteboard and folder paper" environment difficult. It was allowing more emphasis on handwriting, but the teacher said that she had forgotten the "I'm finished. What will I do now?" syndrome as students on-line always had personal investigations and research projects underway.

Desks, each with an IMac, were placed in groups of four or six in the younger classes and in double rows, with students facing each other, in the older grades. Storage areas for books, pens and resources were established between each computer and moveable dividers were placed between students for assessments.

Flexible facilities in Science

Science facilities at Edgewood, Madison aimed for flexibility by **having mobile bench units able to be networked via ceiling points**. Michael Kinnaird[39], when demonstrating the mobility of the science facilities,

[38] Ken Wiseman District Technology Co-ordinator
[39] Advanced Technologies Academy, Nevada

commented “fixing the teacher’s demonstration area in one place was a mistake as it reduced the flexibility of other possible configurations”.

Redesigned science facilities at Worth and King George V School placed computer areas in one or two spaces in the laboratory, work desks/benches facing whiteboards and monitors, with practical work areas in easy reach of both.

For practical work in science at Parry Sound High School, North Toronto[40], free-standing bench units are made into required sizes from **trapezium-shaped, movable components that can be reconfigured around central “cores” to which water, air, gas, electricity and network points are directed**. Further flexibility was gained by a computer area extending into the generously-sized corridor. A **combination of a roller door inside the lab and lockable doors into the corridor, enabled computers in this area to be accessed from the corridor** when the laboratory was not in use.. All computers used in the classroom are linked to the teacher’s computer and display unit so demonstrations can be made in the teaching area, facing the main monitor or via each individual student’s screen.

Portable Hubs

Over the past few years, schools such as MLC in Melbourne have created this flexibility to some extent by the **use of portable hubs** which provide up to 16 connections for student laptops from a single plug-in point that connects all sixteen to the intranet and Internet.

Tools for Flexibility

Laptop carts

Providing security, network connection and recharging for up to 30 laptops, laptop carts, *pictured on the front cover,* were in use in many USA schools. A Teacher Assistant (TA) managed the cart maintenance and bookings. Able to be wheeled from classroom to classroom easily, the carts **give teachers flexibility through access to a class set of computers when needed** without the space implications of permanent desktop PC’s. Lift access enabled their use in multi-storeyed buildings.

Interactive Whiteboard

Niel McLean[41] cited the use of the interactive whiteboard (IWB) as a key tool for enabling teachers to transform their teaching activities. Connected to the teacher’s computer and data projector, the whiteboard becomes a

[40] Viewed in 1995
[41] Director, Evidence and Practice, BECTA, UK

touch sensitive computer screen, and changes made with light pens or electronic erasers are saved into computer files.

Using the IWB to share prepared files with the class enabled closed, private and transmissive teaching (where teachers maintained control of the classroom), to move through stages to more open, collaborative and interactive teaching styles. Control is thereby shared with the students and the needs of varied groups within a class are met.

He explained the evolution in terms of *Stages, Control* and *Arena:*

STAGE	**CONTROL**	**ARENA**
First Stage	Private	Private
Teachers controlled classes in closed classrooms		
Second Stage	Private	Public
Teachers still controlling but interactivity includes others (teacher still controls the IWB)		
Third Stage	Public	Public
Where teachers empower students to organise their learning in an open arena		

Jenny Noel-Storr, Head of Redhill Primary School, Shropshire[42] believes the IWB to be "dramatically successful"[43] in enabling ICT use to permeate the school. "The whiteboards combine with data projectors to give teachers complete, touch-sensitive control of the computer from the front of the class."

Additional software can enable on-screen chat between teachers and students and remote control of the data from a student's individual screen.

Using the IWB at Greensward College, Hockley [44], desktop documents can be displayed (Word, PowerPoint, graphics etc) then adjustments made during the **lessons are archived, with time and date, for recall and revision. This has cut down dramatically the amount of photocopying, text and paper resources. Students who have missed lessons can download these to take home**. The school is preparing to create a 24-hour Lifelong Learning Centre for pupil access anytime, anywhere.

[42] http://atschool.eduweb.co.uk/redhill.primary cited in *ICT in Practice Awards, 2001*, BECTA
[43] TES Online, January 5, 2001
[44] *The Classroom of the Future* DfEE, 2000 http://futureclass.ngfl.gov.uk

Portable presentation system

An interactive presentation station for the classroom could be wheeled between rooms and took up very little room. It comprised a hard drive, data projection, document camera and digital recording camera which enabled computer images to be displayed on wall and filmed as the teacher made adjustments with a light pen during the lesson. Internet connection, keyboard and mouse were included and all were mounted on sturdy cart Lessons can be programmed in and all saved to network or hard drive for retrieval by students later.

Wireless technology offers new options

Schools are **combining the use of wireless networks** – connecting laptop computers within a radius varying from 50 metres to 30 miles[45] **- with already established cabled networks**. This provides "**the ultimate flexibility**" according to Marco Torres, Apple's Teacher of the Year, who is the Technology Co-ordinator at San Fernando Senior High School, California. Picnic tables with shady umbrellas have been set up in the courtyard outside the second-story main laboratory and students are able to work in more relaxed surroundings while still having connectivity.

