Determining an e-learning Model for Students with Learning Disabilities: An Analysis of Web-based Technologies and Curriculum

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A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Victoria University

MELBOURNE, VICTORIA, AUSTRALIA

AUGUST 2010

ABSTRACT

This thesis investigates the impact of ICT on the learning outcomes for Learning Disabilities (LD) or special needs students, in a special school setting. The literature reported a significant prevalence of LD universally, ranging from physical and mild to extreme disabilities. It highlighted that there are a significant number of students with learning disabilities who require assistance and support in their learning. Assistive technology plays a significant role for educators and students with learning disabilities in facilitating the learning outcomes. The Internet and Information and Communication Technologies (ICT) play a major part in shaping the knowledge and skills of LD students. Assistive technology has introduced awareness for both educators and students and, for the past decade, there has been a growing effort in designing and developing ICT based platforms to enhance the learning outcomes of these students. With the emergence of new technologies like Web 2.0, the need to design appropriate tools and provide an environment that is conducive to successful learning is stronger. This thesis examines the various teaching methodologies and ICT innovation in a holistic way. The literature shows that although there are some studies that investigate the impact of technology on the learning for special needs students, most of the data are second source. This study presents results from participant observations in two outer suburban special schools with students aged between 14-18 years, and in addition, examines the role and impact of Education Department policies on the schools' ICT environment. These observations are compared with a study based on an individual case of a student from Prep to Year 12 and TAFE. This study identified different categories of special needs students who were catered for in these special schools. These ranged from students with physical or cognitive disabilities, to mainstream students placed temporarily in a hospital. The latter group received ICT support to continue their studies which is now facilitated through a virtual classroom environment.

Data analysis reveals that a significant role is played by the actors. An e-learning model appropriate to this study was adopted and applied to gather data from the first school during the early phase, namely, Macedon Ranges. The model was later refined to facilitate further in-depth observations whilst the study was shifted to the second school, Concord. At Concord, a specific project, called 121 ICT, provided data over a lengthy time period of three years. The study identified key actors, their influence on the curriculum and use of ICT. Furthermore, it revealed significant differences in

leadership and e-learning plans for special needs schools in the State of Victoria, Australia. The data showed that a strong focus on the use of technology in teaching and the curriculum can lead to stronger engagement by students and teachers. The strong belief in school policy by the key actors raised the status and standard of the learning outcomes. Participation in the pioneering project provided a comprehensive way of observing the integration of ICT into the curriculum; and how this approach extended the skills and knowledge of the students in the special schools. Moreover, the study provided evidence on how the students worked at the school, and later, how they sought pathways into life and work. The ICT programs and environment were reflected in the attitude, motivation and communication skills of the actors. Although in some cases, the students faced difficulty with motor skills[1], it was observed over a significant time period that these handicaps were overcome with the use of ICT. For senior students in the school, the curriculum offered alternative studies such as the Victorian Certificate for Applied Learning (VCAL). ICT was clearly seen as a driver or force for students with special needs in this research field. It should be noted that the concept of the 121 ICT Project was also independently implemented by the Queensland Department of Education. The 121 ICT Project provides evidence that scaffolding with a direct teaching approach enhances the learning outcomes of LD students. In addition, the study further demonstrates that infrastructure is a significant factor in the successful adoption of ICT in these schools.

The thesis examined studies from a global perspective; for example, the OECD, UK, Asia, USA, and Africa. E-learning models from the literature were used in the study to gather data and the results were applied to formulate the design of an e-learning model for LD students. The thesis confirms and extends previous findings regarding the impact of ICT on the learning outcomes of LD students. The present findings strongly support that ICT increases the motivation, independence, self-esteem and communication skills of LD students. Moreover, the study provides evidence that a significant attainment in skills and academic knowledge is facilitated by the adoption of ICT.

[1] The skills included writing, drawing, spatial perception and speech.

DECLARATION

Degree Title: Doctor of Philosophy

I, Anastasios (Tas) Adam, declare that the PhD thesis entitled "*Determining an e-Learning Model for Students with Learning Disabilities: An analysis of Web-based Technologies and Curriculum*" is no more than 100,000 words in length, exclusive of tables, figures, appendices, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

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Signature of Candidate Date

ACKNOWLEDGEMENTS

This study would not have been possible without the support and advice of my wife in guidance of our son who was diagnosed with developmental delay in his preschool years. The objective and main drive was to explore learning models and tools to assist him with his early and latter schooling years- leading to the transition to work. The views of many researchers like Bloom, Piaget, Gardner, and more recently socio-technical thinkers who developed ANT like Callon, Latour and Law, have influenced the thinking and research approach in this work.

This was an anthropological research study and, as such, it needed participant observations to gather first hand data. I am most grateful to the Principals of the two schools: Mr Peter Redenbach, Principal of Sunbury and Macedon Ranges Special School; and Mr Colin Schot, Principal of Concord School Bundoora. In addition, I would like to express my gratitude to various staff members who worked closely with me and allowed me to participate in their classroom activities.

I wish to express my gratitude to VU and DEET for the ethics approvals that were required to conduct research in the above mentioned schools.

Of course the thesis could not have been completed in its current format and standard without the support and assistance from the following persons: my wife for editorial assistance, HOS Con Nikakis, for his level of enthusiasm and support, Associate Professor Dr Geoff Sandy for his advice and support from the early candidature period. In particular, for his research supervision and guidance, Associate Professor Dr Arthur Tatnall who guided and supported me in every way possible with this challenging task. He provided the mental and intellectual stimulus and made the task possible in the end. He was certainly a main post in this huge project and I am indebted to him for his support and collegiality.

Thanks to the University for granting me SSP leave to work on the research. To the colleagues who provided support and inspiration in dealing with this study and last, but not least, my former HOSs Angela Scollary (retired) and Julie Fisher (now at Monash University) for their advice and support for this dissertation.

I have reserved the final tribute for a previous colleague- Professor Glenn Lowry. *Glenn, if it wasn't for you running the research induction seminars back in 1999, I don't think I would ever have pursued this work. Your effort and interest in my work at the time has culminated in this final dissertation.*

In closing, I wish to acknowledge my mentor in life and the person responsible for providing me with the mental courage, support and challenge to overcome difficulties - my father.

Dedication: This work is dedicated to my wife Dimitra, son George and daughter Sophia. Thanks for all your support, patience and love.

PUBLICATIONS ARISING FROM THIS THESIS

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STYLE OF THESIS

A Note on Style

Personal history is shown as journal in 2 columns in several parts of the thesis.

Research Field: The research schools or fields will be referred to also as the research environment throughout the thesis.

Tools used in the thesis: I have applied Mind Manager where possible to model the infrastructure and other relevant aspects of the research.

Main Models

- Actor network model
- ICT learning model
- Research plan
- Research Timeline
- Research design
- Schunck e-Learning model
- E-learning Model
- Brain model
- Learner interface model
- Petri Net model for e-Learning

A note on LD: LD is a universal term that refers to students with learning disabilities.

Education Department: this is used in place of DEST (Federal), DEET (State) and DEECD (State) throughout the thesis

Research Project Funding: The research on Infrastructure was funded by the former School of Information Systems in 2005. The research was further supported by a grant from the Special Studies Program (SSP) of the University in 2007.

Specific project at Concord School: The 121 ICT Project provided resources like laptops to each individual student to work in class.

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Microsoft
Spectronics
Dragon Naturally Speaking- Nuance
AutoDesk
Adobe
Mind Manager

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GLOSSARY

ABS: Australian Bureau of Statistics.

ACER: Australian Council for Educational Research.

ACLD: American Council for Learning Disabilities.

Actor: Human or Non-Human Entity Object.

Adaptive Learning: Learning where the content presented to the learner, and the order that content is presented, varies depending on the results of pre- and post-assessment of the learner's mastery of the content knowledge.

AERA: American Educational Resources Association.

ANT: Actor Network Theory.

AREA: Australian Resource Educator's Association.

Assessment: A tool used to evaluate a learner's skill or knowledge level in a particular subject area.

Assessment item: A question or measurable activity used to determine if the learner has mastered a learning objective.

Assistive Technology: Technology that is used to support special needs students.

Asynchronous collaboration: Interaction with learners and instructors that is not in real time, such as e-mail conversations or posting comments to a discussion.

Asynchronous learning: A learning event where the interaction is delayed over time, such as a correspondence course. Also sometimes used to describe a learning event that is delivered after the original live event (usually as a recorded version of the event, with associated materials).

Asynchronous learning delivery system: A learning delivery environment that can combine a number of asynchronous collaboration components.

Authoring tool: Software application used to produce electronic learning content

Becta: British Educational Communications and Technology Agency.

Brain Models: Models which explain the function and behaviour of the brain and provide models for learning and memory (Kolb and Hebb).

Broadband: Term for sufficient bandwidth to receive streaming video and sound. Usually refers to bandwidth equal to or greater than Asynchronous Digital Subscriber Line (ADSL) or Cable Modem speed.

CAI: Computer Assisted Instruction.

CBT: Computer Based Training.

CERI: Centre for Educational Research and Innovation

Cognitive Generative Model: Model by Osborne and Wittrock for conceptual understanding in familiar concepts.

Computer-based training (CBT): Any instructional event that can be accessed via a standalone computer.

Constructive Learning Model: Learning Model that is used for students on an individual basis (Constructivism) proposed by Mercer 1981.

Content item: A small piece of information that is stored in a database and is used to communicate skills or knowledge. It can be in any media format including text, graphics, animation, video, audio, and HTML plug-in.

Content Management System: An environment where learning developers can create, store, reuse, manage, and deliver digital content from a central object repository.

CTE: Career and Technical Education.

Da Vinci Project: European Secondary Schools Program

DEETYA: Department of Education Employment Training and Youth Affairs (Also known as the Education Department).

Delivery Management System: A range of technologies that support the delivery of learning content to a learner in self-paced, collaborative, real time, and asynchronous modes.

DEST: Department of Education Students and Training (Federal Education Department).

Digital Portfolio: A method of file and presentation management for digital media

Distance learning: Any learning event where the learner is not required to travel to a specific location.

DSP: Disadvantaged Schools Program (Federal Government Funded Project for Schools in the 80s).

Dyslexia: Learning Difficulty in reading and writing.

Edna: Education Network Australia (**edna.edu.au**) provides resources identified and contributed by Australian educators and networks the bodies responsible for education.

Effect size: This is a statistical metric that is calculated by the difference of the mean of comparisons and experimental mean and weighted by the standard deviation of the group of comparisons. $E = (\mu_c - \mu_{exp}) / \sigma_c$.

E-Learning Model: A model that is based on a range of technologies (such as Internet, TV, video, intelligent tutoring systems and computer-based training) to facilitate teaching and learning. It is an integral part of a complete learning environment.

Ethnography: A research method that is based on people joining the research group and taking part in the activities under investigation.

Experiential Learning Model: A learning approach based on students gaining experience through participation and engagement.

Gap analysis: Assessing the gap between existing versus desired skill levels, competencies, and certifications. A term typically used in the corporate as opposed to 14the education environment.

Human Capital Development: A term used to describe extensions to Learning Management Systems (LMS) vendors product offerings that are intended to help clients link learning more directly to the improvement in the productivity and value of their human capital i.e., their employees and partners.

ICT: Information Communication Technologies.

IDEA: Individuals with Disabilities Education Act (1990)

IEEE LTSC: IEEE Learning Technology Standards Committee. This group approves internationally recognized standards for e-learning interoperability

ILS: Integrated Learning System.

IMS Global Learning Consortium: IMS is an important player in the development of e-learning interoperability standards.

Inclusive Schools: Schools which accommodate all children regardless of their physical, intellectual, social, emotional, linguistic or other condition. This should include disabled and gifted children and other special needs students in the curriculum.

Informal/formal learning: Formal learning is a class, a seminar, a self-study course everyone recognises it as learning. Informal learning is over the water cooler, asking a co-worker in the next cubicle to help out, collaborative problem solving, or watching an expert.

Instructor-led training (ILT): A **scheduled** event conducted by an instructor, either in a classroom or through network delivery.

IQ: Intelligence Quotient.

JNCLD: Joined National Council of Learning Disabilities.

LD: Learning Disability is a learning difficulty arising from physical or cognitive handicap, for example developmental delay.

Learner: A more general term than student, learner refers to any person receiving training or education in a formal or informal environment.

LCMS: Learning Content Management System is a content management system specifically intended for learning objects.

Learner Interface Framework: Interface that links learners, teachers and the delivery methods of instruction by Papert and Brusilovsky.

Learning Styles: These relate to Models of experiential learning based on Kolb and they try to explain individual differences in learning.

LMS: Learning Management System.

Learning object: From an operational perspective, learning objects are chunks of data that are used by e-learning systems they are authored, stored, catalogued, assembled, delivered, and reported on. A more down-to-earth approach is to think of a learning object as a digital part of a course ranging in size and complexity from a single graphic to an entire course itself.

MCEETYA: Ministerial Council on Education Employment Training and Youth Affairs

Metadata: Information about learning objects that allows them to be stored in and retrieved from a database in a meaningful way. Metadata describes what is inside a chunk of learning.

Mild LD: Mild Learning Disability/Difficulty.

NCLD: National Committee of Learning Disabilities (USA).

OECD: Organisation for Economic Cooperation and Development.

Offering: Any learning event or service that is offered to learners.

PISA: Program for International Student Assessment (EUROPE).

Portal: A specific view into a set of applications that matches a person's role and requirements to the available services and learning offerings.

RCH: Royal Children's Hospital (Melbourne).

RSS: Really Simple Syndication is a family of web feed formats used to publish frequently updated works, such as blog entries.

SCORM: An acronym for Sharable Content Object Reference Model. The US Federal Government's reference model for the use of learning content standards and specifications. It is built on the work of AICC, IMS and IEEE.

Self-paced learning: An offering where the learner determines the pace and timing of content delivery.

SNE: Special Needs Education (UK).

Special Needs: Needs for students with learning difficulties or disabilities arising from a vast range of cognitive and physical impairments.

Special Schools: Schools that cater for special needs students.

SPELD: Specific Learning Difficulties Association.

Subject Matter Expert (SME): An individual who is recognized as having proficient knowledge about a subject area. Usually considered as a source of content in the e-learning context.

Synapse: Part of a neuron that receives and transmits electrical and chemical energy to other neurons.

Synchronous learning: Learning event delivered in real time to the learner that can include immediate, two-way communication between participants.

TAFE: Technical and Further Education.

VCAL: Victorian Certificate for Applied Learning.

Virtual classroom: Delivery of a scheduled offering to multiple locations (either desktop or classroom) via a networked solution.

Ultranet: A network that provides Schools, students and parents an interface to work with Web 2.0 tools and social networking in Victorian Schools.

Virtual Community: A group of people who share a common interest or goal and communicate principally through the internet.

Web-based training (WBT): Any instructional event that can be accessed via the Web.

MAIN ACTORS

Coding of Actors (Human) - Conversion Table for Case studies

Actor	Role	Field	Alias
AM	Principal 1	Macedon	Peter
GM	Teacher 4	Macedon	Carole
HM	Teacher 5	Macedon	Helen
JM	Teacher 6	Macedon	Joanne
IM	IT Support	Macedon	Jenny
PM	A Principal	Macedon	Philip
EM	IT Coord1	Macedon	Eleonora
NM	IT Support	Macedon	Renee
MM	ICT Coord2	Macedon	Con
MC	School Council	Macedon	Parents
BM	Teacher7	Exchange	Barbara
RM	IT Support	Exchange	Ron
PR	ETH1	Author	Tas
DD	DEET 2	DEPT	Dept
NH	ED1	RCH	Tony
OH	ED2	RCH	Peter
VS	Supervisor	VU	Arthur

Table 0-1: Main Actors at Macedon Ranges

Actor	Role	Field	Alias
BC	Principal	Concord	Collin
CC	IT Manager	Concord	Andrew
DC	Teacher 1	Concord	Anna
EC	Teacher 2	Concord	Ann
FC	Teacher 3	Concord	Rhonda
WC	Teacher4	Concord	Warren
KC	A Principal	Concord	Jason
QC	ICT Coord3	Concord	Richard
SC	School Council	Concord	Parents
PR	ETH1	Author	Tas
DD	DEET 2	DEPT	ETHICS
NH	ED1	RCH	Tony
OH	ED2	RCH	Peter
VS	Supervisor	VU	Arthur

Table 0-2 : Main Actors at Concord

Actor	Role	Field	Alias
AI	Doctor	Z	GP
BI	Psychologist 1	Z	Maria
CI	Speech Path	RCH	Tanya
DI	School X	School Yard	Beatrice
EI	School XX	Alphington	Bill
FI	School XXX	Omiros College	Tassos
GI	Psychologist 2	PEGS	Carole
HI	School support 1	PEGS (Prep –Y8)	Debra
II	School support 2	PEGS (Y9-10)	Lorraine
JI	School support 3	PEGS (Y11)	Russell
KI	School support 4	TAFE	Rob
LI	Teacher	TAFE	Rupert
MI	Jobs support	Jobs West	Raelene
NI	Psychologist 3	Z	Alfie

Table 0-3: Main Actors for the Individual study (Z)

Actor	Actor	Actor	Actor
Teachers	Teaching Assistants	Policy Procedures	Protocols
Curriculum	Assessment	Software Programs	Lab Computers
School Buildings	Network	Internet	Beliefs
Attitudes, Interests & Motivation	Interests & Agendas	Networks & Stability	Alignment
Translation of Interests	Inscriptions & Precedence	Irreversibility	Black Boxes
Laptops	Mobile Phone	iPod	Email
Mouse	Games Software	Timetable	Office

Table 0-4: Main Non-Human Actors in the Research Study

CHAPTER 1

1 INTRODUCTION

"*The beginning of knowledge is the discovery of something we do not understand.*"

Frank Herbert (1920 - 1986)

1.1 THE LONG JOURNEY HOME

This research study arose from two specific points of interest:

1. The PhD induction in the School of Information Systems at Victoria University, in late 1990s, by Professor Glenn Lowry and
2. Motivation to find ways and means that could assist children with learning difficulties.

The first provided the impetus to launch myself into research and research methodologies whereas the second provided the scope for the unit or field of discourse. The PhD induction course was a fast track course which involved a substantial number of colleagues, many of whom have now completed their own PhD study. Although the task appeared easy at first, it proved to be difficult at the beginning of the study. As is the case for most researchers, the most difficult and challenging task was the identification and the contact with a relevant organisation that was willing to allow me to conduct the research study.

Various organizations were approached, including the Royal Institute for the Blind, but I was unsuccessful in gaining access to their learning environments. It was by accident that I was introduced to the first special school through one of the campus managers who was attending a particular university committee meeting. He asked "How is your research going?" and after explaining my dilemma, he contemplated for a moment and then made a suggestion that I should approach the special school at Sunbury[2]. His suggestion was followed and the road opened for me to begin investigating and making arrangements towards the first special school.

[2] Sunbury is a regional town in Victoria, Australia.

I began my visits and observations in order to gauge an understanding of this learning environment. My observations included a range of age groups, junior to secondary and a variety of learning areas, ranging from Technology to English and Personal Development. Although at this stage limited data was gathered, the early obstacles that were faced were soon overcome and I was ready and willing to commence the task. However, it must be noted that I was completely unaware of the time commitment that would be demanded. I was faced with the challenge of coming to terms with students of varying learning difficulties and special needs as well as familiarising myself with the teaching and learning environment in order to make my observations.

I met with many staff members (Actors) in addition to the significant actors. For example the School Principal pledged his full support for my research program and assisted me in all the necessary procedures to gain ethics approval from the university and the Education Department of Victoria.

His unreserved support gave me absolute confidence to observe various classes and learn about the special needs environment, teaching methods, curricular and in particular the educational technology plan. He was the gate keeper for this study. Furthermore, I became familiar with people in respective areas of the Department and had meetings with them to gain more information and the level of support for videoconferencing between schools and other projects on the Internet.

As luck would have it, I was invited by the School Principal to accompany him on a visit to another school. I had no idea at this stage that this was going to provide the bulk of my research data with a specific project and regular observations through a Special Studies Program of the University (SSP).

Due to some staffing issues beyond my control, my research plan was not progressing as well as I had expected and subsequently I followed my earlier link (actor) to make contact with a second school. The principal was very happy to support my research and he invited me (and my supervisor) to a School Council meeting to make a brief presentation about the aims of the research project. Subsequently, I learned from the principal about a special project that some of the staff members were thinking of running and was invited to join this project. I was delighted with this news and commenced meetings with the leading project teacher, the ICT co-coordinator and Principal.

In a few months, the conceptual phase of the project was reached and after several more months the project implementation started. The necessary infrastructure and hardware was put in place and each individual student in the project was provided with a laptop to use in class.

The road from there on was very clear and once again I was back on track working, observing and collecting data. My participant observations allowed me to work with students and teachers in various classes as well as the Special Project class. This was a senior class of students with mild learning difficulties who were referred to as the Transition Group. The school provided an ICT centre with “state of the art” equipment and a robust data communications network, which was administered by a dedicated IT manager for the school. This was in addition to any other support available from the Education Department.

I think that it is worthy to mention here that although there may have been other research studies conducted in this area, this study is unique in that the data collected was “first-hand” and the research method was applied in a holistic manner. Actor Network Theory (ANT) was a suitable analytical tool as it allowed me to follow the actors and gain an insight about the teaching and learning models in the two schools. The expressions ‘Learning Disabilities[3]’ and ‘special needs’ are used in the dissertation to refer to conditions that are basically the same; these expressions are used interchangeably. I hope that the thesis will make the reader aware of this incredible journey; a journey that was full of aspirations, frustrations and finally through persistence over several years, I was finally able to deliver the final product or achievement. Figure 1-1 on page 4 illustrates my research journey described above over a significant time period of approximately 10 years.

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3 The universal term LD is used to refer to learning disabilities. In the state of Victoria, the term used for this category of students is ‘special needs’. This is preferred by schools, teachers and the Education Department. Chapter 2 discusses the issue of the definition and the one adopted in this thesis. The thesis title is related to the generic term LD which is a subset of learning difficulties.

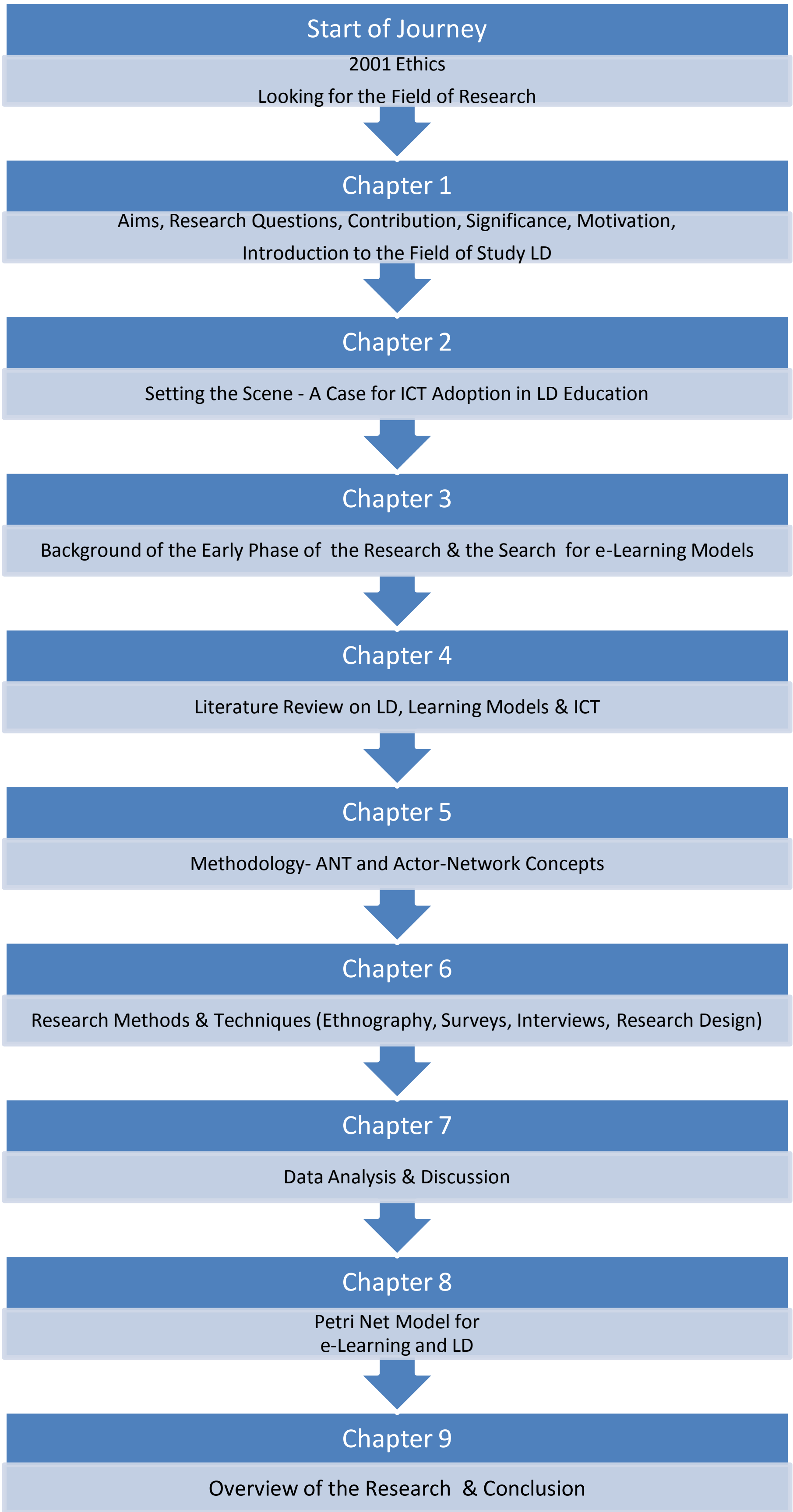

Figure 1-1: The Research Journey

1.2 SUMMARY OF SIGNIFICANCE

A review of the available literature indicated crucial limitations on the understanding and use of ICT as a tool for teaching and learning for LD students. This research was significant because its findings have identified significant learning models with ICT and pathways for further study, training or work placement for LD students.

There was very little research that provided information about the impact of technology in teaching and learning for students in special schools in Victoria. Although DEET[4] and ABS[5] studies had included students with LD in normal schools, very little work was carried out that incorporated the aspects or role of technology in these schools. The present study has provided information that will be of benefit to these school communities. ANT embraced the differences in educational, technological and sociological aspects in a non-deterministic manner.

In order to overcome the boundaries of several school disciplines the study needed to take a holistic approach which observed and analysed the way teachers and students changed their practice when using Web-based and Information and Communications Technologies to assist them with teaching and learning.

Further, the study was significant because it shed some light on curriculum that is aided by technology. In addition, the analysis of various support structures could provide future institutions with a better approach to curriculum and instruction design. The Australian Bureau of Statistics (ABS 2006) (*Australian Social Trends* 2000, 2006) estimates that 8% of all children aged 5-17, have a disability involving a specific restriction capable of impacting on their schooling, and MCEETYA (1997) indicated that the prevalence of LD is approximately 10-15% at the primary levels and is still significant at the secondary level at 5-10%. The figures for Australia followed similar trends to those from the USA and other countries; and this was supported by the National Committee for Learning Disabilities (NJCLD 1994). Research from MCEETYA (1999) reported that there was inconclusive evidence of the impact of

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4 DEET – Refers to Department of Education at the State level in Victoria, Australia.

5 ABS – Refers to the Australian Bureau of Statistics, a Federal Body that conducts the Census.

technology in many special schools that catered for students with LD. The need for further research in this field is further highlighted in White (2005), Liu et al. (2007) and Warnock (2005) on special educational needs in the UK.

No holistic[6] research was found that had explored how technology influenced LD students' learning outcomes. The present study was based on a holistic approach to research in an institutionalised setting. While the study was located within special schools, its findings provide information about the adoption of Web-based (ICT) technologies in teaching and learning, as well as learning for the workplace for students with learning disabilities.

The thesis also provides a significant e-learning model and ICT application that could impact future funding implications for the identification and analysis of at-risk factors and an analysis of the impact of educational paradigms for students with learning disabilities.

The financial implications should be prioritised as the results from this study have identified the views of the various stakeholders of the learning community. The thesis provides discussion and analysis of these views with the objective of proposing and designing a suitable model for learning with technology as its strong focus (ABS 1997; DEETYA 1996-1999; Higgins 2003; Calnin 2006; DETYA 2001a; MCEETYA 2008; ACER 2005; Shaddock 2007 and DEETYA 2003).

1.3 CONTRIBUTION TO KNOWLEDGE

As the reader will discover, this thesis contributes to the body of knowledge by having extended the application of ANT to technology and people with learning disabilities. The research provides (1) a basis for developing a constructive model[7] to assist in designing and delivering technological curriculum for online learning and teaching instruction for students in special schools or learning communities[8]; and (2) a

6 Holistic – the term holistic here is used to refer to many interrelating factors.

7 "Social constructivist model". Teachers and students exchange ideas to generate new knowledge, share the role of learner and focus on social inter-subjective nature of knowledge.

8 "Learning Community". This term is adopted from Wenger (1998).

description and analysis of learning communities and the impact of technology on teaching/learning for LD students. It has identified a set of processes for setting up a suitable e-learning model that may be implemented in this environment and beyond. Given the increasing use of teaching with Web-based flexible delivery tools at these schools over the next few years, it is anticipated that strong emphasis on the technology will lead to significant learning outcomes for the students of the schools.

The work of the thesis further provides an analysis of the mechanism of how organisations and educational institutions could design and deliver their curriculum. It will also be of value to training institutions as it could provide information for the workplace training and learning for using ICT in the workforce.

A recent publication by Abbott (2007) highlights the need to conduct research in this field by applying actor-network theory. This thesis has successfully applied this methodology and established significant results and observations regarding trends in the learning models with ICT for LD students.

The observations and data collected recently (in 2007 & 2008) have shed some light on how Web 2.0 technologies can be used to assist students with learning difficulties and foster their learning outcomes, for example to prepare them for life-long learning. This area was identified in the Becta (2008) report which stated that this area needed studies to establish evidence of the impact and effect of Web 2.0 on the learning outcomes for students in general. The thesis reports on findings of the impact of Web 2.0 on students with special needs and it discusses the present Victorian government policy regarding e-learning and access to resources via the Ultranet.

Finally, the thesis makes a contribution by modelling the e-learning platform for LD students through an examination and application of a suitable Petri Net model.

1.4 AIMS

The aim of the study was to examine the place of ICT and e-learning models in an environment involving learning disabled students. This study was concerned with how computer (including Web and Internet) based technologies are used in a specific learning community. Consequently I[9] aimed to develop an understanding of the Web based technology and ICT that is employed for a particular group of teachers and learners in this setting. In addition, I explored the use of Actor-Network Theory as a holistic way of analysis in practices in an educational setting. In order to achieve these general aims, the following main research question was pursued.

1.4.1 Major Research Question

The major research question in the thesis was:

"How do e-learning models form and stabilise when Web-based technologies are introduced to support learning communities involving students with learning disabilities?"

1.4.2 Sub-questions

Although relating more generally to all schools (not just for special schools), the following sub-questions for the study were also framed in an ANT approach:

1. *How do teachers and students negotiate (Callon 1986b) with innovations such as Web-based technologies in order to achieve particular learning outcomes?*
2. *How do the human and non-human (Latour 1986) aspects of the socio-technical network that staff and students construct involving these Web-based technologies, lead to positive outcomes?*
3. *How is the technology integrated into the teaching and learning curricula? (Lave & Wenger 1991)*
4. *What are the implications for the transition into further education, work placement or training for students with LD?*

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[9] First Person. I have used first person in line with Creswell (1994), as this is the most appropriate approach with studies such as the one investigated in this thesis.

In particular, I have also explored the following complementary questions arising from the literature in relation to LD students:

Does ICT help students with special needs in teaching and learning, and if so, how?

What are the factors that enable the students to facilitate their learning and improve the academic outcomes?

What teaching and learning models and policy (metrics) would provide better outcomes? For example the literature identified the following metrics: self-esteem, motivation, communication skills, independence and participation level ACER (2005), Becta (2003), OECD (2001, 2004, and 2005).

How can ICT be used as an enabler for good pedagogy for this learning community? (MCEETYA 2005)

How can brain model theories be applied to explain the learning outcomes with respect to a specific area like graphics or multimedia?

How does ICT assist in the acquisition of skills and application of various software packages such as Photoshop, 3D studio Max, Adobe Premier, Sound and Video production?

After considerable research and analysis of the research questions, I determined that the most useful way to illustrate the thought processes is to present the reader with the evolution of the research questions over the duration of the research project. Figure 1-2 shows the range of pertinent questions that were considered before the study and the outcomes after the study**.**

1.5 EVOLUTION OF THE RESEARCH QUESTIONS

Before Research	After Research
How can computers enhance the learning environment for people with special needs?	Integrated approach, common approach supported by studies from the UK, Europe, Asia, Africa, the USA and AUS.
How can the Internet be used to foster a positive learning environment?	Access, regulation, constraints, security issues Becta, OECD, Tanzania
What model could be proposed to incorporate the main aspects to learning: physiological? Psychological? Technological?	Integrated approach, Holistic model.
What domain of knowledge (lit) unit of research should the unit of analysis encompass? Actors?	Main actors were identified: - organisations, policy, teachers, leaders and students with learning difficulties or special needs.
How can technology provide an alternative flexible delivery of instruction that is suitable for students with learning disabilities?	Infrastructure, ILS, CAI, LMS adaptive technology, e-learning
What role can the Internet provide to measure the performance differences for such students?	Actor, enabler, facilitator, non-human
What is an appropriate education / instruction model that could be applied to U0?	(2001) P0-P1-P2, I applied the Schunck e-learning model in the initial phase to determine the movement of students from P0...> P1 or P1 > P2 with an initial skills matrix.
What is the necessary infrastructure to carry out an appropriate experiment design?	Special schools, participant visits, observations, Moyle, Cordella (ANT).
How does the technology motivate slow learners /achievers?	Raises self-esteem, Becta studies, USA, AUS, OECD PISA, Scottish report.
Should technological curriculum be integrated into standard curriculum for students with special needs?	Yes, Becta, OECD, Australian studies.
How does technology facilitate the alternative delivery of curriculum mode successfully?	Becta studies, USA, AUS, OECD PISA, Scottish report.
How should the technology be used to achieve the desirable outcomes?	Through proper policy and professional development.
What methods of teaching need to be established /targeted?	Constructivist, thinking curriculum.
What kinds of instruction might inspire a student to learn something in which she has no natural interest?	Student centred, thematic, constructivist
What is the link between technology and the biological basis of learning?	The Generative learning model established
How can alternative learning techniques facilitate learning techniques for people with learning disabilities through the use of technology?	Technology can be an enabler or facilitator.
What services on the Internet can be identified as enabling a more efficient way of learning?	Email, Blogs, Facebook, Wikis.
How does technology facilitate the cognitive processes? Intellectual disability? Physical disability?	Assists both low and high order processes and thinking. Provision is made by adaptive technologies for physical impairments like speech, vision, handling of input and output devices, such as the mouse and keyboard. The introduction of picture symbols (widgits) is also another way that assistance may be provided via technology.
How does technology minimize environmental disadvantage?	An opportunity learning cost similar to that of Petty from NZ could be associated with access to ICT resources and curriculum for special needs students.
What are the advantages to a student with learning disabilities in using technology innovation?	The students would gain skills and knowledge to support them in their leisure, work and life.

Figure 1-2: Evolution of Research Questions

In addition to the above complementary questions, in this study I was also particularly interested in the following research question:

> *How can the Internet be used as a tool to facilitate and evaluate the specific set of learning criteria as proposed by Bulgren (1998), Torgesen et al. (1983), Pillay (2000), Quinn (1996), and Lloyd et al. (1998)?*

These authors analysed the main elements that are related to role playing, games theory, concept maps, and virtual reality. In particular, Lloyd and Forness (1998) had used an approach that was based on meta-analysis and effect size[10] to determine the relative weights on the learning outcomes and the intervention metrics needed for students with special needs. It should be highlighted that a research study from New Zealand by Petty (2005) had postulated a set of parameters called the "*opportunity-to-learn*[11]" and these were used in a model to explain the learning outcomes for students who were visually impaired. These parameters will be examined and their relevance to the present study will be discussed in Chapter 8 of the thesis.

1.6 MILD LEARNING DISABILITIES (LD) & MILD MENTAL RETARDATION (MMR)

In this thesis I was particularly concerned with mild learning disabilities. A comparison of LD and MMR was provided in a study by Fletcher et al. (2000). The study explored three groups of students under categories of several cognitive tasks - some in the domain (e.g. language) and some generalist (pattern types). Their results demonstrated the following relationship with respect to ability:

NA > LD > MMR.

Here, NA = Normally Achievable, LD = Learning Disabilities, and MMR = Mild Mental Retardation.

The results identified that whenever the tasks were relatively easy, the mean NA and LD results were similar. When the tasks were relatively difficult, the mean LD and

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[10] For a definition of this term, see Glossary.

[11] This term is also used by Newhouse et al. (2002) in the Review of the Impact of ICT on Learning and Teaching, and it is listed as one of the key learning attributes (Constructivist Attribute).

MMR results were closer. Therefore, students who belonged to the LD class tended to have a special need in a specific domain, whereas students who were identified in the MMR category showed a wider range of special needs. These results were also supported by data from Becta (2003), MacMillan & Hendrick (1993), and recently by Shaw & Grimes (2005). Shaw & Grimes argued that the problem with the instruction of slow learners is the notional split between special education and general education. There are arguments that slow learners require some level of additional support to improve their learning outcomes and achieve success. Therefore, it is essential to examine the teachers' attributes and their effectiveness as well as the school environment for such students. For example, a charter school dedicated to meeting the needs of slow learners can address many issues by providing an environment to develop an individualised form of instruction for them. This would enhance their social skills, increase the participation of parents in curriculum design, and thus develop and evaluate the best possible curricula and teaching approaches for this particular group of students. For example, the Nevin Center is a public charter school in Greensville, South Carolina dedicated to developing academic resilience in students not having academic success in the traditional public school setting. (The Center was designed for students with IQ scores between 70 and 85 and who had failed academically (Shaw & Grimes 2005 and Kavale 2002)).

