

**LITERATURE REVIEW FOR THE
EVALUATION OF THE DIGITAL
OPPORTUNITIES PROJECTS**

Report to the Ministry of Education

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INTRODUCTION AND BACKGROUND

Introduction to the Literature Review

This literature review is focused on international and New Zealand evaluations of “technology-rich” information and communication technologies (ICT) initiatives in schools from 1990 onwards. This review is written for an audience of researchers, policy makers, and educators.

The projects reviewed here attempted to lessen the digital divide, that is, they provided students of low socio-economic status (and in some cases families and communities), and those in isolated areas, with increased access to technology. In particular, evaluations of ICT initiatives that included empirical evidence about the effects of the processes and outcomes of these initiatives are examined. The purpose of this review is to provide information about the evaluation of these ICT initiatives, and summarise the findings of these initiatives, to inform the evaluation of the four Digital Opportunities projects currently underway in a number of New Zealand schools. The review concerns evaluations of projects that are considered relevant, but not necessarily limited to, the ICT delivery methods that are being implemented as part of the four Digital Opportunities projects. A secondary aim of this review is to inform policy developments in the area of ICT use in schools. For this reason this review includes an overview of other international initiatives that are designed to introduce effective ICT strategies in low decile schools and the schools’ communities.

The bulk of the review concerns projects located in upper primary and secondary schools, though information from elementary schools in the United States and primary schools in other countries has been included where relevant.

This review is in four sections; the first provides background on the literature review, the digital divide, and the Digital Opportunities projects in New Zealand; the second overviews briefly international initiatives similar to the Digital Opportunities projects; the third summarises information from evaluations and research of projects similar to the four Digital Opportunities projects; and the fourth presents conclusions.

Annotated Bibliography

An annotated bibliography is provided with this review. This bibliography provides a summary of each initiative and its associated evaluation including details of:

- the aims, goals, or desired outcomes of the initiative,
- the scope, implementation, and timeframes of the initiative,
- the funding of the initiative and the partnerships created,
- the evaluation goals, design, and timeframe,
- the main findings, success factors, or conclusions from the evaluation.

Search Strategy

Most of the literature for this review was sourced on the Internet from two search engines: Google,¹ and Altavista.² In addition, a search of relevant databases was conducted by the NZCER Information Services team, including ERIC (United States), International ERIC (Australian and British education indexes), INNZ (New Zealand articles), Informit (Australian education, multicultural, and public affairs databases), Te Puna (New Zealand monographs); Dialog (including Education and social sciences databases); and the Australian, British, and Canadian education indexes. The library searches were conducted initially including the keyword “evaluation”. In some cases this proved too restrictive and therefore the search was broadened to include a consideration of research studies that had the hallmarks of an evaluation, but were not described as such in the keywords, and research studies which focused on student outcomes.

As this field concerns ICT and the relatively recently named phenomenon called the “digital divide”, traditional sources such as ERIC do not seem to be updated fast enough to list recent evaluations and research in this area. It is likely that researchers and evaluators conducting ICT evaluations are conversant with new technologies and therefore are more likely to disseminate their findings on a website than lodge them with ERIC or other libraries. Using Internet search engines enabled many recent studies to be sourced, though in the absence of any agreed-upon keywords and descriptors for the reports located on the Internet, it is likely that some literature has been overlooked.

What this Review Does and Does Not Contain

The focus of this review is on projects that aim to increase students’ access to the Internet and other ICT, rather than projects that focus on increasing teacher access and use of ICT through equipment provision or professional development. Therefore only evaluations or research which included a consideration of student outcomes were selected. Research studies or evaluations that examined only part of an innovation, rather than the whole innovation, such as quasi-experimental studies concerning the use of computer modelling in a science classroom, were also excluded as being too dissimilar from the four Digital Opportunities projects. This review is concerned with literature from 1990 onwards as there were few initiatives similar to the Digital Opportunities project prior to 1990 considering that the Internet only took its present graphical form in 1994.

Initially the focus of the review was on evaluations of initiatives that aimed to address the digital divide, that is, initiatives in schools located in low socio-economic areas, rural schools, and schools with a high proportion of minority ethnic group enrolment. Most of the schools providing study centre facilities were located in low-income or isolated rural areas. Only a small number of evaluations of “laptop school” projects aiming to bridge the digital divide were sourced. Laptop schools historically have been located in high-income communities due to the amount of funding necessary to provide such initiatives. Therefore, for the laptop school area, the scope of the review was broadened to include all laptop school evaluations.

¹ <http://www.google.com>

² <http://www.altavista.com>

This review focuses on the main school-based initiatives and projects developed to lessen the digital divide in New Zealand, Australia, the United States, the United Kingdom (and some information on projects in Canada) and their associated evaluations. The majority of evaluations located for this review were situated in the United States and Australia and almost no projects were sourced from non-Western countries. For this reason a decision was made to focus on initiatives in the countries listed above.

An example of the individual case studies from the recent international OECD/CERI study of organisational change is included in the bibliography (Toomey, Ekin-Smyth, and Nicolson, 2000) as well as the methodologies for the quasi-experimental study (OECD, 2000a) and the case studies of organisational change (OECD, 2000b). Also included is the draft report from the case studies (Venezky and Davis, 2001). As there are a large number of case studies the full range has not been included.

This review aims to comment on the main studies which are similar to each Digital Opportunities project but does not necessarily cover the whole range of literature for each of the four areas.

The Nature of the Digital Divide

Research in the United States has highlighted that ICT resources and Internet access is inequitably distributed among different groups, that is, that there is a “digital divide” between the “haves” and the “have nots” (National Telecommunications and Information Administration (NTIA), 2000; Smolenski, 2000). Commentators on the digital divide have conceptualised it in a range of ways, but essentially the characteristics are the same (that is, similar types of groups lack access). Depending on the geographical and population characteristics of a country, the areas of emphasis within the “divide” can be slightly different.

Smolenski (2000) suggested that there are three main divides, the first being a divide between those of high and low socio-economic status (which includes minority groups and solo parents), the second divide is in experience, and the third is access, for example, due to a lack of infrastructure people in isolated rural areas may find it difficult to access the Internet.

For students in the compulsory-schools sector the divide is seen to manifest itself in a lack of access to technology-rich environments both at home and at school for students who are poor, from ethnic minorities, female, or in rural areas. The OECD (2000c) has defined the digital divide for students in three ways:

- *Missing Link* – in remote rural or poor inner-urban areas where telecommunications are limited and/or expensive and for students who have disabilities.
- *Wasteland* – groups who find the technology isolating and mechanical, for example, females and some minorities.
- *Foreign language* – high poverty homes lacking equipment and language skills.

In terms of socio-economic status, lower levels of access to technology are often reported for students living in poor areas (Cattagni and Westat, 2001), or those from

ethnic minorities (Novak and Hoffman, 1998; Cattagni and Westat, 2001). A gender divide in access, participation, and attitudes between males and females has also been reported (AAUWEF, 1998).

The latest National Center for Educational Statistics report on access to the Internet in United States public schools (Cattagni and Westat, 2001) suggests that, in the United States at least, some of the gaps observed in the early 1990's no longer exist. That is, public schools with high minority enrolment, or with a high proportion of students living in poverty, are now just as likely to be connected to the Internet as other schools. Although most public schools in America are now linked to the Internet (96 percent), some gaps in access still exist. Public schools with high minority enrolment or with a high proportion of students living in poverty were more likely to have a smaller proportion of rooms with Internet connections compared with other schools, and were more likely to have a higher number of students to each Internet-connected computer.

Although the digital divide in school in the United States may be closing, this is not the case for the home environment. The NTIA (2000) reported that home connection rates dramatically increased from 26 percent in December 1998 to 42 percent in August 2000. Some traditional gaps between groups of "haves" and "have nots" are closing, for example, those in rural areas versus those in urban, and females versus males. But a number of traditional "have not" groups are still less likely to have a connection, that is, people who are poor, have low levels of education, are Black or Hispanic, are over 50 years old, are sole parents, or who have disabilities. The NTIA report highlighted the importance of locating access in schools, libraries, and other public places for those who did not have Internet access at home.

Targeting Policies to Address the Needs of Those on the Wrong Side of the Divide

Commentators have criticised digital divide research as being too focused on access to technology at the expense of examining how the technology can be used to assist low-income individuals and groups to better their situation. A re-focus on narrowing the social divide rather than the digital divide is suggested by these commentators (Kirschenbaum and Kunamneni, 2001; Morino Institute, 2001). In the report *From Access to Outcomes*, Morino Institute (2001) concluded that providing access alone is more well-meaning than effective. The report suggested that initiatives developed by low-income communities to address their immediate issues and concerns are far better at producing meaningful change as communities use the technology to meet tangible social, economic, or educational goals, such as effective schooling or access to improved healthcare.

A similar suggestion was made by Lazarus and Mora (2000) who reported that apart from a lack of access, there is one other main barrier for low-income groups in using the Internet, that is, a lack of relevant content. Lazarus and Mora analysed discussions with 107 low-income adults, youths, and children, interviews with people involved in providing online access and information to low-income groups, and current web content. From this research they suggested that Americans on the wrong side of the digital divide wanted:

- local information regarding employment, business, education, and other areas,
- information that can be understood by low-literacy users,
- information in the languages of the local community and in multiple languages, and
- opportunities to create content and interact with it in culturally appropriate ways.

Essentially digital divide research appears to suffer from a similar problem to the larger body of knowledge surrounding ICT innovations, “that is, it is dogged by concerns about what” (that is, access and infrastructure) at the expense of questions concerning “how” people use the technology and “why” access can be beneficial.

The Digital Divide in New Zealand

In New Zealand, national statistics on access to the Internet are not collected; information that is available indicates similar disparities to those evident overseas (Barker, 2001; Maharey and Swain, 2000; Doczi, 2000). Barker (2001), in a report published by Te Puni Kōkiri, summarised the findings from a survey of access to the Internet. He reported that those who were on a low-income, living in a small town, Maori, had a low level of educational qualifications, or were over 60 years of age were less likely to have access. Barker (2001) also reported that existing data showed that Maori were under-represented in the ICT industries and were less likely to own computers. Maharey and Swain (2000) and Doczi (2000) reported that census data has shown that low-income families, Maori and Pacific Nations peoples, and beneficiaries (particularly those living in certain areas, for example, isolated rural regions), have lower rates of telephone connectivity, and therefore less access to the Internet, than other groups. Maori and Pacific Nations peoples, and low-income households are less likely to have computers. Maharey and Swain (2000) have suggested that the groups most likely to be on the wrong side of the digital divide in New Zealand are:

- Maori and Pacific peoples,
- those on low incomes,
- sole parents,
- older people,
- people who have low or no qualifications or poor literacy,
- the unemployed and the underemployed,
- people in locations lacking a sound telecommunications infrastructure, such as rural areas,
- women and girls, and
- people with disabilities.

(Maharey and Swain, 2000, pp. 1–2).

The Digital Divide in New Zealand Schools

In terms of the school environment, a recent Learning Centre Trust report on ICT use in New Zealand schools, which includes results from a random sample of 396 schools, reported that 98 percent of the primary and 100 percent of the New Zealand secondary

schools they surveyed had access to the Internet (Fink-Jensen, McLennan, and Dickinson, 2001). Data by school decile was not provided but an analysis of the figures for Maori medium schools (which were all sent questionnaires) shows similar trends to the United States. Maori medium schools had slightly less overall access to the Internet and almost half of Maori medium schools had less than 25 percent of classrooms connected to the Internet in comparison to just over a quarter of primary schools. The authors noted that due to the low response rate from Maori medium schools (38 percent compared to the total response rate of 66 percent for the equipment questionnaire) there may have been a non-response bias. It is likely that this is the case; a recent census of computer availability in New Zealand schools, conducted by the Ministry of Education (Kerslake, 2001), reported a lower rate of Internet access than the Fink-Jensen, McLennan, and Dickinson (2001) study. Kerslake reported that 91 percent of New Zealand schools had administration computers connected to the Internet indicating that the Fink-Jensen, McLennan, and Dickinson (2001) figures may have been slightly over-inflated. Kerslake's (2001) figure did not include classroom connections, but it is likely that it reflects non-connectivity overall, as historically the administration computer has been the first to get connected to the Internet in many New Zealand schools.

Fink-Jensen, McLennan, and Dickinson (2001) also reported that, in comparison to primary schools, Maori medium schools had fewer CD-ROM curriculum support and other reference materials available, employed fewer technicians, and were less advanced in terms of the stages of ICT adoption.

In New Zealand the ICT innovations in the compulsory-schools sector that have been evaluated are located in medium or high decile schools (e.g., Parr, 1993; McKinnon, 1995; Boyd, 1997; Selby, Elgar, and Ryba, 2001). The four Digital Opportunities projects are an exception to this.

Maharey and Swain (2000) have suggested that there are a number of dimensions to the digital divide that need to be considered in developing policy to address inequalities. One dimension of particular relevance to New Zealand schools is a lack of ICT infrastructure, such as broad bandwidth, available in rural and remote areas and areas with small populations. This lack of infrastructure impacts on the ability of schools in these areas to access ICT such as video-conferencing. The other dimensions of the digital divide as suggested by Maharey and Swain (2000), and confirmed in stakeholder discussions facilitated by the Labour Market Policy Group (2001), are similar to those mentioned in international research. They are as follows:

- attitudinal (such as a perceived lack of relevance of the Internet and other ICT, lack of confidence, lack of use by those with limited English language skills),
- skill and support barriers (insufficient training of educators and others to support ICT use),
- financial (equipment too costly for low-income families or schools in low decile areas),
- content (online content relevant for all groups).

The Four Digital Opportunities Projects in New Zealand

In an attempt to address some of the concerns mentioned above, the Ministry of Education has initiated four Digital Opportunities projects.³

The general aim of these projects is to assist in bridging the digital divide for low decile schools, or schools for which access to adequate ICT infrastructure has previously been limited. The projects are developed from a partnership between schools, businesses, and Government. The general goals of the projects are to:

1. Enhance the educational achievement of the students and community particularly in mathematics and science.
2. Help overcome the barriers of access, ability, and attitude.
3. Work in partnership with all stakeholders.

(Digital Opportunities contract, project 4, Ministry of Education, 2001a, p. 8).

The implementation of the four projects was started in 2001. Each project will run for the 2002 and 2003 school years. The four projects are:

1. Laptops for teachers and senior students in the Hutt Valley, Wellington (Notebook Valley)

Notebook Valley is a laptop school project in which students and teachers at three schools in the Hutt Valley and Wainuiomata are provided with personal laptops, training, and access to the Internet both at school and at home. This project aims to improve student achievement by providing access to tools and resources for learning, and increase retention in senior science and mathematics.

2. Learning communities in the far North (FarNet)

FarNet provides 10 schools in the Far North with access to: computers, software, and professional development as well as high quality broadband connections to the Internet. Through access to the Te Kete Ipurangi (TKI – an online bilingual education site for teachers and students) teachers and students are provided with bilingual learning resources and the opportunity to create resources using existing materials from Television New Zealand and Independent Newspapers Limited archives. The resources are designed to make mathematics and science more relevant to students, and therefore improve student retention in these subject areas. This project aims to develop local networked “learning communities” of teachers.

3. ICT technology training in West Auckland and Gisborne (GenXP)

GenXP is a vocational education project that provides students in five low decile secondary schools in West Auckland and Gisborne with access to computers, software, and professional development as well as high quality connections to the Internet. Students are provided with the opportunity to gain, as part of the NZQA framework, vendor technology qualifications from Microsoft and other providers (e.g., the Microsoft Office User Specialist (MOUS) qualification). Gaining these qualifications will hopefully assist students to gain entry to the workforce.

³ http://www.tki.org.nz/e/community/digiops/what_is_do.php

4. **ICT-boosted study support centres in Southland and Canterbury (WickED)**

WickED provides three study support centres, accessible to Year 5 to 8 students and the community, in Southland and Canterbury, with computers, software, and professional development, high quality connections to the Internet, and technical and student support. This project aims to enhance student learning outcomes through the use of ICT-based resources and develop local “learning communities”.