H P Academy, Hawaii used **wireless cards in their laptops** when studying the regrowth of plants in a burnt out area. Students from different areas of the study scene took **digital pictures** and downloaded them into a central database. The **school jeep, with a wireless broadcast antenna beamed the pictures back to school**. They compared results on site and the pictures were also discussed back at school. The teacher suggested an expert on the mainland who could look at the pictures and comment on what they have found. Now the students are overlaying their data on to old surveillance maps and creating a useful resource.

At Hamakua, **wireless broadcast antennae** were set up in 5 schools to assist students who "do interesting stuff at school but have **no power at home**" (Power only on 2 hours a day.) They **take laptops home** and do interviews of old people. Then download the information back to school.

Similarly, at John Paul College in Queensland, classes are gradually being provided with wireless cards for their laptops. Flexibility in classroom groupings and activities has been enabled by **freedom from having to be connected to stationary network points**.

Because **WAN technology (wireless area networks) obviates the need for costly cable infrastructure**, schools embarking on ICT provision at this time, could well save considerable expense.

[45] Quote: Bill Wiecking, Maui High Performance Computer Centre, Maui, Hawaii (SuperComputer)

Changes in traditional library areas

Resource-based learning has placed a heavy reliance on school libraries so I was interested to observe how learning technologies had changed the configuration and operation of libraries. All **had computers available for accessing catalogues and on-line resources and the most proactive included facilities for students to create digital presentations**. It was seen as increasingly important to ensure that staff in the library understood curriculum objectives and had the will to become a "**cybrarian**".

Media centres where computer access, digital presentation equipment and reference materials are combined in one central area e.g. Elk Grove, Chicago District 214 where the media centre comprises 100+ computers attached to library pending integration into single space. Separate writing room adjacent.

MLC Sydney - the **Independent Learning Centre** is a four storeyed building combining laptop service centre (ground floor) integrated library and IT services on each floor; fiction area and multipurpose space on top floor. Double-glazed, silent reading and study rooms are incorporated on each floor and computer suites are located on two floors.

Worth School, West Sussex – Featured an **Integrated Learning Centre** combining their computer training laboratory with reference and fiction resources.

Oregon, Wisconsin – Information Centre also **distributes video on demand to teachers in classrooms**. The keypad on the telephone in each classroom has the dual function of video control.

The Resource Centre at John Paul College, Queensland, (library) comprises Fiction Lounge, IT teaching area with screen and projector, research area, **multimedia teaching room attached with removable walls** and Primary library area. The laptop station with screen and printer provides a space where students have free use of scanners, printers, data-projector, video, and monitors to connect to their laptops.

Research Question Two

How is ICT use changing the way teachers and administrators approach curriculum delivery?

The impact of ICT on student learning

Much has been written elsewhere regarding ways ICT can be used in the school curriculum and these are not included in this paper, except by way of illustration. My research focused on curriculum practices reflecting fundamental changes in understanding about how the new technologies could support and enhance learning.

The Need For ICT Integration In Schools Recognised

In each of the countries visited, national authorities recognised the need for change to integrate ICT into curriculum delivery. In the USA, IT standards have been produced and in the state of Wisconsin, IT standards have been developed and published directly relating to curriculum standards. Funding differs from state to state e.g. centralised in the LAUSD: government funding supplemented by a private fund-raising for innovation through a Public Education Foundation in Nevada. In the UK, guidelines have been published (IT booklet) although Director of BECTA, Niel McLean stated that OfSted evidence suggests that schools in UK are bimodal regarding ICT. "A significant group (30%) are at the leading edge, there are others who haven't begun to grapple with it at all." Each state visited in Australia demonstrated a commitment to ICT in schools with Victoria and South Australia devoting high levels of funding to support the development of techno-literate graduates.

Research studies have identified the key changes in student learning behaviour attributed to the use of computers, the Internet and other learning technologies.

Researchers Robert Bracewell of McGill University, Therese Laferriere of Laval University and the consulting firm of Reginald Gregoire, Inc collated summary observations and reference points from a wide range of research papers pertaining to the integration in the classroom of information and communication technologies.[46] Their results grouped firstly, around the specific learning achieved, student motivation and the relationship of students to knowledge. Secondly, they grouped

[46] Full paper at http://www.fse.ulaval.ca/fac/tact/fr/html/impactnt.html *The Contribution of New Technologies to Learning and Teaching in Elementary and Secondary Schools*

observations related to the consequences of appropriate use of technologies on the teaching function of teachers, including planning of teaching, intervention with a group of students and the assessment of learning. They identified "participants having knowledge and skill in computer use" as a prerequisite to effective classroom use and noted that many studies researched did not deal with this issue for students or teachers.[47]

Changes in student behaviour attributed to ICT

Their fourteen observations relating to the changes brought about by effective classroom integration of ICT were as follows:

1. The development of various intellectual skills is noted e.g. reasoning and problem solving, learning how to learn and creativity.