In a study by Janette Klinger et al. (1998) it was found that the academic outcomes for students in inclusive classrooms showed no improvement when they were compared with mainstream students. It has been well documented that the effectiveness of general education classrooms for students with LD may be affected by many factors including the type and severity of the disability (Klassen 1994, Deno et al. 1990, Marston 1996, Shaw et al. 2005, Kavale 2002 and Zigmond et al. 1995).

1.7 A BRIEF NOTE ON THE SPECIAL SCHOOLS IN THIS STUDY

In seeking an environment that would allow me to carry out my research, I was influenced by the information provided and the views of an actor that is listed in Table 0-3, from the educational group School Yard. This actor (Beatrice) was instrumental in influencing my thinking about brain models and the early attempts to find an opening for a suitable site. I began my journey by asking the Royal Institute for the Blind (RIB) in Melbourne for permission; however I faced enormous ethical and administrative problems and abandoned the request. I subsequently analysed the categories and factors for LD, and considered that it would be best to carry out the research study for this thesis at government funded special schools which provided mainstream and specialist curricula. Furthermore, these curricula were aided by Information and Communications Technology (ICT). The final choice of schools was purely accidental and demonstrates an important application of Actor-Network Theory. The schools that this study is based on have students with a wide range of learning difficulties- physical and cognitive, although, the participant observations were conducted with mainly mild LD students. Inevitably, an area like this has a number of technical terms and abbreviations and full details and explanation of these will be found in the Glossary.

1.8 OVERVIEW OF THE THESIS

Technology has played a very important role in learning and work for many people. In the past several decades it has played a significant role for specific disadvantaged groups like the blind, in providing media to facilitate communication and also education for this group (Poon & Head 1985). The literature showed that many technologically based learning projects were designed and implemented in specific fields to support or enhance the learning of a specialist group of students in a specific manner. For example, two decades ago, Papert (1980) introduced the concept of LOGO to help students develop good problem solving skills. Although most researchers applied one determining factor to the exclusion of others, e.g. social, educational or technological, this study focuses on the integration of these elements by following a holistic approach to determine an e-learning model for students with learning disabilities.

In this study, it was necessary to crossover several boundaries in order to apply the socio-technical approach in this dissertation. Because there are several complex interrelating factors that link Education, Psychology, and Technology, for LD students. In particular, Actor-Network Theory (ANT) was chosen to conduct the research following the work of Bigum (1998a), Gilding (1997), and Tatnall (1999) in educational settings. These researchers used ANT as a framework for their analysis of teaching and learning with and about technology. This research has extended the previous research to the specialised group of students with Learning Disabilities (LD[12]). ANT is a well-known approach in social research; it uses a non-deterministic way of handling the contribution of both human and non-human actors. Its main proponents include Law (1992), Callon (1991), and Latour (1986). This research study was carried out primarily at two special government schools- Sunbury and Macedon Ranges Special School, at Sunbury, and Concord School, at Bundoora. An application through DEET was approved and allowed me to carry out the research study. Further, the knowledge that was gained from these fields of research was applied to the individual study that I will discuss further in a later section.

This study adopted a holistic approach and used ANT as an analytical framework. A previous National Study on Technology in Schools (DEET 2000) examined the adopted practices with regard to teaching and general information about the use of computers. It did not give the detail of how technology impacts on the learning of students with special needs. For instance, the study identified schools that were providing a focus on technology; schools in Victoria that had developed a Learning Technology Policy that was supported by the government. One of the main aims of this policy was to remove disadvantage for remote schools.

Recently, a network that incorporates Web 2.0 technologies has been piloted in several government schools and is planned to go live in September 2010. This huge project is called the Ultranet project and its scope and significance will be discussed later in the thesis. Undoubtedly ICT has been viewed as a significant component that could impact the learning outcomes for learning communities like the students with special needs around the globe. The OECD and the UK government had carried out considerable research in trying to determine the impact of ICT on motivation, self-esteem and the learning outcomes for LD students (OECD 2005, Becta 2008).

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[12] Learning Disabilities (LD) is a well-recognised and accepted term in the literature: The definition that is being adopted in this thesis is the one provided by the National Joint Committee on Learning Disabilities (NJCLD) – see Section 2.2.

Several boundaries from technology, education and psychology were considered in a holistic manner, and the most appropriate approach to conduct the study was the ethnographic approach. This approach facilitated the entrance and the data collection in the fields of research, namely the special schools. The study further examined the respective infrastructure and e-learning or technological plans for both schools.

1.9 THESIS ORGANISATION

Chapter 1- Introduction

This chapter provides the background to the motivation for this research study and the approach that was taken to identify the research field. One important aspect was to examine the definition of LD and this was done both at local and global levels. Given the nature of the research field, it was considered most appropriate to apply a holistic method to gather the research data. Therefore, a fairly substantial list of actors was identified and followed through to derive information about the relationships of these actors and how they impacted on the learning environment for LD students. To assist the reader a table was compiled to describe the various actors and their roles in the three different field scenarios of this research study. These were the two special schools and the individual study respectively, in the thesis.

Chapter 2- Setting the Scene - Perceptions and Connections: A case for ICT Adoption in LD Education

The chapter presents the case for special needs education, the definition of learning difficulties (LD) and prevalence. In order for the reader to gain an appreciation of the impact of the teachers and how they have adapted their approach to work with LD students' learning outcomes, I have presented a brief analysis from the literature about the qualifications and attributes of the teachers. A brief discussion is presented on the barriers and enablers to effective use of ICT in schools leading to policy.

Chapter 3- Background of the Early Phase of the Research & the Search for e-Learning Models

This chapter discusses the research field and introduces the reader to ANT as a suitable tool for analysis of the data gathered from participant observations and other means that will be discussed in Chapter 6. An analysis of infrastructure is provided and this leads to Learning Objects. A review of Learning Management Systems (LMS), Integrated Learning Systems (ILS) and e-Learning models was conducted, and this is presented in this section. The chapter concludes with a discussion on Web 2.0 technologies and the framework for designing an e-Learning model for the present study. A brief review of school-to-work transition literature is also included in this chapter.

Chapter 4 - Literature Review- LD, Learning Models & ICT

This chapter presents a review of the literature on LD, ICT and educational models with LD and ICT. It discusses the local and global prevalence rates as well as the significance of policies on LD and learning. It is important to analyse the factors that impact on learning with ICT and the chapter has presented literature from local and global perspectives. In addition, brain model theories of Hebb, Kolb and others are discussed, which subsequently lead to the generative learning model and its relevance to LD. To conclude this section, I have also included Learning Styles in an effort to highlight some of the social as well as the cognitive differences in LD education. The chapter further provides discussion on the factors that affect teachers' use of ICT in the classroom and concludes with teaching and learning paradigms.

The role of games was also investigated, and further brain models and learning styles were researched with the aim of applying a certain matrix called the skills matrix in a specific project in the field. Of special importance was the finding in the literature that in the USA, LD students were generally placed in mainstream schools, whereas in Australia similar students are placed in separate special needs schools.

The literature indicated that the learning outcomes were not improved to a significant extent. In fact, some studies have reported that LMSs were more appropriate to deliver content and were limited for social networking and collaboration as can be achieved with Web 2.0 technologies (Lytras 2005). The chapter also concludes with an observation that in order to overcome boundaries, i.e. technical, educational and psychological, the application of Actor-Network Theory is the most suitable analytical tool that should be used to carry out the data analysis in a holistic way.

Chapter 5- Methodology - Actor-Network Concepts

The chapter presents the main concepts and the original proponents of Actor-Network Theory. These include Callon (1986), Law (1991), Latour (1996), and several examples of where and how the ANT framework was employed in research studies. The chapter discusses several studies of ANT in education and argues that as a logical extension this is applied to special needs education and ICT. The relevance of this methodology to the study is discussed as a way that overcomes the limitations and boundaries that are imposed on the field of study. The chapter draws the reader's attention to some of the limitations and criticisms of ANT.

Chapter 6- Research Methods & Techniques

The study has drawn from several research methodologies including Ethnography and Case Study. From the early phase, it was necessary to focus on a conceptual model that incorporated various actors. This model is presented in this chapter to complement the research roadmap, which is introduced in chapter 3, as an overview of the path that was taken to conduct the study. Further, the chapter discusses the various approaches that were followed in setting up the research framework. It discusses the relevance or appropriateness of the ethnographic approach that assisted with data gathering. The questionnaires and interviews that were conducted were first approved by both the University and the Victorian Education Department's ethics committees. In addition, the chapter highlights the "gatekeeper" approach that was supported by the Actor-network theory application. The main argument that is highlighted is that this is a holistic research study, and subsequently, there are several tools and methods that can be applied to gather data for the study. The data are presented and discussed in Chapter 7.

Chapter 7- Data Analysis & Discussion

The chapter provides samples of the data that were collected from all research fields. The participant observations were tabled through a series of journal entries with concept maps during the visits and these are summarized and reported in this section. It further discusses the participant observations and draws conclusions about the significance of the actors on the learning and teaching outcomes in the research environments. ANT is used to analyse the data from the special schools and the individual study.

Chapter 8 – Petri Net Model for e-Learning & LD

This chapter introduces the main concepts of Petri Nets and presents a rationale for a Petri net model for e-learning. This model captures the necessary elements and actors and their interactions, which are analysed and represented through the firing sequence of transitions in a Petri net. The thesis discusses how this model can be applied to LD as a standard of determining the opportunity cost for teaching and learning.

Chapter 9- Overview of the Research & Conclusion

The chapter discusses the findings in terms of the main research question and sub-questions using the ANT analytical framework. It also makes recommendations for further work that should be carried out in the future, given the importance and significance of the special needs area. The Schunck and Nielsson (2001) e-learning model from Chapter 3 is extended to facilitate the learning of LD students. The chapter concludes with a review of the observations from the research and the significance of leadership for ICT adoption. The final design of an e-learning model is presented and recommended for the teaching and learning for LD students.

Mind Map for the Thesis

As an overview and summary of the thesis organisation, I have incorporated use of a mind map. Figure 1-3 below shows a Mind Map of the organisation of the thesis. As mentioned earlier, I have used the software tool called Mind Manager in several places to show several other important representations. These include Learning with ICT, Technology and Learning and Modelling of the main Actors in the research field. From a researcher’s point of view, Mind Manager has served very well as it provided various features and tools that I could work with by having an overall model for my research plan and analysis. As the reader may see from the figure, I was able to summarise most of my sources, such as internet links (URLs), set up my own reference notes for the research visits and set up links to relevant and significant organisations for students with LD.

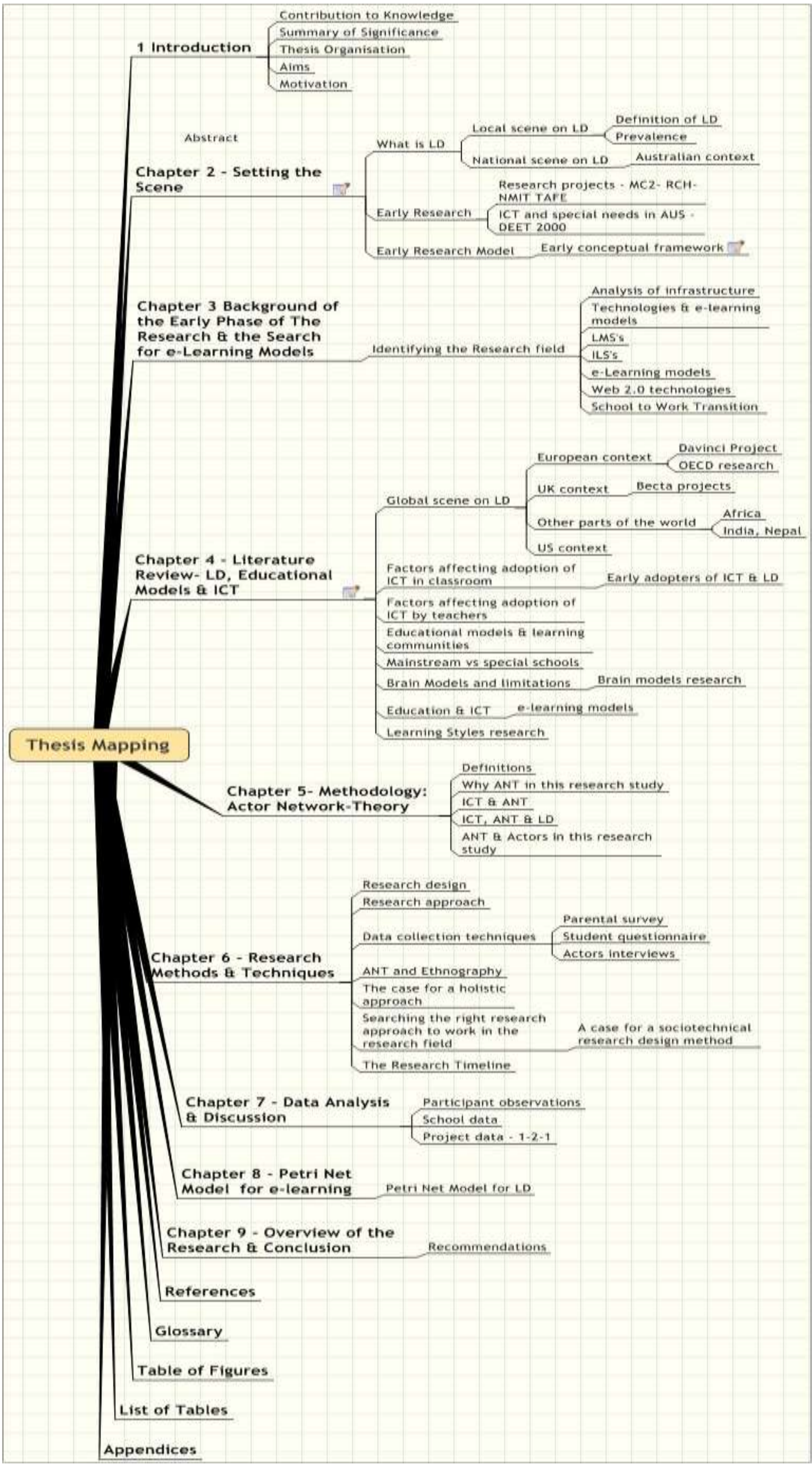

Figure 1-3: Thesis Mapping

1.10 MOTIVATION

Following the discussion of the journey (Section 1.1), it may be useful to look a little more closely at my motivation for performing this study.

> "*Learning without thought is labour lost; thought without learning is perilous.*"
>
> **Confucius (551 BC - 479 BC)**, *the Confucian Analects*

My background is in teaching at secondary and tertiary levels. Whilst in the Victorian Education Department, I worked on the Disadvantaged Schools Program (DSP) and specific projects to enhance students' learning outcomes. I had pioneered special laboratories in Mathematics for both high and low achieving students. My interest in ICT can be traced to the introduction of PCs in schools - Apple computers in early 80s. My interest led to the introduction and curriculum innovation in Computer Studies in middle levels and Y10, and subsequently, Y11 and Y12 Computer Studies / Computer Science in the Victorian Certificate of Education (VCE). I had an active role with the Mathematical Association of Victoria (MAV) and was chair of the Students Activities Committee. This group was responsible for the running of the Mathematics Talent Quest (MTQ) in the state of Victoria. A paper was presented at the 1980 Maths conference at Monash University that detailed the curriculum innovation for Computer Studies in Mathematics. This was later followed by many schools. In addition, my motivation and commitment to use computers both in class and the office was demonstrated via a series of workshops for staff and students and the introduction of the computer club in the school. I began to study formal concepts that were later applied to business and of course to tertiary studies.

The main motivation to undertake this research, however, was a personal one. I have looked at ways that could assist me to help my own child. My child was identified as a late developer at an early age and for obvious reasons there has always been the demand and the need to find appropriate school placement for him. My wife and I had decided that the best setting would be one where he would be monitored carefully, in a mainstream environment.

The work of the speech pathologist (at the RCH) and a special learning support person (School Yard) made me aware and realise that the road ahead would be a very bumpy and difficult one and most certainly challenging for the family.

The thesis will provide information to the reader about the various phases of his education including the present phase (TAFE), and a model will be presented to demonstrate what actions took place to foster and progress his learning from prep to middle to senior school levels. The culmination of all work and effort led to a TAFE entry. This is important to note as the thesis investigates several research sub-questions, one of which is the school to work transition process.

The thesis outlines and contrasts the research from the two special schools and the individual case study and shows how the knowledge and skills that were gained from those participant observations assisted the learning outcomes with the individual case study. There is strong evidence that demonstrates how the learning difficulties were overcome to a significant extent. (This can be substantiated from School reports and references). The key component of the research related to ICT and the relevant software; ICT skills and methods have played a very significant part in his education thus far. This research study will provide the reader with sufficient support and evidence about the positive contribution that ICT has made to the learning and educational standard in general.

I acknowledge that this personal involvement may create a bias to my view of the area, but I would argue that this bias has not extended to data collection and analysis. The ANT analytical approach has been followed and it ensured that the attributes of the actors and their interactions were not altered in any way whatsoever.

CHAPTER 2

2 SETTING THE SCENE- PERCEPTIONS &C ONNECTIONS: A CASE FOR ICT ADOPTION IN LD EDUCATION

"*We learn by example and by direct experience because there are real limits to the adequacy of verbal instruction.*"

Malcolm Gladwell, *Blink: The Power of Thinking Without Thinking, 2005.*

2.1 THE CASE FOR SPECIAL NEEDS SCHOOLS

There are over 100 special needs Schools in Victoria and over 1200 in Australia (www.australianschoolsdirectory.com.au 2009). An analysis revealed over 1000 special schools in various categories[13]- ranging from mild to physical and severe learning difficulties. Table 2-1 below provides the various categories that can be found in the directory of special needs schools.

Special Need Category	
General Disabilities	Intellectual Disabilities/Autism
Hearing Impaired	Learning Difficulties
English Learning	Moderate to High Needs
Distance Education	Multiple Disabilities
Autistic	Physical Disabilities
Emotional Behaviour	Speech / Language Disorders
High Needs	Vision Impaired
Intellectual Disabilities	Young Mothers

Table 2-1: Summary of special needs categories (Source: Australian Schools Directory 2009)

Although policies existed for several decades to integrate students with learning difficulties into the mainstream classroom, this has not provided the best learning environment for all these students (Johnson & Carmine 1998) and this is supported by more recent work from Shaw & Grimes (2005). The literature provided many examples where the demands of the students in this category could not be catered for in an adequate manner, for example Klinger (1998) and Zigmond (1995).

[13] These include learning difficulties/disabilities of general nature, intellectual and physical

In the USA there are many students with learning disabilities who attend mainstream classrooms. Most of the research on LD has discussed this environment and the findings clearly indicate that the needs of these students are not being met adequately (MacMillan & Hendrick 1993).

In Europe and the UK, similar learning platforms and standards exist for special needs students, and this is referred to as Special Needs Education (SNE). However, in the UK, there has been strong interest to establish an understanding and recognition of the rights and privileges of special needs students. (Shakespeare 2005, Riddell et al. 2003).

2.2 HISTORY & DEFINITION OF LD

The history of LD has been well documented with respect to the nature of particular problems (specific language and reading disorders and the behavioural correlates of brain injury) and the structure of special education at the time; a compelling case was made for the need for a category like LD (Kavale & Forness 1995). It should be noted that given the sensitive nature of this problem and the wide range of special needs, one must be very careful in applying the definition, as inferences could be drawn that could lead to negative results.

The history of LD in Australia has been documented in several studies, including Jenkinson (2007), Elkins (1997, 2000), and Rivalland (2000). In a publication "Mapping the Territory – Primary Students with Learning Difficulties: Literacy and Numeracy, Vol 1", John Elkins et al. (1997) an analysis of the Australian local scene and context is provided. In fact the definition of LD that is adopted and accepted in a significant way in this important field is also debated and according to this analysis the definition hinges on the following main terms that are used in Australian schools. These terms are used to describe children who have difficulties with literacy and numeracy learning:

- Learning difficulties
- Learning disabilities
- At educational risk
- Special needs

It should be clear to the reader that the meaning of these terms varies from State to State and from school to school in Australia. In fact, my own experience when I came face to-face with the main actors of the first special school was such that I was told not to refer to students with learning difficulties as LD students, but instead I should adopt the term “special needs”. Although these perceptions may be present, I have adopted the term LD as it is used globally to refer to students with learning disabilities, even though in the UK the term Special Needs Education (SNE) is used in a formal context to distinguish students with learning difficulties and other disabilities. In some publications the term ‘Learning Disabilities’ was used by the Department of Education, Employment Training and Youth Affairs (DETYA 1999) and was also used to classify funding categories for special needs students:

> *“a student, who has been assessed by a person with a relevant qualification, as having intellectual, sensory, physical, social/emotional or multiple impairments to a degree that satisfies the criteria for enrolment in special education services provided by the government of the state or territory in which the student is located”* (DETYA 1999, p2).

The definition of LD appears to be a little vague, and evidence from previous studies in the literature (Kinzer 1994, MacMillan & Hendrick 1993) indicates that the normal mainstream curriculum appears to disadvantage this category of students. The question of "What is LD?" has been a long-standing source of controversy, conflict and crisis (Keogh 1996). Although research in LD has experienced unprecedented growth and has had significant impact on special education, it remains among the most problematic classifications because of the vagaries and antagonisms surrounding the definition (Mather & Roberts 1994, Shakespeare 2005).

Over time, a number of LD definitions have been proposed, but none had emerged as an unequivocal favourite (for example Tucker, Stevens, & Ysseldyke (1983). Currently the two definitions that dominate this area are the legislative definition found in the Individuals with Disabilities Education Act (IDEA 1997), and the one proposed by the National Joint Committee on Learning Disabilities (NJCLD 1994), a consortium of representatives from organizations interested in LD.

The definition of learning disabilities (LD) is a very strongly debated matter. Organisations such as the National Joint Committee on Learning Disabilities (NJCLD 1994) in the USA, Becta (2002) in the UK, and Australian government groups such as MCEETYA (1999, 2005), have considered and debated the relevant definition of LD or special needs.

A useful definition of LD comes from the Learning Disabilities Association of Canada (LDAC) who defines LD as:

> *"a number of disorders which may affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information. These disorders affect learning in individuals who otherwise demonstrate at least average abilities essential for thinking and/or reasoning. As such, learning disabilities are distinct from global intellectual deficiency"* (LDAC 2002).

LDAC (2002) suggests that LD results from impairments in one or more processes related to perceiving, thinking, learning or remembering, and include language processing; phonological processing; visual spatial processing; processing speed; memory and attention; and executive functions (Adam & Tatnall 2007; Adam & Tatnall 2008) and that it varies in severity and may interfere with the acquisition and use of oral language, reading, written language and mathematics (Learning Disabilities Association of Canada 2002).

The definition of LD which has been adopted in this thesis is the one presented by Kirk (1962) and is quoted here for completeness:

> *"A learning disability refers to retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioural disturbances. It is not the result of mental retardation, sensory deprivation or cultural and instructional factors*"(Kirk 1962, p263).

An issue that has concerned education authorities around the world is whether students with learning disabilities should receive their education in mainstream classrooms or in some form of special schools. A number of researchers support the view that students with LD require an alternative approach to their learning, while others claim that it is best to integrate these students with mainstream classes (Bulgren 1998, Shaw et al. 2005, Kavale et al. 1995, Kavale 2002). Overall, however, there is considerable evidence to support the existence of special schools to cater for the needs of LD students (Adam and Tatnall 2003). These schools often exist on a small amount of funding support from the government; however, they cater for individual differences in a significant way through their own fundraising and budgeting efforts.

There is little recent primary research data available on the use of ICT for students with LD, but a Deakin University report (Blackmore, Hardcastle et al. 2003) provides useful secondary information. It should be noted that a research study that was conducted nationally in Australia in 2000, had identified particular schools for their comprehensive curriculum's integration of ICT (Cormack, Couch et al. 2000)[14]. One of the schools included in that study was Concord School, in Bundoora, Victoria; that was also part of this study.

Early researchers concentrated on the learning difficulties of a single primary area or field like English, Mathematics or Science. Their work and analysis depended on the identification of some criteria or factors like IQ, which did not adequately demonstrate the full scale of the learning problems and disabilities (Bulgren 1998).

Studies that were conducted in the USA by Forness et al. (1998) revealed that more work was needed to identify the learning patterns (styles) of students with LD. From the early days of computers and technology, teachers and researchers, were keen to explore computer-based tools in order to enhance learning outcomes (Kulik et al. 1983). In particular, some of the computer-based software on dyslexia in the 80s was developed by people who were closely related to students who suffered from dyslexia. For example, Stanovich (1980) and Davis et al. (1994) used dyslexic software programs to aid students in this area. It should be noted that similar software application programs were used in the UK, and in particular people with dyslexia were assisted with ICT (Becta 2003, 2005). Other computer-based software involved mathematical

[14] This was a significant study for special needs and ICT by DETYA in 2000.

problem solving, games and simulations. The latter is a significant area that involves ongoing research about the way games can stimulate and engage students with learning disabilities (Pillay 2002).

Whilst these approaches may have provided an environment for work, and stimulated the students' own interest, it was found inconclusive to suggest that the learning outcomes had improved to a significant extent through these approaches (Newhouse et al. 2002 and Becta 2003). The thesis will discuss and compare the participant observations from the special schools, and in particular, in Chapters 7 and 8 it will provide evidence of the impact that games have on self-esteem, engagement and learning outcomes for LD students. Furthermore, these results will be correlated with the results from the individual study.

2.3 HOW BIG IS IT?

It should be stated that globally, the students with LD (OECD 2005) are a unit of interest for researchers and in some cases they appear as a sub-unit (subset) of a larger group of people who are disadvantaged in life – for example the Australian Aborigines. In the UK, the House of Commons Education and Skills Committee, 2005 report summary states that:

> *"In 2005 around 18% of all pupils in school in England were categorised as having some sort of special educational need (SEN) (1.5 million children). Around 3% of all children (250,000) had a statement of SEN and around 1% of all children were in special schools (90,000)—which represents approximately one third of children with statements. With such a large number of children involved, it is important to recognise that many children are receiving the education they need in an appropriate setting. It is equally important, however, to highlight the difficulties faced by a large number of parents for whom the system is failing to meet the needs of their children"* (HC: 478 I 2005-06, p5).

The Australian literature identified a study by Elkins (1997) where an analysis of learning difficulties and disabilities was reported. The sections below provide a summary of the main findings about this important area. The prevalence and identification or reference to special needs is also extracted from a study by Rivalland (2000).

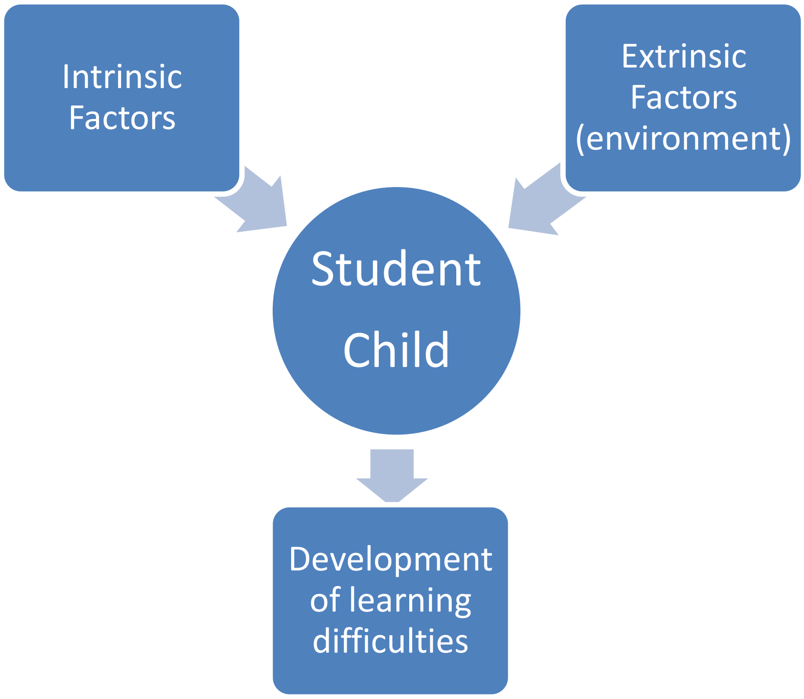

Figure 2-1: Learning difficulties-factors (Source: Elkins 1997

The prevalence data were analysed state by state in Australia in a study by (Rivalland 2000) in "Policies and Practices: Students with Literacy Difficulties" case study in Elkins (2000) "Mapping the Territory" Vol 1.

Western Australia	**Victoria**	**New South Wales**	**South Australia**	**Queensland**
Crestwood (20%)	St Bernadette's (5%)	Lake Hewitt (25%) estimated by principal	Messiah (13%)	Bennetts Hill (24-25%)
Rivergums (30%)	Hilltop (10-20%)	Grisham (15%)	Franklin Landing (15%)	Durie (25%)
St Gerorge's (22%) District High (10%)	Mountain Ash (10-15%) (In Victoria, very high estimate of 'at risk' students were shown at the beginning of Year 1)	St Philomena (15%)	Beachcliff (17%)	St Evangeline (32%) Thornburn Not applicable. Learning Disabilities program.

Figure 2-2: Prevalence data (Source: Rivalland 2000)

What is important here is quoted in the following paragraph from the report by Rivalland:

> *"The many differences in definition and identification across the systems and sectors make it very difficult to make generalisations about prevalence.*

However, the case study schools do tend to reflect the findings of the Survey of Schools. Most of the case study schools, like the schools in the survey, reported a range between 10 per cent and 30 per cent. Many of the case study schools clustered between 15 per cent and 25 per cent with three schools reporting prevalence data below 15 per cent" (Rivalland 2000, p51).

The terminology of learning difficulties and learning disabilities is further reflected in a survey (Rivalland 2000, p69) where principals referred to these categories by the following percentages listed in Table 2-2.

Factor	**%**
Learning Difficulties	47%
Children at Risk	37%
Special Needs	17%
Learning Disabilities	10%

Table 2-2: Reference to learning difficulties (Source: Rivalland 2000)

The term "Learning Disabilities" was more likely to be used by teachers with special education training and by school psychologists. The term LD is widely accepted in the psychological field in USA, but is usually qualified in Australia to specific learning needs. (Chan & Dally 2000, Vol 2)

The definition that has been used for the term LD by MCEETYA (1999) is similar to one from the USA and is provided here to assist the discussion:

"A generic term that refers to a heterogeneous group of students who have significant difficulties in the acquisition of literacy and numeracy and who are not covered in the Commonwealth's definition of a student/child with a disability…Learning Disability is believed to be a difficulty that is intrinsic to the individual and not a direct result of other conditions or influences" (MCEETYA 1999).

2.3.1 Range of Special Needs

Given the complexity of the definition of learning difficulties, one way to represent these differences is with the following Venn diagram shown in Figure 2-3.

Figure 2-3: Venn diagram for learning difficulties

The term "Learning Difficulties" is used to refer to a large group of children who need extra assistance with schooling while "Learning Disabilities" refers to students who are a small sub-group who exhibit severe and unexplained problems. In fact, in the USA, it is also referred to as "Learning Educational Disabilities".

The present research originated with an interest in dyslexic students. A federal government report on Students with Disabilities – "Technology for Learning: Students with Disabilities", reported 21% prevalence (Cormack et al. (2000), DETYA (2000). In a study by Miles et al. (2003) in the UK, a number of issues were discussed that might account for the difficulty of assessing the prevalence rate with dyslexia around the world. Amongst these is the issue of resources to carry out the analysis, and dyslexia variants. The prevalence rate varies between 5%-17% (Wikipedia) and Miles (2004) arrived at the conclusion that in the UK there are approximately 4-6% people who are dyslexic. (The British Dyslexia Association's prevalence estimates are either 4 per cent for severe dyslexia or 10 per cent to include mild dyslexia, and these have been described as both theoretically and technically contentious). All that can be said with any certainty is that in every English-speaking country a significant percentage of the population has reading and spelling difficulties varying from mild through to severe. A recent Parliamentary Report titled "Helping People with Dyslexia: A National Action Agenda" (Bond et al. 2010) shows that the prevalence rate across all states in Australia ranged from 5-10%. These facts show that the prevalence rate of dyslexia has not changed by a significant amount over the last two decades.

As mentioned earlier, I was very highly motivated to work with students with learning difficulties in my teaching career. I had co-ordinated a school's DSP program and received federal government funding for the allocation of resources for students with special needs in the 80s. This interest and motivation culminated in the present research study. It led to the close participation and observation of students with special needs in two outer suburban (regional) special schools (Macedon Ranges and Concord), and in addition, an individual case study to apply some of the early findings and make a comparison. One of these schools provides a basic ICT infrastructure for its staff and students, whilst the other provides a more enhanced "state of the art" ICT environment that is integrated into the school's curriculum.

These two schools provided two distinct geographical groups of students and were observed over a significant time period. During this time various government departments and agencies were also visited so as to gain an insight into the level of ICT support for students with learning disabilities (or special needs). These included Technical & Further Education (TAFE), the Royal Children's Hospital (RCH)[15] and also some private individual consultants. These consultants worked with a significant group of LD students on a regular basis on language skills and speech pathology at RCH. I had personal experience especially with one of these, namely the person or actor who is referred to as CI in the main actors Table 0-3.

I would like to conclude this section by stating the fact that the investigations on the infrastructure provided a strong link with the Department's IT services. This link enabled the study to determine the level of support that existed for school projects including those that involved ICT with videoconferencing. It should be noted that the Department provided the necessary support for the investigations and analysis of the infrastructure; indeed, this support was essential in setting up the link between the

[15] RCH – Melbourne Victoria, Australia.

special schools through the Local Area Network (LAN) of the Department. A sample of the link and trial result is presented in Chapter 3.

2.4 MAINSTREAM TEACHERS & SPECIAL NEEDS TEACHERS: COMPARISON OF QUALIFICATIONS AND ATTRIBUTES

Mainstream teachers' attitudes towards inclusion (Avramidis et al. 2000, 2002) were discussed and teachers' beliefs were also investigated by Kalyva et al. (2007). Other studies looked at integration and inclusion in Turkish Schools (Demiraslan 2008) where flexibility, willingness to learn and lifelong learning was listed as the main attributes of teachers. In a paper by Shaddock, several attributes were mentioned for teacher "super-heroes" and some of these included: "organised, patient, able to motivate students, understand special needs, creative, applying different teaching methods to reach students, communicative, co-operative, able to interact with other students, parents and the school administration and community" (Shaddock 2007).

In a study by Rizzo et al. (1992), gender, age, years of teaching experience, and previous experience, were discussed. Another study from Singapore by Teo et al. (2003) carried out a comprehensive analysis of attributes and attitudes of primary school teachers. The study emphasised that policy and professional standards for teachers, as well as professional attributes and professional skills, played a significant role in determining teacher's qualities. The study was based on the Teacher's Attribute Scale (TAS) and it involved 240 Primary teachers in the sample. Of those, 86 teachers were in special education, 47 in the mainstream schools area and 107 in nine gifted education program schools. The items on the TAS report included the following teacher attributes: forbearance, trustworthiness, truthfulness, honesty, love, care, justice, politeness, creativity, courage, respect, selflessness, service, appreciation of student's gifts and talents, flexibility and adjustment to educational policies, willingness to learn new things and skills, belief in use of information and communication technology in class, being aware, respecting and nurturing student's talents, abilities and disabilities, being a life-long learner and finally their belief that educational changes are for the betterment of students. Table 2-3 below shows the data analysis and the rankings from the study by Teo et al. (2003). The table shows that the belief in lifelong learning was ranked as the highest attribute. Other attributes such as being caring towards pupils and creativity were ranked least.

Rank (n = 240)	Teacher's Personal Attributes
1	Belief in life-long learning
2	Willingness to learn from colleagues
3	Self as a life-long learner
4	Truthfulness
5	Justice
6	Honesty
7	Integrity & respect for others
8	Fair-mindedness
9	Trustworthiness
10	Self-knowledge of gifts and talents
11	Selflessness
12	Courtesy
13	Being forgiving towards pupils
14	Being caring towards pupils
15	Tolerant & able to overlook the faults of pupils
16	Courage
17	Creativity

Table 2-3: Personal attributes of primary teachers- Singapore (Source: Teo et al. 2003)

In a study by Avramidis et al. (2000, 2002), a survey of mainstream teaching attributes was carried out and the significance of classroom setup and layout was also investigated. The analysis revealed that teachers who implement inclusive[16] programs, and have experience of inclusion, tend to show more positive attitudes towards SNE students. The report emphasised the importance of professional development for trainee teachers in this field.

A DEETYA (2003) report provides a number of characteristics or qualities of a good teacher that were referenced in Banner & Cannon (1997). The following were rated very highly: personal qualities of the good teacher, and the perspective of humanistic learning. Furthermore, the terms effective, successful, and good teachers, were used interchangeably; and the teachers displayed the following traits or characteristics: were lifelong learners who possessed knowledge; demonstrated authority and practiced ethics

[16] Inclusion implies a restructuring of mainstream schooling that every child can be accommodated irrespective of the disability, (accommodation vs. assimilation) and ensures that all learners belong to a community.

to benefit their students and the profession; demonstrated leadership and order and had high aspirations; showed imagination and compassion to help students with ideas and knowledge so that they could apply these to their own lives; showed patience and tolerance and character to accommodate and enhance their students' learning outcomes.