INTERNATIONAL DIGITAL DIVIDE INITIATIVES IN SCHOOLS

This section of this review overviews the main Government initiatives in New Zealand, Australia, the U.S, the United Kingdom, and Canada which attempt to lessen the digital divide for students in the compulsory-schools sector, and the evaluation information that is available concerning these initiatives. Initiatives that target the whole compulsory-schools sector rather than schools in low-income areas, such as professional development, were not included in this overview unless this initiative was part of a strategy to lessen the digital divide.

New Zealand

In New Zealand the Ministry of Education has outlined a vision for the use of ICT in schools in its draft ICT strategy: This vision is

- for all students, irrespective of their backgrounds,
- to develop the knowledge, understandings, skills, and attitudes,
- to participate fully in society,
- to achieve in a global economy,
- and to have a strong sense of identity and culture.

(Ministry of Education, 2001b, p. 12).

To address this vision for students on the wrong side of the digital divide the New Zealand Government has recently supported, facilitated, or provided continuing support for a number of initiatives aimed at lessening the digital divide in schools, these include:

- **The Digital Opportunities projects** (already discussed above).
- **The Computers in Homes project.**⁴ This project aims to lessen digital divide in communities that are served by decile 1 schools (Communications Trust 2000).
- **Kaupapa Ara Whakawhiti Matauranga (KAWM).** Wharekura and Maori boarding schools have been provided with ICT resources to assist development of videoconference links to enable the breadth of courses schools offer to be extended and to raise student achievement. This network currently links 24 schools from Kaitaia to Invercargill.
- **Project Rorohiko.** A computer recycling scheme in the Gisborne/Wairoa area.
- **Te Kete Ipurangi.**⁵ (TKI). A bilingual website which provides access to resources and information for teachers and students.
- **Netday.** A scheme that provides free assistance to schools to network school buildings.

⁴ <http://www.computersinhomes.org.nz/>

⁵ <http://www.tki.org.nz/>

- **Learning Power.**⁶ A national computer recycling scheme coordinated by the Computer Access NZ Trust.
- Distance education initiatives, for example, Cantatech and the Correspondence School.

United States

In 2000, the United States Department of Education outlined five national technology goals in their e-learning plan:

- Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.
- Goal 2: All teachers will use technology effectively to help students achieve high academic standards.
- Goal 3: All students will have technology and information literacy skills.
- Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.
- Goal 5: Digital content and networked applications will transform teaching and learning.

(United States Department of Education, 2000, p. 33).

A number of initiatives are funded by the United States Department of Education to meet these goals. Some of these initiatives are specifically directed towards bridging the digital divide. The information below outlines the most recent initiatives of most relevance to this review and the associated evaluations of these programmes:

- **The Technology Innovation Challenge Fund.**⁷ This fund aims to assist schools to bridge the digital divide and use educational technology by awarding grants to consortia of school districts, universities, businesses, etc. The consortia are required to develop and evaluate school-based ICT programmes. Funding over a five-year time span has been provided to 42 school districts in partnership with businesses and community organisations. Recipients of the grant are required to evaluate and document innovative ICT use. One example of an evaluation of a Challenge project is the Louisiana Challenge (Jackson and Guerin, 1999). Other examples are the Utah SURWEB evaluation (Tyner, 2000) and the evaluation of the Virtual High School (Kozma *et al.*, 2000).
- **The Community Technology Centers (CTCs).** This programme aims to expand the access of low-income communities to technology by providing grants to develop CTCs. CTCs have ties to schools, tertiary education institutes, literacy programmes, and employers, and are mostly located in schools, libraries, or community centres. To provide technical assistance to CTCs the United States Department of Education has linked key partners in the America Connects

⁶ http://www.tki.org.nz/r/ict/pedagogy/learningpower/index_e.php

⁷ <http://www.ed.gov/Technology/challenge/faq99.html>

Consortium⁸ (ACC). One of the partners, CTCNet, has conducted evaluations of CTCs (see Chow *et al.* (1998) for a quantitative survey of CTC users from 44 centres.) The main CTC evaluation programme is managed by another partner, the Center for Children and Technology⁹ (CCT) (see Ba *et al.*, 2001; Henriques and Ba, 2000). Other evaluations have been conducted by SRI International (see Penuel and Kim, 2000).

- **The Technology Literacy Challenge Fund.** This fund provides money to assist schools to purchase hardware and software, train teachers, and connect to the Internet. The 2001 fund is aimed towards increasing the technological literacy of teachers in schools serving low-income areas.
- **The E-rate scheme.** This scheme provides a range of discounts to schools for telecommunication initiatives such as Internet access and network wiring. The majority of schools in this scheme are situated in low-income communities. Carvin (2000) has provided suggestions for schools on how to evaluate E-rate programmes.
- **The 21st Century After-school Community Learning Centers Scheme.**¹⁰ This scheme awards grants to community based after-school programmes to assist the achievement of students who are at risk of academic failure due to factors such as poverty or lack of parental support. Programme providers are required to complete an extensive evaluation report,¹¹ and are provided with the *Guide to Continuous Improvement Management*¹² developed to assist self-monitoring. Evaluations of this programme have been conducted by Dynarski *et al.* (2001) and Raphael and Chaplin (2000).
- **The STAR Schools programme.** This programme aims to serve those on the wrong side of the digital divide by using telecommunications to improve instruction in mathematics, science, languages, literacy education, and vocational education (see Tushnet *et al.* (1994) and Maushak and Manternach (1997)).
- **Computers for Learning.**¹³ This is a United States Government scheme to donate surplus computers to schools.

Evaluation of Governmental Initiatives

The National Technology Goal 4 specifies that research and evaluation is a key factor in government-funded programmes in the United States. The Department of Education has commissioned a number of formal evaluations of its schemes. In addition, grant recipients are obligated to conduct annual evaluations. This literature review includes a number of evaluations such as these conducted by external reviewers (Jackson and Guerin, 1999; Tyner, 2000; Kozma *et al.*, 2000).

Publications are provided to assist schools or community groups to develop their own evaluations, for example, the United States Department of Education has published an

⁸ www.americaconnects.net

⁹ <http://www.ed.gov/offices/OVAE/CTC/>

¹⁰ <http://www.ed.gov/21stcclc/#background>

¹¹ <http://www.ed.gov/21stcclc/apr2001.pdf>

¹² <http://www.ed.gov/offices/OUS/PES/21cent/cim226.pdf>

¹³ <http://www.computers.fed.gov/>

Educator's Guide to Evaluating The Use of Technology in Schools and Classrooms (United States Department of Education, 1998), and Michalchik and Penuel (2001) have developed a framework to assist CTCs to evaluate their outcomes.

Other Initiatives in the United States

A number of other initiatives have been developed in the United States that address digital divide issues for students. Many of these projects are in the development stage and therefore there is little evaluation information about them, for example:

- **PowerUP.**¹⁴ Since November 1999 PowerUP has installed computer labs in schools, community centres, public housing complexes, and other youth serving facilities throughout the United States and Puerto Rico to provide underserved youth with access to the Internet. PowerUP aims to foster positive youth development through the use of technology. An evaluation report on PowerUP is due at the end of 2001.
- **Project Smart Schools.**¹⁵ This project provides computers in middle school classrooms in schools in East Harlem as well as professional development for teachers. This project has been evaluated but the findings are not publicly available (Gura, 2001).

Individual states also have other initiatives (for example, the Governor of Maine has stated that he will give every 7th grade student in the State a laptop). Information on ICT initiatives in the United States is provided by Orszag (2001) who overviewed national and statewide ICT initiatives in 18 states in the United States and in 9 other countries. Most of the State reports include sections on evaluation of the access to technology and/or the effectiveness of technology use. Some evaluations, such as studies on Computers in Homes schemes, are outside the scope of this review, for example, Birenbaum *et al.* (1998) have evaluated *Project TELL (Telecommunications for Learning)*, a Computers in Homes project for “at risk” students in New York.

Australia

In 2000 the Australian Commonwealth Department of Education, Training, and Youth Affairs (DETYA) produced the publication *Learning for the Knowledge Society: An Education and Training Action Plan for the Information Economy*. This plan establishes a framework for stakeholders to:

¹⁴ http://www.powerup.org/evaluation_reporting.shtml

¹⁵ <http://www.nycenet.edu/oit/projectsmart.htm>

. . . ensure that all citizens possess broad literacy, numeracy, and technological literacy skills for life, work, and lifelong learning and that there are adequate numbers of people with the specialist skills needed by the information and communications technology (ICT) industries . . .

(DETYA, 2000, p. 10).

This plan designates five areas for which key outcomes and priorities are identified:

- people,
- infrastructure,
- online content, applications, and services,
- policy and organisational framework,
- regulatory framework.

One of the key priorities for people addresses the needs of students who are on the wrong side of the digital divide:

. . . the education and training sector will investigate approaches to address the needs of students who do not have access to technology-rich environments at home, through programs targeted at students experiencing educational disadvantage.

(DETYA, 2000, p. 12).

The goals for schools are further expanded upon in the document *Learning in an Online World* (EdNA, 2000). Some of the initiatives designed to address access to ICT and resources for those on the wrong side of the digital divide in Australia are:

- The development and promotion of the website Education Network Australia¹⁶ (EdNA) as a public gateway to educational resources and services. EdNA includes a “Leading Practice” site that summarises school-based projects judged to be innovative in the use of ICT.
- Development of an Aboriginal and Torres Strait Islander Education Website¹⁷ (though not multilingual).
- Models of School Teacher Professional Development Project.¹⁸ This project specifically targets teachers of students in rural and remote areas and indigenous students for ICT professional development.
- The Computers for Schools schemes provided by DETYA (a computer recycling scheme for schools).
- Project Computerbank,¹⁹ an initiative to supply computers to low-income schools, individuals, and community groups.
- A number of states have developed community centres in schools which have aims similar to the CTCs in the United States (that is, to provide low-income communities access to ICT and to support students in completing homework), for

¹⁶ <http://www.edna.edu.au/EdNA>

¹⁷ <http://www.acsa.edu.au/indigenous/index.htm>

¹⁸ <http://www.noie.gov.au/projects/access/community/digitaldivide/Digitaldivide.htm>

¹⁹ <http://www.computerbank.org.au/>

example, South Australia's NetWorks for You Centres,²⁰ Tasmania's Access Centres,²¹ and Victoria's SkillsNet.²² Currently only descriptive information appears to be available on these centres (e.g., information about SkillsNet can be found in Bates (1999)).

- Distance learning initiatives to provide access to learning via ICT to remote and rural areas (e.g., a trial of one such initiative was evaluated by Wallace and Boylan (2000)).

Individual states in Australia have also initiated programmes, for example, the Navigator schools project²³ in Victoria. In this project, four primary and three secondary schools (some serving low-income areas) were financed to provide ICT professional development and create a network of lead schools in which there is access to ICT in every classroom. These schools were required to provide evidence of enhanced teaching and learning outcomes stemming from the changed environment and share their experiences with other schools. A summary of other state initiatives is available on the Government website.²⁴

The United Kingdom

The Department for Education and Skills²⁵ (DfES) is the organisation in the United Kingdom responsible for educational policy development. The DfES administers a number of initiatives designed to lessen the digital divide for schools and students including the:

- **National Grid for Learning²⁶ (NGfL).** An education website in England and Scotland which provides access to resources for all teachers.
- **UK Online project.²⁷** The goals of UK Online are to enable all United Kingdom citizens to gain access to the Internet by 2005, and to make the United Kingdom a leading knowledge economy. UK Online is a partnership between government, industry, the voluntary sector, trade unions, and consumer groups. The main projects that impact on school students are a drive to get all schools online and to develop online centres in England and Scotland that enable all citizens to access the Internet in schools, libraries, churches, community centres, or company offices.
- **Computers Within Reach.²⁸** A computer recycling scheme to provide computers for low-income individuals and families receiving benefits, to assist family members to improve their employment prospects, to assist with lifelong learning, and to assist with children's homework.

²⁰ <http://www.iepo.sa.gov.au/networks/networks/>

²¹ <http://www.tco.asn.au/>

²² <http://www.skills.net.au/>

²³ <http://www.sofweb.vic.edu.au/navschls/about.htm>

²⁴ <http://www.noie.gov.au/projects/access/community/digitaldivide/Digitaldivide.htm>

²⁵ <http://www.dfes.gov.uk/index.htm>

²⁶ <http://www.ngfl.gov.uk/>

²⁷ <http://www.ukonline.gov.uk/>

²⁸ <http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmhansrd/vo000317/text/00317w04.htm>

- **Wired Communities project.**²⁹ Provides families in low-income areas with a computer and an Internet connection.
- **National e-Learning Foundation.**³⁰ Provides affordable laptops and Internet access to students, particularly those in deprived areas.
- **The Excellence in Cities project.**³¹ One of the main components of this project is the development of City Learning Centres which are equipped with cutting-edge technology for use by students, schools, and the local community.

Most of these schemes are relatively recent and therefore there is little evaluation data available on them.

Other Initiatives in the United Kingdom

Other United Kingdom initiatives related to the Digital Opportunities projects include:

- **DRWS.**³² A bilingual English/Welsh website with resources for teachers.
- **New Opportunities Funding.**³³ A lottery fund that provides funding to address digital divide projects in health, education, and the environment. One project provides teachers with training about how to integrate ICT into the classroom. Another involves the development of a network of ICT learning centres, the People's Network.³⁴
- **Notschool.**³⁵ An Ultralab project which developed a virtual school for students who are, for various reasons, outside the formal school system.
- **Project 2002: Raising Standards through world class facilities.**³⁶ A partnership between business and local government in Glasgow which aims to provide all primary and secondary students with the ICT equipment and infrastructure to develop core ICT skills and allow access to high quality Internet-based learning materials. Some of the goals of this project are to raise student achievement and improve absentee rates. Teachers are provided with notebook computers, ICT professional development, an online administration, and a multilingual curriculum support system. This project started in 2000 and will be independently evaluated in 2004 and 2005.

Canada

Industry Canada³⁷ is the main agency in Canada responsible for developing initiatives to bridge the digital divide. Industry Canada administers projects that are developed as part of the Connecting Canadians strategy, the goal of which is to make Canada the most connected nation in the world.

²⁹ http://www.dfes.gov.uk/pns/DisplayPN.cgi?pn_id=2000_0168

³⁰ http://www.dfes.gov.uk/pns/DisplayPN.cgi?pn_id=2000_0489

³¹ http://www.dfes.gov.uk/pns/DisplayPN.cgi?pn_id=2001_0383

³² <http://www.drws.co.uk/>

³³ <http://www.nof.org.uk/>

³⁴ <http://www.peoplesnetwork.gov.uk/>

³⁵ <http://www.notschool.net/>

³⁶ <http://www.glasgow.gov.uk/schools/>

³⁷ <http://www.ic.gc.ca/cmb/Welcomeic.nsf/ICPages/GovernmentInitiatives>

The main project administered by Industry Canada is the Community Access Program (CAP) which provides affordable public access to the Internet and training. Initiatives that Industry Canada provides in the compulsory-schools sector are:

- **The SchoolNet website.**³⁸ An online educational resource for students and teachers developed by a consortium of federal, provincial, and territorial governments, education associations, and the private sector. SchoolsNet is bilingual (English and French), and includes a First Nations website³⁹ as well as the Network of Innovative Schools⁴⁰ (NIS). NIS was developed to share innovative approaches to ICT use in schools. One of the requirements of the project is that NIS schools work with the university research community to develop best practices for ICT in learning as well as develop and extend business partnerships. An evaluation of the services the website provides has been conducted.⁴¹
- **The Computers for Schools Program.** A national computer recycling scheme which aims to provide schools with computers.

Other Initiatives in Canada

Other digital divide initiatives in Canada include:

- **The Community Learning Networks.**⁴² A scheme administered by the Office of Learning Technologies. This scheme funds pilot programmes for projects which offer access to a variety of ICT-related learning resources “within and across” communities. There is no publicly available evaluation data on these programmes.
- **Reboot Canada.**⁴³ A computer recycling scheme to provide computers for low-income individuals, communities, or students.

³⁸ <http://www.schoolnet.ca>

³⁹ <http://www.schoolnet.ca/aboriginal/menu-e.html>

⁴⁰ <http://www.schoolnet.ca/nis-rei>

⁴¹ http://www.schoolnet.ca/home/e/documents/SN_evaluationE.pdf

⁴² http://olt-bta.hrdc-drhc.gc.ca/CLN/clninit_e.html

⁴³ <http://www.reboot.on.ca/>

EVALUATIONS

Evaluation Designs

There are a number of models and approaches to evaluation, for the purposes of this review the evaluation and research included in the bibliography has been classified using three categories: formative, process, or outcome. Most of the evaluations reviewed did not include a discussion of the model of evaluation used, but many commented on whether one or more of these three approaches was taken.