2. Specificity of what is learned using the new technologies is broadened and deepened.

3. Students demonstrate a greater spontaneous interest in a learning activity

4. The time and attention devoted to learning activities increases when students use ICT.

5. The ease of access to information sources develops the research spirit.

6. Broader co-operation among individuals within and beyond school is enabled through technologies.

7. The availability of simulation, virtual manipulation, graphic representation and rapid merging of data contributes to linkage in knowledge and leads to more integrated and better-assimilated learning.

8. Teachers gain information on new instructional resources and availability of support for their use much more readily with ICT.

9. Teacher co-operation with others both within and beyond the school when planning activities.

10. The orientation of planning is more towards students performing real work in co-operation with other students.

11. Relationships between teachers and students more interactive and guiding, rather than transferring information from teacher to student.

12. A different vision of teaching and learning; learning seen more as continuous research than a body of facts.

[47] .This is an important pre-service issue for teacher training. New Zealand teachers are currently being encouraged in ICT skill development through the Ministry of Education technology school clusters throughout the country. See also the Navigator Schools' project in Victoria.

13. Assessment of learning uses more demanding methods

14. More effective diagnosing of specific difficulties.

It is of critical importance that changes such as the above be accommodated when planning suitable programmes of learning for 21st Century students.

Curriculum Changes Need to be Planned

Marie Jasinski[48] states:

> *"There are eight defining principles education will have to meet in order to satisfy market demand in the knowledge economy with its convergent technology infrastructure."*

These are:

1. lifelong learning
2. learner-directed learning, with the teacher becoming the facilitator, diagnostician and therapist
3. learning to learn so that individuals can plan and realise their own learning
4. contextualised learning
5. customised learning, designed to meet different needs, preferences and cultural practices
6. transformative learning, enabling the changing of belief systems to overcome disability and disadvantage
7. collaborative/co-operative learning
8. just-in-time learning, as individuals choose from the global *supermarket* of opportunities.

These combine to give a radically changed model of education from last century's teacher-centred schools delivering set curricula, chosen and sequenced by the teacher. Students respond intuitively to technologies that have surrounded them all their lives. For them,

> *"the Internet is instantly interactive and the user can control what happens. It responds to the individual and is an empowering medium that allows them to do things that their teachers don't understand or can't do."*[49]

[48] TAFE, South Australia *Teaching and learning Styles that Facilitate On-Line Learning*
[49] David Campbell. Independent Education, October, 2000

So how far have we come in achieving the desired student-centred classrooms, featuring a range of teaching and learning styles and technologies with 'the teacher's voice one among many'?[50]

Not far enough, is the short answer.

Reasons for Delay in Integration of ICT in Schools

In 2000, a group of New Zealand secondary school staff cited the following reasons for the delay (in no particular order).

- Teachers' lack of ICT qualifications
- too little time to plan and learn the skills effectively
- student anxiety to learn only what would be tested in examinations
- lack of money leading to limited access to computers
- expensive software
- timetable restrictions
- lack of creativity
- limited availability of equipment such as data projectors
- unwillingness to change
- difficulty in linking ICT to the curriculum
- needing IT facilities in classrooms rather than laboratories

Equity issues were identified as an inhibitor in some states in the USA as it was held unfair to promote the activities of one particular school until all schools had the connectivity and ability to benefit from an IT programme. Consequently, while IT enthusiasts celebrated the work of individuals and visionary schools, they felt frustrated that similar initiatives could not proceed state-wide.

The Use of ICT is Changing the Ways Schools Operate

Changes are occurring, however and these will be discussed under the following headings:

1. Rethinking The Timetable
2. Growth Of On-Line Learning
3. Rethinking What Is Being Taught
4. Real-Life Learning Experiences
5. Teachers Collaborating To Share And Develop Expertise

[50] Paul Butler , Caulfield Grammar, Melbourne

Rethinking the timetable

Debunking myths about timetabling

Niel McLean,[51] applauds the schools using IT tools to enable the kind of **data collection that helps schools make informed decisions and choices**. "For example, there is a myth that you can't have double Mathematics on a Friday afternoon – but is this so? How do we know? Tracking test scores to find out if there is a significant difference is now possible because this myth is a timetable constraint that is not necessarily true." Schools can now be **more flexible with timetabling and school organisation. To measure effectiveness**, data can be collected after changes and tracked. Schools are receiving much quicker and more reliable feedback with IT.

Do all subjects need to be timetabled?

MLC, Sydney reviewed subjects being taught and identified **Music** as one that could be **tailored to meet the needs of students without being timetabled** in the regular way. Excellent facilities are available to students and all music is taught on a contract basis rather than permanent staff basis.

Staff mapped the Music curriculum, outlining the **key competencies** in each area of the course - aural, musicology, composition, performance. They created **a grid of these and tasks and assessments** for each outcome.