The last trait that is included in the study is pleasure and Skilbeck & Connel argue that it is difficult to imagine effective teachers who do not have an abiding fascination with their subjects, who do not love being among students, and who do not gain fulfilment from nourishing others' minds and lives (Skilbeck & Connel 2003).

The same DEETYA (2003) report further stated that:

> *"A second perspective on what is (good) teaching is that of the noted American researcher on teachers and teaching, Lee Shulman, who, in outlining major research modes and traditions relating to teaching, conceptualises good or effective teaching, not by identifying personal traits or elements, but by identifying areas for cultivation and disposition of professional knowledge and expertise"* (DEETYA 2003, p77).

According to Shulman (1992) the most significant modes or aspects to good teaching are not the personal traits, but the areas that may be identified through their dependence on professional knowledge and expertise, like behaviour, cognition, content, character and teacher knowledge of various sensitive areas such as culture, society, politics and the students' own environment. These should be reflected in student outcomes, the design of effective curriculum, and the teachers' knowledge of the cognitive domain or specialty.

In Australia, the main elements that relate to teachers' basic knowledge and competence are: (1) subject matter knowledge related to curriculum content, either broadly defined (for primary school teachers), or as two or more specialist subjects (for secondary school teachers); (2) pedagogical skills and (3) general education. According to Turner-Bisset, there are 12 categories in the model of knowledge bases for teaching and these comprise: substantive subject knowledge, syntactic subject knowledge, beliefs about the subject, curriculum knowledge, general pedagogical knowledge, knowledge/models of teaching, knowledge of learners: cognitive, knowledge of learners: empirical, knowledge of self, knowledge of educational contexts, knowledge of educational ends and pedagogical content knowledge (Turner-Bisset 2001, p13).

The DEETYA (2003) report further provides student views of effective teaching, where amongst these the students consider, from their perspective, the following traits for the ideal or effective teacher: relations with students, personal traits and approach to teaching.

2.4.1 Teacher Adaptations for Students with Disabilities

A 2007 Australian Government Department of Education, Employment and Workplace Relations Research Project report titled "Project to Improve the Learning Outcomes of Students with Disabilities in the Early, Middle and Post Compulsory Years of Schooling" (Shaddock 2007), provides a specific study on the teachers' adaptations for students with disabilities. The study involved 294 mainstream Australian teachers who were randomly and proportionally drawn from all states and territories, all sectors, and from primary, secondary and post-compulsory settings. The results of the study showed that mainstream teachers in Australian schools are moderately supportive of including students with a disability in the mainstream classrooms, but that they are more positive about the social benefits than about the academic benefits of inclusive education. The following main points are presented in the summary of the report:

- The mainstream teachers made a moderate number of teaching adaptations and modifications for LD students, but made accommodations for the whole class in a more effective manner. They made few adaptations that involved major changes to class organisation or for individual LD students however, they supported the inclusion of LD students and were more positive about the social benefits of LD students. They were less convinced that inclusion improved the academic outcomes.
- The mainstream teachers who had completed a Special Education qualification were flexible and ready to alter the curriculum and also alter instructions.
- The mainstream primary school teachers showed a more positive attitude towards inclusion than their secondary counterparts.

The following quote describes clearly the views of the teachers in this study:

'Sixty percent of the variance in teachers' perceived barriers to including students with disabilities is accounted for by: inadequate level of assistance from support personnel; insufficient knowledge, expertise and experience; unsupportive school policies and practices; the diversity of student needs; stresses related to student behaviour; and inadequate training' (Shaddock 2007, p14).

Obviously, there is an issue with most teachers about the perceived lack of time for preparing for and responding to the vast range of special needs of the students in their mainstream classes. In a study by Elliott (2008) it was found that a relationship exists between teacher attitude toward inclusion and teacher effectiveness. Teachers with a positive attitude towards inclusion provided their students with more support; they had higher expectations for their students' motor performance and a higher level of success (Elliott 2008).

The literature provides examples of situations where mainstream teachers have not responded positively towards the inclusion of students with learning difficulties. Therefore, it is essential to examine teacher beliefs and attitudes in this important area and find how these can influence the learning outcomes. A study by Woolfson & Grant (2005) in Glasgow, Scotland, provided a comparison of special, regular and support teacher's beliefs about children's learning difficulties. The study compared the attributions[17] of the three groups of teachers based on locus, stability and controllability. [According to attributions theory, these are viewed as lying on three dimensions: locus of control (internal or external causes), stability over time and controllability. (Can the individual act to change the outcomes? (Weiner 1985))]

Table 2-4 below provided by Elliott (2008) gives a summary of research on teachers' attitudes toward inclusion.

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[17] Attributions theory provides metrics for causes of behaviour for teachers. Studies have shown teachers make causal attributions with respect to the academic performance of their students. (Ho 2004)

Research Conclusion
Students with disabilities are viewed more favourably in lower grades than in higher grade levels.
Students with less severe disabilities are viewed more favourably than those with more severe handicaps.
Teachers' attitudes are more likely to be favourable if they have: (a) higher perceived teaching competence, (b) greater educational preparation, and (c) more experience in teaching students with disabilities.
No gender differences in attitude toward teaching students with disabilities.
Older physical educators have less favourable attitudes than younger educators do.

Table 2-4: Summary of Research on Teacher' Attitudes Toward Inclusion (Rizzo & Vispoel, 1992) cited in Elliott (2008)

Special education teachers and mainstream teachers appear to use different attributions. The former tend to view learner difficulties as external, unstable and uncontrollable. The latter appear to view students with learning difficulties with completely the opposite attributions, namely, stable and uncontrollable factors. Neither the teacher nor the student can act to change or improve the situation or the learning outcomes. Consequently, this leads to continued low expectations of future performance (Georgiou 2002, Medway 1979).

The summary of results from the above study of Woolfson et al. (2005) shows that:

a.) Mean scores for the locus of causality were higher for special school teachers than for the other groups. (This suggested that special education teachers viewed the cause of the learners difficulties as more external (teacher, family, curriculum) than internal (due to lack of ability or effort).

b.) Special education teachers in the sample viewed learning difficulties to be more amenable to change than did the other groups of teachers who worked in mainstream settings (likelihood of change).

c.) Mean scores were the highest for mainstream regular teachers and lowest for the special school teachers for controllability. This showed that the mainstream teachers viewed the learner as having the greatest degree of control over their academic performance. (Note: cultural differences are not considered here, these are discussed in studies by Ho (2004) and Artiles (2000).)

2.4.2 OECD Projects

The OECD (2001) "Learning to Change: ICT in Schools" Centre for Educational Research and Innovation (CERI) Report elaborated on teacher roles and professionalism. The report emphasised that teachers play a central and crucial role regarding ICT in schools.

The open applications of ICT bring about a dynamic, interactive environment that requires a more demanding, creative, interesting and professionally rewarding role. This expanded role obviously has resource implications in terms of staffing levels and professional development needs. Teachers will need to modify their pedagogy considerably and on a continuing basis. The teachers are seen as lifelong learning members of education. An important factor for the teachers is their digital literacy level, the level of ICT skills and understanding. The report further highlights the fact that teachers' pedagogical beliefs play a central role in the adoption of ICT. This has already been discussed in Handal (2004) and Niederhauser and Stoddart (2001). Another important area which has been highlighted in the OECD Report is teacher professional development (OECD 2001, p.77).

A strong argument that has been put forward by many researchers is that pedagogy must be considered before technology. New internet tools do provide fresh impetus, but Web 2.0 tools alone do not form the necessary basis for realising such a disposition. The ideas have to be considered in unison with curriculum and assessment, where the latter has received attention in e-learning platforms, for example, enGauge (2003).

The OECD (2001) has set up several projects, and these are named, Leonardo Da Vinci, Comenius, and Erasmus. Figure 2-4 below provides an overview of the Da Vinci Project. This project links European institutions and provides a policy for a life-long learning program, for example the program links policy to practice in the field of vocational education and training (VET). The Comenius-Action for School program focuses on the first phase of education, from pre-school and primary to secondary schools. It is relevant to all members of the education community: pupils, teachers, local authorities, parents associations, non-government organisations, teacher training institutes, universities and all other educational staff.

Leonardo Da Vinci programme

The programme has three general objectives:

- to improve the skills and competencies of people, especially young people, in initial vocational training at all levels; this may be achieved inter alia through work-linked vocational training and apprenticeship with a view to promoting employability and facilitating vocational integration and reintegration;
- to improve the quality of, and access to, continuing vocational training and the lifelong acquisition of skills and competencies with a view to increasing and developing adaptability, particularly in order to consolidate technological and organisational change;
- to promote and reinforce the contribution of vocational training to the process of innovation, with a view to improving competitiveness and entrepreneurship, also in view of new employment possibilities; special attention will be paid in this respect to fostering co-operation between vocational training institutions, including universities and undertakings, particularly SMEs.

Figure 2-4: The Aims of the Leonardo Da Vinci Program, source: (Source: http://eacea.ec.europa.eu/llp/index_en.php)

Further, with respect to ICT, the European Union (EU) actioned aims to harness the power of ICT in order to develop innovative education and training practices, as well as to improve access to lifelong learning and help develop advanced learning management systems.

The ICT project is an integral part of the Comenius and Erasmus programs. The project summary states that:

> *"Progress in the use of ICT for education and training across Europe has been substantial in the last years. However, studies show that ICT has not yet had as significant an impact as expected"* (Executive Agency, Education, Audio-visual & Culture 2008).

As in other studies concerned with teacher professionalism and roles, the project also expressed the view that:

> *"Effective integration of ICT into education must go beyond simply replacing, streamlining or accelerating current practices. It must also find new and more effective ways of operating, supporting pedagogical and organisational innovation. ICT has become embedded in our social and economic fabric and it should be similarly embedded in education and training systems"* (Executive Agency, Education, Audio-visual & Culture 2008).

The project is aimed at different aspects of technology and how these might be used to enhance the learning environments and experiences of teachers and students. The student centred paradigm where simulations, discovery learning, enabling learning outside the school environment and bridging the 'digital divide' between those with access to technologies and relevant skills, and those without, is being adopted. Erasmus is the EU's "flagship education and training programme, enabling more than 180,000 students to study and work abroad each year, as well as supporting co-operation actions between higher education institutions across Europe. It caters not only for students, but also for professors and business staff who want to teach abroad and for university staff who want to be trained abroad" (http://eacea.ec.europa.eu/llp/index_en.php).

2.4.3 Teacher's Beliefs and Instructional Practice

Ertmer et al. (1999) classified two kinds of barriers, first and second order. Niederhauser and Stoddart (2001) conducted a study in the USA to investigate the relationship between teachers' beliefs and instructional methods that were followed by them. For example, teachers who were trained with traditional methods followed didactic (direct) instructional methods, on the other hand whereas teachers who followed the constructivist approach tended to use student centred inquiry based methods. Their study was concerned with the teacher's perspectives about educational uses of computers and whether these could be characterised in terms of their pedagogical orientation (didactic or constructivist). Their results indicated that teacher's perspectives about effective technology based pedagogy are related to the types of software they used with their students. Therefore, this is important for policy makers, administrators and teachers in the way they design and implement technology-based curriculum. Clearly, this has implications for professional development of teachers and other relevant members of the school community, if technology is to be adopted in the schools program (Sandholtz et al. 1997, Baskin et al. 2006). Handal (2004) surveyed the teacher's instructional beliefs for the integration of educational technology, and in his concluding remarks, he states:

> *"The current links between technology in education and constructivist learning environment will succeed more favourably if teachers' beliefs are considered and confronted. Otherwise, despite the quantity of resources poured into the purchase of hardware and software in schools this may*

result in a waste of energy and resources. Certainly, a more grass-root perspective is needed in implementation approaches" (Handal 2004).

An Australian study by Newhouse (1998) found that teachers were reluctant to implement technology in their classroom even when they possessed technical skills. They questioned the benefits of computers in education, particularly for those who were influenced by traditional methods of instruction. A more recent study by Calnin (2006) revealed a change in attitude and a more positive trend towards the adoption of ICT in the classroom by teachers of both mainstream and special schools. However, it is significant to end this section with the following quote from Calnin (2006):

> *"Claims made for the impact of computers on teaching and learning are difficult to assess and remains problematic"* (Calnin 2006, p 4).

2.5 BARRIERS AND ENABLERS TO EFFECTIVE USE OF ICT IN SCHOOLS

The thesis explored various issues regarding both the adoption and impact of ICT in teaching and learning. The main regions that were considered were Australia, UK, USA and Africa. In addition, studies were found from some other countries like Turkey, Nepal and Malaysia, where technological, political, and socio-technical factors were investigated. The main findings from these studies relate to school leadership, professional development and perceptions from parents. In a study by Elliott (2005) the main factors that were identified were in fact divided into two categories: structural and process barriers; and are summarised in Table 2-5 and Table 2-6 below.

According to Elliott (2005):

> *"ICTs have not had the widespread impact on teaching and learning processes envisaged a decade or so ago is disappointing but not surprising. Most educational innovation happens slowly and ICT is in itself continually transformed by new developments and market conditions. It is not a discrete subject and its applications in education are the subject of considerable debate, informed by a combination of scholarly discourse, opinion and research"* (Elliott 2005, p8).

Elliott further provides a summary of the literature for barriers to effective ICT learning in schools. The following are highlighted in several contexts (e.g. Elliott 2004a, 2004b; Ely 1999; Florian 2004; Leonard 2001; Ramsey 2000; Schiller 2003; Stevens 2004; Underwood 2003; Woodward & Reith 1997; Zhao & Frank 2003) and calls for national ICT standards, greater institutional support and infrastructure, and better professional development for teachers have been addressed to varying degrees in all states and territories (DEST 2002).

Structural Barriers	**Research**
Limited Classroom Space	Collins 1996
Lack of computers and/or Internet in classrooms	Zhao & Frank 2003, Leonard 2001, Elliott 2000, Redmond & Brown 2004
Unreliability of the technology	Cuban 2003, Zhao et al. 2002
Lack of leadership and support from principals	Ely 1999, Schiller 2003
Lack of institutional support and encouragement	Ely 1999, Leonard 2001
Poor technology infrastructure	Zhao & Frank 2003, Redmond & Brown 2004
Class timetabling difficulties, short lessons	Leonard 2001, Redmond & Brown 2004, Zandvliet & Fraser 2004

Table 2-5: Structural Barriers for ICT Adoption (Source: Elliot 2005)

Process Barriers	**Research**
Poor teacher attitudes towards technology, lack of teacher confidence	Cuban 2001, Becker 2000, Zhao & Conway, Schiller 2003, Downes et al. 2002
Conflicting information on the value of ICTs in learning	Zhao & Frank 2003
Limited teacher skills and competence especially in the face of rapidly changing technology	Leonard 2001, Zhao & Frank 2003
Classroom management difficulties	Cuban 2001, Elliot 2000, Leonard 2001
Difficulty to adjusting to new pedagogies	Underwood 2003
Lack of professional development or inappropriate PD	Cuban 2001, Leonard 2001, Redmond & Brown 2004
Lack of time for planning and preparation	Rheingold & Hadley 1990 Means & Olson 1995
Lack of involvement in computer room and /or classroom layout/planning	Zandvliet & Fraser 2004

Table 2-6: Process Barriers for ICT Adoption (Source: Elliott 2005)

Elliott further proposed the following factors should be considered for the adoption of ICT in schools: school leadership (Caldwell 2006), teacher competency, level of support, teachers of LD and ICT ongoing, teacher awareness, and teachers' view of ICT (Handal 2004, Soderstrom 2009).

Further studies from Newhouse et al. (2002), UNESCO (2005) and White (2005) have provided both local and international views regarding teachers' views and ICT inclusion in the curriculum.

In a study by Bates et al. (2007) models of early adoption of ICT innovation in education were considered. In particular, the characteristics of early adopters were reviewed and these basically related to the following main areas:

- Experienced microcomputer users
- Individuals displaying opinion leadership qualities
- Individuals more likely to investigate new developments
- Males (Chau et al. 1998).

A study by Simon (2006) investigated the views of women on technological change and it discovered that there is a positive attitude towards ICT. A model by Marcus (1986) described in Bates et al. (2007) and Ankem (2004) highlights the importance of the value that the innovation provides to the adopters. This value can be measured in terms of cost and benefit. In fact, Marcus argues that there are two kinds of factors, personal and institutional and when these are combined it is possible to determine the adoption of ICT. The personal factors include costs, time, necessary skills, effort to pick up new skills, risks of failure, loss of self-esteem and prior experience with similar innovation. Institutional factors include resources, equipment, finances and training, although it could be argued that there is a possible overlap between the two groups or factors.

According to Rogers (1995) there are specific attributes of an innovation that could be applied to determine the rate of adoption. These are the relative advantage, compatibility, complexity, trialibility and observability. Obviously, if the perceived advantage to the use of an innovation is positive, there is a greater likelihood that it will be adopted rapidly. Consequently, complex innovations that are difficult for adopters to understand will result in slow rates of adoption. The author has personal experience in this area, and more specifically with the introduction of computer technologies in the 80s in Victorian Government Schools. The adoption relied heavily on initiatives of dedicated teachers (strong determination) to incorporate computers in the curriculum. The reluctance of staff in general, including office staff, was instrumental in the slow uptake of the technology in the classroom. Other barriers included the lack of support and professional development for staff. Another barrier was the threat felt by some staff that the computers were going to “take over” their job. Although two or three decades have passed some of those factors or barriers are still present as the perceptions of teachers have remained similar over this period. From the author’s observations, the main difference now appears to be the fact that the teachers face technology in a period where they cannot neglect its use, as the students have surpassed them in use and knowledge. For example, this study has shown that the students nowadays are engaged heavily in communications involving social networking in Web 2.0 technologies (Leeson 2008, DEECD 2008).

Elliott (2005) further argued that in order for technology to be accepted and incorporated in learning and communication, the following three main areas must be considered:

1. Encouragement of teachers to embrace ICT in their teaching and school culture.
2. Investigation of how ICT can best support and improve the learning outcomes.
3. Analysis of the impact of the “digital divide.

With technological convergence there is a greater focus on knowledge, construction and collaboration, as we see with Web 2.0 technologies.

In general, Australian teachers feel that they do not have adequate support for effective ICT use and integration of ICT in the curriculum (Finger et al. 2005). This view is also supported in research studies by Becta (2004) and Mumtaz (2000). Moreover, research studies by OECD (2005), Afshari et al. (2009) and Meiers (2009) provide similar arguments and concerns from the teachers.

2.6 COMPARISON OF MAINSTREAM & SPECIAL NEEDS TEACHERS QUALIFICATIONS AND ATTRIBUTES (OECD 2001)

The OECD Centre for Educational Research and Innovation (2001) provided three main reasons for schools to include ICT in their curriculum. These were the *economic rationale, the social rationale and the pedagogical rationale*. The first relates to the perceived needs of the economy and the capacity for areas of employment to have skilful people with ICT skills. The second focuses on facility with ICT developing as a strong agent in work and society, where competence in ICT is considered as an essential "life skill" – similar to literacy and numeracy. This is the ultimate result in digital literacy that becomes the requirement and the right for all learners, including students with special needs. The third concentrates on the role of ICT in teaching and learning and how this can improve the learning outcomes for students in general.

As a result of this shift, educators and implementers of curriculum must acknowledge that new approaches to assessment and learning must be followed in order to enrich the learning and take advantage of new opportunities (enGauge 2003). ICT brings new depths to learning and the challenge for schools is how to capture the new opportunities and adopt the innovation of new technologies. Therefore, the educators need to refine learning and teaching strategies; in addition, they must accept the development of new policy directions (enGauge 2003).

The OECD (2001) report supports the view that significant benefits can be derived from the use of ICT for students with special needs; furthermore, the report examines special schools as early adopters[18] of ICT:

> *"while this cannot be analysed in any depth here, it is important to note that in certain countries special schools were among the early adopters of the new technologies. ICT has allowed children with visual and muscular difficulties to read, write and express themselves. In some cases the technology has allowed children with special needs to attend ordinary schools"* (OECD 2001, p28).

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[18] Early adopter as explained in Rogers (1995).

The early phase of this study had explored the ways and means with which ICT can in fact support the learning of LD students at Macedon Ranges and Concord. In fact, it would be appropriate to consider Concord as an early adopter of ICT in its curriculum, given the advanced technological platform/environment of the school.

2.7 ICT POLICY DEVELOPMENTS IN VICTORIA

The Victorian government Department of Education recognised this demand, and need, for schools to implement policy on ICT in their curriculum. The Department invited schools to plan and develop their own technology or e-learning plan in the early 2000s. This policy was extended recently to promote the ICT skills of teachers through the e-potential program (DEECD 2008). In this program, or platform, the role of principals and teachers has been extended and there needs to be support for professional development and adequate provision of suitable educational software of high quality and easy access. The policy requires a partnership between school, home and the community. In order to have a successful implementation, there needs to be strong school leadership and management with a strong commitment to ICT adoption (Caldwell 2006, Shaddock 2007). The thesis will examine the impact of leadership and management as well as curriculum design in the concluding sections and see how these were related in the case studies. Clearly, any model that I would propose must have as its integral part a focus on leadership and curriculum management as it is identified by ANT. Figure 2-5 and Figure 2-6 show the modelling of the research field including the actors, and learning with ICT, in the early phases of the study.

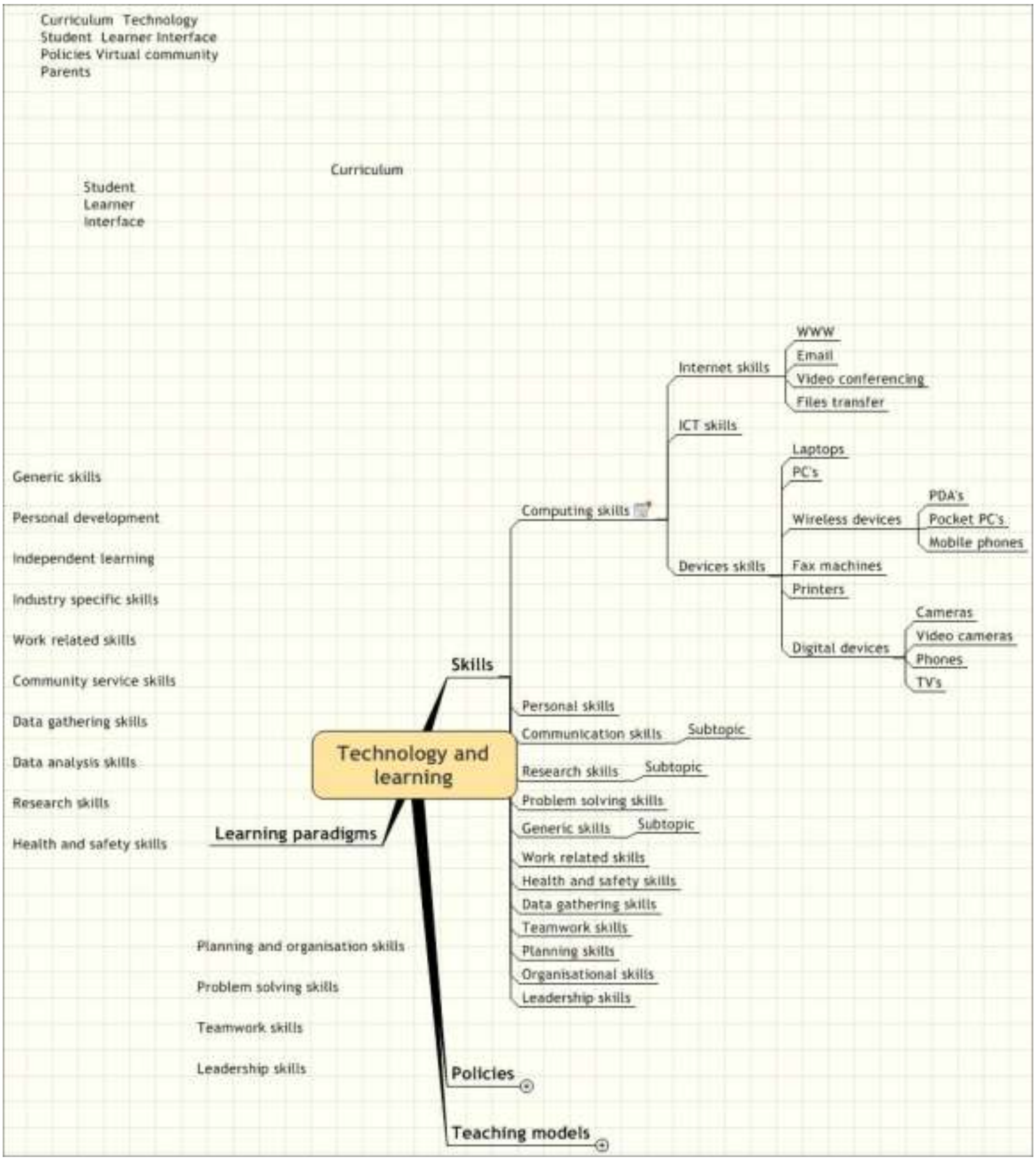

Figure 2-5: Actors and Skills in Technology & Learning

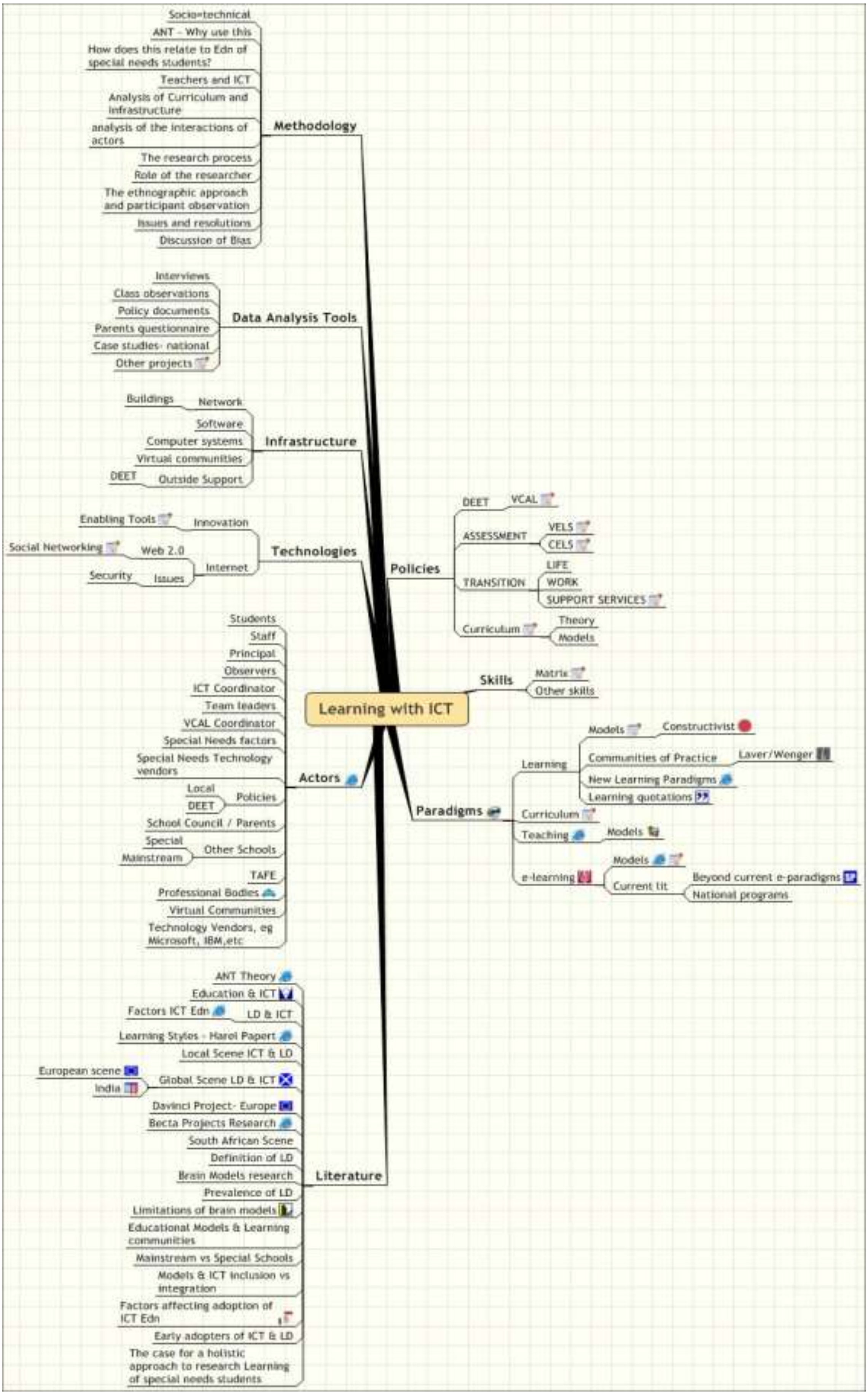

Figure 2-6: Learning with ICT- Using Mind Manager to assist the research study.

Historical Note

As mentioned earlier, my own personal experience was similar to those stated in the various research studies. In my role as computer co-ordinator, I had faced great difficulty in introducing computers across the curriculum as most of the teachers adhered to their traditional beliefs of instruction and styles. Although the constructivist paradigm was gaining momentum, it did not readily adopt the new technology of the time. Teachers in mathematics were the first to open the doors and allow the computer to enter their classroom. With software particularly designed for enrichment work, games and simulation activities. The DSP program (A Government funded program) provided resources nationally to schools that were targeted as being disadvantaged and most principals purchased a full laboratory of personal computers. The demands on teachers to learn new skills and possibly to change their teaching style was a large inhibiter in general for the adoption of computers in schools.

Even with limited professional development and support from local business groups and professional groups like the CEGV, it took almost two decades for teachers to welcome technology in their classroom.

2.8 OTHER STUDIES ON THE IMPACT OF ICT AND INNOVATION

National and other studies on the use of technology by Newhouse (1998), Shaddock (2007), Meiers (2009) and White (2005) established that ICT has a positive effect on teaching and learning. In the UK, Becta carried out several research studies to determine the impact and adoption of ICT in schools. The details of these studies will be discussed in Chapter 4 of the thesis.

The movement and acceptance by schools of technology is summarised by Ertmer et al. (1999)

"Despite the fact the number of the computers in teacher's classrooms has increased dramatically in the last 20 years, researchers and educators alike report that integrating technology into classroom curricular is not easily accomplished" (Ertmer et al. 1999, p54).

Undoubtedly, technology has been adopted and integrated successfully in the administration of schools. In Victoria for example, this was promoted and progressively rolled out through policy initiatives between 2000 and 2006. The aim is to provide a standardised platform for Victorian government schools in order to help them manage their core administrative and finance functions. The software, called CASES21[19], is an integrated school administration and finance system that supports approximately 1600 government schools. It is designed to facilitate schools with data reporting to the Department of Education and Early Childhood Development (DEECD). Although The Auditor General's 2008 Report findings show that the system has improved school administration for a broad range of schools, there are a number of large schools that have reported that the perceived benefits have not yet been fully achieved (Auditor General's Report 2008, CASES21 2008).

A DETYA (2001b) report, by Cuttance, on School Innovation, concluded that school classrooms are adapting to the needs of students so that they can develop skills and knowledge to use information, to collaborate and to communicate effectively with others through ICT (Cuttance 2001b). The report further states that there is no

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[19] CASES21 – Computerised Administrative System Environment in Schools.

unequivocal evidence about the impact of ICT on the learning outcomes of students although a significant number of studies have indicated that there is potential for ICT to improve the learning outcomes. What is significant in the report is the statement and reference to students with special learning needs:

> *"Educational technology can have a significant positive impact on learning in most subject areas, and for students with special learning needs"* (Sivin-Kachala & Bialo 1994).

In addition, similar to the findings from Becta (2004) and Becta (2003), the report supports the view that computers in classrooms increase student motivation, and increases student control over learning and access to information (Shaddock 2007, Meiers 2009). My own involvement in the 121 Project in research Field Y allowed me to observe the immediate, spontaneous and enjoyable engagement of students with special needs with technology and laptops (Adam et al. 2007).

As a last example to innovations and projects in this section, I refer to the Innovation and Best Practice Project (IBPP) from the DETYA (Cuttance 2001) report. This report included a study on the impact of laptops with 20 schools in the special project (IBPP[20]). For one of the groups where the students had their own laptop, the research evaluation for the innovation program did not produce evidence of their impact to be as strong as the group that used desktop computers. The innovations were based on constructivist learning principles because contemporary learning theorists argued that this was the most appropriate way to facilitate the students learning outcomes and allowed them to control their progress in ICT integrated classrooms (Scardamalia & Bereiter 1997, Shaddock 2007, Crook & Harrison 2008 and Cuttance 2001a). Further discussion on the issues of learner-centred discourse and learner-centredness will be undertaken in Chapter 4.

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[20] This was a first large scale research and development project that was specifically focused on innovation in schools. In fact it was one of the largest educational research projects ever undertaken in Australia, where 107 schools participated with the aim to improve the learning outcomes for students. (DETYA 2001b)

2.9 CONCLUSION

This chapter set the scene for the research in this thesis. It has argued that the special needs sector of education is an important area and we need to explore the impact of ICT and Web-based technologies for the learning outcomes of students with learning disabilities. The literature review will highlight some of the gaps present in the research field, and in particular, it will present a case for a holistic approach to be applied as the most appropriate approach in this research study. In following this approach, the thesis will overcome any limitations from the boundaries that are imposed from the social, educational or technological approaches. Therefore, an Actor-Network Theory approach will be considered for the analytical framework of this study. The discussion on methodology of ANT is given in Chapter 5, and details about the methods and techniques, are presented in Chapter 6 of the thesis.

CHAPTER 3

3 BACKGROUND OF THE EARLY PHASE OF THE RESEARCH & THE SEARCH FOR E-LEARNING

> "*I never teach my pupils. I only attempt to provide the conditions in which they can learn.*"

Albert Einstein (1879 - 1955)

3.1 CHAPTER SYNOPSIS

This chapter sets the context for the research study and provides background material for the special schools and the individual study. It describes related research projects and investigations that were carried out in determining the infrastructure of the research field. Early e-learning models are examined for the early phase of the study. The LD definition has been applied to a Learner Interface Framework Model with the application of the e-learning model by Schunck et al. (2001). A model to determine the actors and a consistent approach to teaching and learning for students with LD is provided via a mind map. The chapter discusses several of the OECD projects (such as the Da Vinci project) and the emergence of recent technologies, such as Web 2.0, on teaching and learning. The thesis analyses the significance of infrastructure which is discussed from a technological, policy, as well as ANT perspective. Furthermore, it presents a brief literature on school–to-work transition and lifelong learning for LD students.

3.2 THE RESEARCH FIELD

The research includes case studies from two special schools and an individual student. The schools had different student populations and a significant difference in resources, especially ICT resources. Geographically, one is in the outer regional Melbourne town at Sunbury, while the other is situated in an outer Melbourne suburban area, Bundoora.

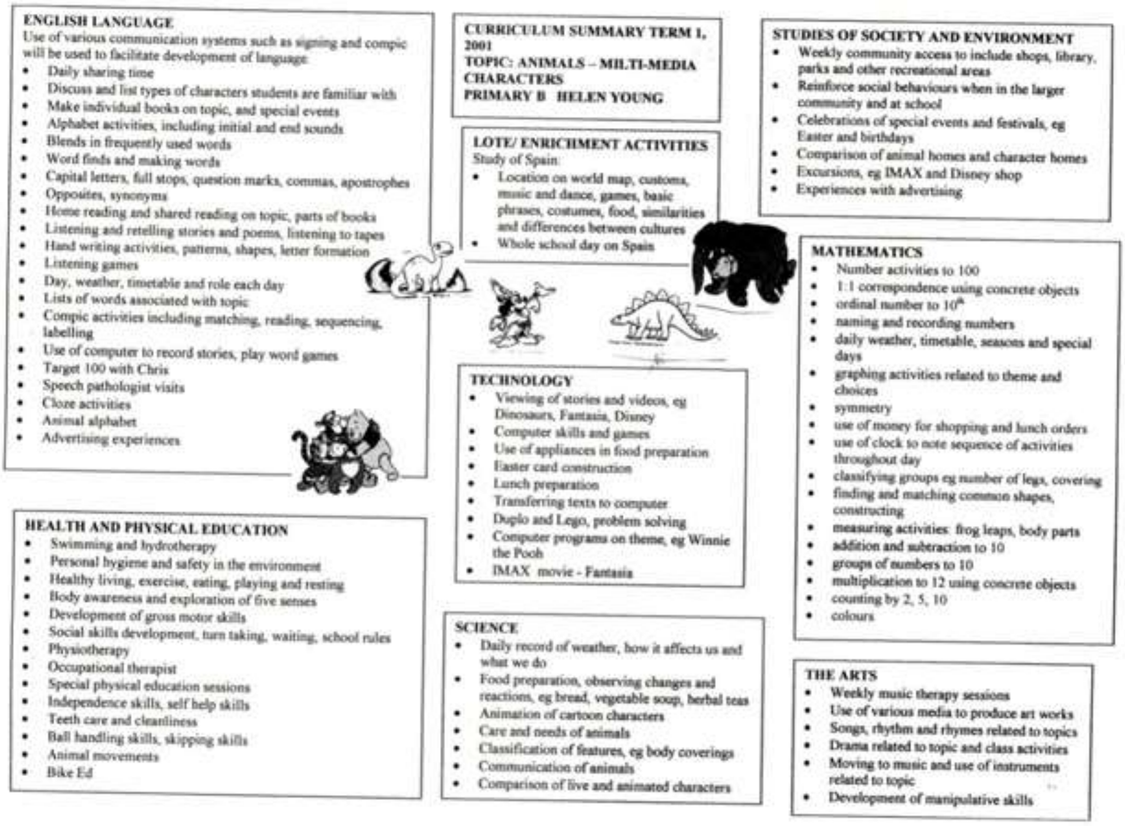
Inevitably, a topic like this has a number of technical terms and abbreviations-full details and explanations of these will be found in the Glossary (page xxviii in the dissertation).