Formative or monitoring evaluations are typically conducted jointly with the programme providers and are instrumental in developing goals for the programme and improving the programme in its initial set-up phase (Patton, 1990). Process or implementation evaluations are usually descriptive and document the set up of the programme (Gray, 2000). Outcome or summative evaluations tended to be conducted a year or two into the programme and focus on measurable outcomes, drawbacks, or benefits of the programme; these benefits or drawbacks can be both intended and unintended (Patton, 1990; Gray, 2000).

In the next section of this review the evaluations of projects similar to the four Digital Opportunities projects, and their main findings will be overviewed.

A) Evaluating Laptop School Projects Similar to Notebook Valley

Laptop Schools in New Zealand

New Zealand has a number of primary and secondary schools in which students use personal laptops, for example, Tawa School in Wellington. Evaluations of some of these programmes are available, for example, the King's College Computer Project (Parr, 1992; Parr, 1993); and the St Cuthbert's Junior School College laptop project (Selby, Elgar, and Ryba, 2001).

Laptop Schools Internationally

There are many "laptop schools" around the world. Australia has been pioneering in its utilisation of laptops in schools. A school-wide reform approach, the School Design Model (SDM), which was developed in Australia, has been adapted for use in the United States (Bain, 1996) and is the foundation for the Microsoft Anytime, Anywhere Learning (AAL) programmes in the United States, the United Kingdom, Australia, and Canada. A couple of independent longitudinal multi-site evaluations of AAL programmes have been undertaken in the United States (Rockman *et al.*, 2000) and the United Kingdom (Passey *et al.*, 1999, 2000, and 2001). In addition to the formal evaluations of the AAL programme, case studies on Canadian,⁴⁴ United Kingdom,⁴⁵ and Australian⁴⁶ schools which have adopted the AAL model are available.

⁴⁴ http://www.microsoft.com/canada/education/k12/k12_canadian.asp

⁴⁵ <http://www.microsoft.com/uk/aal/casestudies.htm>

⁴⁶ <http://www.microsoft.com/education/?ID=ecsJPC>

Research and evaluation into the phenomenon of “laptop schools” has been conducted in Australia though most of these schools are not located in low-income areas. It is possible that in projects such as Shears (1995) at least one of the 10 schools involved could have been located in a low-income area but this is not clear as socio-economic status was not used as a variable for analysis.

The design and outcomes of a number of evaluations of Australian “laptop schools” are reported on in this review (Kessell, 2001; Grasso and Fallshaw, 1993; Newhouse, 1999; Rowe, 1993; Ainley *et al.*, 2000; Shears, 1995; Fisher and Stolarchuk, 1998; McLean, 1996; Owen and Lambert, 1996).

The United States followed Australia’s lead in the personal use of laptops by students. A number of evaluations of laptop schools have been conducted in the United States including the recent Rockman *et al.* (2000) study on the AAL programme. Some schools in low-income areas, such as Mott Hall School,⁴⁷ in Harlem, New York, United States, are part of the (AAL) programme (see Ricci, 1999). Other evaluations reviewed in this report, of laptop schools located in the United States are Bain (1996), Abrams (1999), Stevenson (1998 and 1999), Hill *et al.* (2000), and Woodbridge (2000).

The Government in the United Kingdom has financed a few laptop school projects (Gardner *et al.*, 1992 and 1993; Stradling *et al.*, 1994). One recent study conducted in the United Kingdom is on the AAL programme (Passey *et al.*, 1999, 2000, and 2001). This study includes a number of low-income schools.

Extending the laptop school concept to low-income schools is a relatively new idea. Only one evaluation reported on here is conducted solely in a low-income community (Ricci, 1999), two others report findings for low-income students (Stevenson, 1999; NetSchools Corporation, 2001). A number of other evaluations include low-income schools but findings for these schools are not reported separately (Passey *et al.*, 2001; Rockman *et al.*, 2000; Stradling *et al.*, 1994; Shears, 1995).

Who Conducts the Laptop School Evaluations and Collects the Information?

The majority of the evaluations and research concerning laptop schools in this review were financed by the programme funders and conducted by independent researchers and evaluators (e.g., Rockman *et al.*, 2000; Passey *et al.*, 1999; Gardner *et al.*, 1992 and 1993). A small amount of research was undertaken by infrastructure providers (NetSchools Corporation, 2001) or by school staff (Abrams, 1999; Bain, 1996).

Focus and Nature of Laptop School Evaluations

Most of the laptop school evaluation or research projects in this review were oriented towards outcome evaluations, although many also contained formative and process approaches. Only a minority of reports included any discussion of how the evaluation fitted into either a model of evaluation or a model of school change. The Bain (1996) evaluation is one example of this approach, in which the evaluation was part of the School Design Model (SDM), an approach to school-wide reform in which evaluation was an integrated and on-going component of the innovation. The SDM comprised a

⁴⁷ <http://www.motthall.org/intro>

number of facets such as an initial needs assessment, collection of school data, and self-reflection by staff.

Other laptop school initiatives were introduced as part of new teaching and learning models such as the Microsoft AAL approach (e.g., Rockman *et al.*, 2000; Passey *et al.*, 1999) and other constructivist models. These models were oriented towards the use of new technologies and how this use could facilitate a change in philosophies concerning teaching and learning, but did not necessarily include a focus on how evaluation fitted into this process.

How the focus of each evaluation or research project was expressed varied between reports. Mostly the focus was framed as either a goal or set of goals, aims, objectives, or research questions or a combination of these.

The formative component of the evaluations concentrated on identifying implementation issues that could be resolved (e.g., Robertson *et al.*, 1997). Most evaluations included some process components, that is, describing and documenting the implementation, but this was not usually included in the goals of the evaluation.

For outcome evaluations the focus was on evaluating the impact or effect of the programme. The focus could be general such as the impact or effect of the programme on teaching and learning (Hill *et al.*, 2000; Newhouse, 1999), or it could be specific such as the impact or effect of the programme on:

- student achievement (Ricci, 1999) or student test scores (Rockman *et al.*, 2000),
- student motivation (Ricci, 1999),
- student attitudes (Fisher and Stolarchuk, 1998),
- student technology skills (Robertson *et al.*, 1997) or other specific student skills such as writing (Hill *et al.*, 2000),
- teacher attitudes, skills, and roles (Ricci, 1999).

In a few cases a more conditional approach was taken, for example, the goals of the Passey (1999) evaluation were to identify

- positive practice and outcomes where this occurs, and to consider why, how, and under what conditions this occurs,
- less positive practice and outcomes where this occurs, and to consider similarly why, how, and under what conditions this occurs.

(Passey, 1999, p. 12).

The goal of the research conducted by Mitchell and Loader (1993) was to find ways to make the school more “effective, efficient, and rewarding.” (Mitchell and Loader, 1993, p. 3).

This focus on the conditions under which innovations are successful is one that is favoured by commentators in this area. After reviewing the research and evaluation models employed in examining ICT innovations in schools, Culp, Hawkins, and Honey (1999) suggested that much past research looked at technology as being the only variable and has ignored pedagogy, teacher practices, student experiences, and the impact of the interaction between these. They suggested that a “consensus has emerged” (p. 7) in regard to the wider issues that need to be addressed when examining ICT initiatives, that is, understanding *how* the innovation occurred and examining the nature of *successful*

innovations. The characteristics of research and evaluations that address this issue are that:

- researchers and evaluators have an understanding that the use of technology is not an end in itself and that ICT use needs to be understood in context,
- the goal of the research is to understand how the innovation occurred (not just what the outcomes were or how it assisted students to achieve within the traditional paradigm),
- the research or evaluation is multidisciplinary and involves long term collaboration with educators at different levels of the school system.

Timeframes and Design of Laptop School Evaluations

The majority of laptop school studies examined in this review include a longitudinal multi-method case study of a single site (Bain, 1996; Hill *et al.*, 2000; Kessell, 2001; Mitchell and Loader, 1993; Newhouse, 1999; Rowe, 1993; Ainley *et al.*, 2000), a longitudinal multi-method comparison study across a number of sites (Rockman *et al.*, 2000; Passey *et al.*, 1999; Gardner *et al.*, 1993; Stevenson, 1999), or a multi-method one-year case study of a single site (Robertson *et al.*, 1997; Selby, Elgar, and Ryba, 2001; Parr, 1992; Parr, 1993). Other designs include case studies of a number of sites (Shears, 1995; Stradling *et al.*, 1994; Netschools, 2001) and a snapshot study across a number of sites (Fisher and Stolarchuk, 1998). Some studies combined two approaches, for example, the first phase of Ricci (1999) involved an evaluation of a pilot in one school, and the second phase, an evaluation of outcomes across a number of school sites. On the whole the most common design was a case study. As noted by Yin (1994) this type of design is usually employed for phenomena such as innovations (for example, new technology) in school settings.

All studies typically used a mix of quantitative and qualitative methods to collect data from a range of stakeholders: students, teachers, school administrators, and parents. A number of the studies compared student data with non-laptop comparison groups, mostly at the same school (Abrams, 1999; Ricci, 1999; Parr, 1992; Parr, 1993; Passey *et al.*, 2001; Gardner *et al.*, 1993; Stevenson, 1999; Fisher and Stolarchuk, 1998) and occasionally at other schools (Newhouse, 1999; Bain, 1996). One study involved both types of comparison groups (Rockman *et al.*, 2000).

The longitudinal case studies and comparison studies that covered two or three years of the implementation of a programme, usually collected some common data each year. Typically an evaluation of the implementation of the project was conducted in the first year, and then an analysis of student outcomes was conducted further into the programme (Rockman *et al.*, 2000; Ricci, 1999; Hill *et al.*, 2000; Passey *et al.*, 2001; Stevenson, 1999; Newhouse, 1999). Most of the one-year case studies combined elements of a process and an outcome approach within the same year (Stradling *et al.*, 1994; Shears, 1995; Selby, Elgar, and Ryba, 2001). An element that was rarely included in the longitudinal designs was a follow-up after more than three to five years from the initial implementation. Newhouse (1999) was one exception to this, following-up students in their seventh year of the programme – a long period of time and after the “novelty” effect of the programme had worn off. Newhouse reported that only half of the Year 12

students in his study still had their laptops and most were only using them as a word processor.

Some studies (Stevenson, 1999; Newhouse, 1999) only showed significant gains in student achievement measures after a minimum of three years into the evaluation. Longitudinal studies over two or three years in length appeared to be better placed to show conclusive changes in terms of student outcomes (Stevenson, 1999). As Stevenson noted change in school systems and in students' learning practices can be slow. Bain (1996) suggested that long timeframes are necessary to ensure that teachers can be provided with adequate professional development. These evaluators consider that a one- or two-year timeframe can be too short to adequately do justice to reporting the outcomes of a programme. In recognition of this situation many evaluators documented the process of implementation in the first year of the evaluation and waited till at least the second or third year to report on outcome data.

Culp, Hawkins, and Honey (1999) have suggested that there is increasing recognition that technology is part of a wider system of complex changes and therefore cannot be viewed in isolation. Hence the growing popularity of case study designs which attempt to examine how technology is integrated into the school system and the curriculum and how technological changes interact with other changes, for example, in school-wide communication.

Outcomes of Laptop School Projects

Table 1 summarises a range of typical outcomes of laptop school evaluations and some of the common ways these outcomes are measured.

Table 1
Expected Outcomes and Methods of Measurement for Laptop School Projects

Expected outcome	Common measurement methods
<i>ICT access and usage</i>	
Increased access to computers for students and teachers, and in some cases the students' family.	Data on access to ICT, student and teacher questionnaire, and teacher interviews. (Parent questionnaire or interview for home data).
Increased use of computers by students and teachers (frequency, in a range of subjects, at home, using a range of applications, types of activities undertaken).	Student and teacher questionnaire and teacher interviews.
<i>Student learning at school</i>	
Increased ICT skill development.	Student questionnaire and pre- and post-test of ICT skills.
Improvements in indicators developed from the goals of the project, the most common being: improved presentation of work; improved writing, editing, spelling, and grammar skills; mathematics and science data handling ability.	Specially designed assessments to suit the indicator and analysis of work samples.
Increased or maintained standardised test scores, classroom test scores, external examination scores, and other measures of educational achievement.	Standardised test scores, grades, examination scores, school records, and analysis of work samples.
Increased programme completion and qualifications.	School records.
Increased information literacy skill development, including problem-solving ability, self-directed learning, independent learning.	Student and teacher self-report in interviews, questionnaires, and focus groups. Classroom observations.
Changes in types of classroom activities involving ICT use, e.g., more presentations to class.	Student and teacher self-report in interviews, questionnaires, and focus groups. Classroom observations.
<i>Student learning at home</i>	
Increased completion of homework/less TV watching.	Student and parent questionnaires and interviews.
Increased parental assistance with homework.	Student and parent questionnaires and interviews.
Increased use of ICT at home for learning purposes.	Student and parent questionnaires and interviews.
<i>Attitudes and motivation</i>	
Positive attitudes towards the project and computer use by students, teachers, and parents. For students, improved attitudes towards learning.	Student, teacher, and parent interviews and questionnaires. Attitude scales.
Increased student motivation and interest (e.g., increased homework completion).	Student, teacher, and parent interviews and questionnaires.
Improvements in student self-esteem.	Student and teacher interviews and questionnaires.
<i>Student behaviour</i>	
On-task behaviour.	Classroom observation.
Increased co-operative behaviour/peer tutoring observed.	Classroom observation and student and teacher questionnaires and interviews.
Increased ability to direct own learning.	Classroom observation and students and teacher questionnaires and interviews.
Lower suspension rates.	School data.
<i>Classroom and learning environment</i>	
Integration or "institutionalisation" of ICT across the school and into classroom practice.	Student and teacher interviews and questionnaires. Classroom observations. Scales assessing classroom environment.
Classroom organisation (a wider range of teaching strategies used).	Teacher interviews and questionnaires. Classroom observations.
Nature of tasks (students are given real life tasks that motivate them).	Student and teacher interviews and questionnaires. Classroom observations.
Teacher-student relationships (increased learner-centred/constructivist learning environments).	Teacher interviews and questionnaires. Classroom observations.
<i>School and post-school data</i>	
Improved retention rates (roll increase, larger number of students staying at school).	School data.
Improved attendance rates (absentees and late arrivals).	School data.
Student destinations (such as further study or employment).	Student follow-up questionnaires or interviews or intentions survey.

Findings from Laptop School Projects

Very few studies included a consideration of the outcomes for low-income students, but those that did reported positive findings (Ricci, 1999; NetSchools Corporation, 2001; Stevenson, 1999). Ricci (1999) and NetSchools Corporation (2001) noted that the use of technology had assisted in improving the link between school and home. Ricci (1999) and Stevenson (1999) provided information to show that the laptop students in their study maintained their test scores in comparison to non-laptop students whose test scores decrease over time. NetSchools Corporation (2001) found increases in test scores. NetSchools Corporation (2001) reported declines in student absenteeism, and time-on-task in the classroom, and an increase in school effectiveness. Declines in absenteeism were also noted by Stevenson (1999). The students in Ricci's (1999) study stated that, at home, they spent more time on homework and less time watching TV, and that using a laptop had improved their performance and their attitudes to school. The parents and teachers in this study supported these findings.

Ricci (1999), NetSchools Corporation (2001) and Stevenson (1999) all considered that the projects had been successful. Ricci (1999) concluded that there was a need for teachers to focus less on the tool and the teaching of ICT skills and focus more on content. Stevenson (1999) suggested that further analysis was needed to identify how laptop use actually assisted learning outcomes. He also suggested that continued professional development was necessary.

Most reports included a description of some of the successes and challenges of the project (e.g., Rockman *et al.*, 2000; Bain, 1996; Owen and Lambert, 1996). On the whole most findings were positive (the range of expected outcomes is noted in Table 1), although in a couple of cases little change in practice beyond students using laptops as a word processor were reported (Ainley *et al.*, 2000; Newhouse, 1999). Universally reported as an outcome were increases in students' and teachers' ICT skills, and access to and usage of ICT at school and at home, as a result of laptop projects.