Most music teachers do not have classroom lessons. Years 9, 10 and 11 Music is scheduled at same time and if a student or students need class contact, they get it. Music is still on students' individual timetables and there is a Year 9, 10, 11 Resource person for each group of students. Students log on to "Trackit" where tasks and assessments are recorded. There is a composer in residence who gives student time; student performances, including **all extra curricular activities**, have been **brought into the curriculum and gain credit**.

Breaking out of the timetable "straitjacket"

In the **Year 7 and 8** area, MLC, Sydney, have created a **more flexible timetable to provide a "line day" every second Tuesday**. Every department wanting to be involved gives one period a week so **that every 6 weeks they gain a full day for that subject** e.g. English, Humanities.

[51] BECTA, UK

There are two compulsory staff team meetings per week; the Mathematics Department opted out of line day so Maths lessons are not scheduled for a Tuesday. Because Languages have only two classes per week, they do not give up a period for line day. All exams to be held on Tuesdays (no home room times on Tuesday)

Line Day has lead to **more flexibility, more project - based study** and the extended time of Line Day encourages teachers to plan time use effectively.

At Leosowes, UK, every Friday is a **Flexi-Friday**, **where one subject is studied from 8.30 am until 1.30 p.**m. For example, on the English Flexi-Friday, classes created *Romeo and Juliet* storyboards using the digital camera; they found sites within the school to stage scenes from the play and recorded their performances. PowerPoint presentations then made with pictures, text and sound.

Worth, West Sussex have a **Learning Together Day** where the timetable is collapsed on a regular basis to allow Year 9 and 10 students to participate in a lot of different learning activities, relating to learning needs. E.g. juggling, mindmaps, time management, memory development, miming and higher order thinking skills.

Advanced Technologies Academy was established 5 years ago with a clear technological vision "which teachers are coming to terms with".[52] Traditional timetabling was holding back achieving the IT vision for the school so, to overcome these drawbacks, the school now **operates on 8 classes a day for three days with a block schedule for 2 days**: 6.45 am until 2.05 each day.

To create more flexibility for students, classes in the Oregon School District High School are scheduled in **90-minute blocks, with five teachers allocated to one hundred and twenty-five students**. This allows for more creative approaches in curriculum delivery and requires advanced planning to ensure that the needs of students are being met. All school organisation is based around the House concept.

Growth of on-line learning

Web-Based Courses

A key area of rapid growth has been that of on-line learning, both in web-hosted environments and in packaged form on CD. The use of **web-based courses** is **proliferating** in Australia and the USA. Schools are providing wider curriculum choices and more individualised programmes through the use of web courses; home-based students of all ages are now able to choose courses and gain qualifications from a widening range of organisations.

[52] Principal, Michael Kinnaird www.atech.ccsd.k12.nv.us

www.ultralab.net, www.notschool.com and www.vsg.edu.au are examples of web-hosted, virtual classrooms where the students may be distant from the teacher and resources.

Curtin University, Western Australia[53] has developed a comprehensive offering of on-line courses, qualifications and resources for educators.

Consortia of Schools

Co-operative ventures between schools are being developed e.g. Florida High School[54] and The Concord Consortium, in New England,[43] where a consortium of 10 school districts has combined to create a virtual school. Each agrees to provide a teacher and can enrol students in proportion to the number of teachers provided.

Rupert Murdoch's News Corporation announced[55] "a joint venture with eighteen leading universities to tap the global higher education market. This consortium, called **Universitas 21**, includes the University of Melbourne, University of Queensland and University of New South Wales, and it represents … the **birth of a private, global, virtual university** controlled by News Corporation, which will purchase and deliver course content via its Internet, interactive satellite and television services."

Technical Colleges **in the USA are creating** virtual high schools for practical subjects where they find it difficult to get teachers, and for advanced placement courses**. The models range from Correspondence School on-line to a project-based method of delivery where a co-ordinator checks on students once a week to see how work is proceeding.**

Powerful School Intranets

Bendigo Senior Secondary College, Victoria is working with a software group to develop Year 12 certificate courses on-line. Twenty of these VCE[56] courses have been prepared, **supplemented by courseware on CD**. See www.xsiq.com. This company also has certificate subjects for New South Wales and Queensland.

Staff at Netherhall Secondary School, Cambridge [57] developed **CD resources** that are now being put **on the web**. They are also involved in a **digital TV trial involving 100 families** which increases the interactivity possible for students studying from home.

[53] www.curtin.edu.au
[54] http://fhs.net Florida High School
[43] http://vhs.concord.org
[55] *Education Age* 31.4.2000, Australia
[56] Victoria Certificate of Education, Australia
[57] ICT Coordinator, Alistair Wells; www.netherhall.cambs.sch.uk

OAC, Open Access College, Adelaide, is a distance education community with the school complex based at Marden. **A range of technologies is used to deliver the curriculum: print-based, video, interactive CD, interactive conferencing screens with on-line audio-conferencing taking place through the telephone for one-on-one or more students to a teacher**. The multimedia production suite employs 11 people producing interactive CD resources as well as contract work for community organisations. **Careful analysis takes place as to which aspects of the curriculum are best suited to each medium for teaching and learning** eg for teaching graphing to two students, the interactive screen and coloured "pens" were used so that the teacher could see what each student drew in response to the conversation.