Schools of all types form part of the broad community in any city and schools themselves form a series of communities within the broad community. Educational institutions that cater for children with special needs, sometimes also known as learning disabilities, have a lot in common with each other, but less in common with mainstream schools, even when these are located quite close by. These special schools need to form community groupings and particularly groupings consisting of other special schools and educational institutions offering support to students with special needs. The problem is that these educational institutions are often geographically well separated and this is where the Internet offers a good means of providing the infrastructure to support virtual communities of special schools.

3.2.1 BACKGROUND AND PURPOSE - MACEDON RANGES

Sunbury and Macedon Ranges Specialist School is a purpose built school for students with Learning Disabilities. This school is one of 84 Government funded Specialist Facilities in the State of Victoria. The school is located in Jacksons Hill, a newly developing and rapidly expanding suburb of Sunbury, about 50km north west of Melbourne. The school's catchment area is broad and students travel long distances to attend the school from as far away as Trentham, Kyneton, Melton, Greenvale and Diggers Rest. Students are identified as being 'at risk' by the very nature of their disabilities. In addition to this a number of families are in receipt of the Education Maintenance Allowance which is indicative of their lower socio-economic status.

The School provides a range of educational programs for students who present with special learning needs including global development delay, autism spectrum disorder, physical, social and emotional disabilities. It provides an extensive curriculum consisting of Arts, English, Technology, Health and Physical Education, Studies of Society and Environment, and Science and Mathematics.



ENGLISH LANGUAGE
Use of various communication systems such as signing and compic will be used to facilitate development of language

- Daily sharing time
- Discuss and list types of characters students are familiar with
- Make individual books on topic, and special events
- Alphabet activities, including initial and end sounds
- Blends in frequently used words
- Word finds and making words
- Capital letters, full stops, question marks, commas, apostrophes
- Opposites, synonyms
- Home reading and shared reading on topic, parts of books
- Listening and retelling stories and poems, listening to tapes
- Hand writing activities, patterns, shapes, letter formation
- Listening games
- Day, weather, timetable and role each day
- Lists of words associated with topic
- Compic activities including matching, reading, sequencing, labelling
- Use of computer to record stories, play word games
- Target 100 with Chris
- Speech pathologist visits
- Cloze activities
- Animal alphabet
- Advertising experiences

CURRICULUM SUMMARY TERM 1, 2001
TOPIC: ANIMALS – MILTI-MEDIA CHARACTERS
PRIMARY B HELEN YOUNG

LOTE/ ENRICHMENT ACTIVITIES
Study of Spain:

- Location on world map, customs, music and dance, games, basic phrases, costumes, food, similarities and differences between cultures
- Whole school day on Spain

STUDIES OF SOCIETY AND ENVIRONMENT

- Weekly community access to include shops, library, parks and other recreational areas
- Reinforce social behaviours when in the larger community and at school
- Celebrations of special events and festivals, eg Easter and birthdays
- Comparison of animal homes and character homes
- Excursions, eg IMAX and Disney shop
- Experiences with advertising

MATHEMATICS

- Number activities to 100
- 1:1 correspondence using concrete objects
- ordinal number to 10^{th}
- naming and recording numbers
- daily weather, timetable, seasons and special days
- graphing activities related to theme and choices
- symmetry
- use of money for shopping and lunch orders
- use of clock to note sequence of activities throughout day
- classifying groups eg number of legs, covering
- finding and matching common shapes, constructing
- measuring activities: frog leaps, body parts
- addition and subtraction to 10
- groups of numbers to 10
- multiplication to 12 using concrete objects
- counting by 2, 5, 10
- colours

TECHNOLOGY

- Viewing of stories and videos, eg Dinosaurs, Fantasia, Disney
- Computer skills and games
- Use of appliances in food preparation
- Easter card construction
- Lunch preparation
- Transferring texts to computer
- Duplo and Lego, problem solving
- Computer programs on theme, eg Winnie the Pooh
- IMAX movie - Fantasia

HEALTH AND PHYSICAL EDUCATION

- Swimming and hydrotherapy
- Personal hygiene and safety in the environment
- Healthy living, exercise, eating, playing and resting
- Body awareness and exploration of five senses
- Development of gross motor skills
- Social skills development, turn taking, waiting, school rules
- Physiotherapy
- Occupational therapist
- Special physical education sessions
- Independence skills, self help skills
- Teeth care and cleanliness
- Ball handling skills, skipping skills
- Animal movements
- Bike Ed

SCIENCE

- Daily record of weather, how it affects us and what we do
- Food preparation, observing changes and reactions, eg bread, vegetable soup, herbal teas
- Animation of cartoon characters
- Care and needs of animals
- Classification of features, eg body coverings
- Communication of animals
- Comparison of live and animated characters

THE ARTS

- Weekly music therapy sessions
- Use of various media to produce art works
- Songs, rhythm and rhymes related to topics
- Drama related to topic and class activities
- Moving to music and use of instruments related to topic
- Development of manipulative skills

Figure 3-1: The Key Learning Areas of Curriculum (Courtesy: Macedon Ranges Special School)

In addition to delivering the key learning areas as part of the curriculum, the school provides a broad range of programs that are designed to further enhance the independence of its students. Some of the programs include Augmentative Communication, Work Education, Outdoor Education, Bike and Road Safety Education, Music Therapy, Swimming and Hydrotherapy Programs, Riding for the Disabled, Home crafts, Recreation and Leisure and Health and Human Relations Programs.

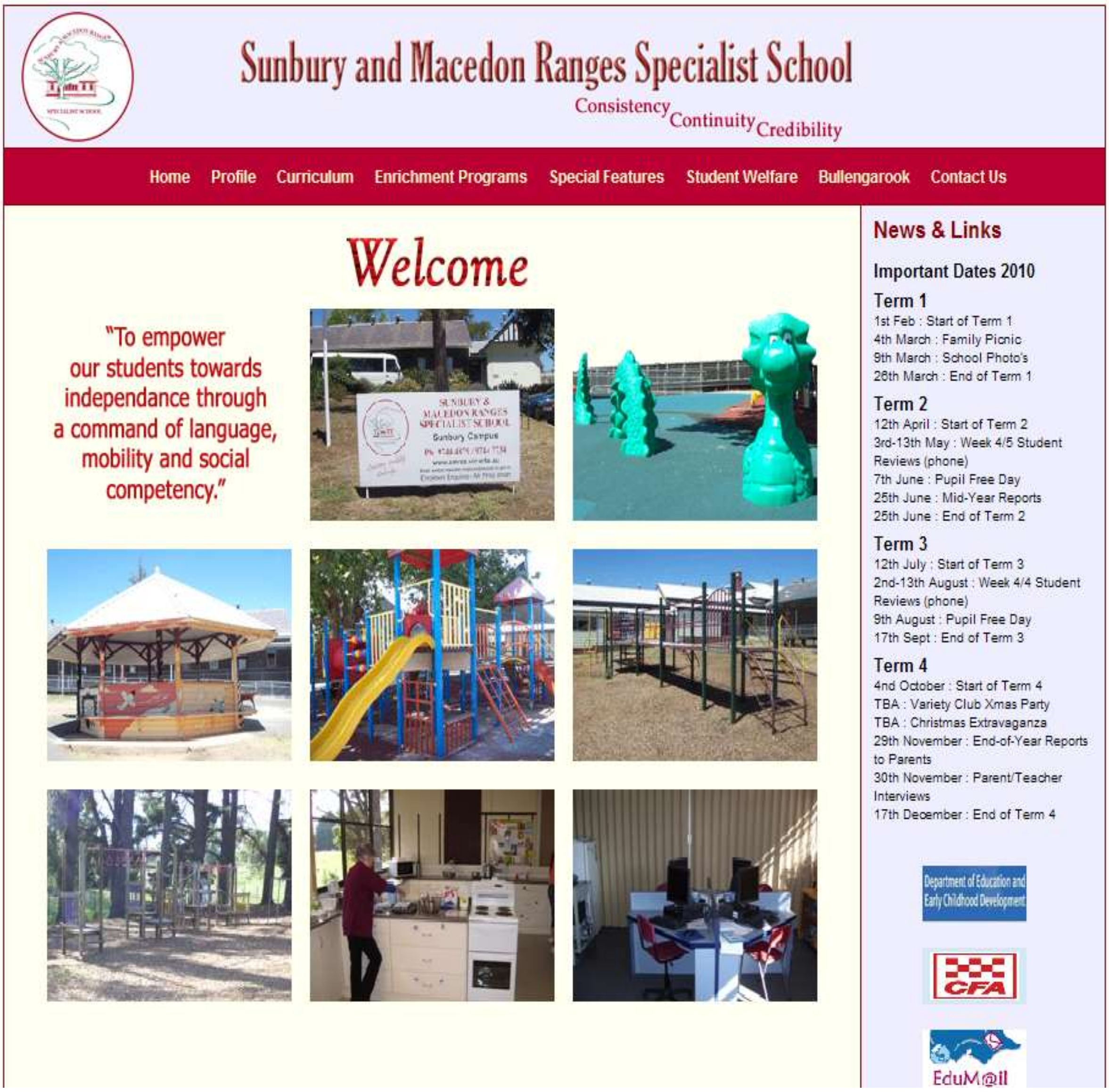


Figure 3-2 Macedon Ranges Website, 2010[21] (Source: Internet & Courtesy Macedon Ranges)

During the early phase of the study, Sunbury and Macedon Ranges Specialist School had approximately 40 students in 2001 and had grown to 90 students by 2007 (MRRS Annual Report 2006). It had 8 full-time and 3 part-time teaching staff, 15 part-time school support officers and 2 part-time administration staff. The students were quite diverse in their special needs, both physical and intellectual. They used limited ICT resources in their learning. For example, in 2003, the computer systems included several ACORN computers but very few PCs. The majority of the software was based

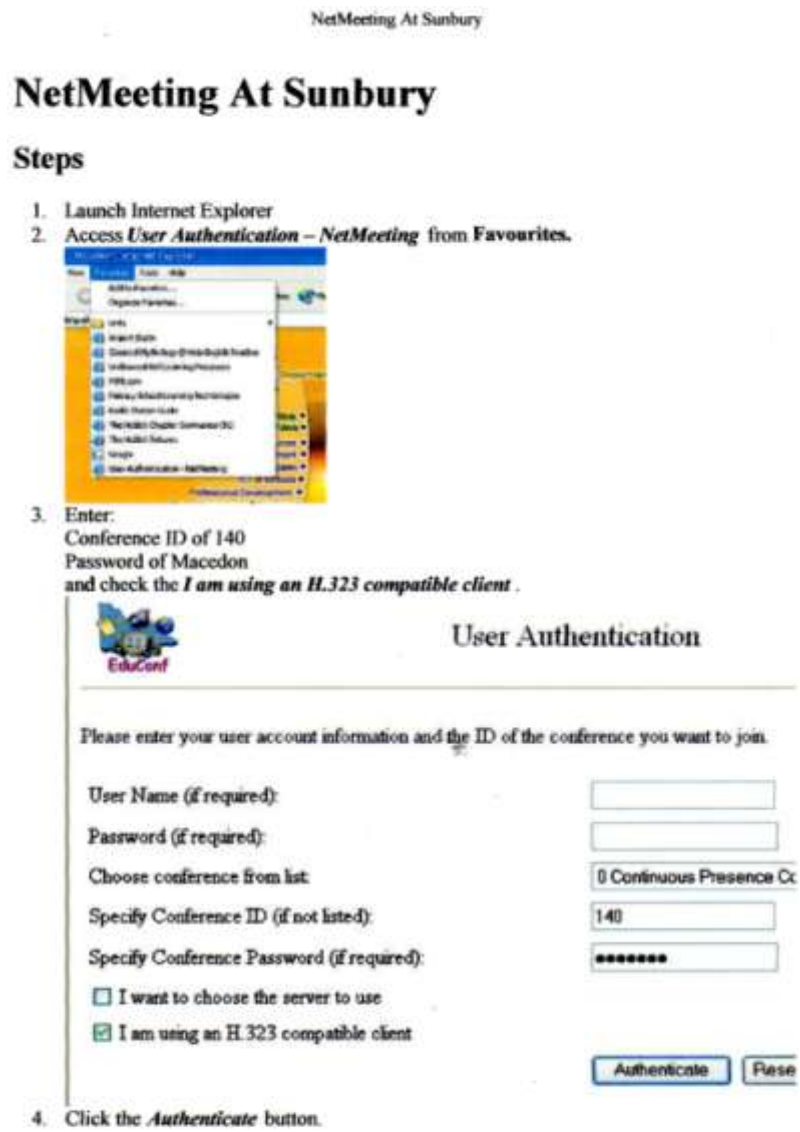
21 http://www.smrss.vic.edu.au/bullengarook.html

on the DOS operating system platform where graphics and sound quality was limited. The library had a PC to allow the students to access the Internet.

The PCs were predominantly used to reinforce language and numeracy skills. The list of computer skills, as was evidenced by the student survey, indicated that some key programs were used to assist the students in their learning. The staff were quite happy with these programs as they felt these were adequate for their students' needs. An examination of the school's technology policy and curriculum showed that the use of ICT was an integral part of the classroom teaching and learning. The school heavily relied on ICT policies and support from the Department of Education – both for network access and software supplies. The administration system was also provided and supported by the Department.

As mentioned earlier, the research investigated the infrastructure in order to set up links between different classes at the local level. Given the limited support and availability for videoconferencing by the Department's resources, the attempt was welcomed by the school's relevant staff. The students showed high level of enthusiasm and immediate engagement when they began to communicate via the web cameras. The main issue, as expected, was the limited bandwidth from the Local Area Network[22]. Figure 3-3 below shows the steps of an early videoconferencing session that was set up to link several classrooms and the library at this school. The application available at the time was the Microsoft product Net Meeting with a web camera installed. The infrastructure at the time supported this particular application, even though the Department used the CUSeeMe platform.

[22] This is abbreviated as LAN in data communications.



NetMeeting At Sunbury

NetMeeting At Sunbury

Steps

1. Launch Internet Explorer
2. Access ***User Authentication – NetMeeting*** from **Favourites.**
3. Enter:
   Conference ID of 140
   Password of Macedon
   and check the ***I am using an H.323 compatible client*** .

4. Click the ***Authenticate*** button.

Figure 3-3: Setting up video conferencing at Macedon Ranges

Another significant issue was the security constraints and filters that were imposed by the Department's VicOne Network. This matter was further investigated in the following year of the research, and it was discovered that videoconferencing was not in high demand for schools, and hence the support was downgraded considerably. It is true to say that some pioneers and innovators were responsible for the numerous projects that were listed on the DEET website at the time. In 2005 following several meetings, the IT Manager indicated that the service was to be phased out and the solution which was provided through the CUSeeMe platform was soon to be abandoned.

It was evident that in order to provide adequate videoconferencing links, the schools relied on DEET policies and support to achieve this (capability). Among the issues that confronted the schools during this period, were cyber space issues and these placed server constraints for Internet access. This was apparent, in particular, where innovative approaches were concerned; for example, programs like Flickr, which is a web application that enables the sharing of images and albums (Social Networking Software, introduced in 2007-Educational reviews March 2007).

For specialised schools, even for these, the Education Department Policies on assessment and certification; e.g., VCAL and VELS do certainly play a significant role in the design of the curriculum. (There appears to be a driver from these policies for ICT to be integrated into the schools' curriculum). This is a general trend and the two schools that were investigated in this study revealed that this was the strategy for their Learning Technology and Implementation Plan (see Appendices A and B).

3.2.2 BACKGROUND AND PURPOSE - CONCORD

3.2.2.1 Concord School

Located on two campuses in Bundoora, a northern suburb of Melbourne, Concord is a day specialist school which caters for students with mild to moderate intellectual disability between the ages of 5 and 18 years. Students come from a wide geographical area and a diverse socio-economic background. Concord's junior annexe is in the grounds of Watsonia Primary School and provides three classrooms for students aged between 5 and 9 years of age. The school itself is situated in attractive, well maintained grounds with excellent facilities which include: Technology Centre, fully equipped gymnasium, Healthy Living Centre, Art and Craft room, well-resourced library, modern playground equipment, four school excursion buses, computer networking across the school, multi-purpose room, shaded outdoor playing areas and membership of Blackwood Outdoor Education Centre.

The vision of the school community encompasses a commitment to achieving excellence in education for students, with additional learning needs, through a curriculum which integrates learning technologies with best practice in teaching and learning. The values embraced by the school community are: **Respect, Personal Best**, **Happiness**, **Cooperation**, and **Honesty**. These values are imbedded in the Student Code of Conduct and the Staff, Principal and School Council Codes of Practice.

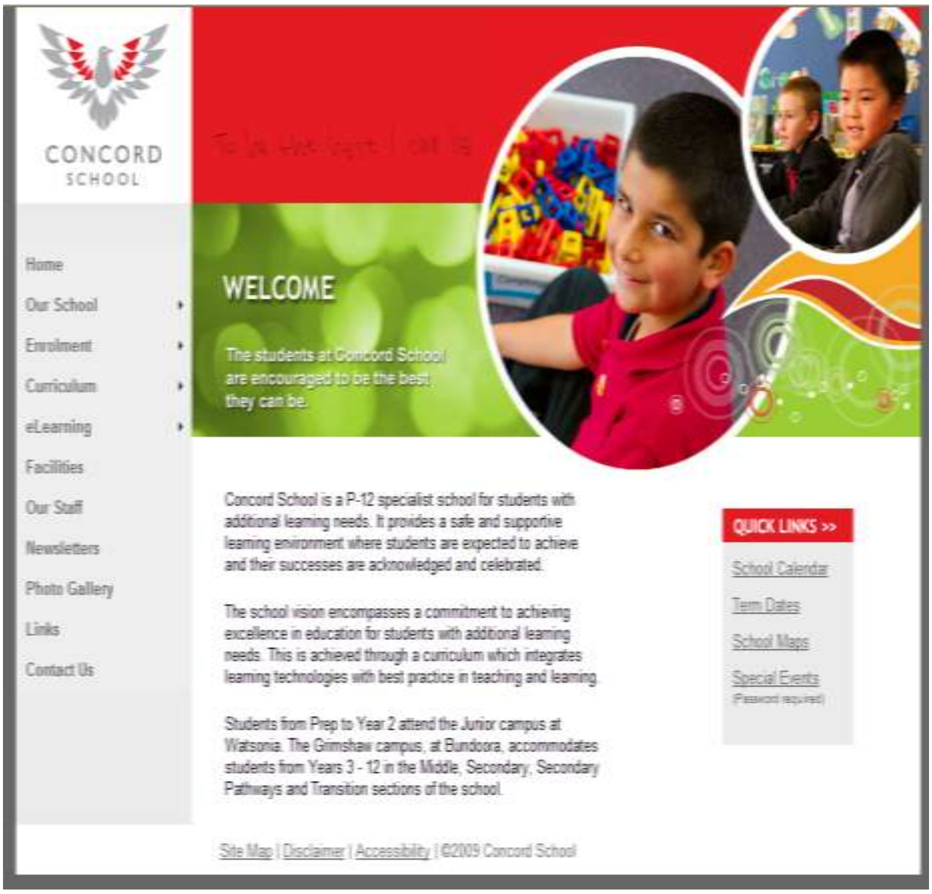


Figure 3-4 Concord School Website[23] (Source: Internet and courtesy of Concord School)

The school, with over 70 teaching and ancillary staff had an enrolment of approximately 250 students in 2006 (Concord Annual Report 2006). Enrolment is dependent on eligibility criteria determined by the Department of Education and Training. A significant number of teachers at the school have a post-graduate qualification in special education. Concord supports integration into or from mainstream schools. Support services available to parent/carers and students include social workers, guidance officers, speech therapists and visiting teacher services.

Concord is focused on student achievement and learning. Concord school is recognised as being a world leader in the provision of education for students with additional

[23] http://www.concordsch.vic.edu.au/

learning needs and, as a specialist school, is highly regarded for its curriculum, learning technology programs and educational leadership.

The school is organised into four sections providing a comprehensive curriculum in seven of the Key Learning Areas together with social skills development. The implementation of the Early Years Literacy and Numeracy Program at Junior and Middle school levels has increased opportunities for improved student skills in literacy and numeracy. The Secondary School has a focus on the enhancement of student engagement through Middle Years strategies based on improved Literacy and Numeracy, and the introduction of 'Thinking Curriculum'. The Transition Centre caters for students from sixteen to eighteen years of age with a focus on the development of dual pathways to cater for the diverse needs of the students. This is the section where I based my research with the 121 Project.

Concord School has a high level of commitment to a curriculum which integrates learning technologies with best practice in teaching and learning in order to enhance educational outcomes for its students. The Technology Centre has facilitated opportunities for its students, its staff and for staff from neighbouring schools. Other facilities include the completed construction of a new Multi-Function Centre, Healthy Living Centre and Library under the school's Master Planning Program which ensures its students have access to outstanding facilities and resources in these areas.

It was observed, as stated in the School's Annual Report (2006), that staff members place a high priority on communication and work with parent/carers in Program Support Groups to communicate and discuss individual Student Learning Plans. These Plans focus on the development of learning targets based on the course content of the Curriculum and Standards Framework. Student progress is closely monitored against these learning targets through extensive formal and informal assessment within the Key Learning Areas.

Furthermore, student achievement is celebrated to promote increased self-esteem and self-confidence to assist students to become independent in their work and acknowledge participation at school. It was observed that, at Concord, the students are expected to develop respect for others and achieve personal excellence. The values of the school are promoted through all curriculum areas and emphasised through student responsibility areas such as the Student Representative Council, School Captains and Bus Captains.

Concord School provides many enrichment programs such as**:** specialist speech program, work experience, travel training program, excursion/camping program, swimming program, inter school sport, electives, Duke of Edinburgh awards, a Debutante Ball, perceptual motor program, annual Christmas concert, bike education and special events. The school looks forward to continuing to meet the challenge of educating its students so that each student can follow its motto: **'*To be The Best I Can Be'*.**

Since 2006, Concord School has introduced a number of social and networked learning activities and practices. This research study reports on the activities undertaken, technologies used and the progress made during this period. Although the individual items of social software used at Concord have been appraised separately, in practice these tools and technologies are complimentary and have been used concurrently. In fact, much of the power of social software is its interoperability.

In using these tools, the school expects its students to create and publish content and respond to the content creation of others. Created content can be aggregated to show progress and richness and depth of learning. Students can respond to the work of others, provide feedback and learn through their interactions with others online. Not only are the students learning, they are also learning how to be independent learners. This sentiment was echoed through the words of the Principal during a conference in 2008 where the school was invited to present or showcase its ICT curriculum. His voice was expressed by the statement: "***the students will become independent life-long learners***" (Elluminator Conference 2008).

Collaborative Web 2.0 technologies and practices strongly support effective knowledge management practices (Lee and Lan 2007). By using open web-based standards, such as RSS and XML and open API web services, complimentary software can share data in rich and unique ways. In future years, interoperability may well be the key criteria for introducing new technologies and systems, as teachers and administrators become more familiar with working in networked environments.

In introducing social networking software at Concord School, the aim was to integrate these with existing practices, so that web-based tools and technologies would construct richer tasks for the students. For example, using web-based photo sharing, students and teachers tagged photos which were then used in student digital portfolios. By using this approach not only were the skills and practices introduced, but the school also reduced the workload for teachers who had previously organised the resources for use in the student digital portfolios. The reader is referred to Appendix B for samples of work.

By reviewing at their existing curriculum they were able to identify opportunities to use web collaboration. For example, they found they could use the social media sharing website ccHost within their loop-based music creation topic. Having traditionally used the audio samples that came with the software, they discovered they could easily integrate online networked learning to increase learning outcomes. Now students can find audio samples based on tags, use these samples in their composition and then share their composition online, highlighting the samples that they used. Other students could then make derivative works by taking samples from the composition of others.

At Concord School, social networking web services are provided via the intranet. This ensures that the students' privacy and security can be carefully monitored. The impact of computer based technology (ICT) was (and still is) certainly at the heart of the curriculum. Although the broad aims are to provide ICT as an integral part of the curriculum, the school community and management has the strong belief (or view) that technology is the best vehicle to provide lifelong skills for their students. Data collected from parental and staff questionnaires revealed a very strong perception regarding the role of technology (ICT) at this school. The curriculum was supported strongly by the network infrastructure throughout the school (through its wireless network). In particular, a project that was discussed earlier, the 121 ICT Project, was piloted to see how technology can assist these students in 2005. This was consolidated and later extended to other Transition classes in Years 11 and 12. Further details about this pilot project are given in section 7.4 of the thesis.

3.3 BACKGROUND AND PURPOSE - FIELD Z (INDIVIDUAL STUDENT)

3.3.1 RESEARCH FIELD Z

Prologue

Prior to the commencement of this thesis, I was confronted with a family concern – the education of my own child. The problem was that it was difficult to place him in a government school while at the same time he did not fit the norm for a special school. In the end, we selected a school environment that was considered to be more caring for him.

From the beginning my family faced the challenge of how to improve his learning outcomes and make him a lifelong learner. He was diagnosed with "a late developmental delay" when he was 4 years old.

This research was carried out in order to learn more about the teaching and learning methods for students with LD.

My objective was to examine possible approaches so that I would endeavour to apply these in helping my own child. In particular, I was searching for a medium like technology, to see if this would become an enabler, as I was previously involved with programs like the Disadvantaged Schools Program (DSP), in secondary schools and saw the influence that computers had on students who suffered with dyslexia and other disabilities in the 80s. Although most of the computer software might have been regarded as primitive by today's standards, they played a significant role in raising the awareness and self-esteem of those students. The present study is an extension and aims to update the learning paradigms with the application of ICT and up to date curricula in special needs schools.

3.3.2 Individual Study (Z)

The following timeline, Figure 3-5, provides a summary of the different stages of development and education for the individual student (Z). The prime actors are listed in Figure 3-6 below and a list of human and non-human actors is given in Table 03 at the beginning (page xxxii) of the thesis.

Time Line

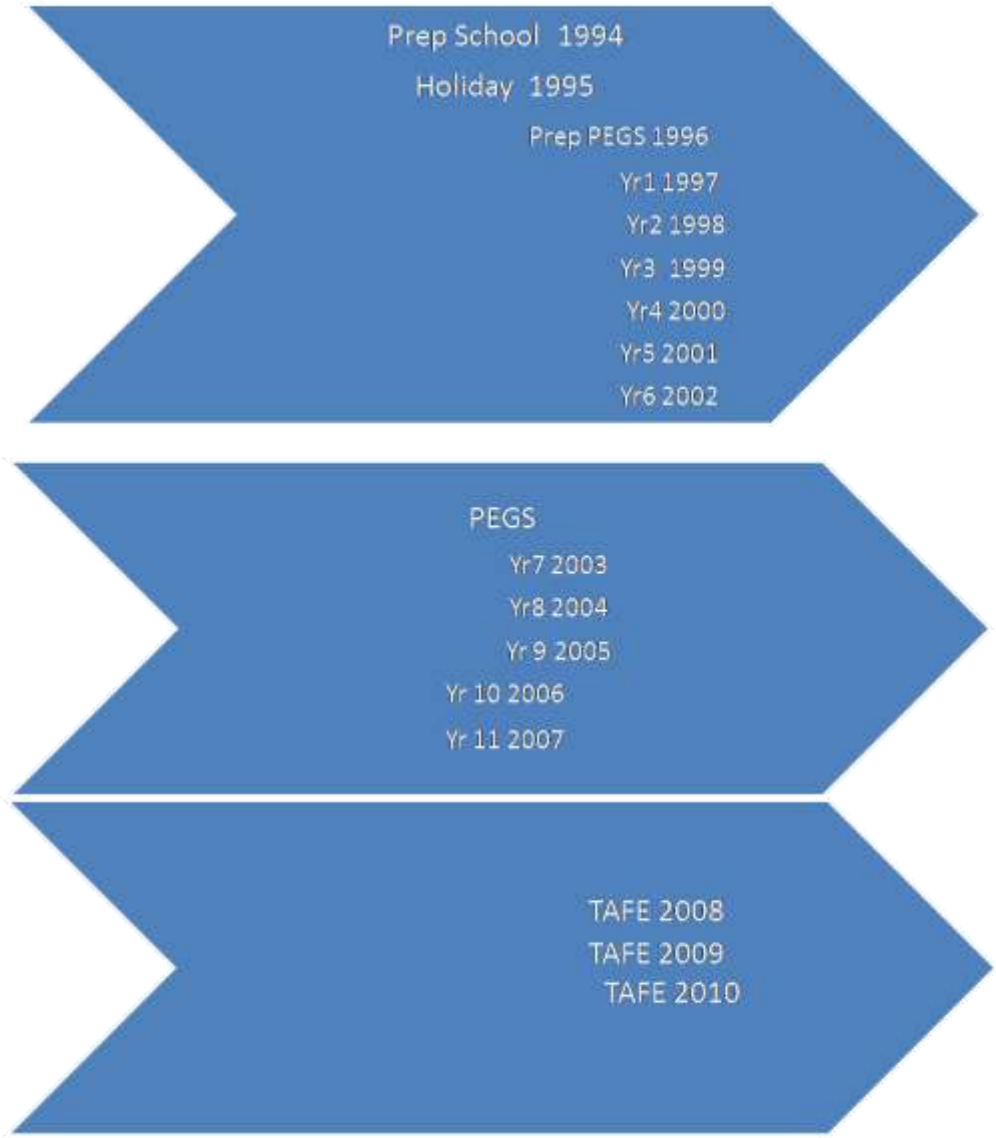


Figure 3-5: Time Line for Actor Z

3.3.3 Actors (Non-human) Software Programs

Thinking Things Collection –Music, Geometry, Numbers (software program)	iPod	
Mobile Phone		
PC/Laptop	PDA	
Reading magazine, Graphics Image	IT Studies Curriculum	Writing Notes
Photoshop (Software by Adobe)	Reading	Music Instrument
3D-Studio Max (Animation software by AutoDesk	Simulation Games	Cars
Illustrator (software by Adobe)	PlayStation	Internet
E-mail		Video Camera

Figure 3-6: Additional actors (non-human) (compare with other students of fields M and C)

3.4 THE RESEARCH ROADMAP- SEARCHING FOR SITES & ACTORS

Initial Motivation

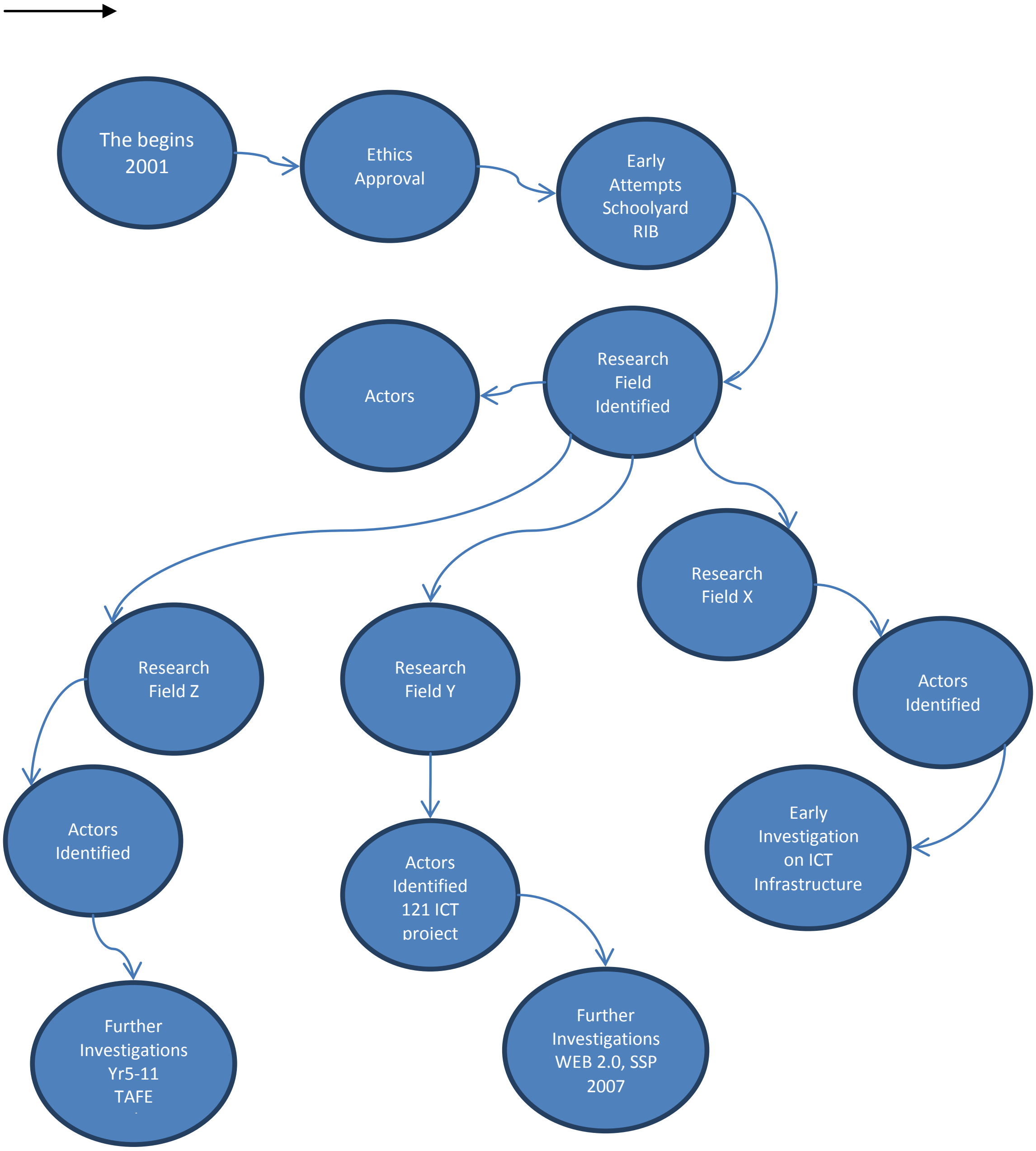


Figure 3-7: Research Roadmap

The research fields X, Y and Z [24]

[24] For brevity, X represents Macedon Ranges, C represents Concord and Z represents the individual student in this study.

3.5 RESEARCH TIMELINE & ITS EVOLUTION

In order to make the reader aware of the scope and duration of the research project, I have constructed a timeline that shows the time and location of the research work at various stages. Figure 3-8 illustrates this timeline.

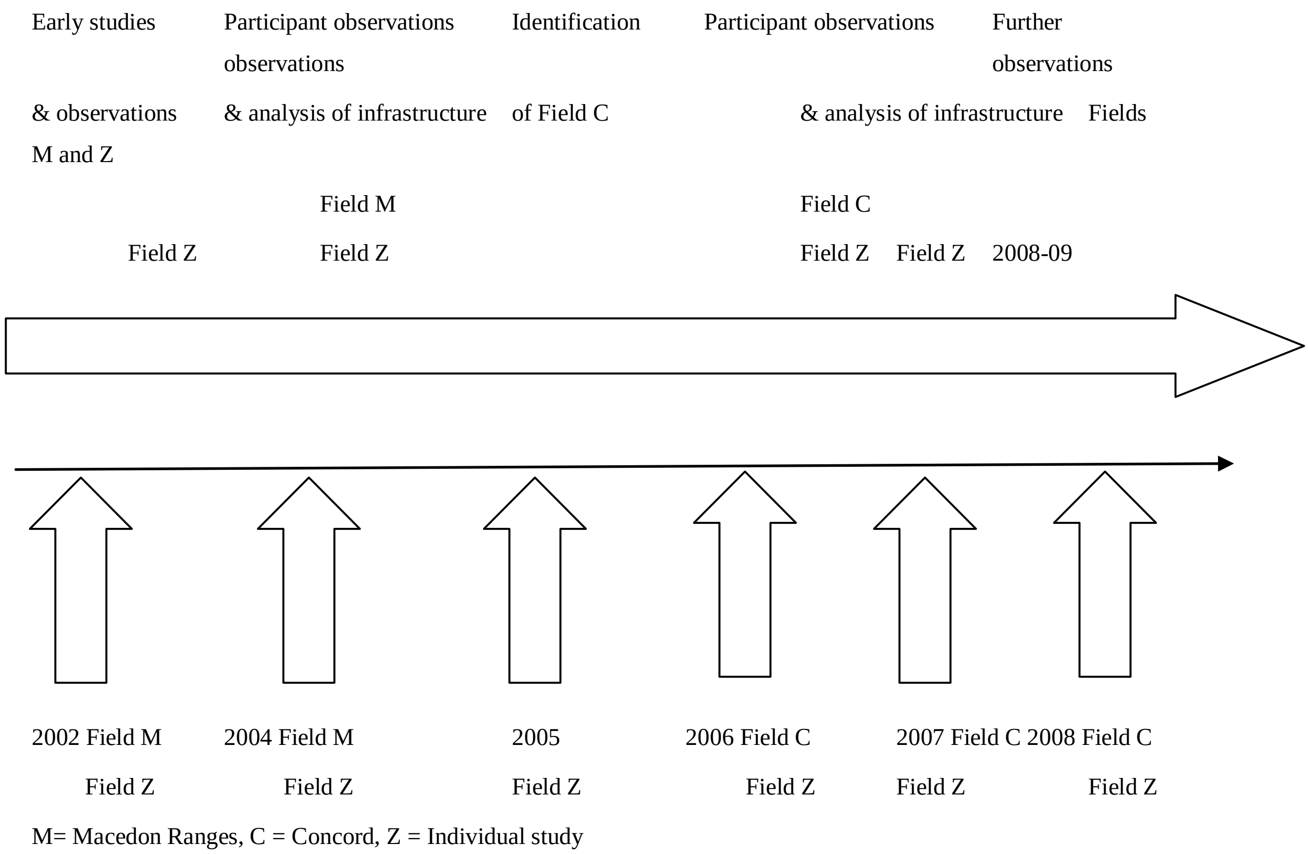


Figure 3-8: Research Timeline

My research journey began in 2002 in field M (Macedon Ranges) and stopped in 2004. From 2005-2007, I moved to another school, Concord (C), where a significant part of the data gathering was completed. I have included a summary of all visits in Appendix E. The timeline is significant in that it shows that observations were carried out over a 7 year period and this could be considered as a triangulation on the original set of observations and reflections. I believe that even though the timeline is large, the data remained current over this period and I feel that I was able to update the data to incorporate the more recent usage of ICT in both schools. I returned to the first school in July 2007 to investigate the changes that occurred since 2005 and updated the data. Figure 6-4 in Chapter 6 illustrates the elements of the early research plan for this study.