The often-reported improvements in students' achievement, attitudes, motivation, and information literacy skills were not necessarily clearly reflected in changes to student achievement measures (Rockman *et al.*, 2000; Gardner *et al.*, 1993). Positive changes to student achievement were more likely to be reported from qualitative, rather than quantitative, data, for example, Gardner *et al.*, (1993) reported that ICT-related gains (that is, a development in students' ICT skills) could be shown by quantitative measures but curriculum-related gains were only shown by qualitative measures. Data concerning students' achievement on standardised tests and external examinations on the whole were inconclusive. Some authors question the validity of these tests in measuring the types of gains expected from ICT innovations (Rockman *et al.*, 2000; Gardner *et al.*, 1993). However, indicators of student achievement that were specifically tailored to the goals of an initiative, such as the ability to handle mathematics and science data, (for example, as developed by Passey *et al.* (2001)) were not necessarily any more successful in quantifying gains. In some cases these measures did show more variation than standardised tests, for example, Rockman *et al.* (2000) reported inconclusive data from comparisons of standardised test scores, but laptop students' scores on writing assessments were significantly higher than non-laptop students.

Aside from the suggested lack of validity of the quantitative measures used to assess student achievement, there are two possible reasons for the reported lack of impact. One is that the use of laptops does not in fact have any effect on student achievement. The other, perhaps more likely, reason is that changes to student achievement are conditional on context, that is, changes are due to complex interplay of factors such as teachers changing their pedagogical approaches to support a more student-centred environment in which ICT use is integrated into the curriculum and ubiquitous. If this does not occur, and laptops are used within the traditional classroom environment simply as word-processing and presentation devices, then it is unlikely that improvements in student achievement or changes to classroom environments will be reported.

The importance of context can be seen from the results of a number of studies, for example, in Kessell's (2001) and Newhouse's (1999) studies, students reported that they mainly used laptops for word-processing, and that this use had not improved their problem-solving or information literacy skills. On the other hand, studies such as Passey *et al.* (2001) provided some evidence to support the fact that changes in student achievement will occur if attention is paid to how laptop use is integrated into the curriculum. Passey *et al.* (2001) reported a wider range of significant gains in student spelling, and mathematics and science data handling skills, in the only school out of five that had addressed most of the "key integration factors" identified in their study. Fisher and Stolarchuk (1998) also provide evidence that supported higher student engagement and achievement in student-centred self-directed learning environments. McLean (1996) examined the development of a cooperative classroom culture using the Learning Preferences Scales. He found that students in laptop classes rated their classroom environment as more cooperative than the state norm. This was supported by data from interviews with teachers and observations. McLean (1996) suggested that these changes were supported by the introduction of a more flexible curriculum and teachers' "willingness to adopt new strategies". Newhouse (1999) reported that computers were used more in classes in which teachers used student-centred approaches.

A few studies reported negative outcomes for students, for example, Robertson *et al.* (1997) reported lower achieving students became de-motivated by laptop use. Kessell (2001) found that the older students in their study (Year 5 and 6) did not view the laptop project at their school positively compared with the younger students.

The main challenges of these laptop projects were the increase in teacher workloads and the fact that teachers took time to adjust to the new student-centred environment that ICT use could facilitate and therefore needed more professional development and technical support. Hill *et al.* (2000) reported that there could be a tension between programme goals and actual activities; although teachers wanted students to become more self-directed in their learning, most classroom activities were in fact teacher led. Hill *et al.* (2000) suggested that this indicated a need for more professional development on how to integrate ICT use into the curriculum. Many other authors echoed these sentiments (Ricci, 1999; Robertson *et al.*, 1997; Gardner *et al.*, 1993; Kessell, 2001; Stevenson, 1999; Newhouse, 1999).

In a couple of cases, researchers commented on the rushed introduction of a project. In these projects it appeared that teachers (and parents and students) lacked understanding of the goals of the programme and therefore an idea of how to integrate ICT use into the

classroom (Kessell, 2001; Woodbridge, 2000). In these projects the researchers suggested that the school staff and community needed to work together to develop a framework for how ICT was to be integrated, and then supply appropriate professional development.

Laptop School Success Factors

Passey *et al.* (2001) suggested that gains in learning outcomes were due to the complex interplay between a number of key factors. They suggested that these gains were more likely to be shown in schools that had addressed a number of key integration factors:

- i) there is an adequate focus on, and understanding of, how laptop use supports and enhances the curriculum,
- ii) the focus is on learning and the need to understand pupil uses, and how pupils benefit from the uses of laptops,
- iii) classroom issues are identified as they arise, and addressed positively,
- iv) the social concerns and needs of parents, teachers, pupils and others are understood and handled flexibly,
- v) management is committed to the partnerships with parents, an OEM [original equipment manufacturers] provider and others,
- vi) parental confidence is built, and interest is positively developed,
- vii) parents are actively involved in the project,
- viii) management operates at a strategic level to create vision, and at an implementation level, to ensure that both teachers and pupils are supported,
- ix) teachers are engaged in the process, and their commitment is sought,
- x) ongoing internal evaluation identifies benefits and weaknesses, and is used by all concerned to develop more positive practice,
- xi) technological support and maintenance exists, at least at minimal levels, and
- xii) OEM providers' support is managed to match school needs.

(Passey *et al.*, 2001, p. 3).

Owen and Lambert (1996) also suggested that there were a number of criteria necessary for the success of this type of innovation:

- teachers need to have ICT skills training prior to using the laptops in the classroom,
- teachers need to be provided with professional development and time to develop an understanding of how to integrate ICT use into the classroom,
- teachers need access to support from other teachers and experts, at least at the implementation phase,
- teachers need to be able to influence the decisions concerning the implementation and on-going development of initiatives,
- school staff need to have an understanding that the laptop curriculum is different from the pre-laptop curriculum and that this has implications for practice,
- the school needs to encourage on-going partnerships with the community to support the laptop curriculum.

Other success factors included thorough planning (Selby, Elgar, and Ryba, 2001; Bain, 1996), a shared vision concerning ICT use (Kessell, 2001; Bain, 1996), the use of a concentrated model in which all students in the class had laptops (Rockman *et al.*, 2000); and students staying with the same teacher rather than being moved from class to class (Kessell, 2001).

One of the success factors for projects seemed to be that the programme was part of school-wide changes in approaches to teaching and learning rather than an isolated project. For example the Bain (1996) evaluation is one example of this approach, in which the evaluation was part of the School Design Model. When this integrated and whole school approach was taken the innovation seems to have been more successful in eventually spreading throughout the school (for example, although not laptop schools, the multi-faceted and comprehensive school review approach taken by the Navigator schools (Toomey and Ekin-Smyth, 2001) also seemed particularly successful. Although this may well have been due to the high level of support and professional development that was provided to teachers).

In summary, as Kessell (2001) noted, one of the most important factors in the success of an initiative is undoubtedly the willingness of teachers to put in the extra work required. Related to this was adequate professional development and technical support, a shared vision for the use of ICT throughout the curriculum, and pedagogical change.

B) Evaluating Resource Development Projects Similar to FarNet

FarNet – Development or Maintenance of Bilingual Programmes

One of the components of FarNet is the expansion of bilingual resources and their delivery via ICT. Only one or two projects overviewed in this review focused specifically on the development of bilingual resources (Chavers, 1996), or on assisting the maintenance or further development of bilingual communities through the use of ICT (Latino Issues Forum, 2000; Derewetzky, 1992).

The target population of other projects reported on here was bilingual (Macias *et al.*, 2000; Dynarski *et al.*, 2001) but language maintenance was not a focus of the project or the evaluation. Instead the main emphasis of these projects was the development of literacy and English language skills. Other descriptive reports, outside the scope of this review, concerning bilingual projects in technology-rich environments are available, for example, Vásquez (1994).

FarNet – Development of Resources

A common aim of the Digital Opportunities projects is the development of resources that are located in an online environment, and can be shared with other teachers. A few projects included in this review have similar resource development components to the Digital Opportunities projects (Spielvogel *et al.*, 2001; Chavers, 1996; Tyner, 2000; Derewetzky, 1992; Means *et al.*, 2001; Penuel *et al.*, 2001a).

A number of other projects included in this review also incorporated other resource development components, for example, a number of distance education projects developed curriculum resources for use by distance education teachers and students

(Tushnet *et al.*, 1994; Maushak and Manternach, 1997; Wallace and Boylan, 2000; Kozma *et al.*, 2000; Bigbie and McCarroll, 2000; Leonard, 2001; Hawaii State Department of Education, 1999).

FarNet – Development of “Learning Communities”

Another aim of the FarNet project is to develop a networked “learning community” of teachers. A couple of the projects included in this review also aimed to develop communities of teachers (Means *et al.*, 2001; Spielvogel *et al.*, 2001).

Who Conducts the Resource Development Evaluations and Collects the Information?

The evaluations of the resource development projects similar to the Digital Opportunities projects were mostly conducted by commissioned researchers (Spielvogel *et al.*, 2001; Tyner, 2000; Means *et al.*, 2001; Penuel *et al.*, 2001a). In one case, the evaluation was conducted by the programme funder (Derewetzky, 1992), and in another, by school staff with input from an independent evaluator (Chavers, 1996).

Focus and Nature of the Resource Development Evaluations

The focus of the resource development evaluations was mostly process and outcome in nature, though a number also included a formative component as the project implementation was improved over a number of years. As most of these evaluations had been running for more than two or three years, a consideration of student and teacher outcomes was included (Spielvogel *et al.*, 2001; Derewetzky, 1992; Chavers, 1996; Tyner, 2000; Means *et al.*, 2001; Penuel *et al.*, 2001a).

Timeframes and Design of Resource Development Evaluations

Most of the resource development project evaluations were longitudinal three- to five-year multi-method case studies (Spielvogel *et al.*, 2001; Derewetzky, 1992; Chavers, 1996; Tyner, 2000; Means *et al.*, 2001; Penuel *et al.*, 2001a). Two projects collected and combined various types of longitudinal data from a range of sites (Derewetzky, 1992; Tyner, 2000). Tyner (2000) also included a couple of quasi-experimental studies to examine the impact of the project on academic achievement and higher order thinking skills.

Similar to research and evaluation conducted in other areas, the longitudinal studies appeared to be better placed to show conclusive changes in terms of student outcomes (Chavers, 1996; Tyner, 2000; Means *et al.*, 2001; Penuel *et al.*, 2001a).

Themes and Methods of Measurement of Resource Development Evaluations

Two of the projects which focused on the development or maintenance of a bilingual community incorporated a formal assessment of students’ language skills in English and the other target language to assess language development, for example, the Language Assessment Battery given in Derewetzky (1992), or the oral language assessments given

in Chavers (1996). The Latino Issues Forum (2000) evaluation did not appear to include any formal monitoring of students' language development.

The evaluations of projects in bilingual communities also surveyed students about their attitudes towards the bicultural environment that was created (Derewetzky, 1992) or their motivation towards learning (Chavers, 1996).

These projects all involved parents to either further develop parents' language (Derewetzky, 1992) or ICT skills (Latino Issues Forum, 2000), or as resource people to call on to assist in lesson delivery and the development of locally-based curriculum materials (Chavers, 1996). A further aim of these projects was to encourage the involvement of the community in the education of their children (Latino Issues Forum, 2000; Chavers, 1996; Derewetzky, 1992).

Data on parental involvement was collected and reported in a number of ways, for example, descriptive information about parental involvement was included as part of a case study (Chavers, 1996; Latino Issues Forum, 2000); the number of parents who attended training sessions was reported (Derewetzky, 1992); or the viewpoints of parents who participated in surveys and focus groups concerning the implementation of the project and the impact on their family and children was discussed (Latino Issues Forum, 2000).

The main focus of the general resource development project evaluations was to present information:

- on the implementation and nature of the project, for example, the issues faced in developing resources. This information was collected from project records (Spielvogel *et al.*, 2001) and surveys or interviews with teachers (Spielvogel *et al.*, 2001; Tyner, 2000; Means *et al.*, 2001; Chavers, 1996), project directors and other school staff (Spielvogel *et al.*, 2001; Derewetzky, 1992; Means *et al.*, 2001), and other stakeholders (Spielvogel *et al.*, 2001; Means *et al.*, 2001),
- on teacher access to and use of the resources developed. This information was collected via self-report (Derewetzky, 1992; Spielvogel *et al.*, 2001; Means *et al.*, 2001) or from site traffic on the project website (Tyner, 2000),
- on changes in teacher attitudes towards the project's approaches. This information was mostly collected from teacher surveys and interviews (Spielvogel *et al.*, 2001; Derewetzky, 1992; Tyner, 2000; Means *et al.*, 2001),
- on the professional development provided by the project. This information was mostly collected from surveys and interviews with teachers (Spielvogel *et al.*, 2001; Tyner, 2000), as well as observations of professional development sessions (Spielvogel *et al.*, 2001; Tyner, 2000),
- on changes in classrooms that occurred when resources were used, such as, classroom dynamics and environment, teacher practices, and student behaviours, for example, working collaboratively. This information was mostly commonly collected from surveys and interviews with teachers (Spielvogel *et al.*, 2001; Derewetzky, 1992; Tyner, 2000; Means *et al.*, 2001), and less commonly, from classroom observations (Spielvogel *et al.*, 2001; Chavers, 1996),

- about the impact of the project on student achievement by analysing student scores on standardised tests or grade averages (Spielvogel *et al.*, 2001; Derewetzky, 1992; Chavers, 1996) or criterion referenced tests (Tyner, 2000),
- on students' development of other specific skills, for example, Derewetzky (1992) used pre- and post-tests to collect data on students' ICT and career development skills, and Tyner (2000) used concept maps, diaries, and a test of creative thinking to collect data on the development of higher order thinking skills. Tyner (2000) also collected data from a comparison group of non-project students,
- on student attitudes to school, motivation, or self-esteem mostly collected from surveys of students (Chavers, 1996; Derewetzky, 1992),
- on student attendance collected from school records (Chavers, 1996; Derewetzky, 1992),
- on other student data such as demographics collected from school records (Derewetzky, 1992; Chavers, 1996),
- about how easy the programme was to replicate. This information was collected mostly from interviews with stakeholders at sites that had replicated the programme (Chavers, 1996; Spielvogel *et al.*, 2001).

Less common focuses of the evaluations were to provide information:

- on the number of resources available. In Tyner (2000) this information was obtained from website records,
- on parental views on training sessions (Derewetzky, 1992),
- about how lead teachers facilitated resource development by other teachers. In Spielvogel *et al.* (2001) this information was collected from stakeholder interviews as well as observations of professional development sessions,
- on whether the resources developed met curriculum learning objectives (Spielvogel *et al.*, 2001),
- on the design and ease of use of the project website. In Tyner (2000) this information was collected from focus groups of teachers.

Spielvogel *et al.* (2001) noted that most of the information collected for their evaluation was based on teacher or student self-report in the form of surveys and interviews, though they also collected information from project records, observation of classroom and professional development sessions observations, and analysis of existing data such as test scores. This reliance on self-report was a common feature of some of the evaluations in this area (Means *et al.*, 2001; Tyner, 2000).

Findings and Outcomes from Resource Development Projects

Mixed success was reported for the two projects that included a bilingual component. Derewetzky (1992) noted that the project met its objectives for career education, curriculum development, staff professional development, and student development of computer skills, but had failed to meet objectives for language development and parental involvement. In contrast, Chavers (1996) reported significant gains over a 13 year timeframe in students' language development and academic achievement, and

improvements in students' motivation and attendance. A number of schools had replicated this programme.

For the general resource development projects positive findings were reported, but these appeared to be conditional on teachers actually using the resources that had been developed, and grounding this use within a student-centred framework. Spielvogel *et al.* (2001) concluded that, although teachers considered that the project had provided valuable professional development, impacts on students' test scores were not shown unless teachers actually used the resources in the classroom. Interestingly, although Spielvogel *et al.* (2001) reported that most of the teachers used the resources, there were a number that did not. The reasons for this lack of use were not provided. A similar situation, reported in Means *et al.* (2001), might shed some light on this. One of the four teams in the project evaluated by Means *et al.* (2001) opted out as they felt that the project-based learning approach that was being advocated was inappropriate for their students who lacked basic skills.