Further web addresses for on-line learning institutions are provided in the Appendix.

Rethinking what is being taught

Authentic contexts

Teachers in schools using ICT effectively, soon find that much of **the repetitive "busy work" and unreal, contrived exercises are no longer relevant** in an environment that allows students direct access to engaging information sources. This realisation has led to new approaches being made to curriculum content and the encouragement of information literacy skills development. Students are being encouraged to use higher order thinking and given strategies for powerful learning in this new environment.[58]

Using Higher Order Thinking Skills

At John Paul College, Queensland, strong school policies regarding the integration of IT and research in the curriculum have seen a greater emphasis on digital presentations; these have lifted senior scores and oral communication considerably. **The "hunting and gathering" side of research has been closed down resulting in much more analysis and synthesis of information.**[59] All **assignments Years 8 – 12** have to be submitted to HIS who checks **resources available, higher order thinking content and ICT content** prior to approval being given. She thus has a global picture of what students are studying; works closely with academic staff and Director of IT. Redesigning activities for digital form has been challenging and began with Social Sciences.

Because of IT projects in junior schools, **the exercise book size has been changed to A4 with lines on one page and plain on next**, printed

[58] An excellent New Zealand primary school example of ICT integration can be seen at www.tahatai.school.nz

[59] Head of Information Services, Kerryl Fleming

especially for JPC. This allows the seamless integration of handwriting and desktop publishing.

Revising course materials for on-line learning

For publication on the **school Intranet**, what is being taught has been reviewed and rewritten by staff. Students can access the curriculum and find sections entitled: Essential learning: Basic ideas, Themes, Assessments (self-assessments, major assessments), Concepts and Concept Checks, What is being taught, Required Assignments, Useful resources, Key information and ideas, Things to follow up and Extension.

Providing Structures for Learning with ICT

At Worth School, Sussex, a **strategy sheet** is now used by all students for longer assignments with the aim being to **structure students' thinking** and encourage them to **evaluate the best methods** for approaching a task (which may not involve computer use).

Marco Torres[60] requires teachers to complete planning guides prior to using learning technologies. They match their tasks with ICT and curriculum objectives and must include HOTS[61] components in their tasks.

Promoting Powerful Learning

Staff members at Glen Waverley Secondary College, Bendigo, use computer technology to support Teaching and Learning. There has been an **unequivocal focus on theories of learning, brain research, powerful learning, learning to learn, metacognition, visual organisers and other thinking strategies**. Principal Darrell Fraser's keynote entitled *Thinking and Learning Skills: the last Hurrah?* explored the essential ingredients in creating and sustaining a learning community based on **defining the Thinking Curriculum**.

The school mission is **Developing Autonomous Learners**. Do we teach them to be autonomous? What do they need to be able to do? What is powerful learning and how do we enable students to develop the skills to be powerful in learning? How do we promote it?

To promote a thoughtful classroom, teachers have been trained in strategies to **foster metacognitive processes, to learn and apply critical thinking skills and use the language of metacognition.**

GWSC ran a *Learning to Learn* programme for Years 7 to 9 with a Teaching and Learning coach supporting staff to make the changes needed to focus more clearly on thoughtful classrooms. There **is school wide use of thinking "scaffolds" and organisers**. **For one semester, each class**

[60] Apple Educator of the Year, 2000
[61] Higher Order Thinking Skills

was withdrawn for 20 lessons (100 minutes a week), the aim being to move from **Thinking Skills to Thinking Classrooms.** [62]

All staff also went through the course so that there was a shared understanding of what the terms meant – e.g. metacognition, co-operative learning, etc

"Just in time" learning not "Just in case"

At the Technology School of the Future, Adelaide [63]Sue Hollands conducted research - 4MAT[64] - into the effects IT has on Mathematics teaching. IT enables "**Just in time" teaching rather than "just in case" teaching**. It is important that students gain the "big ideas/issues" in Maths, not just disconnected skills.

> *"Maths will encounter the most radical changes through technology use: Some Maths will be more important, some will be less important and some will become possible: Henry Pollak".* Quoted by Sue Hollands at ACEC conference, 2000.

Providing real-life learning experiences

Advanced Technologies Academy, Nevada has a **Business Applications Classroom set up like a corporate office.** Entrepreneurship, accounting, the use of business laptops, fax, copier, phones are taught.. The room is divided into office cubicles, round meeting tables and a board table. The school also has a **partnership with Metro crime Laboratory for their Criminalistics course.** They were given a $100,000 ballistics matching machine; students study crime scenes and collect data on fingerprints and forensics.

Digital design students undertake commercial projects for the Las Vegas business community.