A Note on the Move from Field of Research M to C

The study involved initial discussion at Macedon Ranges, where the principal, computer coordinator and school council granted access to the school to conduct my observations and investigations of the curriculum in 2002. However, as I also needed ethics approval from DEET, my research work was delayed till the start of 2003. I worked well for some time till 2004. I was able to identify various key actors from the school and DEET and piloted a trial video conferencing with limited resources. The aim of this project was to explore the infrastructure and analyse the source and level of support to teachers in the classroom who used technology and the Web. I experienced some difficulties and limitations in 2004 at Macedon Rages due to staff movement and it became necessary for me to move the investigations to another site. In 2005 I commenced regular visits at Concord and participated[25] in a pilot project, called 121 ICT. I attended several IT meetings with relevant actors, observed several classes other than the 121 senior class and conducted interviews, surveys[26] with parents, teachers and students. Working closely with the senior group of students, namely Transition students, enabled me to collect data for the thesis, which are tabled in Chapter 7.

[25] The full schedule of meetings etc. can be found in Appendix B, other relevant data will be presented in Chapter 7.

[26] My surveys were formulated to account for issues that were identified in the literature; I discovered that Paul South, in Becta (2005) study, approached his surveys with similar questions in the UK.

The next section introduces the Learner Interface Framework adapted from Brusilovsky & Papert, cited in IEFTS (2001). An e-Learning model by Schunck & Nielsson (2001) was investigated in the early phase of the study in the first special school and the details of this model are discussed in the ensuing sections.

3.6 MODELLING LEARNING WITH ICT

A starting point in modelling learning with ICT is the Learning Interface Model (Adam, Rigoni et al. 2006) – see Figure 3-9 below. In this model, teaching can be thought of as an interaction between teachers, students, experience and knowledge (Schunck and Nielsson 2001). How these entities interact can be seen in different teaching/learning paradigms, ranging from one characterised by a verbal flow of information streaming from the teacher directly to the students, to the model shown in Figure 3-10 below.

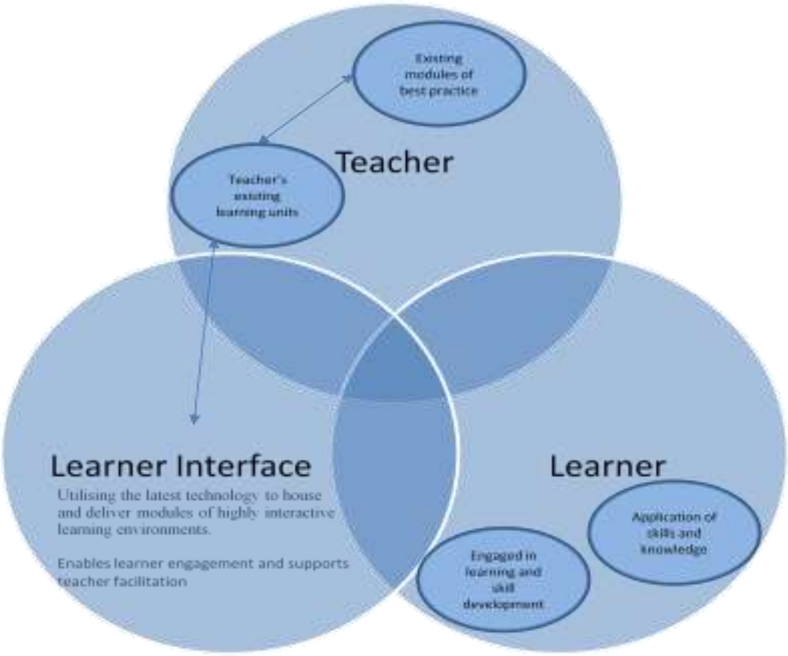


Figure 3-9: Learner Interface Framework - Adapted from Brusilovsky & Papert (Source: IEFTS 2001)

Here, the teacher acts as a catalyst or consultant for students to show them where information can be obtained from. Next, we can consider the model from Schunck & Nielsson (2001) as a starting point to examine what changes are needed to the traditional teaching model as we move towards the adoption of technologies in the curriculum. These changes are captured in Figure 3-11 below; this is a reproduction of the model in a study reported by Schunck & Nielsson (2001).

3.6.1 From Traditional Teaching and Learning Models to E-Learning

In their study, Schunck & Nielsson (2001) examined three different scenarios to describe pedagogic developments from a historical perspective. These perspectives primarily focused upon the interaction between teachers, students and given subject matters (domains). In proposing their model they considered the following paradigms:

the paradigm of yesterday

the paradigm of today and

the paradigm of tomorrow.

Naturally, the structure and the developments in the surrounding society as well as the political dimensions play an important role as far as the models' individual lifetime and the transition from one model to another are concerned. The models may be looked upon as changes of paradigms, assuming new forms in connection with the implementation of new discoveries or theories and new decisions or changes in views and attitudes.

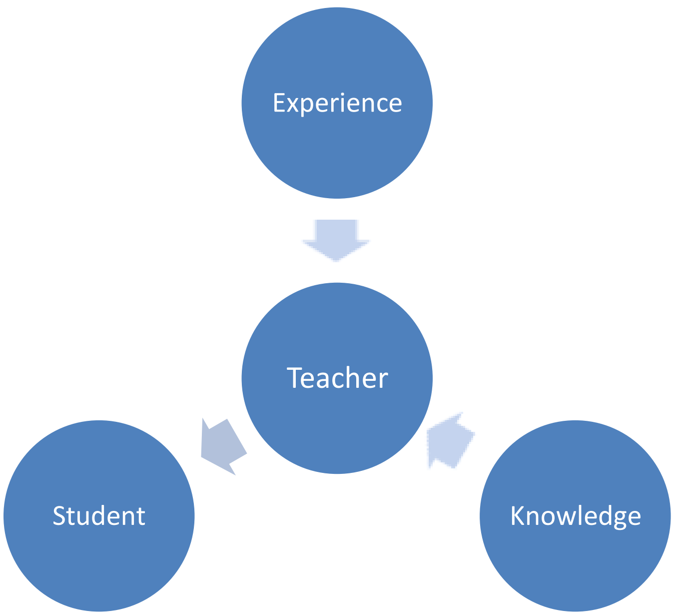


Figure 3-10: Paradigm of yesterday (Source: Schunck et al. (2001))

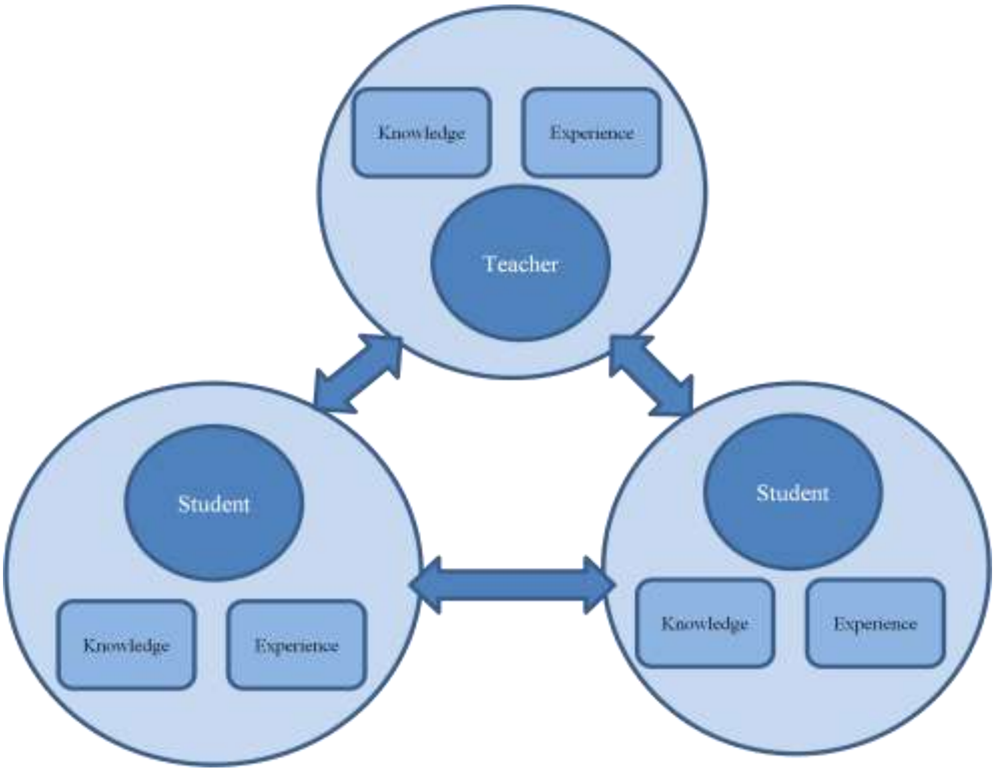


Figure 3-11: Paradigm of today (Source: Schunck et al. (2001))

3.6.2 Adopting the Schunck & Nielsson e-learning Model for LD Students

This study adopted the above e-learning paradigm to determine the impact of technology on the educational outcomes of LD students. The model in Figure 3-12, illustrates the facilitating role of the teacher and the independence of students in working and sharing their knowledge through experiential learning. The early research was proposed at Macedon Ranges where this model was explained to the main actors, like the school principal and the IT coordinator. Fortunately, the model was accepted and the research study commenced through the exploration of the policies and infrastructure that was available at the school level.

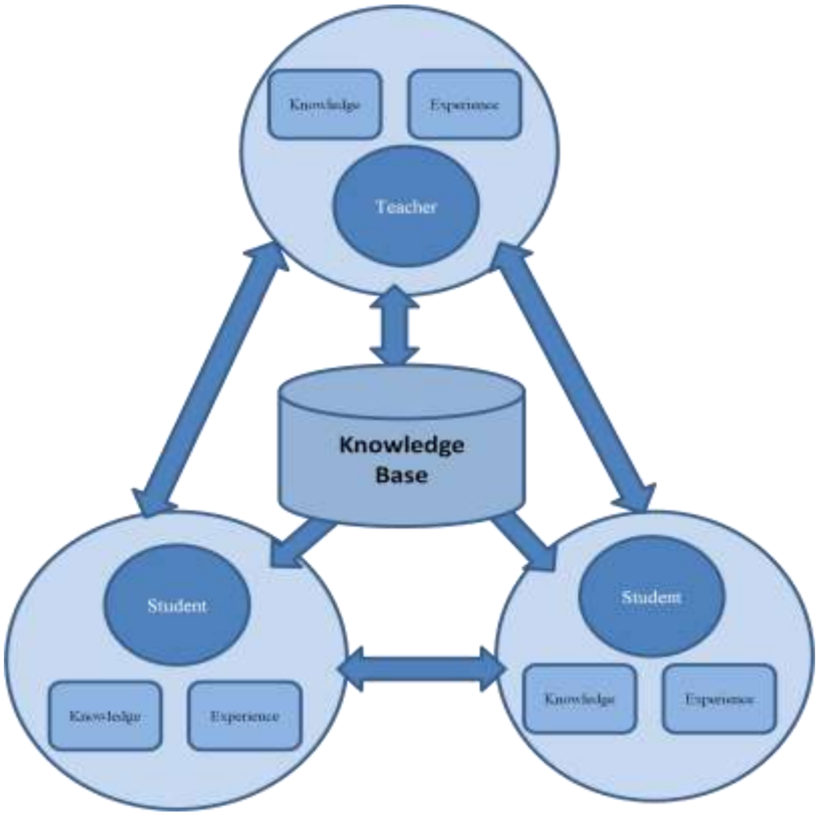


Figure 3-12: The Paradigm of tomorrow -The e-learning Paradigm (Source: Schunck & Nielsson 2001).

This was soon followed by further explorations in the Department to gauge the IT support level for teaching and learning. These early explorations set the scene and the strong research base that was extended to the 121 ICT Project at Concord, in the second and more advanced phase of the research study. The details of the research approach are provided in Chapter 6, which presents the Research Methodology for this thesis. Next, I present preliminary comparison of the two schools in the study, which is followed by a brief discussion on the key actors of the schools. A full detailed analysis and comparison between the two schools will be undertaken later in the dissertation in Chapter 7.

3.7 A PRELIMINARY COMPARISON OF THE TWO SCHOOLS

Concord and Macedon Ranges differ in their student population and intake area and, in addition, they also differ in the severity of the disability or handicap that the students come to school with. Whilst both Schools followed the necessary assessment procedure as set by the Education Department, it was observed that Macedon Ranges Special School provides for a more intense behaviour, and hence, staff need to be better equipped with relevant special education training and qualifications than staff at Concord Special School. School philosophy and the view that ICT is seen as a key motivator and facilitator for life-long learning for the students, can be seen as a significant difference between the two Schools. Macedon Ranges has taken several years to catch up with technological advances including the construction of the School's website. Both Schools now have a Web presence, however, the strong ICT emphasis can be readily recognised at Concord – particularly now with the emphasis on collaborative learning and Web 2.0 technologies in the curriculum.

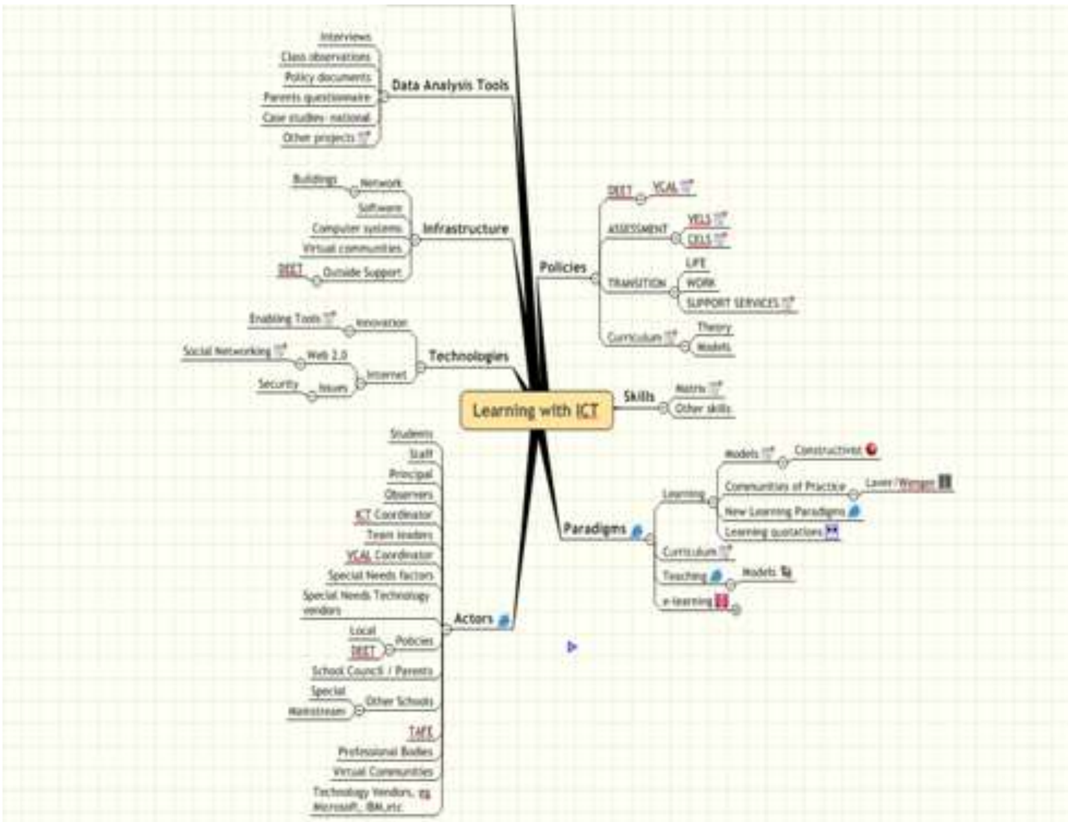


Figure 3-13: Modelling the Actors

3.7.1 A Brief Word on Actors

Actors involved in the adoption of this technology to assist students with LD include: students, parents, teachers, the Web, computers, Education Department policies, learning technology policy, school environment, classroom environment, learning approaches and paradigms, delivery methods of instruction, engagement methods, thinking processes, technology infrastructure-bandwidth, curriculum, Web curriculum, Internet resources, digital libraries and other schools. In an ANT framework, actors are seen to contest and negotiate with each other in an attempt to influence the final outcome in a direction to their own liking. The Education Department, for example might want to ensure that all schools offer a similar level of service to students and to ensure their accountability. The parents of a student with LD, on the other hand, would want the best for their own child regardless of what was going on in other schools. The technology (both hardware and software) itself acts in the way it was designed, both intentionally and unintentionally, to act.

The major challenge of this project was to facilitate a virtual community of special schools through ICT and a Web Portal. I tried to get all the actors to form a common problematisation (Callon 1986) of this form of virtual community, so that they would all see the problem in the same way. If this can be achieved then all the actors can work together to achieve this common goal and ANT offers some ideas on how it might be achieved. ANT considers associations and interactions between human and non-human actors, but its proponents make no claim that this approach can do any more than shed a little light on how a given approach is taken or technology is adopted. Despite this, I believe that if a researcher understands how the factors involved in the adoption of a new technology interact, then it is possible to affect the outcome by assisting favourable interactions and doing one's best to reduce unfavourable interactions.

A full discussion of Actor-Network Theory (ANT) is presented in Chapter 5 of the thesis. This is a brief introduction about the approach taken to use ANT as an analytical tool in this study. Rather than recognising in advance the essence of humans and of social organisations and distinguishing their actions from the inanimate behaviour of technological and natural objects, Actor-Network Theory (ANT) (Latour, Mauguin et al. 1992 :56) adopts an anti-essentialist position in which it rejects there being some difference in essence between humans and non-humans. ANT considers both social and technical determinism to be flawed and proposes instead a socio-technical account (Callon and Latour 1981; Latour 1986; Law and Callon 1988), in which neither social nor technical positions are privileged. To address the need to properly consider the contributions of both human and non-human actors, actor-network theory attempts impartiality towards all actors in consideration, whether human or non-human, and makes no distinction in approach between the social, the natural and the technological (Callon 1986).

When utilising an ANT approach, the research begins by identifying the relevant actors and then looking for their interactions. Actor-network theory identifies two types of actors: human and non-human, but does not treat them with different weights, human actors are observed and interviewed in the normal way. Non-human actors can be 'interviewed' by asking humans about them, by collecting written materials and by observing other actors negotiate with them (Tatnall 2007). Figure 3-13 above, shows the beginning of the process of identifying the actors. The Mindmapper software tool was used to create this model and was updated throughout the research process.

3.8 A VIRTUAL COMMUNITY OF SCHOOLS CATERING FOR STUDENTS WITH LD

A *community* can be seen as a group of people having something in common (Oxford 1973), and this is certainly true of special schools which have in common the education of children with some form of learning disability (Adam, Rigoni et al. 2006). A *virtual community*, on the other hand, is also a group of people who share a common interest or goal, but who do not meet physically, but communicate and relate to each other by some other means, principally the Internet (Matathia 1998; Schneider and Perry 2001 :10).

One example of a virtual community (Lepa 2002; Lepa and Tatnall 2006) is the group of Australian retired people who use the GreyPath Village. This provides for chat facilities, sharing a common bond of ageing (Bosler 2001). Matathia (1998 :156) suggests that these on-line relationships can be every bit as strong and permanent as their 'real world' counterparts.

No school works alone and primary and secondary schools in Australia often form cluster communities with their local counterparts to consider issues such as student welfare, school management and implementing curriculum. All types of schools form part of the broad community in any city and schools themselves form a series of communities within this community. Special schools, however, at present do not see that they have much in common with local mainstream schools and have little interest in forming community grouping with them. Perhaps ICT provides the answer as ICT offers students the capacity to construct their own learning experiences and this applies also to students with Learning Difficulties. Technology can assist students with LD and research with the virtual community has demonstrated how relationships can be fostered through the use of ICT and Internet-based technologies. Perhaps this technology can also assist special schools to form community groupings and particularly of grouping consisting of other special schools and educational institutions offering support to students with special needs.

Special schools, however, often do not feel that they fit into these local communities (Adam & Tatnall 2007). For instance, one special school I worked with found very little in common with the local primary school a few hundred metres away and set up a working relationship instead with two other special schools, the nearest of which was about 15 kilometres distant. Another special school developed close links with the special school in a major hospital some distance away.

One group of special schools are located in major metropolitan hospitals where the Education Unit has a responsibility in caring for the special educational needs of children both while they are in hospital and also when they return home but are not yet ready to go back to their normal school. A typical example here is a child who might be in hospital for a week, but then at home, unable to attend school, for several months. Although the needs of these children are a little different from those with other learning disabilities, schools of this type find a great deal in common with other special schools. (Annual Report Royal Children's Hospital 2006)

I was interested in exploring the links for several special schools in Melbourne, including two hospital schools, in a project to create a virtual community to further their educational aims and support LD students. To some extent these schools already formed a virtual community, but not an online one. As a degree of communication already existed what was needed was some means of enhancing the communication to form a true virtual community. The aim of the project was to set up a web portal to achieve these ends and it was envisaged that the portal's design would enable the warehousing of relevant information and also provide links to many other relevant sites. It would also facilitate communication by use of chat room facilities, bulletin boards and the like as well as providing some access to e-learning facilities. This would be supported by the use of e-mail in conjunction with web cams located at each institution.

The idea was that this virtual community was initially just to share experiences, ideas and teaching resources. At a later time it was to be extended to include the students and the parent community and be used to facilitate learning by creating an environment using ICT to enable the communication of students through videos, email and other suitable programs for students of peer group ability and function. The main question that was proposed was:

Could the e-learning paradigm be extended to include a virtual community?

In their teaching and learning model, Schunck and Nielsson (2001) clearly intended that the Knowledge Base be accessed (at least partially) over the Web, but I was also interested to find answers to the following additional questions:

Could the teacher and students also interact in this way?

Could a teacher from one special school interact in this way with students from another School?

Could students from one special school interact with students from another?

A suitable infrastructure based on communication and access to information via a web portal offers a good means to sustain this virtual community. The portal is not of course the only means by which the community is sustained, as personal and telephone contact may continue and could still have a place into the future. The difference is that while personal contact is difficult given the distance between community members, contact via the Internet has no such problems.

3.9 A NOTE ON THE VICTORIAN GOVERNMENT'S INNOVATION PROJECT FOR ICT- THE ULTRANET

In the past there was no official program sponsored by the Victorian Education Department to facilitate virtual communities of special schools like the one that I have discussed in this study, but hopefully this may soon come with the introduction of the Ultranet (2010).

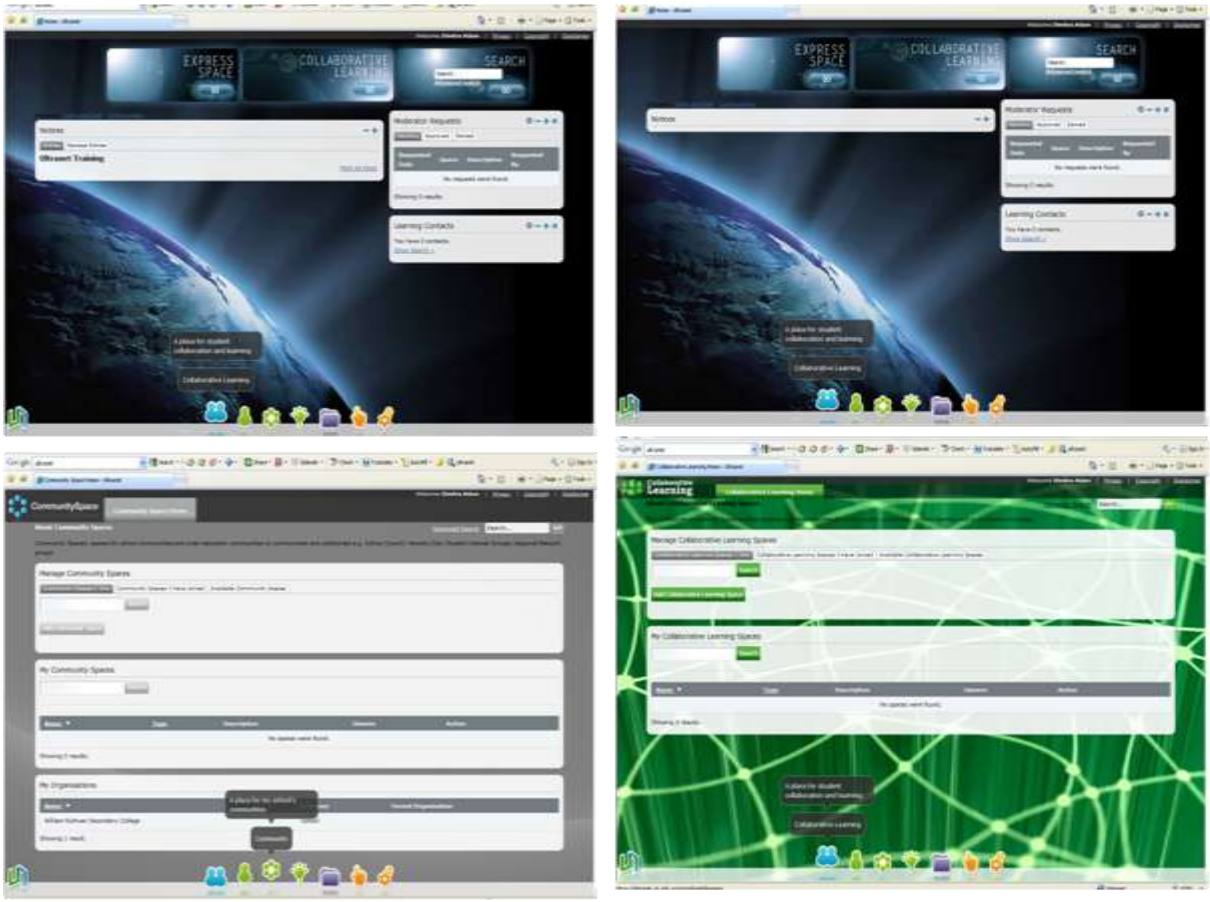


Figure 3-14: Ultranet (Source: ultranet.vic.edu.au)

(https://ultranet.vic.edu.au/portal)

Figure 3-14 illustrates the main areas of the Ultranet which are Collaborative learning, Express space, Community, Design, Content, Actions and Utilities.

The Ultranet is a student centred electronic learning environment that supports high quality learning and teaching, connects students, teachers and parents and enables efficient knowledge transfer. It will establish a schools environment for the future that improves the educational outcomes of all Victorians.

The objectives of the Ultranet are to:

- improve responsiveness to individual learning needs
- provide better information to parents, the school system and Government
- improve efficiency of the learning environment and school administration
- adopt an enterprise approach to intranet development

- exploit previous ICT investments

Key benefits of the Ultranet to the community include:

- establish a school environment for the future
- improve the educational outcomes of Victorians
- reduce the administrative burden on teachers and school leaders
- reduce the future cost of education
- improve educational opportunities for regional, rural and remote Victorians (ULTRANET 2010).

3.10 OTHER RELATED PROJECTS – THE EXPLORATION OF A VIRTUAL COMMUNITY OF SPECIAL SCHOOLS & 121 PROJECT

As part of a collaborative project, the aim of the research project was to set up an environment using the Internet and ICT to enable the communication of students through videos, email, and other suitable programs for students of peer group ability and function in 121 Project. There was a growing interest to set up a virtual community between the schools and expand this further to include an overseas school from Hong Kong. There was also interest in involving TAFE, the Royal Children's Hospital (RCH) Educational Institute and some other organisations. This is discussed further in Section 3.13, page 85.

3.10.1 Background to the Project

The research involved a pilot study of a group of students in the upper secondary (Transition) group in outer metropolitan area of Melbourne. The pilot study focused on curriculum design and the issues associated with this for a special 'thinking curriculum'. The school population was approximately 250, which included students from lower primary to upper secondary age groups. The school catered for students with mild disabilities and it had a technology-based focus. This was recognised as one of the strengths of the school curriculum. The research goal was to find out how technology can be used to establish and/or increase engagement (and thus improve student learning outcomes) for LD students. The desired outcome was to develop a plausible model of technology implementation (hardware and software) to achieve the desired result of increased student engagement and improved learning outcomes. This involved:

- The study of learning models and understanding how students learn as well as the study of teacher paradigms.
- Establishing a technology skills matrix and developing an appropriate teaching/learning model that marries with the skills matrix. The matrix was developed in two parts – thinking/learning skills and technology skills. The skills matrix included such things as problem solving and communication skills (for example). The study analysed what skills might be included in the skills matrix – in reference to 'learning to learn' / 'thinking curriculum' pedagogy.
- The model was then tested via its application in a learning environment and applied appropriate measures. This involved setting criteria for measurement. This part of the study examined whether the application of technology led to students meeting the expected learning outcomes.

The following were the overarching questions for the project:

To what extent can technology be integrated into the curriculum?

How can we harness technology to enhance learning?

How can technology support the VCAL and CTE module learning outcomes?

How can we increase student participation in the 'virtual (global) community'?

The role of the teacher was an 'action learner', and became skilled in the use and application of ITC and then trained other teachers.

Figure 3-15 below, shows my early modelling attempts in the research study. It shows that consideration was needed to determine an appropriate skills and technology matrix so that the learning outcomes could be observed and analysed during different phases in the study. The Skills Matrix was an important component in this study and its design will be discussed in Chapter 6.

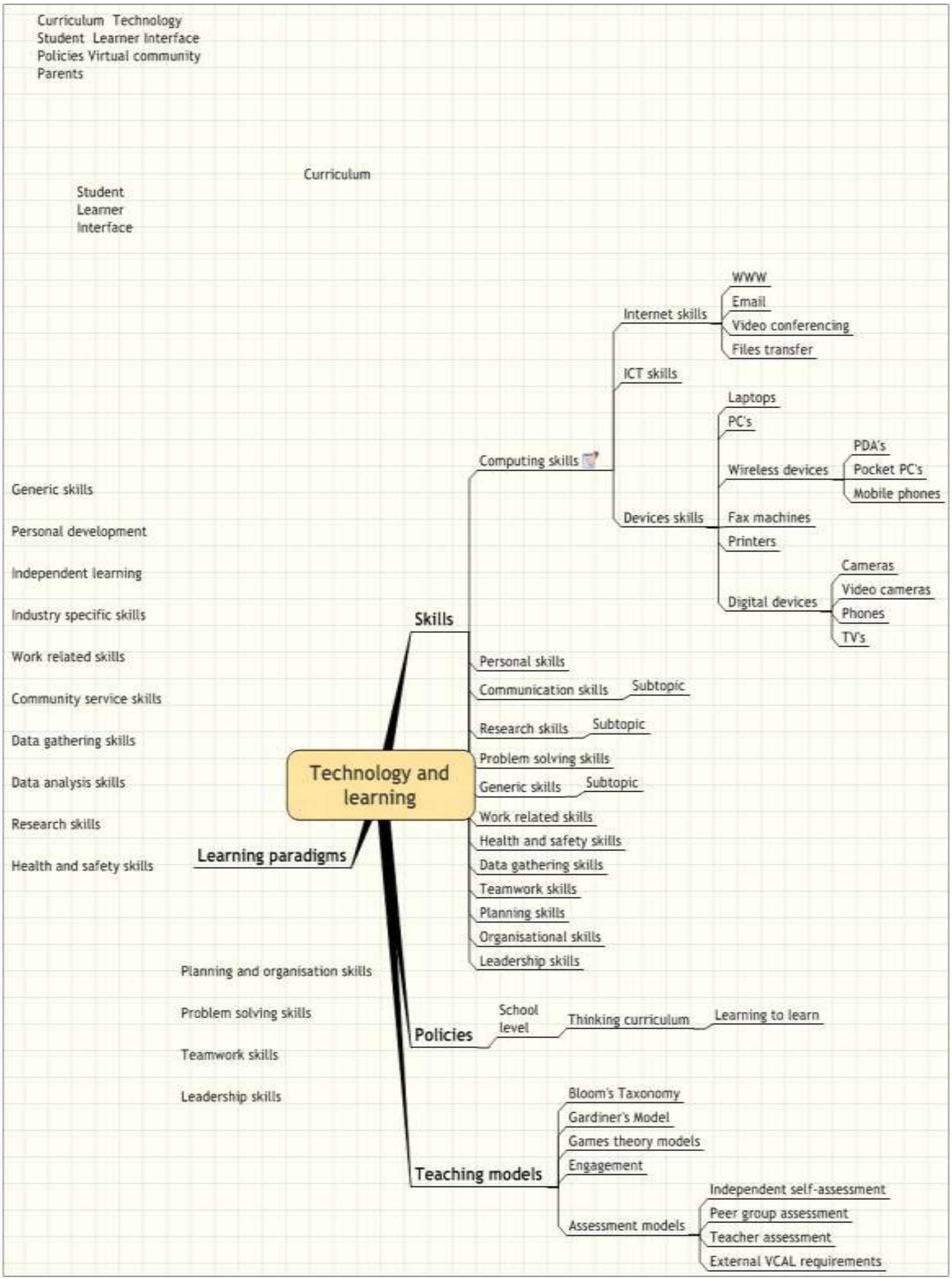


Figure 3-15: Teaching, Learning, Skills & Technology

The following data were to be tracked to demonstrate that investment in establishing a 121 Learning Environments has contributed to improved student learning outcomes:

- Number of students attaining VCAL Certificate, completing unit requirements
- Student self-assessment – reporting on use of ICT in own learning
- Teacher assessment – running records of tasks completed by individuals and class, ICT employed by teacher and students
- Tracking Internet sites accessed
- Parent and student opinion surveys – internal and external (benchmarks)
- Engagement – tracking incident reports, level of behavioural issues, absentee rates
- Development of student digital portfolios for demonstration night.
- Demonstration classes/open classroom for members of the school community to see 121 in action.

The anticipated outcomes included the following: increased student engagement, increased opportunities for students to participate in learning that contributes to competency based assessment, increased opportunities for students to produce high quality work independently, completion of core work on line, and the capacity to complete required assessment tasks as defined by the Victorian Qualifications Authority in respect to VCAL Certification. Further details on the 121 ICT Project can be found in Chapters 6 and 7, and in Appendix B of the thesis.

3.11 A BRIEF WORD ON METHODOLOGY AND DATA COLLECTION

The project required the establishment of a pilot 121 Learning Classroom and the provision of a laptop computer to each student and teacher and a Smart Board to the pilot class. It was necessary to consult with technology staff regarding purchase, installation and training of teachers and students in the use of this new technology. The 121 Learning required a partnership between teaching and technology staff, with technology staff advising and assisting teachers with the integration of ICT into a 121 Learning Environment involving fully integrating technology. Student progress was tracked via the production of technology-based work, the digital portfolio. Further details on the research design and methodology are presented in Chapters 5 and 6 of the thesis.

3.12 THE 'THINKING CURRICULUM' – ANOTHER TEACHING PARADIGM?

The 'Thinking Curriculum'[27] or 'learning to learn' pedagogy requires students learning programs to be personalised, meaning that student learning is student-driven. Learning to learn and understanding how one learns is a critical part of personalised learning pedagogy. ICT offers students an increased capacity to construct their own learning experiences. Technology can assist students with LD and research with the virtual community has demonstrated how the relationships are fostered through the use of ICT and Internet-based technologies. The outcome of the research is a suitable learning model that incorporates technology and human factors in the development of skills and knowledge of students with LD. This research has added to the work that was carried out earlier in the national project in 2000 for this important and vital virtual community.

The two case studies in this thesis will provide evidence about contribution that ICT makes in the special needs area. The power of ICT to include all types of learners and its intrinsic capacity to provide the framework for engagement has been explored further due to the ever changing and rapidly evolving tools and standards in the Web, as well as social networking, utilisation and applications. The thesis explored both early and recent approaches of ICT integration into the curriculum for LD students. The results and conclusions from the study are presented in Chapters 7 and 9.

3.13 LINKING WITH OTHER RESEARCH ACTIVITIES - MULTIMEDIA VICTORIA PROJECT WITH RCH'S SPECIAL EDUCATION UNIT AND NMIT TAFE

In my research I investigated other potential projects in trying to identify LD learning programs. An important discovery was the fact that Royal Children's Hospital (RCH) provides a service for students who are out of a classroom due to medical reasons with the aim of maintaining their learning activities as much as possible by providing links to their home and school. What was useful here was that the learning activity covered students from the entire State.

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[27] Thinking curriculum – from De Bono and later from Lane Clark (2005) - this pedagogy was adopted at Concord where I participated in the 121 project.