Tyner (2000) also reported mixed teacher use of the resources and assimilation of the pedagogical approaches of the project. Although teachers reported successes from the student-centred approaches that they employed when using the website resources, they also noted that they spent little time on these activities. Student computer activities at school were more focused on easier applications such as computer games, word processing, and paint and draw programs rather than using software to design their own webpages or multi-media projects and reports.

Aside from increased tests scores, a number of other positive findings were reported from teachers who used the new resources, for example, teachers in the Spielvogel *et al.* (2001) project reported that their ability to use and integrate ICT into the classroom had dramatically increased, and that this had led to their use of more student-centred teaching approaches.

From the evaluation of a project in which teachers developed resources for the SURWEB website, Tyner (2000) reported increases in the number of resources on the website, increases in teacher and student access and use of the website, increases in test scores and improved attitudes towards instructional approaches for 7th grade students who created multi-media social studies projects from the website resources. Tyner (2000) also reported that compared to non-users, 6th grade students' higher order thinking skills were enhanced by the use of SURWEB resources, but this was conditional on the resources being used as part of a student-centred approach.

Teachers in the Means *et al.* (2001) study reported that students who developed their own multi-media projects were more engaged in learning and had developed further skills in working collaboratively and learning independently. This study did not collect any formal student outcome data.

Issues and Challenges of Resource Development Projects

One of the main challenges in these projects seemed to be encouraging teachers to use the resources and to change classroom practices to support student-centred learning environments (Tyner, 2000; Spielvogel *et al.*, 2001; Means *et al.*, 2001). This seemed to be a long process, for example, Spielvogel *et al.* (2001) reported that the on-going challenges of the project were encouraging teachers to use the project website, and

facilitating teachers, who had not had the professional development provided as part of the project, to use new pedagogical strategies.

Finding a way to assess the impact of the projects on student outcomes was another challenge for evaluators and teachers. Spielvogel *et al.* (2001) noted that only a few items in a test used to assess student achievement related to the learning goals of the project. Means *et al.* (2001) reported that teachers were having difficulty collecting and analysing data that provided evidence of enhanced student outcomes.

A further issue highlighted by the evaluation of one of the resource development projects was the time input required of teachers if they were to be the main developers of the critical mass of resources. Depending on the model used this could be problematic for teachers. Spielvogel *et al.* (2001) reported that, although teachers were provided with professional development and assistance to develop resources, they found that they were often required to create entire units, rather than lesson plans they initially thought they would be developing, and that the time this required could be overwhelming. In contrast, concerns such as these were not reported in projects that used a model of resource development that did not require as much input from teachers or rewarded teachers for developing resources. For example, Chavers (1996) in which a database of curriculum resources had existed for a number of years, Derewetzky (1992) in which a specialist teacher developed the resources, Tyner (2000) in which a collection of online resources was provided and teachers were invited to provide additional resources, or Means *et al.* (2001) in which a number of lead teachers were given assistance to develop resources and provided with incentives.

One of the reasons why these projects experienced some difficulty in spreading the use of resources and pedagogical approaches to the wider teacher population could be that the teachers who were opted in to the programme were different from those who did not. It is likely that the teachers who participated in projects reported on in Spielvogel *et al.* (2001) and Tyner (2000) could have been innovators who were more sympathetic to the goals of the project than the wider body of teachers.

Other problems mentioned by Spielvogel *et al.* (2001) included teachers having difficulty developing links with teachers at other schools that catered for students of different age groups and were not in the same school district; applying a business model to education; and solving technical glitches.

Success Factors for Resource Development Projects

In summary the success factors for resource development projects appeared to be:

- a timeframe of at least two years (Chavers, 1996; Tyner, 2000),
- the use of a less intensive model of resource development that employed specialists to develop resources (Derewetzky, 1992; Chavers, 1996) or provided specialist assistance and technical support to teachers who were developing resources (Spielvogel *et al.*, 2001; Tyner, 2000; Means *et al.*, 2001). This model could also include the use of key teachers and the use of existing resources,
- adequate professional development for all teachers, especially that which included a consideration of pedagogical approaches and how to integrate the resources into the classroom (Spielvogel *et al.*, 2001; Derewetzky, 1992; Tyner, 2000).

Other success factors were suggested by some evaluators, for example, Tyner (2000) reported that maintaining partnerships with local organisations such as museums and state parks was essential for resource development. Chavers (1996) reported that replication of similar bilingual projects in other schools rested on the commitment of staff and the local community.

A major concern of these projects appears to be encouraging teachers to adopt the pedagogical strategies that are necessary for the use of the project resources. Related to this is increasing teachers' use of the project resources. Identifying the conditions to assist these changes could be a future focus for evaluations in this area.

C) Evaluating Vocational Education Projects Similar to GenXP

GenXP – ICT Certification

The concept of students in the compulsory-schools sector gaining recognised vendor qualifications is a relatively new, and therefore uncharted, area for research and evaluation. In this review the literature surrounding the evaluation of general vocational initiatives in schools has been examined in lieu of any available research on ICT certification in schools. As ICT certification is a subset of the wider range of vocational courses available at schools it is likely that the evaluation designs and findings pertaining to the general programmes will be relevant to certification programmes. Most of the general evaluations are of programmes that include ICT-related courses and some (e.g., Bonaventura, 2000) contain certification courses.

ICT Certification and Vocational Education in New Zealand

Students in New Zealand secondary schools are able to study for vocational qualifications in the form of National Certificates in ICT. There do not appear to be any evaluation studies conducted on this area.

One of the main ICT certificates that are available to students internationally and in New Zealand is the International Computer Driving Licence⁴⁸ (ICDL). The ICDL is an internationally recognised industry standard ICT qualification that includes seven modules:

- basic concepts of IT,
- using the computer and managing files,
- word processing,
- spreadsheets,
- database,
- presentation,
- information and communication (e-mail and the Internet).

The ICDL was developed in Europe in 1996 as the European Computer Driving Licence⁴⁹ (ECDL). It is now available in at least 22 countries and is administered by

⁴⁸ <http://www.acs.org.au/icdl/faqs.htm>

⁴⁹ <http://www.ecdl.com/>

computer societies. In New Zealand the ICDL is administered by the New Zealand Computer Society⁵⁰. The ICDL first became available in New Zealand in February 2001 and Samuel Marsden Collegiate School⁵¹ was one of the first schools to offer pupils the opportunity to gain the ICDL.

Other certification initiatives in New Zealand include the Cisco Networking Academy established by Cyberwaka Enterprises in the East Cape settlement of Te Kaha. This project is a partnership between the East Cape Te Whanau a Apanui tribe, the Pacific Islands Matati E Fa Trust of Auckland, and Cisco. The academy provides vocational Cisco training for secondary and tertiary students.

Students in the GenXP Digital Opportunities project are able to gain Microsoft certification.

Tech-Prep in the United States

Tech-Prep is a vocational education programme in United States senior secondary schools that is intended to assist students (in particular average achievers) to prepare for future careers in “high demand, technically orientated occupations.” (Hershey *et al.*, 1998, p. xiv). Tech-Prep includes a common core of mathematics, science, communications, and technology as a foundation that links to two years of specialised post-secondary courses. Tech-Prep also often includes work experience, and is provided by local consortia of school districts and post-secondary institutions.

Vocational ICT Qualifications in Australian Schools

The development of vocational ICT qualifications in the compulsory-schools sector is a strategy designed to assist in developing Australia’s readiness for participation in the information economy. This strategy is outlined in EdNA (2000) as aiming to

Extend programs in the senior years of schooling that provide specific skill training for the ICT industries and promote transition from school to work in these industries.
(EdNA, 2000, p. 6).

In Australia there are a number of school-work linked programmes that are designed to assist students to gain recognised ICT-related qualifications, these are:

- Vocational Education and Training (VET) Programmes, that are similar to the Tech-Prep programme in the United States (Polesel, Teese, and O’Brien, 1999; Malley, Frigo, and Robinson, 1999; National Centre for Vocational Education and Research (NCVER, 2000),
- ITVT in Schools Pilot Project 2000 in Victoria, Australia (Bonaventura, 2000),
- International Computer Driving License (ICDL), for example, students in the ITVT in Schools Pilot are able to gain an ICDL, Cisco networking qualifications, along with other recognised ICT qualifications (Bonaventura, 2000).

⁵⁰ <http://www.nzcs.org.nz/products/icdl.htm>

⁵¹ <http://www.marsden.school.nz/icdl.htm>

Students are able to study for recognised vendor qualifications as part of VET. *VET in the VCE Cisco Networking Academy Program* (Victoria Curriculum and Assessment Authority, 2001) outlines how schools or other institutions can become a “local academy” and therefore provide certification to students. Bendigo Senior Secondary College⁵² in Victoria (a Navigator School) is an example of a school which is an accredited provider of online and school-based Cisco (networking), Microsoft (networking), and Aries (computer construction and maintenance) qualifications.

Research Concerning ICT Certification

Much of the current research on ICT certification is carried out by vendors, and is located in the post-compulsory sector. This research outlines the benefits for employers of employing certified workers in terms of the greater knowledge and professionalism they bring to the workforce (Brewer and Segal, 1999), the benefits for employees in terms of the higher salaries earned in comparison to non-certified employees (Lotus, 2000; RHI Consulting, 2001), and that certification is an important qualification to assist in the development of ICT professional’s career paths (RHI Consulting, 2001). There appears to be no available evaluations that look at the outcomes of certification for students in the compulsory-schools sector.

VET and Tech-Prep Evaluations

A number of commentaries and research on VET and Tech-Prep in schools are referred to in this review. Evaluations of VET programmes have tended to focus on the VET courses as a whole rather than isolating the ICT components. In Australia there has been no individual study of the outcomes of ICT-related VET courses. Bendigo Senior Secondary College was included in the OECD/CERI case studies of organisational change but this research did not specifically address any student outcomes related to the VET programme. The evaluators did however suggest that the recent growth in the school roll was directly related to the growth in vendor VET courses at the school (Toomey, Ekin-Smyth, and Nicolson, 2000). Similarly, in the United States, Tech-Prep evaluations do not include a separate consideration of ICT-related programmes.

Although evaluations of the VET and Tech-Prep programmes are general in focus, the methodologies and findings can still be related to ICT-related programmes. Bonaventura (2000) is currently conducting an evaluation of an ICT certification and e-learning pilot in 10 Australian schools. This project is the most similar in nature to the Digital Opportunities project, GenXP.

GenXP – Delivery of Courses Via a Virtual Classroom

In Phase 2 of the GenXP project, higher level courses will be delivered via a virtual classroom. A number of evaluations of virtual school projects are included in this review (Kozma *et al.*, 2000; Bigbie and McCarroll, 2000; Leonard, 2001; Hawaii State Department of Education, 1999; Bonaventura, 2000).

⁵² <http://www.bssc.edu.au/communication/ict/index.htm>

Who Conducts the Evaluation and Collects Information on Vocational Programmes?

The majority of the evaluations and research concerning VET and Tech-Prep programmes were conducted by commissioned, independent, or Government researchers and evaluators. There is one exception to this, Bonaventura (2000) was the programme provider.

Timeframes and Design of Evaluations of Vocational Programmes

The research designs employed in research and evaluation of VET and Tech-Prep programmes are mostly of two types: multi-method case studies (Bonaventura, 2000; Malley, Frigo, and Robinson, 1999) or student post-course destination surveys (Polesel, Teese, and O'Brien, 1999; NCVET, 2000). Two studies (Bragg, 2001; Hershey *et al.*, 1998), combined both approaches. Except for Malley, Frigo, and Robinson (1999) and NCVET (2000), all the studies were longitudinal.

Focus and Nature of Evaluations of Vocational Programmes

Most of the research and evaluation studies and commentary on the evaluation of vocational education programmes, in both the compulsory and post-compulsory sector, focus on a similar set of stakeholders and suggest similar evaluation strategies. These strategies tend to focus strongly on the student outcomes that most support the main goals of vocationally-based programmes, that is, assisting students' transition to the workforce. The types of outcome measures that support these goals are: increases in the number and type of qualifications gained, participation in further education, and high employment rates in areas related to qualifications.

From a review of research that measured the outcomes of VET, Dumbrell (2000) identified five main groups of VET stakeholders. He discussed the type of information collected either from these groups, or to serve their interests. These are outlined below.

- **Students and VET graduates:** information is collected from students concerning outcomes such as participation in further study, employment status, earnings, occupations related to VET, motivations, and demographics,
- **Governments:** are interested in information that relates the outputs of VET to the needs of the labour market, levels of student participation in VET, student outcomes from VET, employers' views on the relevance of VET skills, and student employment outcomes before and after VET,
- **Employers:** are interested in employer satisfaction with VET, the appropriateness of student skills, and course content,
- **VET providers (e.g., schools):** are interested in student academic outcomes such as qualifications gained as well as less tangible outcomes such as increased self-esteem, Year 12 retention, links between in-school VET courses and post-school VET courses, post-school labour market status of students, the best way to deliver courses, and the influence of industry on VET courses,

- **The wider community:** information that relates the outputs of VET to the needs of the labour market, employer contributions to training, and the impact of VET on lowering youth unemployment rates.

The needs of these stakeholders are relevant to further research in this area. Any evaluation needs to consider the weight given to collecting information that will serve the needs of the range of stakeholders. Depending on the nature of the programme being evaluated it may not be possible to collect certain types of information, for example, a case study of a single school programme will not provide a national picture of skill development.

Dumbrell (2000) commented on the dearth of studies evaluating VET courses. He noted that there appeared to be no national system in place to track the destinations of students undertaking VET in schools, as there is for students at the Australian equivalent of polytechnics (Technical and Further Education Institutes (TAFEs), e.g., NCVER (2000)).

Burnett and Clarke (1999) have also commented on the lack of studies in this area. They examined the literature surrounding course evaluation of VET programmes in the post-compulsory sector. Although this sector is outside the scope of this review, their suggestions are relevant to an evaluation of the compulsory-schools sector vocationally-based courses. They suggested that to evaluate a course, a range of different types of information should be collected from a number of stakeholders, that is:

- student satisfaction with the course,
- student data on course completion and qualifications gained,
- graduate follow-up surveys concerning course satisfaction and destinations,
- feedback from employers and industry representatives,
- self-evaluation by teachers,
- peer evaluation of teachers' strategies by other teachers.

In contrast to this approach other authors have suggested designs that are focused almost solely on student outcomes (Ruhland and Timms, 2001).

Surveying employers is a common way to obtain data on the success of ICT certification programmes in the post-compulsory sector (as mentioned above) as well as general vocational-based programmes in the compulsory sector. In Australia, NCVER has developed a national database that holds information on VET programmes, student characteristics, and funding. NCVER also carries out two national surveys concerning VET outcomes:

1. A survey of employer views on VET and their satisfaction with VET graduates level of skill (NCVER, 2001a).
2. A survey of VET student outcomes that examines VET graduates' satisfaction with VET, and their destinations in terms of employment and further education (NCVER, 2000). This survey focuses on all VET graduates and not those located in the compulsory-schools sector.

In the past NCVET has also examined outcomes for VET graduates from the compulsory-schools sector (NCVER, 1999). As part of their monitoring of VET graduates NCVET have outlined a research and evaluation strategy for VET (NCVER, 2001b).

As well as surveying local employers on the relevance of the courses (Hershey *et al.*, 1998; Malley, Frigo, and Robinson, 1999; Bragg, 2001) many studies also surveyed teachers and school administrators (Bonaventura, 2000; Hershey *et al.*, 1998; Malley, Frigo, and Robinson, 1999; Bragg, 2001). In some cases parents (Bonaventura, 2000; Malley, Frigo, and Robinson, 1999; Bragg, 2001), Government representatives (Bonaventura, 2000; Malley, Frigo, and Robinson, 1999), local educational authorities (Malley, Frigo, and Robinson, 1999; Bonaventura, 2000) or community groups (Malley, Frigo, and Robinson, 1999) were also surveyed.

As suggested by Burnett and Clarke (1999), most studies collected data on student outcomes, such as:

- course completion (Bragg, 2001; Bonaventura, 2000; Malley, Frigo, and Robinson, 1999),
- qualifications gained (Bragg, 2001; Bonaventura, 2000; NCVET, 1999; Hershey *et al.*, 1998; Malley, Frigo, and Robinson, 1999),
- destinations, such as employment or further training that are related to the school programme (Polesel, Teese, and O'Brien, 1998; Polesel, Teese, and O'Brien, 1999; Hershey *et al.*, 1998; NCVET, 2000; Bragg, 2001),
- student satisfaction with the course (Polesel, Teese, and O'Brien, 1998; Polesel, Teese, and O'Brien, 1999; Bonaventura, 2000; NCVET, 2000; Bragg, 2001).