Gold and silver mining is an important part of the history of Nevada. Five years ago, two teachers at Gordon McCaw Elementary School, Henderson, Nevada[65], asked permission to build a papier mache mine tunnel in the classroom, to give the children an idea what it would be like to be a miner. The idea grew and now the school has built a **full-sized Silver Mine complex.** Full-sized tunnels have been created with displays depicting the mining process and teaching areas. These comprise a Geology room, fossil dig, antique equipment displayed with modern technology. Animated figures explain the stories for the children e.g. the origins of the terms,Tommy-knockers and the horse-shoe.

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[62] *Thinking About Thinking* excerpt from Fogarty 1997 and other sheets

[63] Paper delivered at NavCon 2000, Bendigo Senior Secondary College

[64] Documentation available. Outline of a collaborative research project with all the planning documents, topics and approaches, skills and marking schedules. http://www.tsof.edu.au/LT.SA

[65] Principal: Janet Dowbry

A group of senior citizens form the volunteer force to operate the **free field trips other schools make to the facility** each year. **Teaching resources are available on the Nevada school district network.** Teachers bringing classes on field trips, come in for a day of training and preparing resources. Once they have completed the day's training, they can book a field trip.[66] **Grade 4 and 5 students are tour guides one day in 20 weeks** and train with the senior citizens. Nevada history is in the Grade Four curriculum. Other community partnerships include speakers at Geology or mineral seminars, University of Nevada-Reno, McCaw School of Mines, people who mine crystals will put pictures on the web and are available to answer the students' questions.

A CD of the McCaw Silver mine and other similar school-based field trip initiatives **(Marine Laboratory at McDougall, Whitney Mesa nature trail**.; Vandenberger **Biosphere, dome built over courtyard;** Lammas farm) has been prepared by Clark County School District.[67]

The Clark County School District assigns .5 of a teacher's time to the Marine Laboratory and Nature Trail.

The world-wide **Jason Project,** which invites young scientists to participate virtually in research of interest, this year is studying volcanoes in Hawaii. Students are encouraged to become involved and are prepared so they will have plenty of interesting questions to ask. Nevada puts 19,000 students through the Jason Project.

Students at Netherhall, UK, go on **virtual fieldtrips** around the world, preparing visual stories so they can communicate without language (e.g. students in Prague; Chemistry exploring atmosphere of Venus and using research to test spacecraft materials in the laboratory.)

The **use of on-line experts** at Netherhall, UK, enhances the curriculum for students. Emails sent out to the school family resulted in the identification of over 30 people expert in their fields who are willing to respond to questions posed by pupils (Head of Astronomy, footballer, dietitian, head gardener, voice recognition specialist et al.)

At Marshfield, Wisconsin, a group of students were taken **on journey up the river in birchbark canoes, retracing the voyages of 1790's**. They studied the original journals of the time (from the web) and students made multi-media presentations www.marshfield.k12.wi.us/socsci.html Also followed this format when students studied WW2, interviewed veterans and created their presentations. [Same website with /WW2 extension].

At LAUSD, Joe Oliver who visited JPL (Jet Propulsion Lab) and the Planetary Society developed the **Mars Rover Project** at the time of the Mars landing. Teachers in different schools signed up to take part. Building and operating the Rover has to be an integral part of the curriculum in Science and Maths (calibrating the Rover, Cartesian co-ordinates, physical sciences etc).

[66] Supporting materials and slide show available. CD of other field trip sites at elementary schools.
[67] Copy given to the author

Doing the project meets curriculum goals and satisfies appropriate standards for Grade 6, 7 and 8 level.

Each school dedicates an 8' by 8' space to be used by the Rover and builds the robot which has a video camera on top of it (operated by laptop). Then these are collected and redistributed to schools unknown to the makers. The task then is to create a map of the new area through processing the image data gained from the Rover. Students have to work as a team to enable sense to be made of the data. A Laptop computer is used for co-ordinating the image data and students have to deal with any breakdown problems as if they are fixing them from Earth.

Teachers collaborating to share and develop expertise

In each of the areas visited, teachers had the opportunity to meet and collaborate virtually through shared networks and web-spaces. These co-operative sharing and learning communities are transforming the way teachers work and their attitudes towards sharing and learning from each other.

In addition to the government provided virtual meeting places, individual schools, universities, philanthropic foundations and commercial enterprises are creating ways for educators and IT specialists to interact and collaborate.

In a time of rapidly advancing use of information and communication technologies, the old model of an individual teacher isolated in the classroom has gone. For students and teachers to effectively participate in, and benefit from, the global learning community, each needs now to reach out and share in the on-line opportunities available.[68]

[68] See Appendix 1 for selection of sites

Conclusion

Throughout my study, there were visionaries, be they teachers, ICT co-ordinators, school heads or administrators in government roles, creating learning opportunities for students using ICT. Strategies for encouraging (or requiring) whole staff take-up of integrated curriculum use of ICT, features in the two to five year plans of almost all schools and education districts visited.

> *"The terrifying thing about this technology is what it tells us about the rate at which children learn"*, Jenny Noel-Storr, Redhill Primary School, Shropshire.

Once ICT becomes an integral part of student learning, teaching styles and classroom organisation cannot remain unchanged.