A team of main actors who were involved were Peter, Tony, Arthur, and Tas (26 July 2005). The main operational characteristics were discussed by the team members with Peter and Tony. The main service model was also discussed and provided a link between school and home for students with disabilities or special needs. Figure 3-16 below)

Under this model, students could visit the hospital on average of 3-4 days per visit, but they might have spent three to six months at home. The Special Education Unit provided the technological support for the students and their families through a network facility over the Internet and a suitable medium so that they could communicate with the school and keep up-to-date with the school activities and other learning assessment requirements.

Tony explained the hardware and software platform that they have set up. They used Linux with Apache to operate the GNU software called Montana (open source e-learning platform). They also experimented with Moodle that is open-source software for LMSs. This selection was based on the most cost effective manner to provide a technology and a learning platform for the particular group of students.

The group further discussed the terminology or reference to special needs or LD. It became apparent that LD is incorporated a wider group of students – beyond special disabilities. For example, it included country students who were engaged with both school and home duties, as well as students who stayed in the hospital with a significant period as inpatients.

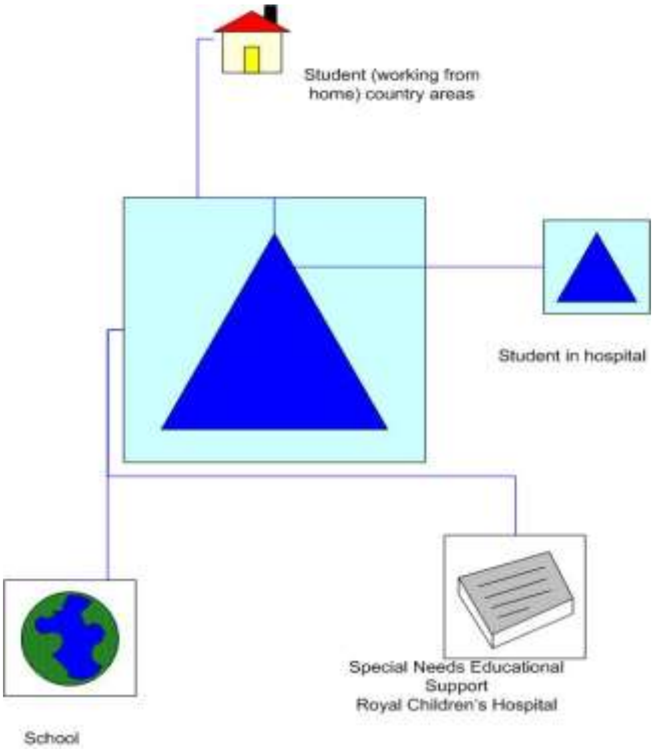

Figure 3-16: Royal Children's Hospital Special Education Unit Support Model

It was explained that hardware resources was not an issue as the students were accommodated with a Personal Computer (PC) or Laptop through a DEET fund. In fact, Multimedia Victoria provided the funds for setting up support for VCE students with internet connection and other resources. The main software platform that was used was the open-source software program called Montana. It should be noted that under this support model, the school provides the curriculum for each student, whilst RCH provides the link and support between student and school. This was made possible through a three year contract with the Education Department where the unit received grants to deliver the necessary services. It was noted that on average they supported 1500 students per year, (Government 70%, Catholic 20% and Independent 10%) RCH Annual Report (2006)).

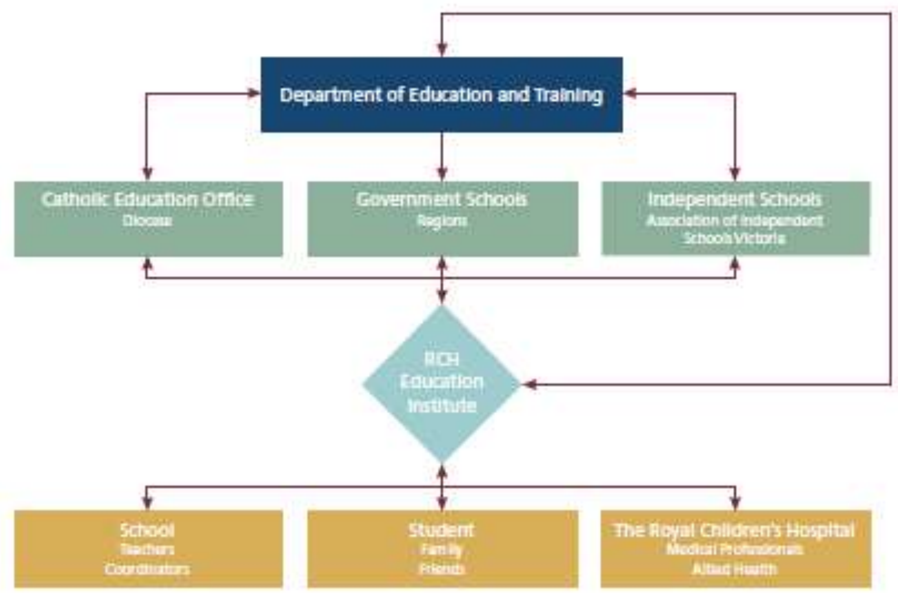

Figure 3-17: DEET & RCH Education Institute Links

Vic Net provides support through its My Connected Community project (MC^2), to groups working through the virtual community links. They provide access to community groups to enable them to communicate in a more effective manner and to become aware and also participate with online services through the Internet. Figure 3-17 above, demonstrates the link between RCH's Education Institute and other educational sectors. (Courtesy: RCH)

The project at RCH was discussed previously by Elkins et al. (2000) where the Unit was referred to as the "Royal Children's Hospital Learning Difficulties Centre" and this provided support for literacy and numeracy (the Centre reported that less than 10% of its students had numeracy difficulties; this proportion was considerably less than the proportions reported for literacy) (Jones et al. 2008) It should be noted that further research is being undertaken at this present time by Potas & Jones (2008).

From an ANT perspective, I was able to identify several key actors in this study and discussed possible future research collaboration. One of the actors was identified early in the research field in 2002, and I finally had the chance to meet with him in 2005. This was important to me as he was an early pioneer in adoption and innovation of ICT in Victorian Schools and a leading actor who had instigated policy for e-learning, which will be discussed below.

3.14 EARLY RESEARCH ON INFRASTRUCTURE

3.14.1 Infrastructure

Funding was provided for research on the infrastructure of the special schools from the School of Information Systems, Victoria University, in 2005. The research project investigated issues relating to infrastructure for the adoption of ICT to enhance the learning outcomes of the virtual community- namely, students with special needs. The research involved setting up an environment using ICTs to facilitate the communication of students through videoconferencing, email and other suitable programs for students of peer group cognitive ability or function.

The significance of the infrastructure is discussed in a study by Cordella (2008). Issues regarding the adoption of ICT in this environment have been discussed earlier in the dissertation and have been accounted by Bates et al. (2007). Other studies concerning the infrastructure were reported by Moyle (2005) and Shaddock (2007). The OECD (2005) report and the study by UNESCO (2004) as well as Strydom & Thompson (2005), reported that access to computers was limited and this had an impact on the integration of ICT in the curriculum. The key areas of concern were lack of computer rooms and scarcity of facilities (reported by 81% of the participating schools in the study for South African Schools for the Intel@tech into the future) and time constraints, for example one lesson per month for integrated technology lessons, which was an issue in rural areas.

A study by Cohen (2003) reported that most the fundamental use of computers was made by the school administration. The main findings of concern were: lack of technical support (35%); lack of suitable software (48%); lack of admin support (43%); lack of Internet connection (44%); and lack of preparation time (37%). Learners responded positively to ICT integrated lessons. Most benefits from ICT integrated lessons were identified with: high motivation (94%), feedback (90%) and collaborative environment (the rest). In general, the educators summarised the main issues according to the following: the number of supply of computers (67%, scheduling issues (lessons disrupted) (62%), inadequate computing skills by learners (61%) and time tabling difficulties for sufficient access (59%).

Obviously these results identified infrastructure issues that inhibited the proper integration and adoption of ICT in South African schools. The infrastructure plays a significant part and it affects the learner's activities. Although policy developments aim to support ICT in schools (with evidence of positive effects) it has been reported that digital technologies are not widely used for students with disabilities in the main stream. The main reasons are inadequate infrastructure and technology, limited teacher confidence, and pedagogical approaches that should be adapted to foster teaching and learning (Shaddock 2007). Cuttance provides an argument in the IBPP[28] project for the development of an infrastructure to support students to access resources, programs and knowledge (DETYA 2001b).

The UNESCO report by Alexey Semenov (2005) describes the following main elements of infrastructure for the introduction of ICT and support: The report noted that the presence of enthusiastic teachers, together with the installation of hardware and software, add little, if support is not present. The introduction of ICT requires establishing and coordinating an entire infrastructure of support. In addition, the report highlights the fact that the infrastructure should be multifunctional and includes:

"technical and organizational support, being educational and multilayered in the school, being present in teachers' and students' homes, being present in local resource centres and teacher clubs, universities, technology providers, national clearing houses, R&D institutions, international communities and organizations" (Semenov 2005, p 189).

In fact, Cuttance in "*Beyond infrastructure to the enhancement of technology and learning*" recommends design of school infrastructure, the structure of curriculum, time space and technologies to support the school vision and agreed conceptualisation of the pedagogy (Cuttance 2001). *The Thinking Curriculum* pedagogy at Concord provides strong evidence of the relationship between infrastructure and successful ICT adoption.

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[28] IBPP The Innovation and Best Practice Project- was one of the first large scale research and development projects that focused on innovation in schools, and one of the largest educational research projects undertaken in Australia. (Cuttance 2001)

The literature identified infrastructure, integration of ICT, leadership, administration of ICT and professional staff development, all play a key part in the successful adoption of ICT in education. These areas will be reviewed later when recommendations and the final e-learning model for LD are presented in this dissertation.

In a study by Trinidad & Newhouse (2002), a school plan was proposed for the provision of the ICT infrastructure and policy. The plan also included curriculum development and teacher professional development and support through a four stage approach. Other studies that have examined the infrastructure include a study from Thailand where the implications for school management, teaching and learning and policy were investigated (Rumpagaporn 2007).

The e-learning model that was introduced by Schunck (2001) relies on robust infrastructure. The model allows students to engage (work independently) and have a positive attitude towards ICT and themselves. It also promotes active and autonomous learning through the use of ICT. The teacher provides assistance, advice and suggestions to help students make decisions and seek the information for learning tasks or assignments. The role of the teacher is to facilitate the resources whose access is enabled and managed via the infrastructure (Moyle 2005, Adam et al. 2003, 2007).

A recent study by Meiers (2009) listed the MCEETYA (2007) assessment frameworks comprising the following six key processes: a*ccessing information, managing information, evaluating ICT solutions, developing new understandings, communicating with others, and using ICT* (MCEETYA 2007).

Moreover, according to a survey of Year 10 students, 67% achieved the proficient standard and in year 6, 49% of students achieved the proficient standard. These results suggested that students used ICT in limited ways. Specifically the main point that was highlighted was that:

> *"within each Year level there are differences associated with socioeconomic background, Indigenous status and remote geographic locations*" (MCEETYA 2007).

The latter point highlights the significance of infrastructure for the successful implementation of ICT in education. According to Moyle (2005) infrastructure of schools is an important element as it must support the wider school community, including administrators. It is important to analyse the human infrastructure of schools, so that we can identify fine teaching and effective leadership as these are important factors that affect student learning outcomes. In addition, we must also investigate the organisational structure to evaluate the strategic plans, the visions and directions of the learning communities, as well as the physical computing infrastructure. The physical infrastructure refers to buildings and classrooms as well as the necessary hardware and local and wide area networks that facilitate the interconnectivity of learners within schools, between schools, and schools their communities in a collaborative way. Further discussion on infrastructure is presented in the thesis in Chapter 5.

3.15 LEARNING OBJECTS & ICT

Freebody et al. (2005) provided an analysis of the impact of ICT in the digital age for Australia and New Zealand and discussed the role and significance of Learning Objects[29] with respect to ICT adoption in education. The significance of Learning Objects was investigated in this thesis through an interview of one of the leading actors. His view was that Learning Objects did not provide the architecture and framework to teachers and students as was envisaged in the national MCEETYA (2001) policy. In general, the key findings from research studies in regard to ICT in the digital age include the following:

- Teacher capacity and willingness to use ICT in class is variable. (Triantafillou 2007)
- The ICT learning objects were not universally adopted (Maths, Science, English)
- Students may access ICT technologies both at home and school and students' use of ICT is dependent on factors such as the environment, leadership and management and integration of ICT in the curriculum (Moyle 2005).

[29] Learning Object - see Glossary for an explanation of this specific learning object in ICT.

Many studies, including the present one, have observed that ICT improves student engagement, supports learning in a variety of ways and is both a tool and process for new ways of thinking and learning. The power of simulations and games played in the early years of computing, provided a shift into thinking about teaching and learning processes, and the more recent digital era has forced educators to work with more natural processes that facilitate communication and learning via social networking (Pillay 2000, Lee & Lan 2007). The next section provides a historical development of Integrated Learning Systems (ILSs), Learning Management Systems (LMSs), and e-learning models and policies that have been applied in local and global educational settings.

3.16 HISTORICAL DEVELOPMENT OF LMS ANALYSIS AND ICT INFRASTRUCTURE

3.16.1 Evolution of Technologies to Support Teaching and Learning

In order to provide a clear picture and follow through the development of education technologies, it is appropriate to examine the role and significance of "Integrated Learning Systems" (ILS) and "Learning Management Systems" (LMS). The literature provided various studies[30] and this section has drawn information from studies including Underwood (1994), Hedley (2004), Becta (2008), Florian et al. (2004), UNESCO (2004), Maddux & Willis (1992) and Somekh (2008). The definition of an ILS is given in Brown (1997) and is as follows:

> *"An ILS is a computer-based system that manages the delivery of curriculum materials to pupils so that they are presented with individual programmes of work over a number of weeks and months. It has three main components to facilitate the management of learning by teachers:*
>
> - *Curriculum content: this comprises an extensive range of tutorial, practice and assessment modules for a substantial part of a pupil's curriculum with coverage across a range of curriculum subjects and levels of ability.*

---

30 There are also studies from Australia that have reported on ILSs, for example Baturo et al. (1999). According to the Deakin report by Blackmore et al. (2003), the attitudes and views of Australian teachers for the use of ILSs appeared to be similar to those from overseas.

- *A pupil record system: this maintains information on every pupil and records pupils levels of achievement.*
- *A management system: this links and controls the flow of data”* (Brown 1997, p7).

Underwood (1997) argues that the fundamental difference between an ILS and a tutoring package is the management system of the ILS. A study by Hedley (2004) explored the effects on learning and self-esteem and examined the advantages and disadvantages of ILSs as well as the implications for teachers in schools. I have reviewed these and presented the main findings in the sections that follow.

Becker (1994) conducted meta-analysis of several studies examining the impact of ILS on learning outcomes and found that ILS had only moderate effects on student achievement. It should be noted that the studies were conducted in USA elementary schools using vendors’ ILS software.

3.16.2 General Views on Benefits & Problems of ILSs

Case studies from the UK (Carter Community Sports College) have shown that many students do benefit from working on ILSs, for example, reading and spelling skills. The studies presented an argument for the cost per student per year after the system was put in place. This was reported to be significantly lower than the cost of most other reading intervention schemes. Thus ILSs can support a teacher led intervention for LD by facilitating a collaborative learning environment (Florian & Hegarty 2004, Lewis 1999, and Hedley 2004). Hedley argued that these are expensive to buy and set-up and since they do not run themselves they need ongoing monitoring and necessary intervention. Therefore, they add to the overall cost and they do not suit all students, as schools must not rely on ILS to solve all students’ learning difficulties. This comes about because the school day is limited and time needs to be devoted to things other than ILSs. In addition, teachers need to ensure that these are used effectively and in efficient manner. Other techniques may be more effective for example literacy Hedley (2004), Maddux & Willis (1992), and Jervis (2005)).

3.16.3 Implications for Teachers Using ILSs

In examining the implications for teachers, one needs to consider the frequency that the students leave class to go to ILS and the level of disruption by this action. ILSs can provide rich information about the student's strengths and weaknesses which in turn can help teachers with their planning and preparation. Teachers however, may need to manage the ILS for their group of students. The ILS fosters learning and not the technology. All teachers should be aware of how to use the software platform in a proper manner to derive the desired benefits. In concluding, Hedley states that we should make sure that the ILS is properly set in place and configured to support the learning. The students need frequent access for short time intervals and this may result in time-tabling implications and a complicated situation with withdrawals and class management (Hedley 2004).

Studies by Jervis and Gkolia (2005) from the UK identified that the most significant issues with the use of ILSs were administrative problems, like management decisions, implementation and technical problems with the software. The teachers expressed the view that lack of uniform software standards which were to be linked with the national curriculum standards was a significant reason for the abandonment of the platform. In addition, licensing costs and technical support were viewed as a regular problem as well as the lack of students' motivation. The following is a quote from the study and it reflects the teachers' sentiments about ILSs:

> *"(The new software) is more about troubleshooting in terms of the concept rather than the software, (it) does not just give you the answer...it gives you the whole mathematical solution and even so they sometimes need detailed explanation while with (the ILS) you spend most of the time going around trying to get people logged on and by the end of the lesson you've finally got everybody logged on and started and then* (*the time runs out)"* (Jervis et al. 2005**).**

According to Vygotsky (1978), pedagogy is defined as the interactive process by which a student's learning is mediated by teachers using a range of tools. The tools consist of conceptual frameworks, artefacts, books, computers and language resources. The main challenge for the designers is how to create technology and ICT for people with LD in order to support language and apply the right pedagogy for this group of students.

Although user agents with adaptive technologies were used in the 90s (Zyjicek & Powell 1997), we need to use functional categories and focus on what web developers should know. Several studies (Patel 1998, Gosper 2007, Standen & Brown 2004, Blamires 1998, and Fischer 2008) highlight the challenge to adopt ICT into the classroom of students with special needs in one form or another, like virtual reality, games simulations and numeracy, as well as literacy reinforcement. Limi & Whiting contend that we need to consider cognitive development, special browsers to facilitate vision, hearing and document structure for LD students (Limi & Whiting 2006).

3.17 INTRODUCTION TO E-LEARNING MODELS

The main area that the present study is particularly concerned with is an examination of e-learning models and their evolution. The remainder of the chapter explores these models and the more recent technologies such as Web 2.0. Although recent studies by Englebrecht (2003) and Mayes & Freitas (2009) do provide sufficient material on e-learning models, there were very few models available in the early phase of the study. Consequently, I was influenced by the models on e-learning in the early 2000s by Sharda (2001) and Schunck & Nielsson (2001). The latter was presented to relevant teachers and Principals at Macedon and Concord. It was accepted and used as an instrument to evaluate their students' ICT skills and knowledge.

3.17.1 What is E-Learning?

E-Learning refers to learning that is delivered or enabled via electronic technology. It encompasses learning delivered via a range of technologies such as the internet, TV, video, intelligent tutoring systems and computer-based training. It needs to be considered as an integral part of a complete learning environment or curriculum (www.eduworks.com 2002, ITIRA 2002).

3.17.2 E-Learning Systems

These are facilitated through high speed internet access and the availability and power of personal computing platforms which have dramatically increased the opportunities for the use of collaborative environments. Figure 3-18 shows various LMS products that have been tried and their limitations are quite significant, especially for students with learning difficulties. It was evident early in the research phase that a significant customisation was required for LMS and other learning platforms for LD students. One of those was the product that was used by Northern Metropolitan Institute of TAFE[31] (NMIT), called “The World of Equity Toolbox”. Figures 3-18 and 3-19 show the main menu that is accessed by the students. This provides adaptive features such as customised menus, large fonts, and easy and user-friendly navigation from screen to screen to learn about the main areas such as communication.

Anlon (Corporate/ Academic)	www.superioredge.com/	Anlon, is an enterprise-level, web-based software with the attributes of a LMS (Learning Management System) and a LCMS (Learning Content Management System) that enables organizations to migrate, develop, deliver and manage e-learning and courses over the Internet, in time frames measured in hours and days, rather than the months and years required to deploy traditional e-learning systems purchased by superior edge.
Angel	angellearning.com/	Angel LMS provides a complete set of easy-to-use teaching and learning features that are open to adaptation. ANGEL's openness allows faculty and information technology professionals to focus on delivering real value. It allows the enterprise to control the capabilities it delivers to its users and add the learning content, resources, and technologies that best fit its users' needs.
Asymetrix Toolbook	www.asymetrix.com/	Now click2learn Toolbook
Blackboard	www.blackboard.com/	Blackboard is a course creation service that enables teachers to add an online component to traditional classes or teach an entire course on the Web. You can quickly and easily create your own course website to bring your learning materials, class discussions, and tests online. Blackboard offers a complete suite of enterprise software products and services that power e-Education programs in our primary markets “Higher Education, K-12, Corporate/Government and International. Blackboard solutions deliver the promise of the Internet for online teaching and learning, campus communities, campus commerce services, and integration of Web-enabled student services and back office systems.
Centra 7	www.centra.com/	Saba Completes Acquisition of Centra Software. Centra 7 is application software that enables online business collaboration, communication and learning. Organizations can share and exchange information and ideas with customers, partners, prospects and employees around the world in real-time. Centra 7 increases productivity and efficiency by helping you automate entire business processes online.
click2learn Toolbook	home.click2learn.com/en/toolbook/index.asp	Formerly Asymetrix Toolbook, this web course development toolkit that can be used in conjunction with (or independently of) the same company's Aspen Enterprise Learning Platform - aimed at the corporate knowledge development/learning/sharing market.
Cobent	www.cobent.com/	Cobent is a leading innovator of platforms for online learning, content and training management - allowing organisations every day to capture knowledge and obtain greater control of information.

31 TAFE: Technical and Further Education

FirstClass	www.centrinity.com/index.shtml	FirstClass is a cost-effective, highly scalable, feature-rich messaging and communications solution for schools and school districts, learning organizations and businesses. At the foundation of our award-winning FirstClass Communications Platform is our Collaborative Groupware, which provides our users with the ability to effectively communicate and share valuable resources and information via email, conferencing, directories, individual and shared calendars and online chats. FirstClass has been used by thousands of organizations to create powerful online electronic communities that enable individuals and groups of people to work more effectively.
WebCT	webct.com/	WebCT, Inc. is the world's leading provider of e-Learning solutions for higher education.
Moodle	moodle.org/	Moodle is a software package for producing internet-based courses and web sites. Moodle is a free, open source learning management system designed to support collaborative, social constructionist pedagogy for students, teachers and developers.

Figure 3-18: Survey of LMSs

Figure 3-19: The World of Work Equity Main Entry (Courtesy: NMIT)

Figure 3-20: The World of Work Main Activities Menu

3.17.3 Technology Infrastructure

From the early stages of e-learning models, the designers were mindful of the fact that in order to have an effective implementation, it was essential to have a clear understanding of how e-learning would support the overall learning objectives. Therefore, it was necessary to put in place the infrastructure that would support the demands of the e-learning community or platform. The infrastructure must further support availability, scalability, be open and stable, and also provide adequate security to protect the users and content. One of the early models was that proposed by Sun Microsystems and this is shown in Figure 3-21. It shows the logical layers and the main constituents like the portal and the e-Learning Service Tier (or Layer) of the model. This provided the framework for the design and implementation of subsequent e-Learning platforms (Eduworks Corporation 2002).

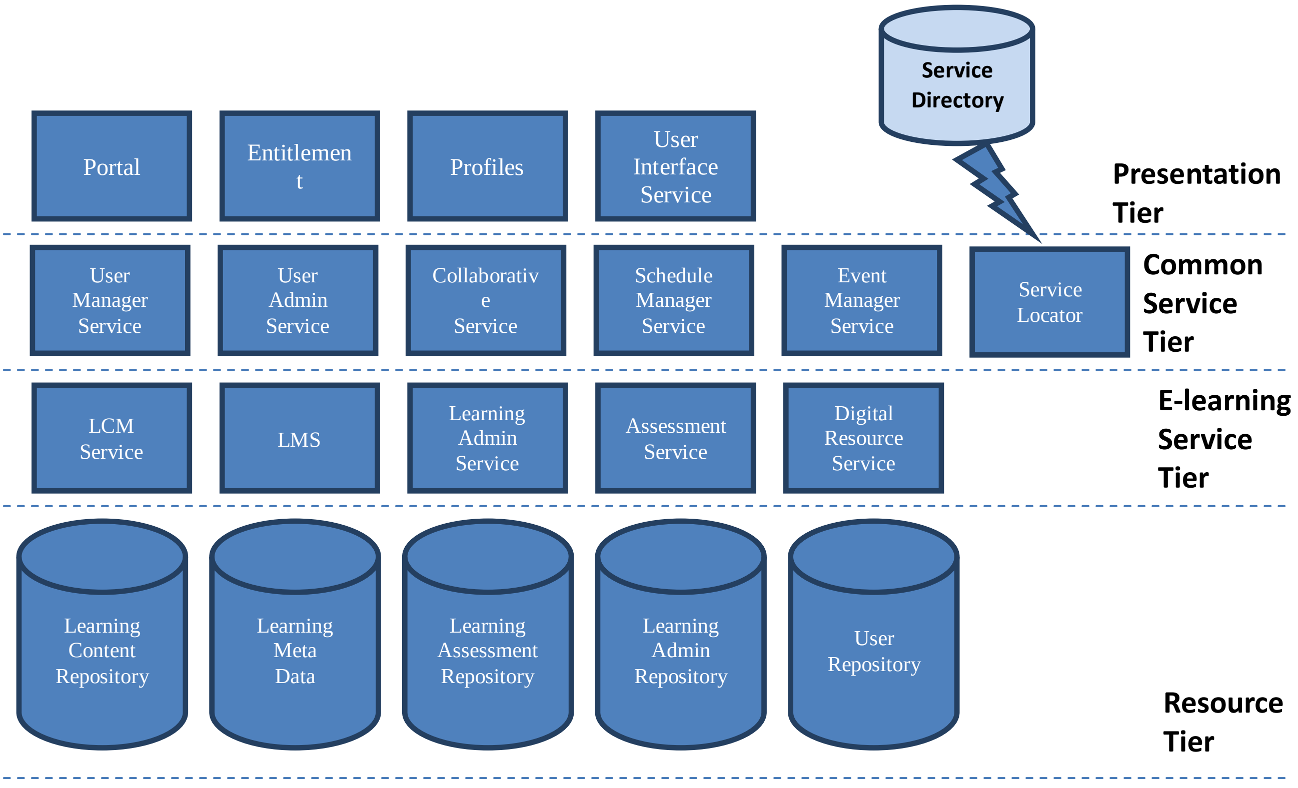


Figure 3-21: e-Learning Framework (Eduworks Corporation 2002)

3.17.4 Virtual Classroom & Collaboration Tools

Virtual classrooms are designed to provide asynchronous tools for learners to interface and interact with the instructors or teachers. These can be accessed via portals or gateways and are limited to a community or group of users over the internet. One of the early systems was CENTRA that was adopted by some organisations and institutions for their training. This is available on several operating system platforms and it can be used by both instructor and learner. Another virtual classroom is provided through Elluminator, where access is relatively easier with synchronous tools. This is more suitable for secondary schools and was used at Concord. This assisted the school in setting up its first conference in 2008.

3.17.5 E-Learning Action Plans

3.17.5.1 Local Scene

The Victorian Education Department introduced a policy that encouraged schools to develop their own individual technology or e-learning plan in the early 2000s (DEET 2001). The policy provided recommendations for an e-learning vision/plan. The aims of the e-learning vision covered the following main areas:

- Foster significant learning improvements, using the most advanced and proven educational techniques.
- Provide present and future students with the information and communication technology skills they will require as employees in a knowledge-based economy.
- Facilitate collaborative learning experiences among teachers and students through electronically based educational projects.
- Develop staff professionally by informing them of opportunities:
    - *Presented by eLearning, and*
    - *For professional development courses to improve their skills* (DEET 2001).

The policy provided guidelines to schools on how to approach digital literacy, set up e-learning plans, provide professional development for teachers, provide resources throughout the classrooms and emphasised the support for life-long learning. In addition, the policy also provided "SafetyNet guidelines" for teachers and students so that the safe use of the internet would be encouraged and followed (Softweb[32]). This

[32] Sofweb was the support group for educational hardware and software for Victorian schools. Website access: http://www.sofweb.vic.edu.au/internet/takecare.htm/ accessed on August 2005

policy endorsed the DEET (1999) findings for engagement, interaction and thinking for students in schools and also the ten learning qualities which were to be applied to higher order learning elements. Several of these included creativity, construction, adaptability, collaboration, autonomy and reflexivity. The main considerations on the research about thinking and learning were linked to student-centred learning, the provision of better learning frameworks and enhancement of the learning outcomes. The latter required a change of classroom practice and new practices and paradigms to incorporate e-learning. These policy recommendations are summarised in Figure 3-22 below, and the reference to high order thinking and multiple intelligences is also discussed in Chapter 4, under the Brain Model Theory section (Gardner 1983, Nelson 2001).

Figure 3-22: Teaching and Learning Framework for Victorian Schools (Source: DEET 2001)

The Victorian Government had detailed its commitment "*to creating an e-learning environment for all Victorians, regardless of where they live and study*" (p13, 'skills x knowledge = growth' statement on ICT Skills by the ICT Skills Taskforce[33]). (DEET 2000) In the e-learning definition they stressed the support for student learning with the

[33] The Kirby Report.

integration of a range of technologies across all areas of schooling with the aim to engage in meaningful life learning experiences through collaborative learning.

What was significant here was the fact that schools were provided with an e-learning plan in the form of a blueprint that considered budgeting and implementation strategies and projects over a specified time period. The actual details of the plan were left for each school to design and incorporate in its curriculum. The plan provided scope for all stakeholders (staff, parents, school council and students) to collectively have the responsibility to work and implement the e-learning plan in their vision. Further information was provided through the Education Network of Academics (EDNA), where advice for teacher ICT competency, links to e-learning curriculum projects both local and abroad were provided as samples of e-learning practice (DEET 2002) (http://www.edna.edu.au/schools/leadingpractice/lead_ed_sys.htm)

Several research studies (Naidu, Cunnington & Jasen 2002; Mulder, Swaak & Kessels 2002) provided evidence on how technology enhanced teaching and learning and how ICT influenced the nature of teaching and learning activities. One particular example was the engagement, thinking and development of high-order learning skills acquired via e-learning.

Australian studies reported evidence of a positive impact of ICT in education. For example White (2005), Shaddock (2007), Moyle (2005), Meiers (2009), Cuttance (2001), Freebody (2005), MCEETYA (2007), Newhouse et al. (2002), Calnin (2006) and Finger et al. (2005). In a study by Seymour (2005) and DEECD (2008), we see reference to a framework for LD and ICT similar to one from the UK. As stated earlier, I was interested to find out how effective has the ICT adoption been and also how it affected the learning outcomes of students with special learning difficulties. The Victorian Education Department report on special needs and policies, the Deakin Report (Blackmore et al. 2003), as well as an earlier national study (DETYA 2000) on technology and LD students, have all highlighted the need to research this area further. The thesis describes how the technology and e-learning plans were implemented in the two special schools in the case studies. As expected, the actors played a very significant role in the design and implementation of the e-learning plan and the results will be discussed later in the thesis.

3.17.5.2 Global Scene

The European e-learning action plan (2001-2003) (European Commission, DG Education & Culture 2007) aimed to present ways and means of implementing and supporting the e-learning initiative, shown in Figure 3-23. The aim of this plan was to involve educationist and other stakeholders (social, industrial, and economic) in order to make life-long learning the driving force behind a cohesive and inclusive society, with a competitive economy. The plan considered the following main objectives: Infrastructure and Equipment; Training; Service and Contents and Co-operation and Dialogue.

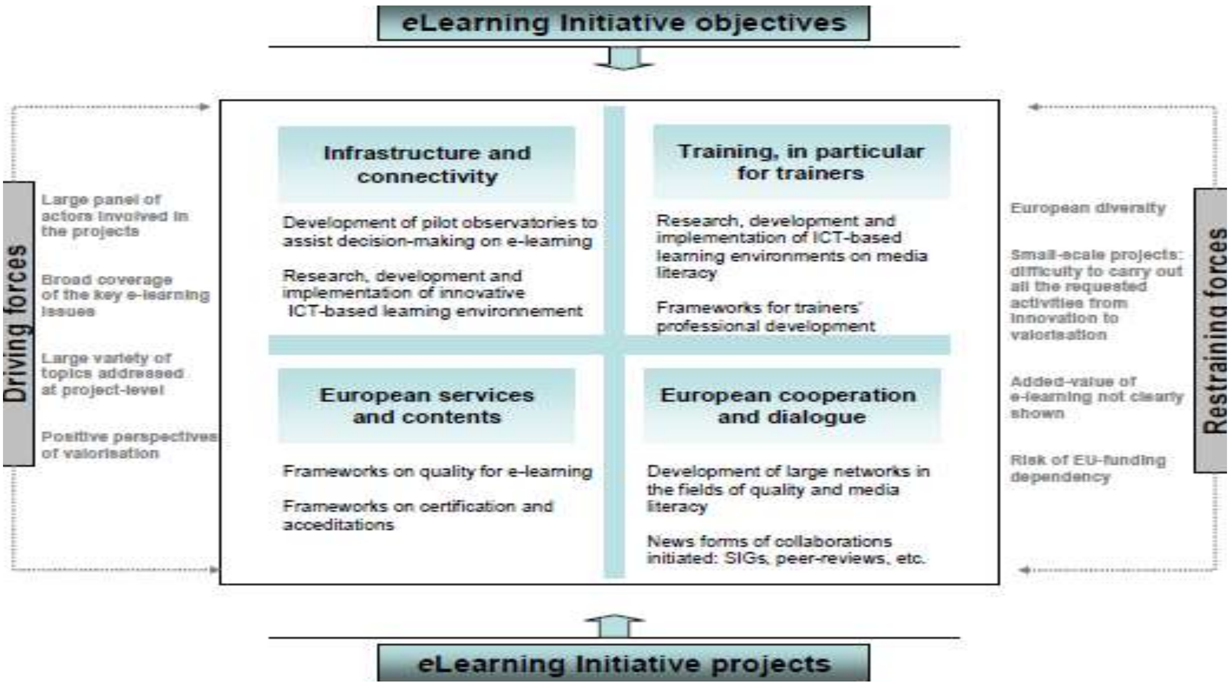


Figure 3-23: E-learning Initiative (Source: European Commission, DG Education & Culture 2007)

One of the significant projects was the DELOS[34] project which designed a list of indicators of ICT in education and training. There were approximately 400 indicators that were identified and these indicators were linked to e-learning at different levels and also to policy. A list of the 10 key policy questions is reproduced in Figure 3-24 below.

[34] DELOS= Developing a European e-learning Observation System- It focused on the identification of relevant indicators of ICT in Education and Training, the definition of collaborative strategies for data collection and analysis and the establishment of a solid partnership relation among the players involved..(http://www.education-observatories.net/delos)

1. *Access to Learning: Is e-Learning an effective means to improve access to learning opportunities?*
2. *Social Inclusion: Is e-Learning actually contributing to social inclusion/preventing social exclusion?*
3. *Quality of Learning: Is e-Learning contributing to quality of learning?*
4. *Cost-Effectiveness: Is e-Learning cost effective / paying for investment?*
5. *Employability: Is e-Learning making people more employable?*
6. *Personal Development & Citizenship: Is e-Learning contributing to personal development/socialisation citizenship?*
7. *ICT & Content Industry: Is e-Learning an interesting development for the ICT and content industry?*
8. *Organisational Change: Is e-Learning a facilitator of organisational change in users organizations (companies, public administration)?*
9. *Internationalisation of E&T: Is e-Learning helping the internationalisation process of education and training systems in Europe?*
10. *E&T Innovation: Is e-Learning supporting innovation processes in existing Education &Training organisations?*

Figure 3-24: DELOS 10 key policy questions (Source: European Commission, DG Education & Culture 2007)

The table on page 45 (of the DG report) describes an overview of the "*observatory-type services*" projects for the various countries and partners and the proposed timeline of the e-learning plan. The outcomes from these projects shall lead to the development of meaningful indicators and forecasting of e-learning in Europe. These indicators were used to define and validate teachers' and trainers' competencies in further projects (for example, ULEARN[35] and eTTNET). The key characteristics of the eTTNET[36] project and frameworks are given in Figure 3-25 below. These projects provide scope for innovators and pioneers for the European syllabus and specifically address five core areas of competence: learning and ICT, curriculum areas and learning resources, collaboration among school actors and ICT, Professional development and school

[35] ULEARN = European Lifelong Learning System on ICT in Education for Pioneer Teachers

[36] eTTNET = European Training of Trainees Network

innovation, and Quality, Education and ICT (European Commission, DG Education and Culture 2007).