Currently there seem to be few studies that combine all the approaches as suggested by Burnett and Clarke (1999); though some have attempted to include the views of most of the main stakeholder groups (Bragg, 2001; Hershey *et al.*, 1998; Bonaventura, 2000). In contrast, other studies in this area have focused almost solely on student destinations (Polesel, Teese, and O'Brien, 1998; Polesel, Teese, and O'Brien, 1999; NCVET, 2000). Other studies are descriptive of the programmes but contain no student follow-up data (Malley, Frigo, and Robinson, 1999).

A couple of studies have included an analysis of the outcomes for matched groups of participant and non-participant students which provided further analysis of the potential difference programmes could make to students' transition pathways and employability (Bonaventura, 2000; Bragg, 2001). This approach is not without its difficulties; although participants and non-participants can be matched in terms of their academic achievement prior to the course, this matching does not take into account factors such as socio-economic status and personal career interests which are likely to also have an important bearing on students' post-secondary pathways.

Findings and Success Factors from Vocational Programmes

Polesel, Teese, and O'Brien's (1999) study tracked the 1997 and 1998 cohort of VET students in the compulsory-schools sector. They concluded that the VET courses appeared to be successful in meeting their aim of assisting students' school-to-work

transition. As 89 percent of students were in full-time work or studying they suggested that this indicated that students had mostly experienced a successful transition to work. High retention rates for those still studying were also taken as an indication of a programme's success. In the absence of a true comparison group, it is not clear whether students' transition to the workforce would have been the same if they had not completed VET courses. Polesel, Teese, and O'Brien (1999) reported that in comparison to national statistics:

- a higher proportion of VET students were at TAFEs,
- a lower proportion of VET students were at universities, and
- a higher proportion of VET students were in the labour force.

The authors concluded that it was

. . . particularly striking that over six in ten of the cohort's members continue in some form of tertiary education, given the group's academic profile.

(Polesel, Teese, and O'Brien, 1999, p. 22).

In the post-compulsory sector, NCVET (2000) reported similar results to Polesel, Teese, and O'Brien (1999), that is, approximately 90 percent of graduates were in further study or employed. In addition NCVET reported that approximately 45 percent of students, who were previously unemployed and who completed a course, found work after completing their course. NCVET (2000) did not follow-up students who had not completed their VET course.

In the United States the outcomes for Tech-Prep do not appear to be as definitive as the outcomes for VET in Australia. Hershey *et al.* (1998) suggested that the creation of Tech-Prep consortia has had important benefits such as an increased emphasis on career guidance and bringing employers into more contact with schools. They reported that Tech-Prep had helped promote student interest in technology careers. One interesting finding of the study was that, although more than half of the Tech-Prep graduates went on to further education or training, only approximately 15–20 percent were in the two-year courses that linked directly to their Tech-Prep course. About 75 percent of graduates were working (many were combining work and study), but only 25 percent reported that their jobs were related to their career goals. The author noted that

. . . the educational path that Tech-Prep programs were expected to emphasize is not the one most often followed.

(Hershey *et al.*, 1998, p. 128).

The authors suggested a number of reasons for this, including students' confusion about how Tech-Prep programmes linked with college study and administration hurdles in post-secondary institutions. They also concluded that, due to the implementation models chosen by some schools, only minor changes to students' experiences occurred in some cases. This meant that Tech-Prep's influence on students' post-secondary paths was likely to be limited. This information shows a need for students to be clearly informed of the education and training opportunities that follow on from vocational programmes.

Bragg (2001) presented some more positive outcomes from a Tech-Prep evaluation. She reported that:

- Tech-Prep participants were more likely to be working (and in full-time jobs) than non Tech-Prep participants,
- Tech-Prep participants were more likely to be working without studying than non-Tech-Prep participants,
- at least 65 percent of Tech-Prep participants enrolled in tertiary courses within one to three years of high school graduation,
- a larger proportion of Tech-Prep participants enrolled in two-year courses than four-year courses.

In a summary article of Bragg (2001) research, Brown (2001) noted that in three consortia, Tech-Prep participants came from lower SES families than non Tech-Prep participants. Brown (2001) saw this as an indication that Tech-Prep provided opportunities for low SES students to become first-generation college students.

These findings for Tech-Prep are likely to be more positive than the norm for Tech-Prep courses as both Bragg (2001) and Hershey *et al.* (1998) selected only leading Tech-Prep consortia to participate in their studies.

D) Evaluating Study Centre Projects Similar to WickED

WickED – Technology-rich Study Centres

A paucity of research and evaluation data on technology-rich study centres in low-income communities exists, probably due to the relative newness of this area and the community-based nature of funding for many of these initiatives (resulting in a lack of funding for evaluations). Some descriptive documentation of technology-rich after-school programmes is available, for example, Walter (1991), but little evaluation information.

An approach to the provision of access to ICT that is similar to the study centres in New Zealand is the development of the technology-rich Community Technology Centers (CTCs) located in the United States and Canada. Both study centres and CTCs provide access to ICT primarily for underserved populations. Study centres are focused on programmes for students but also aim to support the local community, whereas CTCs have a slightly broader focus in that they are located in a wider range of host organisations, primarily schools, libraries, or community buildings, and offer a range of ICT-related programmes which serve a number of target populations, but usually include the development of programmes for school-aged students and youth as one of their main focuses. In New Zealand there are a number of similar community centres such as the Wairoadotcom and Cyber Tek centres described in Barker (2001).

A number of evaluations of CTC are discussed in this review, in addition to a consideration of the literature surrounding technology-rich after-school programmes. The main programmes included in this review are:

- the 21st Century Community Learning Center (CCLC) after-school programme in the United States (Dynarski *et al.*, 2001; Raphael and Chaplin, 2000; United States Department of Education, 2001),

- the Community Technology Centers (CTCs) programme in the United States (Penuel *et al.*, 2001b; Michalchik and Penuel, 2001; Penuel and Kim, 2000; Rockman *et al.*, 1999) and the Community Services Learning Networks (CLNs) in Canada (New Economy Development Group Inc., 1998),
- other related technology-rich community centres with an educational focus (Macias *et al.*, 2000; Latino Issues Forum, 2000),
- other evaluations concerning after-school programmes which involve concentrated use of ICT (Fashola, 1998).

Who Conducts the Study Centre Evaluations and Collects the Information?

With the exception of one project, which was evaluated by the programme provider (Latino Issues Forum, 2000), the evaluations of projects similar to study centres were conducted by commissioned researchers. CTC evaluations were often conducted by one of the partners in the CTC consortium, but as this partnership was probably developed due to a desire to evaluate the programme, this has been viewed as being equivalent to a commission.

Timeframes and Design of Study Centre Evaluations

Due to the unique range of programmes offered by each study centre the research design most often employed in evaluating these programmes was a multi-site, multi-method, case study. One exception to this was Macias *et al.* (2000) who aggregated the themes from a number of interviews across sites.

These case studies were either longitudinal (Rockman *et al.*, 1999; Dynarski *et al.*, 2001; Latino Issues Forum, 2000; Latino Issues Forum, 2001; Henriques and Ba, 2000) or snap-shots (Penuel *et al.*, 2001b; Raphael and Chaplin, 2000; Penuel and Kim, 2000; New Economy Development Group Inc., 1998; Breeden *et al.*, 1998).

Focus and Nature of Study Centre Evaluations

The majority of study centre evaluations focus on collecting qualitative implementation data or information that described the nature of the programme. Outcome data was presented when it was available. A smaller number of evaluations include a focus on assessing the impact of the programme on student outcomes (Dynarski *et al.*, 2001; Michalchik and Penuel, 2001; Latino Issues Forum, 2000; Latino Issues Forum, 2001).

Aside from documenting the implementation of the centre, and the nature of the programmes, the primary goal of most of these evaluations was to identify and document good practice so that it could be replicated in other settings (Penuel *et al.*, 2001b; Dynarski *et al.*, 2001; Penuel and Kim, 2000; Macias *et al.*, 2000; Latino Issues Forum, 2000; Latino Issues Forum, 2001; New Economy Development Group Inc., 1998; Henriques and Ba, 2000; Breeden *et al.*, 1998). In recognition of the difficulties centres faced in documenting outcomes, another main goal of these evaluations was to develop a strategy to assist centres to evaluate programmes (Raphael and Chaplin, 2000; Penuel *et al.*, 2001b; Michalchik and Penuel, 2001; New Economy Development Group Inc., 1998).

Methods and Focus of Data Collection for Study Centre Evaluations

Outlined below is a summary of the main types of information that were collected about the centres and the ways this information was collected.

- **Descriptive information about the centre, its history, and its outcomes.** This information covered, for example, how the project was implemented, infrastructure, technical support, staffing, funding, outcomes for participants, and successes and challenges. This information was mostly collected from interviews with programme directors and staff (Penuel *et al.*, 2001b; Macias *et al.*, 2000; Dynarski *et al.*, 2001; New Economy Development Group Inc., 1998; Raphael and Chaplin, 2000; Penuel and Kim, 2000; Henriques and Ba, 2000; Breeden *et al.*, 1998). Observations of programmes in action were also conducted to give evaluators a picture of the programmes provided (Raphael and Chaplin, 2000; Penuel and Kim, 2000). In some cases interviews were conducted with other stakeholders such as partnership organisations concerning the development, implementation, and continuation of the programme (Penuel *et al.*, 2001b; Dynarski *et al.*, 2001; Macias *et al.*, 2000).
- **Data about the range of programmes offered, and the clients served, and levels of attendance.** This information was collected from centre records (Penuel *et al.*, 2001b; Raphael and Chaplin, 2000; Henriques and Ba, 2000). Information on this area was also collected from the interviews with centre staff.
- **Data on the impact of the programme on students' behaviour, attendance, and academic achievement at school.** This information was collected from interviews or surveys of participants' school teachers and collection of students' school records or results on standardised tests (Dynarski *et al.*, 2001; Latino Issues Forum, 2000; Latino Issues Forum, 2001).
- **Descriptive information about the use of the technology at the centre by participants and the benefits of the centre for participants.** This information was collected from participants via interviews, surveys, or focus groups. (Penuel *et al.*, 2001b; Dynarski *et al.*, 2001; Raphael and Chaplin, 2000; Penuel and Kim, 2000; Latino Issues Forum, 2000; Latino Issues Forum, 2001).
- **Descriptive information about the use family members made of the centre, and outcomes for themselves and their children.** This information was collected from interviews or surveys of parents (Dynarski *et al.*, 2001; Latino Issues Forum, 2000; Latino Issues Forum, 2001).

To assist centres to complete an annual performance review the United States Department of Education (2001) suggested a framework for data collection that covers many of the areas listed above. They suggested that centre staff collect both descriptive and achievement data concerning a standard set of indicators:

- **Achievement outcomes** – students show continuous improvement through measures such as test scores, grades, or teacher reports,
- **Behaviour outcomes** – students show improvements on measures such as school attendance, decreased discipline actions or negative behaviours,
- **Core educational services provided** – more than 85 percent of centres offer high quality services in at least one core academic area,
- **Enrichment and support activities** – more than 85 percent of centres offer enrichment activities such as technology, art, etc.,
- **Community involvement** – centres will establish and maintain partnerships with the community,
- **Services to parents and other adult community members** – more than 85 percent of centres will offer services to parents and other adult community members,
- **Extended hours** – more than 75 percent of centres will offer services at least 15 hours a week and during school holidays,
- **High-need communities** – more than 80 percent of centres are located in high-poverty communities.

The suggested methods for collecting information on these indicators were:

- collection of **programme data** such as the status (goals, focus, key accomplishments) and objectives of the programme, lessons learnt and planned adjustments, success stories, characteristics of the centre in terms of hours of operation, activities provided, links to school, host school, and staff members, participants and the extent of participation,
- collection of **student data** such as an end-of-year teacher survey on students' academic performance, homework completion, attendance, and behaviour, as well as student grades and test results.

Findings from Study Centre Evaluations

Along with documenting and describing the centre programmes, a wide range of positive outcomes from study centres were reported from these evaluations. Perhaps the most common were:

- increases in participants' access to ICT and development of ICT skills (Penuel *et al.*, 2001b; Macias *et al.*, 2000; Latino Issues Forum, 2001; Henriques and Ba, 2000),
- students spending extra time on academic activities or receiving assistance with homework (Penuel *et al.*, 2001b; Raphael and Chaplin, 2000; Henriques and Ba, 2000),
- increases in family and community involvement with the centre (Penuel *et al.*, 2001a; Raphael and Chaplin, 2000).

The main challenges identified were sustainability and sourcing continuing funding (Penuel *et al.*, 2001b; Penuel and Kim, 2000; Macias *et al.*, 2000; New Economy

Development Group Inc., 1998; Henriques and Ba, 2000) and providing trained staff or staff from the local community (Penuel *et al.*, 2001b; Penuel and Kim, 2000; Macias *et al.*, 2000; Henriques and Ba, 2000).

Study Centre Success Factors

Following these research and evaluation studies, a concern with identifying the conditions necessary for effective and sustainable programmes has developed (Fashola, 1998; Breeden *et al.*, 1998; Penuel and Kim, 2000; Macias *et al.*, 2000). Breeden *et al.* (1998) identified a number of success factors for CTCs, that is, that they needed to:

- have strong leadership,
- be grounded in the local community, understanding its strengths, and its needs,
- be respectful of the people served,
- be broadly inclusive and diverse,
- contribute to existing community institutions.

Specific success factors for CTC technology programmes were also suggested:

- effective programme planning and design,
- well-trained staff and volunteers,
- thoughtful and up-to-date curriculum,
- inviting physical facilities,
- expert support,
- an evaluation culture.

Penuel and Kim (2000) identified a number of factors that assisted CTCs to thrive:

- learning opportunities are relevant to, and shaped by, the communities they serve, for example, project-based learning techniques are used,
- staff are recruited who are members of the local community and therefore can act as role models,
- providing up-to-date technology,
- building community partnerships to extend opportunities,
- skill in acquiring new sources of funding,
- evaluating programmes.

Fashola (1998) analysed the information that was available on 34 after-school programmes (only two were technology-rich) and included inferences from other related research to suggest a number of components of effective programmes, that is they:

- addressed the three main developmental needs of the “whole” child; academic, recreational, and cultural,
- provided trained staff to implement the programme,
- provided structured programmes,
- provided one-to-one tutoring,
- included an evaluation component,

- included families and students in the planning of programmes,
- had an advisory board.

Macias *et al.* (2000) identified three main common features of successful programmes:

1. Unity of vision (shared by leaders, staff, participants, and the community) and entrepreneurial leadership.
2. Sustainable funding (grants were a crucial source of funding). Successful programmes employed, or had access to, a grant writer.
3. Addressing staff capacity needs (staff had decision-making power). Successful programmes had trained teachers who were capable of integrating ICT use into curricula and using project-based learning techniques.

Other features of successful programmes identified by Macias *et al.* (2000) included providing state of the art technology and high speed Internet connections, being located where they could best serve their community, focusing on populations in need, encouraging participants to assist in running the centre, and having a full-time technical support person. Penuel *et al.* (2001b) suggested that it was important for centres to develop programmes that are aligned with local needs and were different from the programmes offered by traditional educational institutions.

A feature that seemed to be crucial to a successful programme (that is, it was identified in all of the studies that discussed success factors) was the presence of trained staff or staff from the community served by the centre.

Issues Surrounding Study Centre Evaluations

Some of the barriers to improving CTCs, suggested by Ba *et al.* (2001), which impact on evaluations, are a problematic relationship between programme design and outcomes. Ba *et al.* (2001) also noted that the diversity of site goals can make comparisons difficult.