The Future of Schools

William West[69] sees the future Australian student as

> *" … one who may spend a few hours in a neighbourhood learning centre, primarily to help pick up social, sporting and cultural skills but possibly for some teaching and tutoring in certain subjects. This input could be followed by online tuition, possibly from home, with tutors drawn from all over the country or the world. The student might then log on to research his or her latest project, drawing on the latest information from the world's leading libraries and research institutes". The staff in this scenario will be more diverse, with a greater emphasis on specialisation."*

During a panel discussion in July 2000[70], key features of schools in the future were identified as including:

- downsizing from overlarge schools
- collaborative endeavours will become more common among schools and districts
- there will be a greater emphasis on communication, community and creativity for high, value-added organisations
- "the right connections and the right tools" become more important, emphasising the need for effective technologies

[69] Education Review, Australia, March 2000

[70] ACEC, Melbourne. Speakers Stephen Heppell, Bernard Hollkner, Sue McNamara, Lynne Schrum

- interactive, asynchronous discourse becomes an important learning method
- simulations and virtual field trips become more common
- schools must recognise the need for authentic learning and that it cannot be assessed in old ways or against "old" criteria;
- students will spend less time on campus
- formalised relationships with experts will develop beyond school
- the learning process becomes dynamic, exciting and fun using technology to learn in ways never before possible.

There will also be a continuing focus on ways ICT can streamline administrative tasks, giving students 24-hour access to learning resources.

Countries promoting developing ICT usage and integration to a higher level and most effectively to date, have been those with the most need to connect to information and institutions e.g. to quote Bill Wiecking, "technology reaches over dangerous stuff like sea and desert for Maui and New Mexico." In Australia and New Zealand, too, both long distances from Europe, Asia and the Americas, there have been real advantages in connecting communities nationally and internationally. It is no surprise then to find that best practice ICT use in schools and institutions with geographic barriers to overcome, appear to be ahead of counterparts in other areas studied in this research.

It has also been noted that where rigorous examination systems and prescribed learning outcomes control the curriculum, it is much harder for innovative use of technology in the curriculum to occur. While creative use of ICT has been observed in all schools visited, more timetable flexibility has been implemented in elementary (primary) schools and in states in Australia and USA where national external examinations do not dominate curriculum delivery, e.g. Queensland.

Information and communication technologies are beginning to have an impact on curriculum and classroom redesign in each of the four countries visited. The use of the information gained during this research will drive organisations and individuals towards differing solutions in response to the needs of their students and learning communities. Significant changes involving ICT are planned for in all regions over the coming five years and it is important that educators and administrators collaborate and learn from the mistakes, discoveries and best practice from other schools and researchers. There is much to learn from each other and much to gain for students.

> *Technology is driving the future. The steering is up to us*
> *(Seen in LAUSD IT office)*

Bibliography

ACEC Conference Proceedings CD, July 2000

Candace Thompson, Glenace Melton, *SE Area Science Consortium: Community Science Museum* (CD) Nevada, USA Version 2, April 2000

Crossing the Digital Divide from *Imagine: News for the K – 12 Community from Apple* Vol. 2 No 3, April 2000. USA

Department of Education and Employment and Qualifications and Curriculum Authority *Information and Communication Technology: The National Curriculum for England Key Stages 1 – 4*, 1999

Clark County Public Education Foundation *DreamScapes: A Digital Art Experience (CD)* Nevada, USA 2000

George Lucas Educational Foundation, *Learn and Live*, Editors Burness and Snider. Nicasio, California, 1997 (Book and video)

ICT in Practice Awards: Showcasing Excellence BECTA, NGfL, TES, BT Education, 2001

International Society for Technology in Education and U.S Department of Education *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, USA 2000

Leading IT A joint publication of HMC and GSA, May 1997

Los Angeles Unified School District Board of Education: *Online Literacy Resource (CD) Version 1. USA*

National Business Education Alliance: *Technology Use Profile, State of Wisconsin*, 28.6.2000

TES online; Computers in Education, *2001 A Digital Odyssey*, January 5, 2001

Alan Warhaftig, NBCT, *The Curriculum-Priority Approach to Technology: The Migration Project. The Media Literacy Project.* Fairfax Magnet Center for Visual Arts, August 4, 2000

Towards the Classroom of the Future: Ideas in Action DfEE. UK, 2000

Wisconsin Department of Public Instruction *Technology Literacy Challenge Fund: IASA Title III – Technology FY 1999 Wisconsin summary of Projects*

Wisconsin's Model Academic Standards (CD*) Raising the Bar for all Students,* April 1999

Wisconsin Department of Public Instruction *Wisconsin Educational Technology Plan PK – 12, 1996 (Revised 2000)*