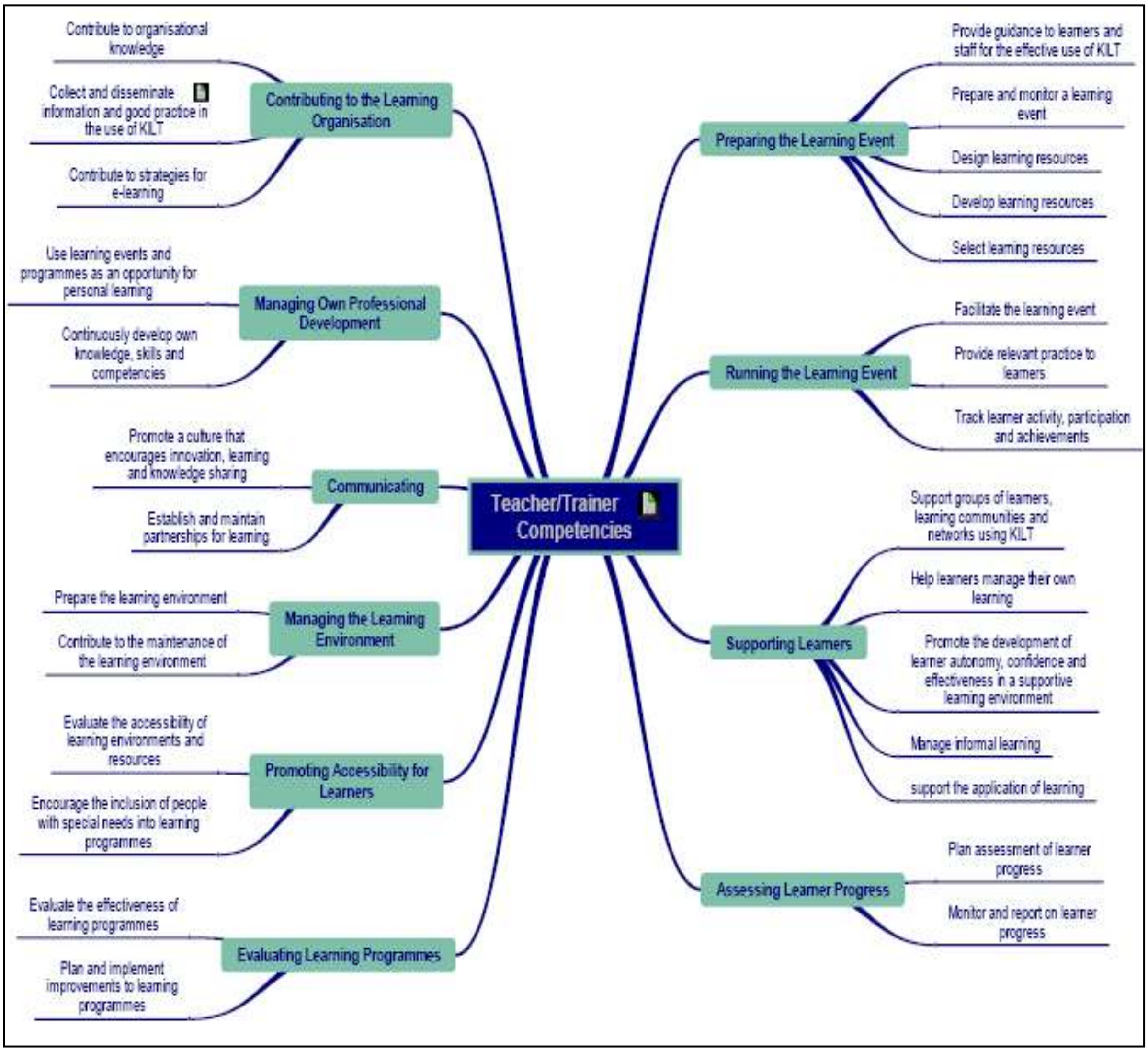
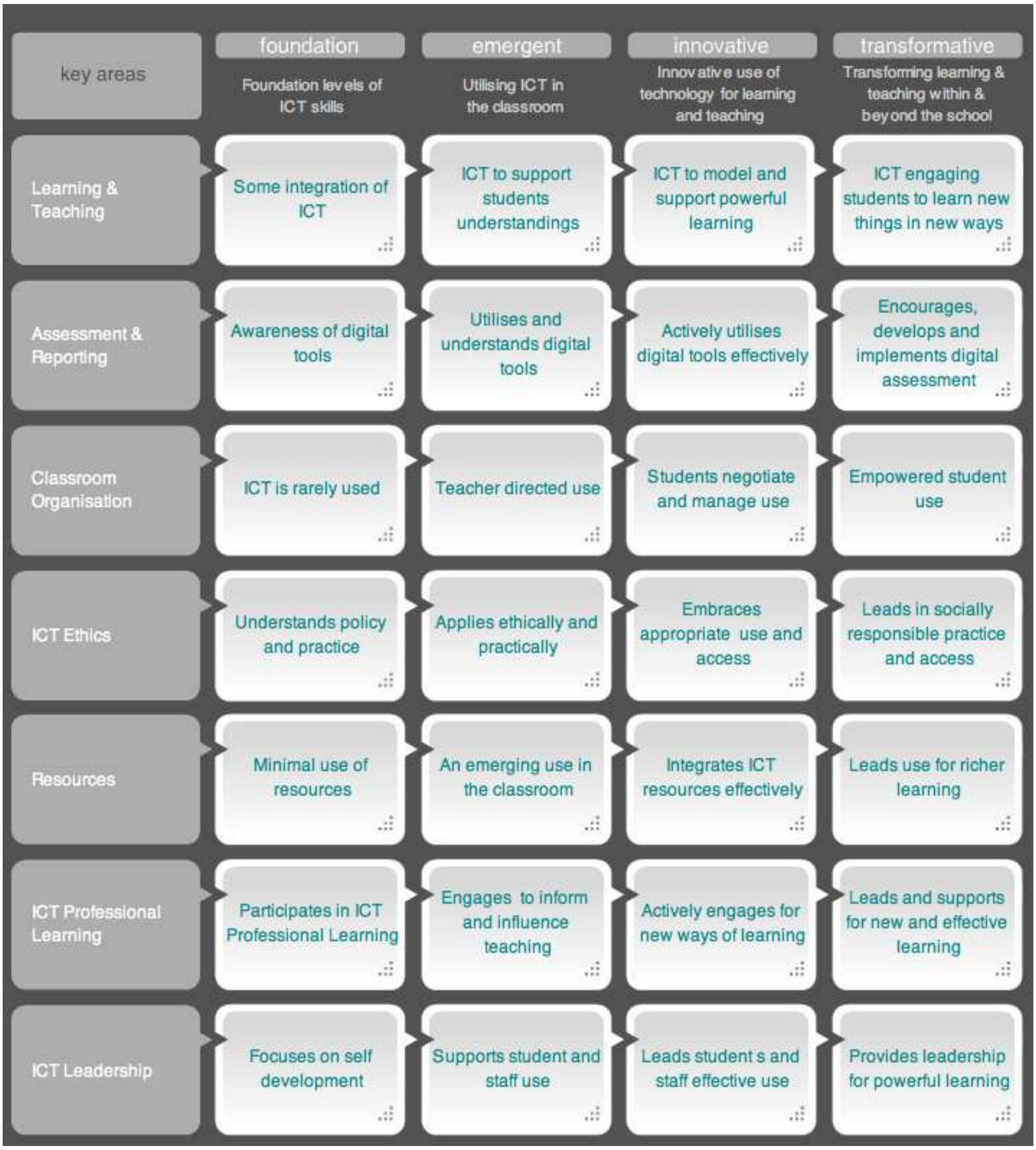


Figure 3-25: e-TTNEt eLearning competency framework for teachers and trainers (Source: European Commission, DG & Culture 2007)

An examination of these competencies will show that similar competencies were also developed to assess the ICT and learning skills of teachers in the Victorian Education Department. This policy was named the Information Potential Policy (ePotential[37]) and will be discussed further, later in the thesis. Figure 3-26 shows the relevant ICT skills that are currently considered for Victorian Teachers. The figure clearly shows the key areas that are highly regarded for ICT innovation in Victorian schools (DEECD 2008). These are categorized as follows with the skills levels of foundation, emergent,

[37] ePotential Policy – This policy requires all teachers to complete an online skills assessment matrix to determine their ICT readiness or standard. A sample assessment report will be displayed in Chapter 4.

innovative and transformative (the more advanced category): Learning & Teaching, Assessment & Reporting, Classroom Organisation, ICT Ethics, Resources, ICT Professional Learning, and ICT Leadership. These skills will be considered, in particular ICT leadership, later in the dissertation when the final e-learning model design is proposed.



key areas	foundation Foundation levels of ICT skills	emergent Utilising ICT in the classroom	innovative Innovative use of technology for learning and teaching	transformative Transforming learning & teaching within & beyond the school
Learning & Teaching	Some integration of ICT	ICT to support students understandings	ICT to model and support powerful learning	ICT engaging students to learn new things in new ways
Assessment & Reporting	Awareness of digital tools	Utilises and understands digital tools	Actively utilises digital tools effectively	Encourages, develops and implements digital assessment
Classroom Organisation	ICT is rarely used	Teacher directed use	Students negotiate and manage use	Empowered student use
ICT Ethics	Understands policy and practice	Applies ethically and practically	Embraces appropriate use and access	Leads in socially responsible practice and access
Resources	Minimal use of resources	An emerging use in the classroom	Integrates ICT resources effectively	Leads use for richer learning
ICT Professional Learning	Participates in ICT Professional Learning	Engages to inform and influence teaching	Actively engages for new ways of learning	Leads and supports for new and effective learning
ICT Leadership	Focuses on self development	Supports student and staff use	Leads student s and staff effective use	Provides leadership for powerful learning

Figure 3-26: ePotential Skills Matrix (Source http://epotential.education.vic.gov.au/continuum.php)

White (2005) describes the background of Learning Theories, such as constructivism, and how these have transformed to learning in the digital age via the inclusion of ICT. He further provides a summary of studies (Siemens 2004), from DfES[38] in the UK, DEST[39] in Australia, and Pennsylvania State University in the USA. These studies identify how ICT learning provides opportunities to: access digital teaching and learning resources at home and school, develop and gain recognition for skills, raise standards through innovation (DfES 2002), independent learning, network learning, classroom interactive learning (DEST 2004), learning with technology, learners as thinkers and distributing cognitive processing (Jonassen 1994).

These modes of learning comprise the main characteristics or attributes of e-learning. As mentioned above, e-learning provides an environment that transforms education and the curriculum. It empowers the learners to become thinkers, designers and managers of their own learning. Therefore, the focus and role of the teacher is shifted from an instructor and administrator, to that of facilitator of resources.

Mlitwa (2005) presented a study based on actor network theory and argued a case for ICT adoption in South African Institutions. In particular, the study highlighted the use of learning through the adoption of LMS as a socio-technical network and explained that this is a significant component for the e-learning environment.

Figure 3-27 below, illustrates my proposed model for the evolution of technology and learning, culminating to e-learning. I have constructed this model from the literature and my work with ICT in business and education from the 80s to the present time.

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[38] DfES = Department of Education and Skills (UK).

[39] DEST Department of Education Science and Training (Federal government Australia)

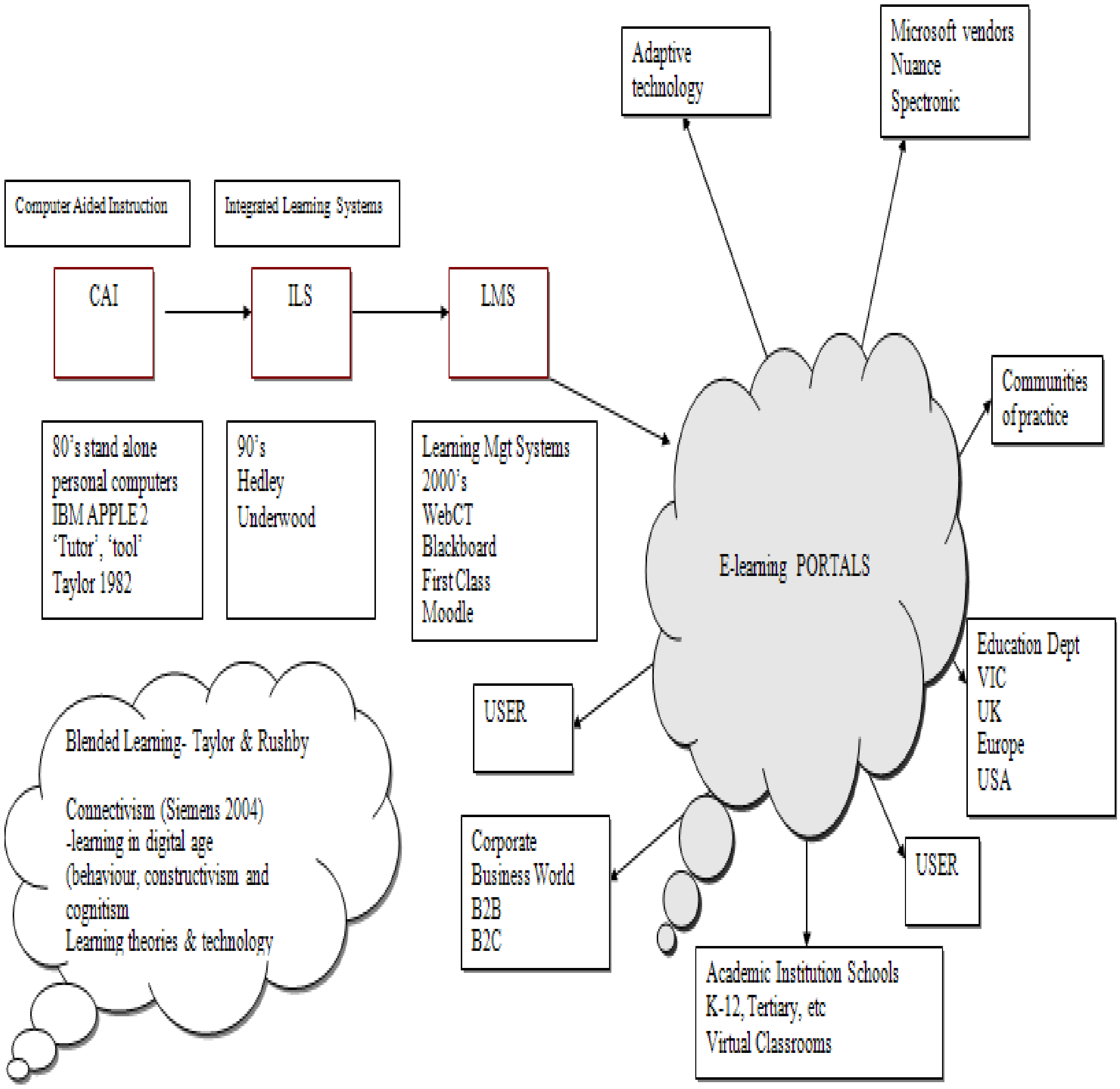

Figure 3-27: Framework for e-learning Evolution

The reader will find further information on observations of e-learning in one of the case studies in Chapter 7 of the thesis. This model was based on the "*Thinking Curriculum*" by Clark (2005).

Given that the thesis is exploring Web-based technologies and curricula, it is relevant to discuss Web 2.0 technologies in this chapter. There was strong emphasis on the introduction and application of social networking in the curriculum at Concord, as was mentioned in Section 3.7 of this chapter, and I believe that the following discussion is necessary, as it provides the reader with the background to the discussion in Chapter 7.

3.18 WEB 2.0 TECHNOLOGIES

3.18.1 What is Web 2.0?

The evolution of web use and the invocation of newer technologies and standards that facilitate social networking, provide access to a large set of networks and services through the introduction of more complex media and data types, including audio and video. These services rely on a wider community collaborating, sharing and creating or designing content. For example, the services include blogs, wikis, social booking, media sharing, rich Internet applications, RSS feeds and several others. The major categories for Web 2.0 activities include trading (buying, selling or exchanging through the Internet), media sharing, media manipulation, data/web mashups (combining data from multiple sources to create a new application), conversational arenas, online games and virtual worlds, social networking, blogging, social bookmarking, recommender systems, collaborative editing and syndication (Leeson 2008).

In their report, Crook & Harrison (2008) state "*despite the anecdotal evidence and hype surrounding the concept of Web 2.0 technologies in education, there is a lack of studies providing empirical evidence on the role of Web 2.0 technologies to support learning"*. They further emphasized that the Web 2.0 use is outside school and for social purposes. In addition, they noted significant gender differences in the use of Web 2.0 technologies: older learners take part in more social networking, younger learners take part in more interacting gaming using the internet, girls are involved more in social networking and boys are involved in internet-based gaming.

There are many technical skills that are lacking and also a lack of awareness for the range of technologies of when and how they could be used. The digital literacy, and critical skills to navigate and use this space, is not yet fully mature. Four potential benefits were identified for teaching and learning from using Web 2.0 and these were described by the following expressions:

> Stimulated new modes of inquiry, Engaged with new literacy, Engaged with collaborative learning activities and Publication of online content. (Crook & Harrison 2008).

3.18.2 Barriers and Issues of Web 2.0 and Beyond

There are a number of significant issues such as legal, privacy and parental concerns which relate to Web 2.0 technologies and learning. I will discuss specific aspects in the case study later in the thesis in Chapter 7, and compare these with the Becta (2008) findings, which are summarized here: technical failures and removal of facility due to insufficient budget; insufficient access to computer resources; insufficient support for Web 2.0 tools; administrative costs; networking issues, for example insufficient bandwidth; storage management issues; teachers lack of legal and copyright laws; portability issues and authentication; cyber bullying issues; and teacher and student safety and privacy protection.

In fact, the Becta (2008) summary report recommends specific approaches to what it calls e-safety. These are referred to as the "*Walled Garden, Empower and manage, Lock down and Open Access"* respectively. The same report emphasizes the need for new modes of learning, different approaches to assessment and an alternative approach to private modes of study, research and production. As a consequence of this approach, there will be new products of learning such as digital literacy, sharing of resources and an enhancement of young people's skills and confidence with multimedia hardware and software.

Furthermore, the report provides guidelines regarding implications for policy on learners' use of Web 2.0. The main considerations are for the activity of learners and the relevant skills to be acquired from social networking by using technology in and out of school. One important aspect is support for skill acquisition post-16 and the requirements of the Leitch [40]implementation plan. Schools might also take more advantage of technologies to which learners have free access, such as MP3 players.

Furthermore, the UK Becta (2008) report proposed the following main principles to policy makers in this field: (1) Web 2.0 should be used to support learning and teaching through engagement and participatory learning by the students; (2) curriculum design and assessment should not inhibit teachers from innovation and Web 2.0 technologies should provide a medium for creativity and incentive; (3) there are various issues such

[40] Lord Leitch 2006 Report in the UK – vision to equip young people with world class skills

as privacy and recording of assessments, file access, storage of files and compliance where schools need to be vigilant to ensure the medium does not compromise teaching and learning; (4) the schools need to exercise a duty of care in relation to cyber safety beyond the school walls to safeguard themselves; (5) In addition, it is significant that they understand the issue of plagiarism and authority of knowledge; the need to develop skills in internet literacy, and to provide the necessary training and guidance, to ensure that the students can use the web in a proper and safe manner.

These main principles will also be explored in the present study to see how the various actors, both human and non-human, are affected by Web 2.0 technologies.

One of the research sub-questions that are presented in the thesis is the issue of school to work transition. The next section provides a brief discussion from the literature on this topic.

3.19 E-LEARNING & TRANSITION FROM SCHOOL TO WORK

It is significant to note that the term "Life Long Learning" originated from the European Community OECD (1996) and UNESCO (1996). The National Goals for Schooling (MCEETYA 1999) make provision for continual learning over the life span of an individual. The Skills Task Force, which was referred to earlier in this chapter, (Kirby 1999, 2000) recommended a policy to develop and enhance young peoples' skills in Victoria. "Australia's future depends upon each citizen having the necessary knowledge, understanding, skills and values.... and open society. High quality schooling is central… learning throughout their lives so that they can exercise their rights and responsibilities as citizens of Australia" *(MCEETYA 1999).*

McKenzie (2003) presented a study which highlighted the need to provide pathways so as to foster lifelong learning for transition students. A fundamental aspect from the MCEETYA (1999) policy is that in making the transition for their students, schools should provide the following: employment related skills; an understanding of the work environment; career options and pathways; positive attitude to towards vocational education and training; and further education employment and lifelong learning (MCEETYA 1999).

As the policy focuses on pathways and lifelong learning for people, and following McKenzie's (2003) arguments, I redefine the questions that were raised by his study:

> *How can such pathways be set up for LD Students?*
>
> *How can ICT influence the students, motivate them in the long term to develop adequate skills and hence increase their employment prospects?*

In this way, one expects that the likelihood of being employed should increase to a significant level. The OECD (2000) review takes several factors into consideration, such as the time horizon, that may impact the transition policy given the individual differences and developmental delay in LD students. It is very challenging to build an initial skillset or base knowledge that encourages and results in greater participation in education and training later on life. Different countries have experimented with various strategies, but all are still at the stage of trial and error (OECD 2000).

According to Finn (1991), pathways have five main elements that include:

> A set of interrelated experiences providing for progression; Education and training should have a sense of continuity even when individuals cross institutional and sectoral boundaries; Young people should have access to a range of different pathways and should be able to move from one to another without losing ground; There is a need for effective credit transfer and articulation arrangements to provide smooth bridges between pathways; and
>
> Signposts (information and career advice) are needed at the start of each pathway and at each junction between pathways.

The OECD (1998) report presented issues such as low levels of attainment and qualifications, amongst young people, school leavers, and their limited opportunities. The report considers key generic employability skills and competencies that students need to continually adapt and upgrade, and it provides a range of indicators showing performance in transition from education to work for a group of students 15-19 years of age. These indicators are compared against those of Australia and they appear to be very similar (McKenzie 2003). The thesis will review this important area in the final chapter and make recommendations for special schools.

3.20 E-LEARNING MODEL EXAMINED EARLY IN THIS STUDY

There are several e-learning models that were identified in the literature. The thesis has analysed the models by Sharda (2001) and Schunck et al. (2001) and adopted the latter for the early phase of the study (see page 73, Figure 3-12). The data analysis will show that this was a very significant e-learning model which was applied to determine the skills and knowledge of the students in the special schools and, hence, assess their achievement. The next chapter will provide further discussion on the integration of ICT into the curriculum and its impact on teaching and learning. As a starting point, the reader may refer to Figure 3-27 , page 108 of the dissertation, which provides the basis for the evolution of e-learning.

3.21 SUMMARY

In search of the research field, this chapter investigates teaching and learning of LD learning communities with ICT in two special schools. The special schools can be considered as a virtual community, and therefore, a brief discussion on virtual communities is presented. The literature identified the infrastructure as a significant area (actor) in the adoption of ICT, and a research study was conducted to determine various actors and their significance in the special schools and other relevant projects, such as Multimedia Victoria Connected Community. E-learning models, which are an integral part of the thesis, are introduced along with the history of ILSs and LMSs, in order to establish the framework for my e-learning model design. Emerging technologies such as Web 2.0 are also discussed as these are gaining momentum with their capacity to facilitate classrooms without walls. The chapter also presented a brief overview of the literature regarding the issue of school to work transition. Figure 3-28 below captures the various components of the research field which provide the context for the study in this thesis and these will be explored further in Chapter 4.

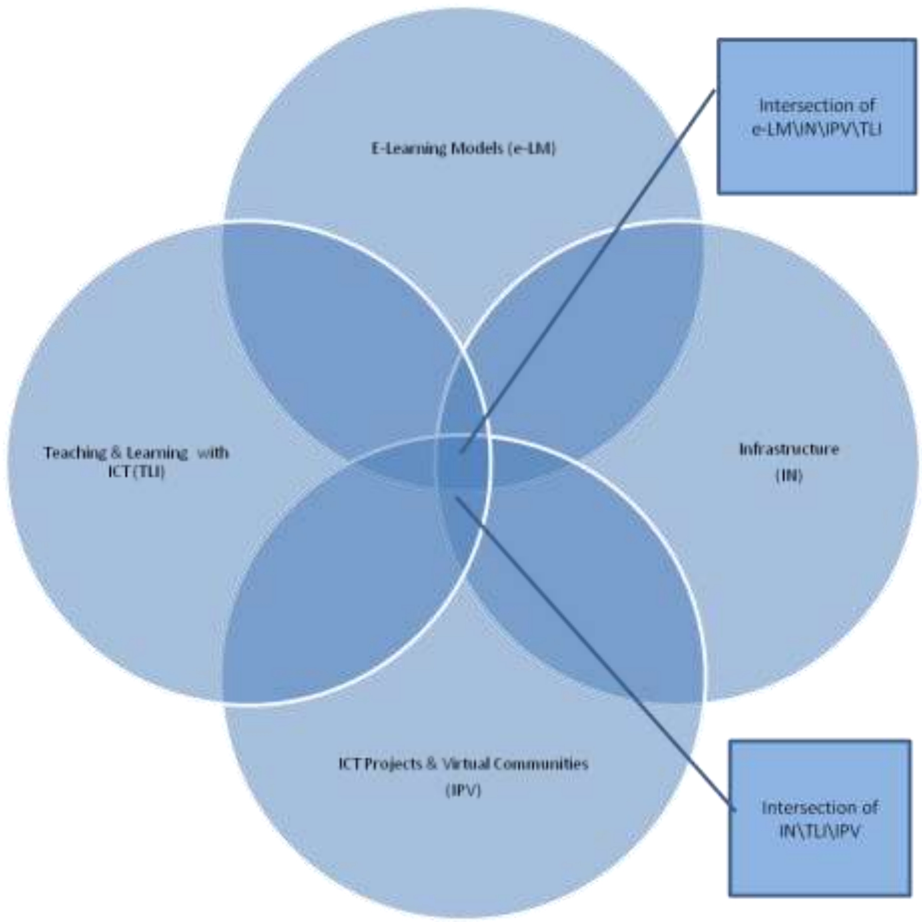

Figure 3-28: Summary of Components of the Research Field

Personal Note on the use of LMS, ILS & CAI

I was motivated with the introduction of technology, the Personal PC and used these in my teaching and learning from the 80s to 90s. I recognized the capacity and empowerment of computer-based tools in "drilling" exercises for Mathematics, Language and Science students. The Victorian Department of Education had set up a special support group for teachers who wanted to use computers in the classroom (Softweb). Individualized special software like the "Birds of Antarctica" were designed and made available to Science teachers in schools. Recent software like Kahootz was also made available to teachers in schools.

As an early adopter and pioneer of using computers in education, I gained significant skill and knowledge and was convinced about their capacity to engage students and in some cases enhance their learning outcomes - this was also my belief for students with learning difficulties, for example via DSP. Anecdotal data supported my actions in setting up a special or remedial laboratory in several secondary schools. However, I was unable to see the impact of the internet in secondary and primary schools as I was no longer employed as a teacher in that field. I had moved to the tertiary sector and through my own specialization in teaching in the computing field I observed the advancements of the internet. The emergence of LMS platforms once again provided new challenges to me and I began using WebCT and CENTRA for both content and delivery and in particular pioneered the development of online units which I am currently expanding across the curriculum. I am an active user of the World Wide Web (www) and adopted e-learning to teach my students off campus.

I will report and discuss my investigations with respect to e-learning adoption of the special schools in the case studies under consideration later in the thesis.

CHAPTER 4

4 LITERATURE REVIEW – LD, LEARNING MODELS & ICT

> "*Only the curious will learn and only the resolute overcome the obstacles to learning. The quest quotient has always excited me more than the intelligence quotient"*
>
> **Eugene S. Wilson**

4.1 INTRODUCTION

The issue of the definition has already been addressed in Chapter 2; however, I need to explore certain other aspects, such as IQ and brain model theories. The latter will be discussed in Sections 4.4 to 4.11, and in particular, emphasis is given on learning, memory and learning styles. Given the complex nature of the study, there were several areas that needed investigation; Education, Technology, Brain Model Theories and LD. A Venn diagram is used to capture and illustrate the links and intersections of these areas. The sections follow a logical path to present the literature review in a coherent manner.

The significance of ICT in education has been reported in several studies including that of Shaddock (2007) and Cuttance (2001). Calnin (2006) provided a review of ICT in Australian and overseas education and other authors (Mumtaz 2000) reported on the impact of ICT on teaching and learning. In addition, the literature presented a limited number of studies that linked education and ANT, for example, Cordella (2008), Gilding (1997 and Tatnall (2000) shows the influence of humans and technology on teaching and the curriculum and infrastructure.

This chapter reviews the impact of ICT to learning and in particular to LD students. The review includes studies from a large geographical area: the UK, Europe, Asia, Australia, Africa and USA. Given the social, technological, as well as cognitive aspects in this field, the thesis identified two relevant areas for discussion and these were respectively: ANT (Latour 1986) and Brain Models theories of Hebb (1949) and Kolb (1983). As mentioned above, in order to capture the links and relationships between these different domains of knowledge, a Venn diagram is used and this is shown in Figure 4-1 below. The chapter further provides a brief summary of the main approaches or strategies to teaching and learning and in particular, those that have been applied to the LD. I conclude the chapter by discussing the limitations of the literature and taking into account the period of the study which was almost eight years. It should be noted that some of the limitations are still present, even though there has been considerable technological advancement during this period.

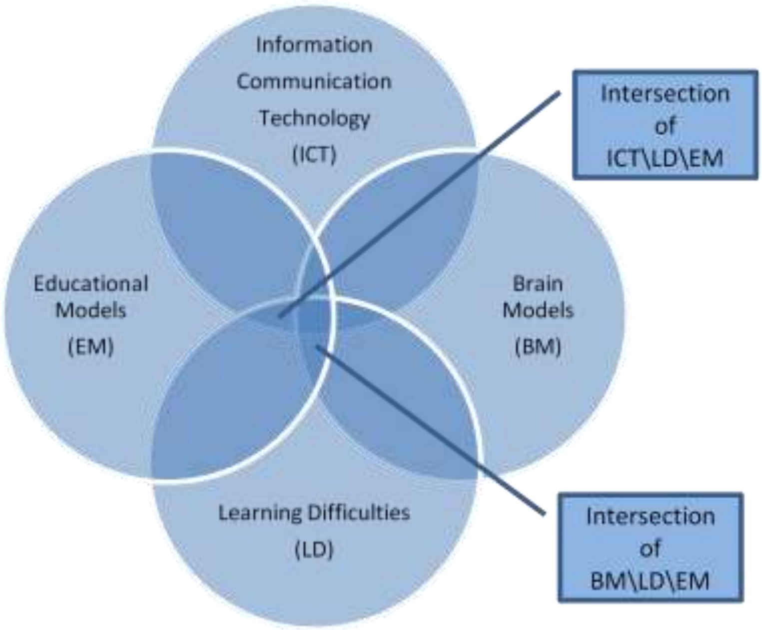

Figure 4-1: Venn diagram - Research domains and their intersections (Constructed from literature)

4.2 EDUCATION OF CHILDREN WITH LD

I reiterate that in regard to the education of children with learning difficulties, the term LD can refer to many different things spanning both physical and mental impairments. Studies over the last twenty years have shown that technology can play a significant role in any work with specific disadvantaged groups such as the blind and those with movement disabilities in the provision of media to facilitate communication and education (Poon & Head 1985 and Blamires 1999). Specific Learning Disabilities is a chronic condition of presumed neurological origin which selectively interferes with the development, integration and/or demonstration of verbal and/or nonverbal abilities. Specific Learning Disability exists as a distinct handicapping condition and varies in its manifestations and degree of severity (Adam & Tatnall 2003). Throughout life, the condition can affect self-esteem, education, vocation, socialisation, and /or daily living activities (ACLD 1986 :15).

Literature from the Australian Bureau of Statistics (ABS 1996; ABS 1997) and MCEETYA (1997) indicates that the prevalence of LD is approximately 10-15% at the primary levels, and is still significant at the secondary level at 5-10%. Figures for Australia follow similar trends to those from the USA and other countries (NJCLD 1994). This presents a dilemma about school membership for students with LD – should they remain in 'mainstream' schools or would they be better served in some form of special school? Even though this data is from an earlier ABS survey, it is unlikely that the proportions have changed (ABS 2006, Chiang & Chang 2009).

There are a number of sources of variation in comparing special education prevalence rates across different nations, including definitions of disability categories and unreliable or invalid data sources. Additionally, mild disabilities such as LD may not emerge in similar ways in different countries due to different cultural, linguistic, socio-economical and philosophical perspectives (Lloyd, Keller, & Hung, 2007).

4.2.1 IQ, LD & Learning

There is evidence to show that to some extent LD and IQ are related. Studies from the USA (Fernell 1994 and Kavale 1995) have argued the connection between IQ and LD, although several other research studies have indicated that there is insufficient evidence that links LD with low IQ scores Detterman (1997)[41]. Finn & Resnick (1984) argued that special education children experiencing particular types of learning difficulties achieve best with instructional strategies different from those that are provided in a regular classroom. Fletcher et al. (2000) carried out a study to find if learning difficulties were accounted by late developmental delay. The study used two different intelligence ability groups and provided evidence for IQ independence, similar to Maybery et al. (1995)[42]. This was a qualitative study that explored the link between implicit and explicit learning and IQ. The three factors that were considered were the Mental Age (MA), IQ and Chronological age (CA). It should be mentioned here that

[41] There has been some discussion on the validity of IQ as a measure of intelligence, but on this scale it still seems to be worthwhile.

[42] Maybery's test was concerned with age independence, rather than IQ independence.

this is significant for this research, particularly for the individual study, where developmental delay was the early diagnosis of the disability for my own son.

It has been agreed by educational psychologists that statistically the prevalence of people with IQ < 70 should be 2.5% (2 standard deviations from the mean). Actually, the prevalence of people with learning disability is 1-2%, and this is due to the following factors: differential mortality[43] ; diagnostic changes with time, as not all cases are classified; the role of functioning - those with IQ<70 but no problems functioning within their environment would not be defined as having a learning disability. It has also been reported that prevalence of people with IQ < 50 is 0.35% (Kendall & Zeally 2007).

4.2.2 In Search of a Link for IQ & LD: Aetiology

It is well known that IQ levels follow a normal distribution curve for IQs above 70 and this has been applied by educational psychologists to determine the level of cognitive function for children with special needs, for example, the Wechsler Intelligence Scale for Children 3rd Edition[44], the Wide Range Achievement Test-Revised (WRAT-R) and the Neale analysis of Reading Ability – Revised (Neale – R). It suffices to say here, that these tests analyse the cognitive ability for verbal comprehension, performance skills, perceptual organisation, processing speed and spatial perception. For lower levels of IQ the curve is skewed due to the addition of pathological (organic) causes of learning disability. The organic causes of learning disability are indicated by the shaded area on the diagram in Figure 4-2 below and this will be revisited when the individual study is discussed later in the dissertation.

[43] The more severe is the degree of learning disability, the higher is the mortality c.f. general population.

[44] WISC-III – this is an individually administered test of intellectual ability, comprising 13 sub-tests.

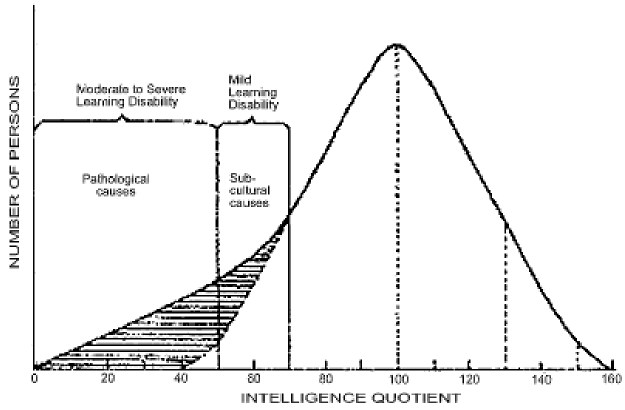

Figure 4-2: Distribution of intelligence in the population (Source: Kendall & Zeally 2007)

4.2.3 Mild Learning Disability

As we can see from Figure 4-2 above, these individuals form part of the lower end of the normal distribution curve for IQ. They generally can communicate with spoken language, but have a deficit in some other significant area like numeracy or spatial perception or motor skill. The role of multifactorial genetic and environmental influences (which also control the variance of IQ above 70) are traditionally thought most important in this group. Higher rates in social classes with a disadvantage, especially with large siblings, overcrowding and poverty, relate to '*sub-cultural causes'* of learning disability. However, there is increasing evidence for organic involvement[45]. Presently the following categories of people have been reported: no cause found > 50%, 15-20% perinatal hypoxia, 10% congenital causes and 5% defined genetic cause.

(www.ncl.ac.uk/nnp/teaching/disorders/learning/)

Studies on LD have focused on only one or two specific factors such as IQ, but the literature shows that a factor such as this does not yield valid results or assessments (Detterman & Thompson 1997). The literature provides examples where these students in normal classroom settings achieve little success in situations where technology was not regarded as an integral part of the curriculum (Zammit et al. 1999). Numerous integration and remedial programs have proved inefficient towards the total learning of this group of students (Adam & Tatnall 2002), and the literature shows that in some selected fields, for example in mathematics and social studies, specialist instruction was

---

45 Recent studies show that up to 45% of people have definite organic factors (subtle chromosome rearrangements, perinatal insults from toxins like alcohol).

applied to this group of individuals with little success (Swanson et al. 1999 , Klinger 1998, and Johnson 1998).

4.3 LEARNING, ICT & LD

Given the recent advances in technology, it would be beneficial for educators, the school community, the students and the government, to find out how technology transforms the learning outcomes of students with LD. Such a study should also provide information about possible bridges or pathways that may involve training, work placement and further education. These findings should facilitate the curriculum and design of an ICT-based course suitable for LD students. The emergence of recent technologies like Web 2.0 will have a significant impact on this process as the highly interactive and engaging environment should provide and augment their skills and knowledge so that they can become life-long learners.

The literature contains early models such as Computer Assisted Instruction (CAI), Computer Based Learning (CBL), and Computer Based Training (CBT), which were used with some success with LD students. Kulik et al. (1983) reported that no significant differences of CAI existed between students of high and low ability. Torgesen & Young (1983), Poon (1985), Schmidt (1986) and Wood (1987), reported on studies that were carried out with microcomputer programs in literacy and numeracy to develop skills with LD students. Computer Managed Instruction (CMI) was also used to support the teaching in general. Yamamoto (1999) used computer-based teaching with autistic children to develop their language skills; Stevens (1991) used microcomputer time delay and CAI to teach spelling to LD students. Clearly the early studies were limited by both hardware and software and they weren't very efficient, even though they provided support to the teaching of these students.