A number of authors comment on the lack of outcome data for CTCs and study centre projects (Ba *et al.*, 2001; Michalchik and Penuel, 2001; Fashola, 1998). For example, Fashola (1998) conducted a review of research and programme evaluation studies to examine the effects of extended-day and after-school programmes in the United States. Fashola attempted to concentrate on evaluations that had experimental or control groups and for which “appropriate” measures of achievement and other outcomes were used. Fashola concluded that few of the evaluations met “minimal standards of research design” and that stronger evaluations of programmes needed to be conducted in order that information could be provided for the replication of programmes that increased student achievement or other outcomes. However Fashola (1998) suggested that these research design problems were partially due to the difficulty of finding a matched control group for programmes in which students self-select to participate. Fashola’s views also probably reflect the particularly quantitative United States evaluation perspective.

E) Evaluating Distance Education Projects

Distance education has a long history and is the first area of education in which ICT was used a way to lessen educational divides for students. Accordingly, a number of distance education projects have been included in this review. Distance education has a well-documented body of related research, although much of this work is descriptive (Paton, 1998; Stevens, 1997; Stanley, 1996) or provides guidelines for others wanting to set up a distance education system (Harasim *et al.*, 1995). For example Canada's involvement in distance learning initiatives spans a number of years. A 1997 bibliography concerning the use of learning technologies by aboriginal, remote, or rural communities is located on the Canadian Government website.⁵³

This review concentrates on recent evaluations of virtual schools, that is distance education delivered online (Kozma *et al.*, 2000; Bigbie and McCarroll, 2000; Leonard, 2001; Hawaii State Department of Education, 1999; Bonaventura, 2000). A consideration of a small number of other distance education projects using more traditional distance education technology such as audio- or video-conferencing is also included (Tushnet *et al.*, 1994; Maushak and Manternach, 1997; Jolly and Deloney, 1996; Wallace and Boylan, 2000; Chavers, 1996).

Distance Education in New Zealand

Along with the Correspondence school, New Zealand has a number of distance education initiatives, for example, the Cantatech⁵⁴ initiative is one of these. This group of six area schools and four Year 7–13 schools in the Canterbury region link using audiographics and videoconferencing to teach courses. No formal evaluation data on this project is available.

Who Conducts Distance Education Evaluations and Collects the Information?

The majority of the evaluations and research concerning distance learning projects were conducted by commissioned or independent researchers and evaluators. There were a couple of exceptions to this. Maushak and Manternach (1997) summarised data collected by each site, and the evaluation reported in Chavers (1996) was conducted and written by the school.

Focus and Nature of the Distance Education Evaluations

The distance learning evaluations overviewed here were more focused on the formative and process end of the evaluation spectrum than the laptop school evaluations. As with the laptop school evaluations these projects did not specify an evaluation framework. There was one exception to this, Maushak and Manternach (1997) trained teachers at each site to use an AEIOU model to organise reporting into five themes: accountability, effectiveness, impact, organisational context, and unanticipated outcomes.

⁵³ http://olt-bta.hrhc-drhc.gc.ca/publicat/bibrur_e.html

⁵⁴ <http://www.cantatech.school.nz/index.html>

Timeframes and Design of Distance Education Evaluations

Most of the distance learning studies were longitudinal multi-method case studies with a duration of either two to five years (Tushnet *et al.*, 1994; Kozma *et al.*, 2000; Jolly and Deloney, 1996; Leonard, 2001; Hawaii State Department of Education, 1999) or one year (Maushak and Manternach, 1997). Three studies were snapshot case studies (Bigbie and McCarroll, 2000; Malley, Frigo, and Robinson, 1999; Wallace and Boylan, 2000). Two studies used a quasi-experimental approach as well as case study methodology (Wallace and Boylan, 2000; Kozma *et al.*, 2000).

Similar to research and evaluation conducted in laptop schools, longitudinal studies of distance learning projects over two or three years in length appeared to be better placed to show conclusive changes in terms of student outcomes (Chavers, 1996; Leonard, 2001).

Themes and Methods of Measurement of Distance Education Evaluations

The main focus of the distance learning evaluations was on presenting information which:

- documented and described the initiative (Jolly and Deloney, 1996; Wallace and Boylan, 2000; Malley, Frigo, and Robinson, 1999). This information was collected mainly from interviews with programme administrators and teachers, and by analysis of project records,
- identified lessons learnt, ways to improve the infrastructure and lesson delivery, or concerns of the community (Kozma *et al.*, 2000; Jolly and Deloney, 1997) This information was gained mainly from interviews and questionnaires with teachers, students, and parents,
- provided information, collected from project records, on how the project had provided access to students who might not normally be served, or had increased the range of courses available to students (Tushnet *et al.*, 1994; Maushak and Manternach, 1997; Bigbie and McCarroll, 2000; Jolly and Deloney, 1997; Kozma *et al.*, 2000),
- evaluated student, teacher, or parent satisfaction with the project (Bigbie and McCarroll, 2000; Kozma *et al.*, 2000). This information was mostly collected from surveys,
- provided information on the nature of classroom or student-teacher and student-student interactions in the distance learning environment (Wallace and Boylan, 2000; Tushnet *et al.*, 1994). This information was mostly collected from classroom observations,
- provided information on student motivation (Maushak and Manternach, 1997; Hawaii State Department of Education, 1999). This information was mostly collected from student surveys,
- assessed whether students and teachers thought that the distance learning courses provided quality content (Maushak and Manternach, 1997; Kozma *et al.*, 2000). This information was mostly collected from student and teacher surveys and interviews,

- evaluated teacher satisfaction with the professional development delivered (Tushnet *et al.*, 1994, Maushak and Manternach, 1997; Kozma *et al.*, 2000). This information was mostly collected from teacher surveys and interviews,
- reviewed the courses (Kozma *et al.*, 2000; Wallace and Boylan, 2000; Bigbie and McCarroll, 2000; Hawaii State Department of Education, 1999). This information was provided by an external panel or the course content, teaching methods, and interactions were compared to set criteria,
- evaluated teacher and student satisfaction with the quality of learning in distance learning classes in comparison to traditional classes (Kozma *et al.*, 2000; Tushnet *et al.*, 1994). This information was mostly collected by comparing the course evaluations of students and teachers who participated in both distance learning classes and traditional classes,
- evaluated student achievement in distance learning classes in comparison to traditional classes by comparing student records (Tushnet *et al.*, 1994),
- provided information on the efficacy of the technology involved (Wallace and Boylan, 2000). This information was collected from teacher, student, and parent interviews,
- discussed the development of instructional materials (Tushnet *et al.*, 1994; Maushak and Manternach, 1997). This information was mostly collected from interviews with programme administrators and teachers,
- discussed community development and partnerships (Jolly and Deloney, 1996; Leonard, 2001). This information was mostly collected from interviews with programme administrators and teachers.

Findings, Outcomes, and Success Factors of Distance Education Projects

Evaluating the effect of the delivery method on student achievement (e.g., Tushnet *et al.*, 1994; Leonard, 2001) was a less common goal of distance learning evaluations compared with laptop school evaluations. Chavers (1996) discussed student speaking skills and confidence developed via participation in a distance learning environment but did not report on student achievement data in relation to distance learning classes even though this information was collected for other non-distance learning aspects of the project.

Rather than improving student achievement, a more important goal of these distance education initiatives, and therefore the focus of the evaluations, appeared to be on providing or increasing access to educational opportunities to underserved students. Most evaluations reported that student access had been increased either in that a wider range of courses were offered, or more students were able to participate (e.g., Tushnet *et al.*, 1994; Jolly and Deloney, 1996; Hawaii State Department of Education, 1999).

This focus on increasing access seems sensible given the conclusion that Russell (1999, cited in Fouts, 2000) drew when he compared 355 research reports examining the issue of student achievement in distance learning classes in comparison to traditional classes. The title of his book, *No Significant Difference*, sums it up succinctly. On the whole, Russell reported very few significant differences in student educational achievement (as measured by standardised tests or end-of-year examinations) in distance versus face-to-face classes. Russell also reported that many studies reported higher

student dropout rates in distance learning courses compared to traditional courses. These findings, are on the whole, consistent with the findings from the studies in this review. The fact that virtual and face-to-face courses are more similar than different is reported in Kozma *et al.* (2000) and Tushnet *et al.* (1994). Higher dropout rates in virtual courses are reported in Bigbie and McCarroll (2000) and by the Hawaii State Department of Education (1999).

On the whole students and teachers expressed satisfaction with the distance learning initiatives (Wallace and Boylan, 2000; Kozma *et al.*, 2000; Jolly and Deloney, 1996). Various positive outcomes were reported such as improvements in students' self-esteem (Jolly and Deloney, 1996) and the development of students' self-confidence and public speaking skills (Chavers, 1996). Hawaii State Department of Education (1999) reported that students identified a number of benefits from participating in courses, such as, valuing the ICT skills they had gained, and increased learning opportunities and flexibility to learn when they wanted.

Aside from dropout rates (as mentioned above), the other main concern highlighted by the evaluations was the lack of student-initiated, or inter-student, communication in distance education classes (Wallace and Boylan, 2000; Kozma *et al.*, 2000; Bigbie and McCarroll, 2000). A problem identified by some evaluators was that the lack of common data collection in some projects made it difficult to specify student outcomes or compare outcomes across sites (Tushnet *et al.*, 1994; Maushak and Manternach, 1997).

A number of other concerns about the distance courses were also expressed but these varied depending on the nature of the course offered, for example, Bigbie and McCarroll (2000) reported that most students found the distance courses harder than face-to-face courses. Jolly and Deloney (1996) reported that staff found scheduling of classes across districts difficult and that teachers needed more professional development to assist them with the new medium.

The Kozma *et al.* (2000) study identified a number of key issues including: the lower reported number of communications and satisfaction with learning reported for the distance courses; the fact that the types of distance courses offered tended to attract high achievers and not the range of students in a school, and sustainability – the distance courses took more time and resources than expected.

From these studies it appears that a focus for distance learning research and evaluation could be to:

- assess whether courses offered expand students' range of opportunities or reach students who previously did not have access to courses,
- document what the conditions were that facilitated low dropout rates, and document ways to facilitate student-initiated communications.

F) Other Evaluations of Technology-rich Initiatives in the Compulsory-schools Sector

A number of other ICT evaluations and research projects are included in this review. One of these is the international OECD/CERI study of the impact of ICT on learning and organisational change. One of the hypotheses for this study is concerned with digital divide issues, that is:

Gaps in academic performance between high and low poverty students will not increase when all students have equal access to ICT. The rival hypothesis is that equal access to ICT will lead to more advantaged students increasing the performance gap with disadvantaged (high poverty) students.

(Venezky and Davis, 2001, p. 11–12).

The sample for this study includes low-income schools, for example, the United States case studies by Dexter and Jeanpierre (2001a, 2000b). A summary of the main findings from this study is included in the accompanying bibliography (Venezky and Davis, 2001). The OECD/CERI study has two components:

1. A quasi-experimental study (OECD, 2000a) which aims to collect a range of information from approximately 100 schools in 18 OECD countries. A random stratified sample of schools was selected according to three levels of ICT infrastructure (high, average, and low). The study examines the relationship between ICT use and the ability of students to learn on their own, the experiences of high and low poverty students, and the conditions that lead to the most desirable outcomes for students. Data were collected in September 2000 to June 2001 and the final results of the study should be available in 2002.
2. The Case Studies of Organisational Change project (OECD, 2000b) for which the final report is available (Venezky and Davis, 2001). This report summarised the experiences of 60 schools from the 18 OECD countries in the study. As this study was focused on organisational change, schools were only selected to participate if they had undergone a major improvement in the last five years and had used ICT widely in the school for at least the previous two years.

Other projects included in the bibliography are two of the Apple Classrooms of Tomorrow (ACOT) study reports. ACOT was an early large United States research project on the impact of ICT on learning (Tierney *et al.*, 1992; Sandholtz *et al.*, 1995). Another project included is the Navigator Schools project in Australia (Education Victoria, 1998; Toomey, Ekin-Smyth and Nicolson, 2000; Toomey *et al.*, 2000; Toomey and Ekin-Smyth, 2001). Also included are McKinnon (1995) and Boyd (1997); two evaluations of technology-rich initiatives in New Zealand secondary schools.

SUMMARY AND CONCLUSIONS

Although the four types of projects in this review are mostly located in technology-rich environments in schools, in some cases this is almost their only connection. Laptop school, resource development, and study centre projects have some elements in common, but ICT certification and vocational education projects are very different in nature to the others. Accordingly, it is difficult to summarise common themes between these projects. A number of debates and concerns discussed in the literature are mentioned below. In most cases these debates are relevant to laptop school, resource development, and study centre projects, but are less likely to be relevant to ICT certification and vocational education projects.

Additional Goals for Projects in Low-income Communities

ICT projects in low-income schools have a different emphasis from those in high-income schools. In addition to the usual focuses of ICT evaluations, such as documenting: the implementation of a project, changes to the classroom and learning environment, and changes to student attitudes and achievement; evaluations of laptop projects, study centres, and in some cases resource development projects, conducted in schools that serve low-income areas have often focused on collecting data on an additional set of possible outcomes such as:

- improved student attendance (Ricci, 1999; Stevenson, 1999; NetSchools Corporation, 2000; Dynarski *et al.*, 2001; Chavers, 1996),
- improved student retention (Rockman *et al.*, 2000; NetSchools Corporation, 2001),
- development of student career goals (Ricci, 1999; Derewetzky, 1992),
- increased student self-esteem (Ricci, 1999),
- increasing the access of the community to ICT (Michalchik and Penuel, 2001; Penuel *et al.*, 2001b),
- development of family or community ICT skills (NetSchools Corporation, 2001; Ricci, 1999; Latino Issues Forum, 2000),
- increased communication between home and school and involvement of parents and the community in the education of their children (Latino Issues Forum, 2000; Ricci, 1999; Penuel *et al.*, 2001b; Rockman *et al.*, 1999; NetSchools Corporation, 2001), and
- lessening destructive behaviours by students such as bullying (Dynarski *et al.*, 2001; Raphael and Chaplin, 2000).

Evaluations of projects in low-income schools often include indicators that aim to measure whether ICT encourages disenchanted students to stay at school. This appears

less of a concern for schools in high-income areas that already have high retention rates and students motivated to continue to tertiary education.

Summary of Findings from Projects in Low-income Communities

Most of the evaluations in this review reported positive findings such as students development of increased ICT skills, increase access to ICT, increases in students' motivation to study, positive changes in students' attitudes towards school, increases in students' self-esteem, or increases in students' employability skills. In most studies these benefits had also been transferred to families who used ICT more as a result of their children's increased access and use.

Though in many cases these positive findings were conditional on a number of factors, such as, teachers being provided with technical support as well as enough professional development to assist them to make pedagogical changes and integrate ICT use into classroom practice. Another factor that appeared to be important was related to professional development, that is, that the school or centre had an overview concerning how ICT could be integrated into their programmes to best assist learning. Providing students with relevant project-based tasks grounded in their local community was also mentioned.

Responses to Projects

Although in most situations stakeholders responses to ICT initiatives were positive, in a few cases it was suggested that the programme be discontinued. This was a result of a negative response towards the programme by students and a lack of implementation planning (Kessell, 2001) or because teachers perceived that the project lacked relevance to their students and was not implemented in a way that supported teachers (Means *et al.*, 2001). This was rare (probably due partially to the financial input necessary to develop these projects it is unlikely that they would be shelved easily!). In one laptop school project, for which longer-term data was available, the programme seemed to have lost its impetus (Newhouse, 1999). King's College in Auckland have also discontinued the laptop programme in the junior school that was evaluated by Parr (1992 and 1993).

Design of Evaluations

Differences in Approaches to Evaluations

The evaluations and research reports in this review show differences in nature due to the differences between the research and evaluation culture in the country of origin of the report. As noted in Gray (2000) the United States has a strongly developed evaluation culture that tends to focus on quantitative measures of student outcomes, such as improvements in standardised tests. This approach is less common in Australasia. Although evaluations conducted in Australasia also collect test data there seemed to be less of a focus on these data and more on qualitative data collection methods than those conducted in the United States. Gray (2000) has summarised a number of criticisms of the approach taken in the United States, including the difficulty of finding reliable and

valid measures of student outcomes. It is likely that the more quantifiable approach of evaluators from the United States has been assisted in its development by the requirement that the recipients of Government grants report annually.

Evaluation Focus

The evaluations of the ICT initiatives reported on in this literature review typically focus mostly on process and outcome evaluation. As many evaluations were longitudinal, any formative components tended to consist of feedback from the first year to iron out implementation issues. Only a few such as the School Design Model suggested by Bain (1996) or Woodbridge (2000) were overtly formative in orientation and therefore specifically examined and refined programme goals and objectives. Bain set out with this formative approach in mind and Woodbridge included a formative side to his evaluation when it became evident that the school he was working with had not developed a framework for how ICT was to be used to assist teaching and learning.