Appendix 1

Supplementary website addresses

UNITED STATES OF AMERICA

www.att.com/learningnetwork AT & T Learning Network. Resources, ListServs, Virtual Academy, professional development, On-line journal et al

www.highwired.net Global High School community; free web building and hosting service; classroom section; tutorials, collaborative, web-based projects

www.mff.org/edtech Education area of the Milken Family Foundation website. Articles and downloads re learning technologies and on-line learning environments

www.virtualhighschool.com Ontario secondary school, advice for parents

http://fhs.net Florida Virtual High School

www.cyberschool.k12.or.us students around the world taught entirely over the internet; includes interactive textbooks with text, audio and video

http://online.usu.edu Utah State University distance education course. Excellent resources for students

www.scholars.com/scholars.asp On-line advisors mentor students 24 hours a day, courseware

www.glef.org George Lucas Education Foundation, K-12 media materials and website.

http://www.nettech.org/tc/common/listservs.html Listservs for Information technology co-ordinators

www.newtechhigh.com Virtual High School, California

www.cpsr.org/home.html Computer Professionals concerned about the impact of computers on society. Essays, newsletters, competitions et al

www.paly.net Digital School, Palo Alto High School

www.ccsd.net Clark County School District, Nevada

www.ccpef.org Clark County Public Education Foundation

IBM REFERENCES

http://ceoforum.org

www.ibm.com/au

www.lotus.com/learningspace

UNITED KINGDOM

www.teachthinking.com

UK project site used by Glen Waverley Secondary College

http://news.bbc.co.uk

www.the-educator.co.uk On-line magazine for educators, curriculum outlines and resources, assessment tools

www.englishonline.co.uk

www.mathsonlune.co.uk

www.virtualschool.co.uk Curriculum sent by e-mail, targeted at parents

www.standards.dfee.gov.uk/thinking

Dr Carol McGuiness *From Thinking Skills to Thinking Classrooms*

www.ultralab.ac.uk

Professor Stephen Heppell's research and activities here. Also: notschool.com the virtual school set up for second chance students with Uni students and adult experts (often retired) as mentors.

http://www.ecis.org/it/Index.htm Information Technology Resources for International educators

CANADA

http://olt-bta.hrdc-drhc.gc.ca/info/eljoue.html Electronic Journals related to Learning Technologies

AUSTRALIAN SITES

www.edna.edu.au/EdNA Education Network of Australia. Excellent on-line discussions for teachers, resources, information

http://education.qld.gov.au Virtual School pilot where students log on and attend "real time" classes and interact with the teacher via voice or software applications.

www.worldschool.com learning resources, tutor for homework assistance, QMAT's (questions, models for an answer and tips) Infobank, Wordbank, Linkbank (thousands of other useful sites)

www.ngs.com.au Net Grammar School, soon to be opened in Sydney

www.xsiq.com Interactive curriculum modules for students, supported by use of multimedia CD's

http://www.tsof.edu.au/LT.SA (learning technologies/teaching plans)

www.linkideas.com (teaching ideas)

http://education.3COM/netprep (course for students)

www.vsg.edu.au (virtual school for the gifted)

NEW ZEALAND SITES mentioned in paper

www.tki.org.nz New Zealand Ministry of Education portal for educators

www.minedu.govt.nz New Zealand Ministry of Education website

www.marsden.school.nz Website address of Samuel Marsden Collegiate School, Wellington, New Zealand.

www.kingscollege.school.nz Kings College, Auckland, offering on-line courses for distance students.

www.tahatai.school.nz Innovative primary school established as an IT school

Further copies of this report may be obtained from:
The Winston Churchill Memorial Trust
P.O. Box 10-345, Wellington, New Zealand.

It may be viewed digitally at www.marsden.school.nz or www.tki.org.nz .

Appendix 2

About the Author

Mrs Gillian M. Eadie, M.Ed., BA., Dip.Tchg, LTCL, MCSNZ., MNZIM

Gillian Eadie's career in New Zealand education includes speech therapy, intermediate and secondary teaching in government, co-educational and single-sex schools in Greymouth and Nelson. Her use of computers in the classroom began in the early 1980's and has encompassed multiple software platforms, desktops and mobile technologies. She is currently Head of Samuel Marsden Collegiate School, an Anglican, independent school for girls aged four to eighteen, in Wellington. Mrs Eadie has lead two other independent schools (St Oran's College in Wellington, now integrated, and Corran School, Auckland). In each, she has been committed to preparing young people to succeed in a world changing rapidly from that of the present day and sees the development of ICT for staff and students as fundamental in creating schools for the future. A priority has been placed on developing staff capabilities and effective network and technical support infrastructure as precursors to inspiring teacher enthusiasm for integrating ICT into the curriculum. Enhancing learning outcomes for students has been a lifelong passion and post-graduate work at Victoria University of Wellington focused on this as well as organisational development and the management of change.

Mrs Eadie has presented at conferences in New Zealand, Australia and the United States of America and has lead workshops and seminars relating to ICT use in schools and other topics pertinent to school leadership.

Published works include:

"Parental Choice of Secondary School in the Hutt Valley" in *Educational Research and the Future: Proceedings of the NZCER 60th anniversary seminar27 May, 1994*

"Modularisation in New Zealand Secondary Schools - A Means to Enhance Learning: Myth or Reality?" *Delta, Vol 42, 2 1997*

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