Depending on the type of ICT innovation the emphasis of the evaluation varied: laptop schools usually included elements of both process and outcome evaluation but were more focused on outcomes; study centres evaluations were process-focused but included outcome data when available; resource development projects tended to have elements of all three approaches; and evaluations of programmes concerning vocational ICT qualifications were much more outcome-orientated.

Interestingly, no studies included a cost-benefit analysis of whether there were more effective (and cheaper!) ways of developing students' skills in environments that were less technology-rich.

Evaluation and Research Methodology

Commentaries on the digital divide have suggested that too much emphasis has been placed on increasing access to technology rather than focusing on the objectives for using technology. It is likely that this situation has developed from the somewhat potted history of evaluations in the ICT area which in the past have suffered from the problem of the technology being seen as an end to itself rather than only one part of the equation. This concern has been reported in Parr (2000) in relation to studies concerning computer-assisted instruction and in Culp, Hawkins, and Honey (1999) who suggested that early research and evaluations of ICT initiatives implicitly viewed technology as a "black box". This research assumed that technology was the only variable and looked for evidence of student learning as a result of "applying" this variable (usually measured by test score gains). This type of approach ignored pedagogy, teacher practices, and student experiences (Culp, Hawkins, and Honey, 1999). The design of earlier ICT evaluations and research has tended to encompass a number of "black box" assumptions (Gardner *et al.*, 1993; Robertson *et al.*, 1997). This is less common in evaluations conducted from the late-1990s.

Lack of Clear Programme Goals

One area reported unevenly in the evaluations reviewed and in the literature summarising evaluation studies is the lack of clarity concerning programme goals and purposes (Fouts, 2000) or learning objectives (Schacter, 1999).

One enduring problem with the use of ICT in schools, as summarised by Schacter (1999), is that on many occasions programme developers and funders are more concerned about the “hardware” that is, equipment, rather than the “software” such as learning goals and professional development. The lack of clear programme goals undoubtedly contributes to some of the variability present in study findings, especially in the case of laptop school studies. In some of the evaluation reports it was unclear what the goals of the programme were. In one case, goals were alluded to but not outlined (Newhouse, 1999); in other cases programme goals were not clearly documented in the evaluation or research report, although they may have existed (Jolly and Deloney, 1996; Gardner *et al.*, 1993; Rowe, 1993); and in further cases, due to a lack of clear goals, the evaluators recommended that the school develop a clear set of learning goals for the programme (that is, other than teachers and students using ICT and developing their ICT skills) (Woodbridge, 2000; Parr, 1993).

For the one truly formative evaluation in this study this goal setting was part of the evaluation process (Bain, 1996). Woodbridge (2000) suggests that a framework that articulates the programme’s “theory of change” is necessary to assist in developing a coherent programme of goal-related professional development, classroom activities, and evaluation instruments.

Some of the programmes evaluated appeared to have an unclear or simplistic focus, that is, increased ICT usage by student and teachers was seen as the main success factor of the programme (Robertson *et al.*, 1997; Woodbridge, 2000). The “how”, that is, how the technology was to be integrated into the curriculum was ignored.

This approach was problematic for teachers and evaluators. In schools adopting this “sole goal” teachers reported that they needed professional development on how to integrate ICT into the classroom in addition to the skills-based training provided. Evaluators suggested that ICT skill development alone is not enough of a reason for a programme and recommended that the schools develop a more comprehensive ICT strategy to include other teacher and student outcomes (Woodbridge, 2000). As Venezky and Davis (2001) concluded:

Successful implementation is not simply a technical issue. It requires a vision about education and about the specific educational goals that ICT is to support. An ICT plan by itself is incomplete. Policy makers should ask first for a strategic schooling plan and then for an ICT plan for supporting educational goals.

(Venezky and Davis, 2001, p. 46).

Most of the recent programmes and their associated evaluations have tried to address the thornier issues of the conditions that facilitate positive outcomes for students from their use of ICT, that is, the “how” and “why” questions.

Matching Programme and Evaluation Goals

In their overview of research concerning the use of technology in education, Culp, Hawkins, and Honey (1999), concluded that “matching the goals of the evaluation to the goals of the program is crucial to effective evaluation research.” (p. 5). In the research overviewed here, this did not necessarily occur, for example, Rockman *et al.* (2000) noted that a goal of United States AAL evaluation was to examine the impact of AAL on standardised test scores, but raising test scores was not a goal of the AAL programme. In other reports, it is not clear whether evaluation goals met programme goals as in some cases the programme goals were not clear or absent.

Evaluation Timeframes

The evaluation literature suggests that conducting an outcome evaluation in the first set-up year while the programme is still in a state of change is problematic. The large international OECD Case Studies of Organisational Change project only selected schools that had at least a previous two-year implementation period (OECD, 2000b). At least one evaluation that did not take this approach, and evaluated the programme’s outcomes in the first year was not well received by school staff (See the Hewitt School evaluation; Gibbs, 2001). Some recent “laptop school” evaluations only reported significant changes in student outcome measures after a minimum of three years into the evaluation (Stevenson, 1999; Newhouse, 1999). As Stevenson noted, change in school systems and in students’ learning practices can be slow. This situation is also reported in regard to ICT initiatives other than laptop schools. In the evaluation of an online resource development project, Tyner (2000) reported that it took two years to build the infrastructure before teaching and learning outcomes could be measured. In another project, Jackson and Guerin (1999) noted that it could take teachers three to seven years to become familiar with using technology. This information implies that a one- or two-year timeframe could be too short to adequately do justice to reporting the outcomes of a programme. In recognition of this, many evaluations document the process of implementation in the first year of the evaluation, and the outcomes in the second or third year.

Selecting a Comparison Group

The use of a comparison group can be a valuable way of ascertaining programme effects and is commonly employed in evaluations of ICT initiatives in schools. This type of design was included in evaluations of all four types of projects in this review. Comparing outcomes between groups of programme and non-programme students or teachers at the same school was a common method of providing data in laptop schools in which laptops have been provided to some classes of students at a school and not others (Abrams, 1999; Ricci, 1999; Parr, 1992; Parr, 1993; Passey *et al.*, 2001; Gardner *et al.*, 1993; Stevenson, 1999; Fisher and Stolarchuk, 1998); and for distance education projects in which some students studied a subject via distance methods and others face-to-face (Kozma *et al.*, 2000; Bonaventura, 2000; Tushnet *et al.*, 1994). In schools in which the programme model was applied to the whole school, comparison groups from other schools were sometimes included in the evaluation design (Bain, 1996; Newhouse, 1999). Comparison

groups were also part of the design of some study centre projects (Dynarski *et al.*, 2001; Fashola, 1998), and vocational education projects (Polesel, Teese, and O'Brien, 1999; Bragg, 2001). Using comparison data from other research projects is another way that comparison groups can be utilised, for example, Wallace and Boylan (2000) compared the percentage of teacher-initiated interactions in a distance learning classroom with other research on face-to-face classrooms.

There are a couple of drawbacks of using an in-school comparison group. One of these is highlighted by Rockman *et al.* (2000): the characteristics of non-programme and programme students can grow more similar over time. Rockman *et al.*, suggested that this could be due to the sharing of pedagogical approaches and ICT skills between the teachers and students in the two types of classes. Another drawback of using comparison groups suggested by Fashola (1998) is the difficulty of finding matched control group for programmes in which students self-select to participate, such as in study centres programmes. This difficulty also applies to vocational programmes such as Tech-Prep, in which students who participate can have different achievement and socio-economic levels (Bragg, 2001).

Collecting Data Only from Exemplar Sites

Selecting exemplar sites only is a valid research design, but the selection needs to be made transparent to the reader. Penuel and Kim (2000) do this to document some of the more innovative CTC programmes available. Other studies tended to be less transparent. The use of non-random or self-selected sampling techniques is a way in which exemplar sites could be unwittingly selected. In the Rockman *et al.* (2000) study of laptop schools, 8 of the 29 pilot sites participated in the evaluation; many sites were excluded for a number of reasons, but it is likely that those who agreed to participate could have been more successful in implementing the programme than others. This could result in findings that are not representative of the group as a whole.

What Indicators to Use?

Many of the studies in this review relied heavily on stakeholder self-report to indicate the success of the programme and identify outcomes for students. Some caution must be exercised in using self-report as an indicator unless positive attitudes or attitudinal change can be shown to relate to improved learning outcomes. This is not necessarily the case. Parr (2000) noted that attitude has been shown to have no significant connection to learning outcomes in relation to integrated learning systems. For this reason Parr excluded attitude as an indicator of learning outcomes in her review of integrated learning systems. Parr (2000) and Wood, Underwood, and Avis (1999) conclude that attitude alone should not be taken as a valid indicator of programme success. This debate is relevant to this review, in many cases attitudinal data was not corroborated with data such as standardised test results. Positive changes to student achievement were more likely to be reported from self-report qualitative data than quantitative data on the same area (e.g., Rockman *et al.*, 2000; Gardner *et al.*, 1993).

One of the reasons for this lack of match could be that standardised or other test results are not a valid measure of gains expected from ICT innovations (Spielvogel *et al.*, 2001;

Rockman *et al.*, 2000). Spielvogel *et al.* (2001) commented that only a few items in the test used in their study could be directly related to the goals of the programme. Rockman *et al.* (2000) concluded that there:

. . . tends to be a disconnection between the purposes of laptop use and the skills measured by the most widely used standardized tests.

(Rockman *et al.*, 2000, p. 4).

A lack of match between the tools used by students, and the tools used in the assessment of student outcomes, is commented on by other researchers (Gardner *et al.*, 1993; Boyd, 1997), and in overviews of this area (Fouts, 2000).

Indicators that are specifically tailored to the goals of an initiative and to the way ICT is being integrated into the classroom, such as the ability to handle mathematics and science data (as developed by Passey *et al.* (2001)), appear to be more valid indicators of the impact of a ICT innovation than generic achievement tests.

Pucel (2001) proposed a change in the types of indicators used to measure the effectiveness of vocational and academic education programmes. This change is directly related to the shift in school goals as a result of the societal shift from the knowledge age to the information age. Pucel's suggestions appear to be applicable to ICT innovations in schools. He suggested that societies' current expectations of students are that they:

- be able to creatively solve problems,
- be able to apply what they learn to their future lives and work,
- have a rigorous background in academic skills,
- develop generalized employability skills,
- explore and become technologically literate on potential careers,
- develop visions of their futures and how their education's can contribute to those visions.

(Pucel, 2001, p. ix).

Pucel considered that widely used indicators such as academic tests (for example, the Scholastic Aptitude Test) are not valid indicators of vocational programme success. He suggested a number of indicators that could be used to "realign educational practice with reform expectations" (p. 153). These are:

- student retention and satisfaction,
- academic skill development and contextual problem-solving, that is, how students can apply academic skills to real-life situations,
- career exploration and skill development,
- employability skill development, for example, that the student has developed competencies such as: information literacy skills, technology and ICT skills, understanding of systems, and the ability to work with others.

A similar suggestion is made by Penuel and Kim (2000) in relation to CTC programmes. They noted that better tools are needed to measure CTC programme outcomes as traditional measures of successful outcomes, such as test results, are not appropriate for CTCs. Measures are needed which are more closely tied to the specific

goals of the centre, for example, how programmes impact on clients' learning or measurement of clients' career aspirations, pathways, or technical skills.

Project Success Factors

The success factors of the projects reviewed here, especially in relation to the laptop school projects, seemed to exist on two levels; the **simple**, and the **complex**. At the **simple level** many ICT innovations were accepted as a success if students, parents, and teachers expressed positive attitudes towards the programme, the programme had increased student and teacher ICT access and usage, and had developed the ICT skills of students and teachers (in the case of laptop and study centre projects), or had expanded student access to new subject areas and experiences (in the case of study centre and distance learning projects). In these situations general measures of academic achievement (such as standardised tests) were often used to assess changes in learning outcomes. These measures mostly showed variable or no clear improvements in learning outcomes for students.

At the more **complex level** laptop projects were seen as a success if improvement of learning outcomes directly related to the programme were evident, for example, students exhibited more on-task behaviours, or developed their information literacy or data-handling skills further. Other success factors at the complex level included whole school change in terms of integration of ICT into the curriculum and school administration practices, and changes in the classroom environment towards a learner-centred environment.

The acceptance of a simple level of success was more common for ICT initiatives in the early 1990s when the main goal of many programmes was to increase the use of technology and therefore the main goal of the evaluation was to report on this use. In these initiatives and their evaluations technology was viewed as the sole variable.

In time the focus of programmes and evaluations has moved away from the "black box" approach to address the context of the ICT innovation. From this change a more complex set of focuses are suggested which are more concerned with changes to teaching and learning rather than just equipment use. This is the focus of some of the more recent laptop schools evaluations (Passey *et al.*, 1999; Selby, Elgar, and Ryba, 2001) and some of the resource development projects. For example, the goal of the IBM reinventing education partnership as described by Spielvogel (2001) was to use ICT as a catalyst to create change in the resources available to teachers and their teaching practice in an endeavour to improve students' achievement. In distance learning evaluations this focus has manifested itself in a concern with identifying the conditions necessary to increase student interactions (Wallace and Boylan, 2000) or decrease student drop-out rates (Bigbie and McCarroll, 2000).

Reoccurring Concerns for School-based Projects

The Lack of Professional Development Beyond Skills Training

Dr Eva Baker (quoted in Spielvogel *et al.*, 2001) suggested that anyone could write an evaluation summary of a school-based ICT project without actually visiting the site; this summary would be “This project has real potential if only it had been implemented more fully.” (Spielvogel *et al.*, 2001, p. 6).

Although this quote is somewhat sobering, it seems particularly relevant to the laptop school projects and some of the study centre and resource development projects in this review. A lack of professional development, and in many cases technical support, were concerns mentioned repeatedly by teachers. The professional development that teachers suggested that they needed more of was based around pedagogy and integrating ICT use into the classroom rather than simply developing ICT skills. Other issues of relevance to many of the projects located in low-income environments were sustainability and continued funding.

Suggestions for Designing Evaluations of ICT Initiatives in Schools

Most evaluations discussed in this review were in the form of two- or three-year longitudinal multi-method case studies of either a single site or multiple sites. The literature surrounding the selection of research or evaluation methods suggests that this is a valid approach for these types of initiatives. The longitudinal evaluations of more than one or two years yielded richer results and more certain conclusions than other designs such as snapshot studies.

Most of the evaluations in this study were either process and/or outcome focused; some included a cursory formative component. From the information summarised in this review it is evident that an increased emphasis on formative evaluation would benefit school-based ICT projects, in that the much reported problems in the literature with inadequate professional development and support could be identified and rectified early on in the life of the programme – given available funding. Formative evaluation could also assist to clarify project goals, and from that, evaluation goals. Process evaluation of pilot programmes could enable others to emulate the programme.

A continued focus on outcome evaluation is also necessary to ensure that the programme is in fact making a difference to teaching and learning. Outcome evaluations need to avoid the “black box” approach by examining the “how” and “why” rather than the “what”. Evaluations that document the experiences of people in low-income communities need to examine more than just increased access. As suggested by the Morino Institute (2001), projects, and therefore their evaluations, should include a focus on what needs low-income communities are addressing through accessing technology, and how these needs are met. Other features of future evaluation could include:

- research questions that encourage the evaluation to consider the complex conditions and interactions that support successful programmes,
- in line with the suggestions offered by Pucel (2001) and Penuel and Kim (2000) evaluations could include a re-examination of the indicators used to ensure that they match the skills required in the “information age”,

- development of measures that are clearly related to the goals of the projects, rather than relying on standardised tests results to indicate programme success,
- an inclusion of some of the extra indicators commonly used to examine the success of initiatives in low-income communities, such as improvements in student retention data, development of student career goals, increased community access to ICT, increased communication between home and school and involvement of parents and the community in the education of their children, or improved behaviour,
- a design that includes the viewpoints of the multiple stakeholders involved in a project,
- a design that ensures that at least two sources of data are used to corroborate self-reported evidence, for example, the inclusion of observational analyses of behaviour.

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