Many studies have investigated the links between ICT and learning and shown that it has played an important role in this field (Torgesen & Young 1983, Dempsey 1993, Quinn 1996, and Pillay 2000). The educational needs of LD students were considered by Torgesen & Young (1983) and they had established two important principles for the design of software programs for LD students: the principle of uniqueness and the principle of educational necessity. The former used tasks or methods for motivation, whilst the latter focused on critical problems with LD students; where most efforts were placed on the development and testing of the software to support the development of more adaptive skills. A variety of teaching models are used with LD students and Agran (1977) and Jay et al. (1999) describe a specific self instructional skills model for persons with mental retardation, while Bulgren (1998) used concept-based teaching routines to enhance the performance of LD students in secondary-level mainstream classes. The literature further describes studies on adolescents with LD (Dillon 1985; Deshler & Ellis 1996). Studies specific to individual reading and natural language include those of Kircaali-Iftar, Birkan and Uysal (Kircaali-Iftar, Birkan et al. 1998), Johnson et al. (Johnson, Gersten et al. 1998) and Swanson (1999). In general, however, these studies were related to mainstream classroom teaching and management strategies (McIntosh 1993), (Shaw & Grimes 2005), and (Kavale 2002).

Teaching can be thought of as an interaction between teachers, students, experience and knowledge (Schunck & Nielsson 2001), and the way that these entities interact can be seen in different teaching/learning paradigms. I have already described Schunck and Nielsson ‘s (2001) three different stages in the development of educational thinking, particularly as related to the use of technology in education: the paradigm of the verbal tradition, the paradigm of the teacher-centred classroom and the e-learning paradigm. In the e-learning paradigm the teacher acts as a catalyst or consultant for students about where information can be obtained and communicates their own knowledge and experience to the students who make extensive use of technologies such as the World Wide Web to obtain information and experiences (Abbott & Cribb 2001). Here the synchronous presence of both student and teacher is no longer necessary and the learning responsibilities of the students are for ‘searching’ rather than ‘receiving’. Another important development especially for LD students has been the introduction of adaptive systems (Liu et al. 2007). These are hypermedia–based learning environments which are capable of altering some part of the instructional process on an individual basis by the use of the individual student (constructivist) models. It has been argued that with increased use of technology to replace traditional forms of instruction, adaptive systems may be able to individualise the instructional process to assist the learning outcomes and cognitive abilities (Eklund 1999, Lytras 2005, Blamires 1999, OECD 2005, Leeson 2008, and Williams et al. 2006).

Figure 4-3 below has been adapted from Blamires (1999) as it illustrates that technology has the ability to motivate children by providing an interactive, multi-sensory feature that allows the learner to engage and stimulate their interest:

> *"Technology is forgiving in that it allows pupils to make mistakes and edit them out without trace. It also produces a high standard of presentation* (Blamires 1999, Hardy 2000).
>
> *"..technology is very adaptable, offering endless modifications that provide access for even the most limited physical ability* (Hardy 2000).

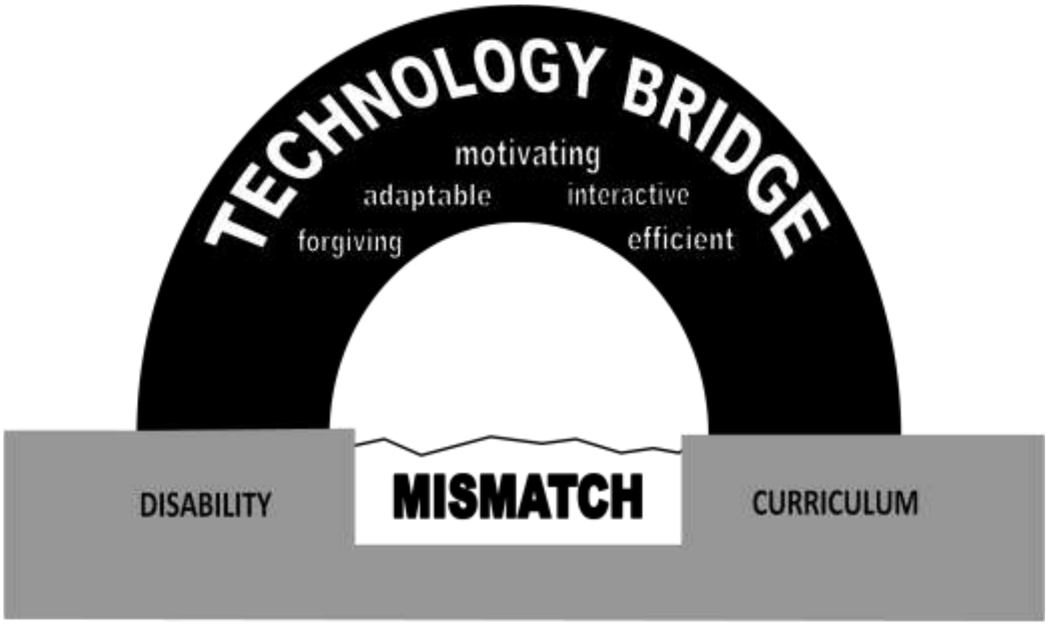

Figure 4-3: Technology Bridge for LD (Source: Blamires 1999)

Bulgren (1998) and Agran (1997), support the view that students with LD required an alternative approach to their learning. Numerous 'integration' or 'remedial' programs had proved inefficient towards the "total" learning of this group of students. The literature further shows that in some selected fields, for example in mathematics and social studies, specialist instruction were applied to this group of individuals with little success (Swanson et al. 1999 Klinger 1998, Johnson 1998). A study from Nepal by Pandit (2004), (Tribhuvan University Journal), conducted an analysis to determine the factors that affected learning disabilities in mathematics. The study of 104 LD students revealed that the factors which contributed to LD related to poor instruction, parents' adverse behaviour, and teacher's negligence in class. The study highlighted the concern over the quality of the teaching strategies and quality of instruction in the schools. Learning disabilities in mathematics has been defined as:

> *"Children with learning Disabilities in Mathematics are those whose mathematics performance is below average but their intellectual functioning as measured by general mental ability test is average or above average, and they have normal hearing and visual acuity, no history of chronic disease, regular attendance in the class and there is a significant discrepancy between their potential or ability and actual achievement"* (Pandit 2004, p2).

The case studies that were cited in the literature referred to one or several specific elements of a disability. The vagueness in the definition of LD, (Kavale (1995), and MacMillan (1998)), made it very difficult to isolate or demarcate some of these elements by using suitable criteria. Even those studies that used the factor approach demonstrated little progress. The literature shows evidence that a factor such as IQ does not yield valid results or assessments in regard to LD (Detterman & Thompson 1997).

Lloyd (1998), Kavale (1995), Forness (1981), and Bulgren (1998), have studied the validity of selecting or using meta-analysis of learning patterns of students with LD. In general, they concluded that it is difficult to paint or explain the full picture; that while students with LD may benefit from some special programs (for example, social studies, numeracy and literacy); overall the progress of these students is not very significant when compared with normal class students (Shaw et al. 2005).

Before I discuss the impact of ICT on teaching and learning, I would like to digress a little by introducing the brain model theories in the subsequent section. This section of the thesis examines the biological basis of learning and LD which will provide the logical link or connection to learning styles and cognitive load theory, and therefore its relevance and space in this thesis is justified.

4.4 THE BIOLOGICAL BASIS OF LEARNING & LD

"*Learning is not attained by chance; it must be sought for with ardour and attended to with diligence"*

Abigail Adams (1744 - 1818), *1780*

4.4.1 Introduction

This is a very complex field but I feel that it is significant in this research study. I have based this section on the work of Hebb (1949), Lowery (2000), Flint (1996), Kolb (1984), Gardner (1983), Stergiou & Siganos (1996), Johnston (2005), Wittrock (1992) and Pavlov (1904), and relied on this work to provide a basis for discussion. The literature presented two approaches to examine learning difficulties- cognitive and social. The former can be linked to brain models which originated from Hebb and the latter can be linked to behavioural theories which originated from Pavlov.

4.4.2 Brain Theory – What does it mean? What do we do?

Learning changes the physical structure of the brain and these structural changes alter the functional organisation of the brain; in other words, learning organises and reorganises the brain. Different parts of the brain may be ready to learn at different times. It is appropriate to examine some of the concepts and models that relate or link brain and memory aspects to learning in this research study, given the specific nature or context of the research fields. In the sections below, the dissertation provides some of the most fundamental concepts and theories that are significant and will be used in order to explain some of the observations that were made in the fields of research. In particular, these will be very useful in one of the case studies, where the learning outcomes of a specific unit (namely screen media/graphics) for an individual student can be accounted for.

The literature provides definitions of memory (Rose 1993) as fundamental memory model that is based on "neural plasticity" or "synaptic plasticity" and the modes of learning, namely non-associative and associative learning. A review of neural networks by Stergiou & Siganos (1996), the authors provided simple illustrations of the neuron components and synapse[46] function. These are reproduced below to assist the reader in this section of the thesis.

According to Stergiou & Siganos (1996), "*much is still unknown about how the brain trains itself to process information, so theories abound*". One way we can view the processing is to examine the theory or model of neurons. In the human brain a typical neuron picks up signals or messages from other neurons through a host of fine structures called the dendrites see Figure 4-4 below. Next, the neuron sends out a series of electrical activities through a long, thin stand known as an axon. The axon splits into thousands of branches as shown in Figure 4-5 below. At the end of each branch, there is a structure called a synapse that converts the activity from the axon into electrical effects. These effects or impulses either inhibit or excite activity from the axon into electrical effects that subsequently, inhibit or excite activity in the connected neurons. The authors further explain the learning process by changing the effectiveness of the synapses:

> *"When a neuron receives excitatory input that is sufficiently large compared with its inhibitory input, it sends a spike of electrical activity down its axon. Thus, learning occurs by changing the effectiveness of the synapses so that the influence of one neuron on another changes"* (Stergiou & Siganos 1996).

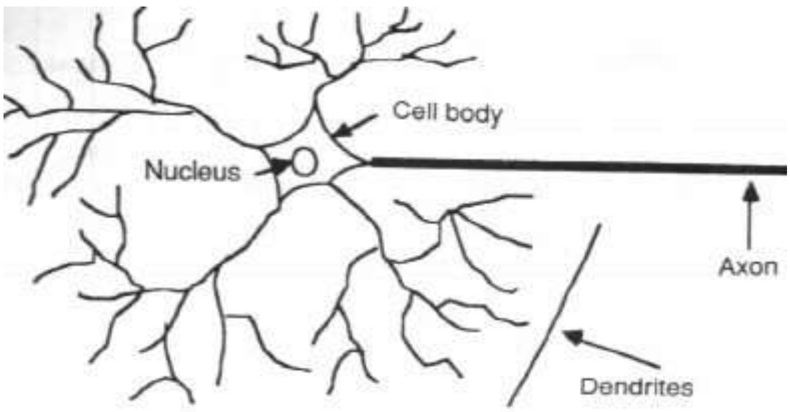

Figure 4-4: Components of a neuron (Source: Stergiou & Siganos 1996)

46 A synapse is a structure in the nervous system that permits neurons to pass chemical activity (messages) and electrical signals to another cell

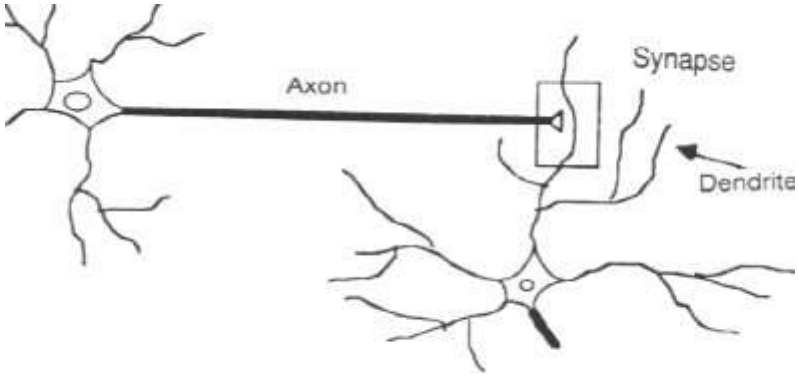

Figure 4-5: The Synapse (Source: Stergiou & Siganos 1996)

The following sub-sections provide background information and knowledge on biological stages of thinking and learning, the first mention is that of the work of Hebb (1949).

4.4.3 Hebbian Learning in Neurons

In his presentation on Learning, Walker (2008), outlined the biological basis of learning and explained that this occurs at the neurological level. He emphasised that learning is "stored" or "created" by changes to the connections (synapses) between neurons. One way of explaining this phenomenon is to accept the Hebbian postulate. According to Hebb (1949) there are two important functions that take place in learning neurons and these are respectively:

- The synapse gets stronger as cells activity gets more correlated.
- The change in synapses seems to be the basis of memory.

> *"When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased"* (Hebb 1949, p.62).

4.4.4 Recent Research

Recent theories and research, (Johnston 2005), further support the neuron theory of the brain. In particular a report by neuroscientists at The University of Texas at Austin in a new study, state that: *"Neurons experience large-scale changes across their dendrites during learning*" and highlights the important role that these cell regions may play in the processes of learning and memory. The research shows that ion channels distributed in the dendritic membrane change during a simulated learning task and that this requires the rapid production of new proteins.

"*Our new work strongly supports the idea that learning involves changes in dendrites*" (Johnston 2005). The research finding could lead to advances in understanding conditions like epilepsy and age-related memory loss and could point to potential treatment opportunities for such conditions in the future.

Since dendrites receive many inputs from other neurons that transmit information through contact points called synapses, a lot of attention is focused on how learning is affected by changes at synapses. They change in ways that make it easier for connected neurons to pass information. What is remarkable is that Johnston and his colleagues contend that learning and memory are likely to, not only involve changes at synapses, but also in dendrites. They argue that channels called h-channels, are distributed throughout the dendrite membrane and allow the passage of potassium and sodium ions into and out of the neuron and these are altered during learning. "*The h-channels undergo plasticity, not near the synapse but probably throughout the dendritic tree*" *(*Johnston 2005).

4.4.5 Main Concepts for Learning and Memory

According to Rose (1993), learning is a response by an actor to a novel situation. The actor's behaviour is modified in such a way as to generate a response that is appropriate to the situation. Consequently, remembering is the application of the modified behavioural response at a later time. (An actor can be a human, animal or a non-human (Latour 1996), for example, special voice recognition software programs, such as Dragon Naturally Speaking).

Bendrups (2000) provides a simplified version of this:

> *"Learning is the development of a change in behaviour or acquisition of knowledge as a result of experience. It is usually adaptive or useful. Memory is the reflexion over time of the change in behaviour or acquired knowledge*" (Bendrups 2000).

It can be argued that learning is a process in which memory is formed (as a result of experience). Therefore, memory is the storage of learning processes or outcomes. An individual's interaction with the environment plays a significant part to the acquisition or storage of memory (Starmer 2004).

In general, lasting changes (storage) are referred to by the technical term "neural plasticity". It is well known that behaviour is changed as a result of learning (Pavlov 1904), and thus there has to be some change in the biological organ which controls the behaviour, mainly the brain. This change is generally called "synaptic plasticity". Therefore, the biological basis of learning and memory is related to "neural plasticity".

The literature described two kinds of learning. The first, non-associative (Bailey et al. (1993) is obtained via simple repetition and it involves strengthening of the synapses leading to a stronger response. This works at the cellular level in many parts of the brain (e.g., cerebellum and cerebral cortex). This is also referred to as "rote" learning in humans. The second, associative learning in Pavlov (1904), is linked to conditioning stimulus and is a more complex type of learning, since it involves stimuli occurring very close in time. Memory is stored as a change in synaptic strength (weight) reward, or punishment. This involves depolarizing the neuron where Na+, K+ and Ca are involved in the process (Hebb 1949).

From a pedagogical point of view, learning organises and reorganises the brain. Different parts of the brain may be ready to learn at different times. Neuroscientists have inquired about brain activity and its link to behaviour and learning. For example, some of the specific questions include the following:

1. *Are there stages of brain development?*
2. *Are there critical periods to allow normal brain development?*
3. *How is information encoded in various nervous systems?*

4. *How does experience affect the brain?*

Let us examine the biological stages of thinking and learning and the nervous system. As was mentioned above, learning adds synapses, whilst exercise does not. Learning specific tasks brings about localised change in the areas of the brain appropriate to the task (Greenough et al. 1979).

4.4.6 Biological Stages of Thinking and Learning

According to Lowery (2000) there are several biological stages of thinking and learning. These are listed in the Figure 4-6 below and their significance is discussed in Section 4.4.10 below.

Stage 1	A child's cognitive development is highly sensory.
Stage 2	Resemblance sorting -at age 3 child displays pre-patterning abilities.
Stage 3	Consistent and exhaustive sorting-age 6 to 8 organisational logical capacity exhibited.
Stage 4	Multiple membership classification-true patterning abilities-ages 8 to 10 shows ability to classify objects into categories.
Stage 5	Inclusive classifying-thinking about the relationships about groups of objects –aged 10: emergence of deductive reasoning, make logical inferences between groups.
Stage 6	Horizontal re-patterning- flexibility in patterning abilities. Age 13, more flexible thinking, organise and re-organise objects or ideas in different ways.
Stage 7	Hierarchical re-patterning. Age 16, classify and re-classify objects or ideas into hierarchies of increasing related or inclusive classes, develop taxonomy based on logical rationale concerning the relationship. This is the cognitive stage that exemplifies the highest order of flexible thinking.

Figure 4-6: Biological stages of thinking and learning (Source: Lowery 2000)

4.4.7 The Genetic Basis of Cognition:

In his paper, Jonathan Flint (1999) discussed the genetic basis of cognition. His review examined genetic variance on cognitive processes and discussed how some genetic disorders have associative cognitive phenotypes. Therefore, the learning outcomes could be affected by single genes or chromosome disorders as there is a purely cognitive phenotype that has a relatively direct effect on cognition (Flint 1996). Table 4-1 lists the categories of genetic disorders which are associated with cognitive impairments. Examples of this are difficult to find and earlier studies on individual differences in intelligence, primarily using IQ measures, have produced evidence for a genetic influence. A large percentage (50%) of the variation of IQ test scores can be linked to genetic variation (Bouchard 1998, Devlin 1997).

Category	Disorder	Genetic abnormality	Location	Abnormal gene product	Function
Dementias	Huntington disease	Single gene	4p	Huntingtin	Unknown
	Alzheimer's disease	Single gene	21q	Amyloid precursor protein	Amyloid component
	Alzheimer's disease	Single gene	14q	Presenilin 1	APP trafficking
	Alzheimer's disease	Single gene	1q	Presenilin 2	APP trafficking
	Pick's disease	Single gene mutation	17q	Tau	Microtubule associated protein
Non-specific MR	XLMR	Single gene	Xq	GDI1	Rho GTPase signalling
	XLMR	Single gene	Xq	PAK3	Rho GTPase signalling
	XLMR	Single gene	Xq	Oligophrenin	Rho GTPase signalling
	XLMR	Single gene	Xq	FMR2	Unknown
Syndromic MR (mutations in a single gene)	Fragile X syndrome (FRAXA)	Single gene mutation	Xq	FMR1	Unknown
	ATRX syndrome	Single gene	Xq	ATRX	Transcriptional regulator
	Duchenne muscular dystrophy	Single gene mutation	Xp	Dystrophin	Cytoskeletal component
	OpitzG/BBB	Single gene	Xq	MID1	Transcriptional regulator
Syndromic MR (segmental aneusomy)	Rubinstein–Taybi syndrome	Single gene mutation	16p	CBP	Transcriptional co-activator
	Williams syndrome	Segmental monosomy	7q	LIM2 kinase	Synapse formation and maintenance?
	Turner syndrome	Segmental monosomy	X	Multiple genes?	Unknown
	Prader–Willi syndrome	Segmental monosomy/parent of origin imprint	15q	Multiple genes?	Unknown
	Angelman syndrome	Single gene mutation/parent of origin imprint	15q	UBE3A	Ubiquitin mediated protein degradation
	DiGeorge, Velocardio-facial and conotruncal anomaly face syndromes	Segmental monosomy	22q	Multiple genes?	Transcriptional regulators?
	Down syndrome	Segmental trisomy	21q	Minibrain?	
Complex disorders	Dyslexia	Quantitative trait locus	6p	Unknown	

ATRX = α-thalassaemia mental retardation X-linked syndrome; MR = mental retardation; XLMR = X-linked mental retardation.

Table 4-1: Categories of genetic disorders associated with cognitive impairment (Source: Flint 1999)

4.4.8 A Biological Generative Learning Model

In her paper, Schaverien et al. (2000, 2002), "A biological basis for generative learning[47]" discussed what the literature presented and how it supported the argument that learning is a generative act. In addition, neuroscience (Edelman 1993) further supported the concept of a biological basis for generative learning in technology and science. This model is relevant for this study as the concept could be applied to interpret the results from the three case studies in this thesis. In particular, the next section introduces the Generative Learning Model that has been applied in teaching and learning.

[47] See Glossary

4.4.8.1 The Generative Learning Model (GLM)

The GLM model was proposed by Osborne & Wittrock (1983) and has four steps that relate to learning and teaching:

1. In the preliminary step, before beginning any formalized instruction, teachers assess students' ideas and conceptual explanations.
2. In the focus step, the instructor provides experiences related to the particular concept that motivates the students to explore their level of conceptual understanding.
3. Next, the teacher helps students exchange points of view and challenges students to compare and contrast their ideas and support their viewpoints with evidence (the challenge stage); and
4. In the application stage, students use their newly refined conceptual understandings in familiar contexts.

This model can be applied to LD students to assess their skill level and to diagnose learning difficulties. The ensuing sections provide discussion on brain structure, gender differences and cognitive function, and the seven stages of biological basis for thinking and learning. These are relevant to this study and are within its scope. The GML model is illustrated in Figure 4-7 below.

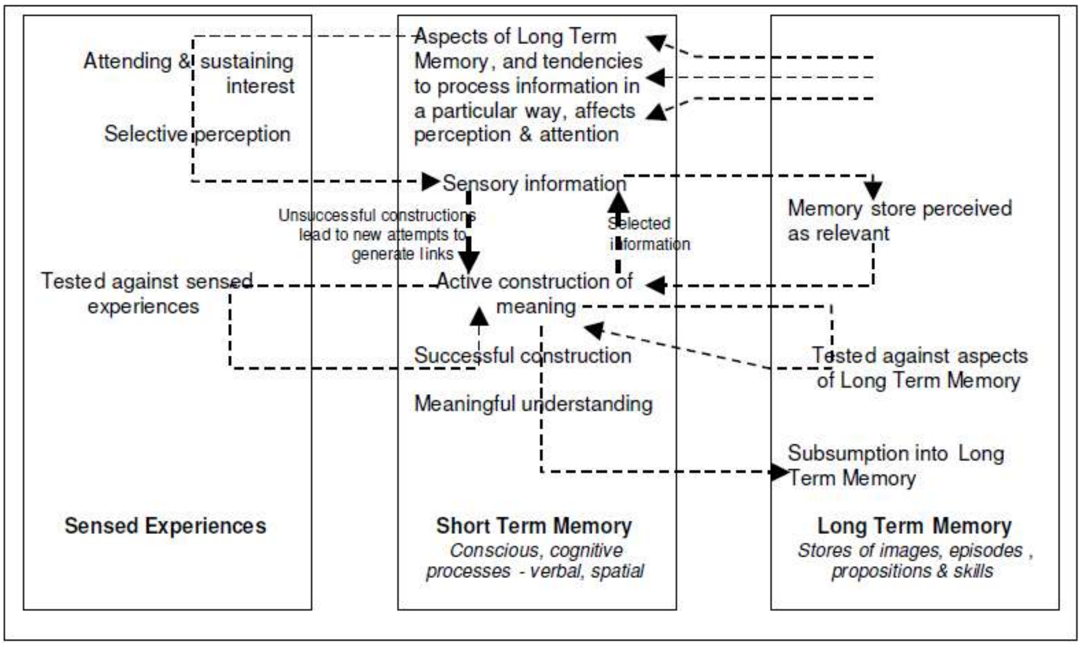

Figure 4-7: The Generative Learning Model (Source: Osborne & Wittrock 1983)

This model can be applied to LD students to assess their skill level and diagnose any learning difficulties. The ensuing sections provide discussion on brain structure, gender differences and cognitive function, and the seven stages of biological basis of thinking and learning by Lowery (1998). These concepts are relevant for this study and are within its scope.

4.4.8.2 Experience & Brain Structure

The literature revealed studies that brain structure can be modified with experience. Questions like "*What is needed within the brain to retain new information that is learnt?*" became very significant. As mentioned earlier, the brain is able to undergo many forms of plastic change. There is growth or change in existing structure, particularly synapse number and structure, which predominately underlies learning. Recovering from damage may depend on similar changes. According to Ivanco and Greenough (2000) a process called neurogenesis is involved in both learning and damage. Hebb's (1949) postulate of firing neurons dependency to maintain synaptic efficacy occurs during learning. Factors mediating plastic change are discussed in Ivanco et al. (2000). The application of Hebbian rules to recovery from damage is a morphological change. The learning brain and the recovering brain may utilise common mechanisms, whereas experience can influence plasticity (Kolb 1995).

4.4.8.3 Cognitive function & Gender difference

The thesis also found studies that relate to gender difference in the cognitive function. There are studies that show close relation between brain size and function (Geschwind & Levitsky 1968, Kimura 1987). Further, studies have also demonstrated a link with structure size, function and intelligence and size of grey matter cerebral structures (Andreasen 1993). A correlation between size and intelligence was found by Willerman et al. (1992) and McGlone (1980).

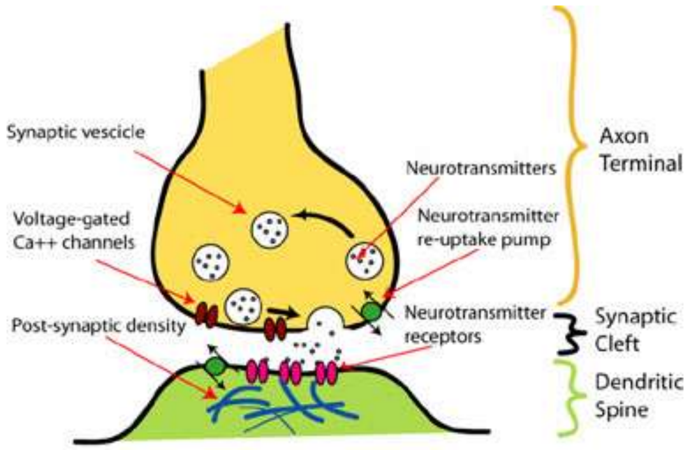

Figure 4-8: Neuron structure model

(Source: www.scq.ubc.ca/.../uploads/2007/05/synapse.jpg ,image at: www.scq.ubc.ca/.../)

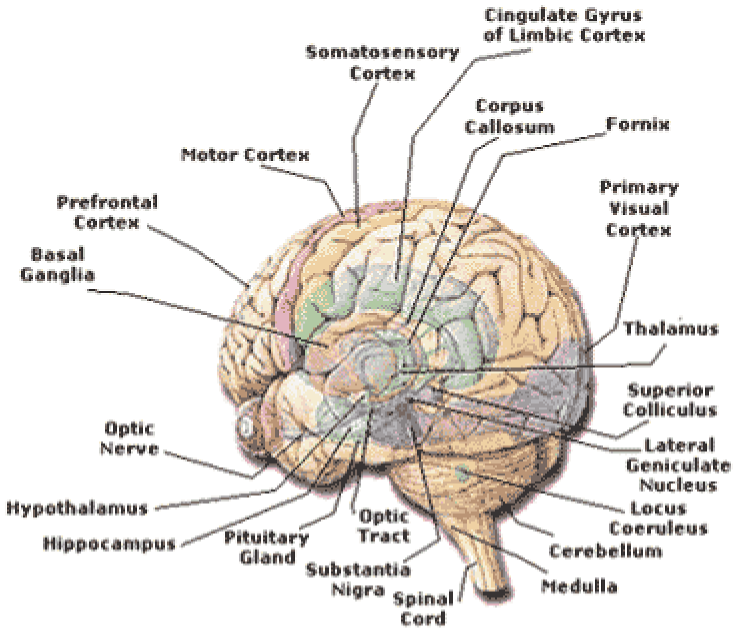

Figure 4-9: Brain model (Source: www.akri.org/cognition/images/brstruc.gif)

Other research studies by Maturana (1980), Lowery (1998), and Aujla et al. (2001) also provided arguments that link the nervous system to learning. In fact, Lowery (1998) provided the seven stage model of biological stages of thinking and learning which was presented in Figure 4-6 above, and this view was linked to non-connectionist models. It was argued that experiential learning induces neurons to act in a logical pattern (Stergiou et al. 1996). Therefore, we may think of memory storage as a collection of electrical patterns produced from a range of neurons. The reverse process is thinking – this involves the release of electrical patterns from memory storage (Lowery 2000). In

Lowery’s view, the neural images are decomposed into components and can be stored in different memory areas which are then reassembled during memory recall.

> *“The nature of thinking capabilities and the sequence in which they appear have been well established on two research fronts. The biological basis underlying their appearance is established by periodic increases in brain size, brain weight, cellular growth within the brain, electrical functioning with the brain and head circumference. The psychological basis is established through evidence of the individual's increasing capacity to deal with independent ideas and to exhibit the same kinds of behaviours as other individuals within two- to – three - year ranges and with growth, the individual's ability to replace naive with more sophisticated views”* (Lowery 2000).

According to Lowery (2000), “*When Stage 7 appears at about age 16, students are able to classify and reclassify objects or ideas into hierarchies of increasingly related or inclusive classes”* (Lowery 2000).

It is now that the individual can develop taxonomy based on a logical rationale concerning the relationships among the objects or ideas comprising the taxonomy while also realizing that the arrangement she has made is tentative and can be changed based on fresh insights. A content expertise is necessary. This cognitive stage exemplifies the highest order of flexible thinking. (See Figure 4-10 below)

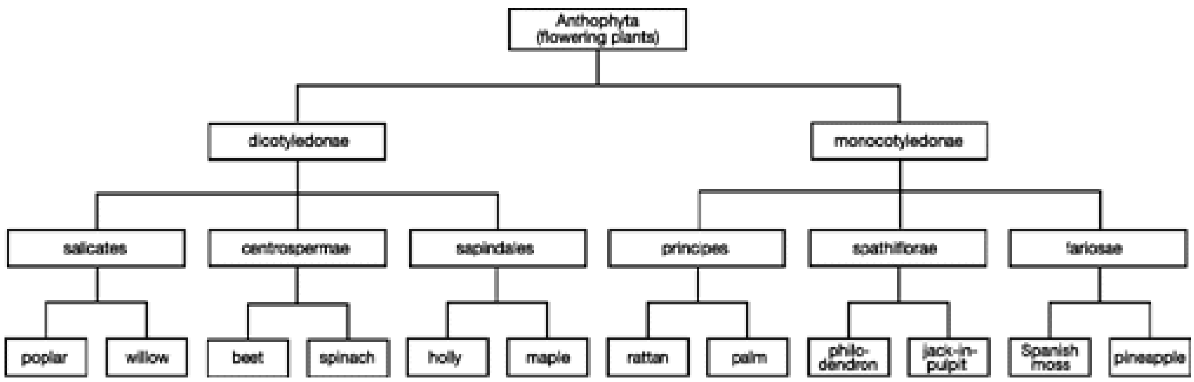

Figure 4-10: The learning activities for Stage 7 (Source: Lowery 2000)

According to Maturana (1980) the three processes: - thinking, learning and memory - can all be regarded as electrical stages existing across neurons carrying specific messages (independent of any given cell). The neuron firing theory can be seen as the carrier or transformation of a sequence of messages from chemical to electrical across the synapsis.

Another important question is "*Does a student's learning environment and their behaviour affect the thinking process?* There are several studies that have investigated this question. For example, Huitt (2000), Schunck (2001) and Boyle (2000) (constructivist principles). Particular importance, for example, was given to the infrastructure and the classroom environment in the case studies in this thesis.

4.4.9 Timeline for Brain Models and Relevant Technologies

The various contributors of brain model theories, and other relevant authors, have been grouped and summarised in the time line below, Figure 4.11. This timeline links the information that is described in this section of the thesis, and provides an overview of the studies and paradigms that have contributed to teaching- both mainstream and special needs education. A summary of the brain models and learning theories is shown in Figure 4.12. Further information is contained in tables 4.5 and 4.6 at the end of this chapter.

Figure 4-11: Contributors of brain model theories (Constructed from literature)

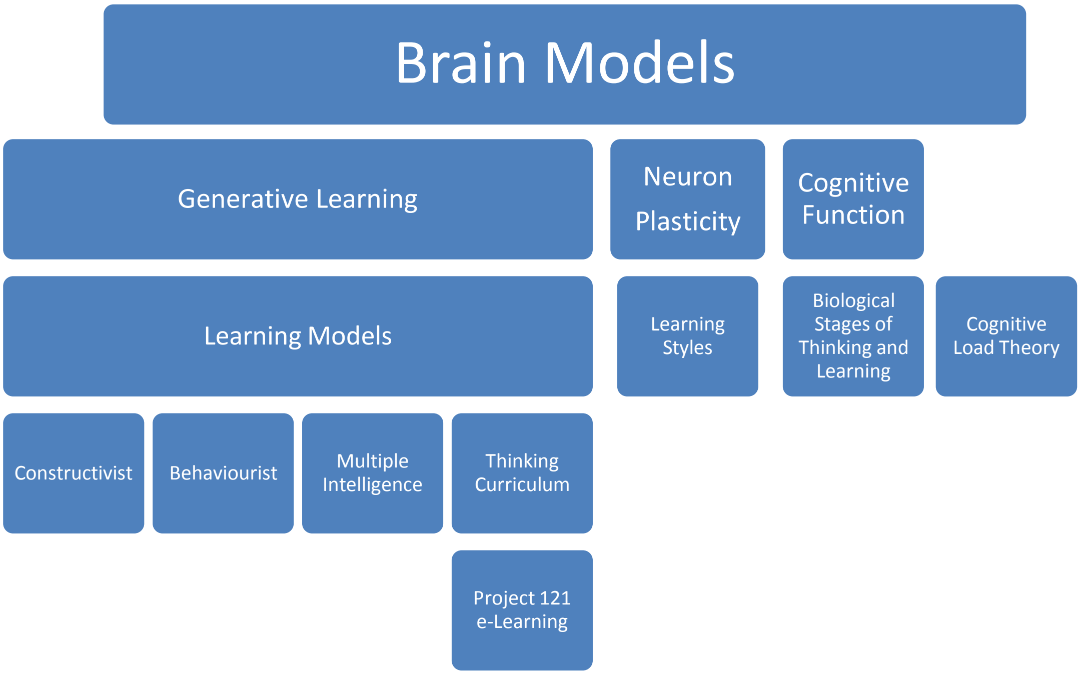

Figure 4-12: Overview of Brain models (Constructed from literature)

4.4.10 The Brain: Foundation for Learning

In summary, the literature indicates that Neuroscientists study the anatomy, physiology, chemistry and molecular biology of the nervous system, with particular interest in how brain activity relates to behaviour and learning. Several crucial questions about early learning particularly intrigue neuroscientists. *How does the brain develop? Are there stages of brain development? Are there critical periods when certain things must happen for the brain to develop normally? How is information encoded in the developing and the adult nervous systems?* And perhaps most important: *How does experience affect the brain?*

A nerve cell, or neuron, is a cell that receives information from other nerve cells or from the sensory organs and then projects that information to other nerve cells, while still other neurons project it back to the parts of the body that interact with the environment, such as the muscles. Nerve cells are equipped with a cell body—a sort of metabolic heart—and an enormous treelike structure called the dendritic field, which is the input side of the neuron. Information comes into the cell from projections called axons. Most of the excitatory information comes into the cell from the dendritic field, often through tiny dendritic projections called spines. The junctions through which information passes from one neuron to another are called synapses which can be excitatory or inhibitory in nature. The neuron integrates the information it receives from all of its synapses and this determines its output (Bendrups 2000, Hebb 1949, Stergiou et al. 1996).

One may ask the following pertinent question:

> *Are the changes in the brain due to actual learning or to variations in aggregate levels of neural activity?*

It is very well known that animals in a complex environment not only learn from experiences, but they also run, play and exercise, which activates the brain. The question is whether activation alone can produce brain changes without the subjects actually learning anything, just as activation of muscles by exercise can cause them to grow (Pavlov 1904).

It has also been established that learning adds synapses; whilst exercise does not. Thus, different kinds of experience condition the brain in different ways. Synapse formation and blood vessel formation (vascularization) are two important forms of brain adaptation, but they are driven by different physiological mechanisms and by different behavioural events (Black 2002).

Learning specific tasks brings about localized changes in the areas of the brain appropriate to the task (Greenough et al. 1979). Clearly, the brain can store information, but what kinds of information?

According to Kuhl:

> *"Very young children discriminate many more phonemic boundaries than adults, but they lose their discriminatory powers when certain boundaries are not supported by experience with spoken language"* (Kuhl 1993*).*

Furthermore, the process of synapse elimination occurs relatively slowly in the cerebral cortical regions that are involved in aspects of language and other higher cognitive functions (Huttenlocher & Dabholkar 1997). As stated above, Lowery (2000), different brain systems appear to develop according to different time frames, driven in part by experience and in part by intrinsic forces. This process suggests that children's brains may be more ready to learn different things at different times. But, as noted above, learning continues to affect the structure of the brain long after synapse overproduction and loss are completed. New synapses are added that would never have existed without learning and the wiring diagram of the brain continues to be reorganized throughout one's life. There may be other changes in the brain involved in the encoding of learning, but most scientists agree that synapse addition and modification are the ones that are most certain (Black 2002).

Language provides a particularly striking example of how instructional processes may contribute to organizing brain functions. This is interesting because language processes are usually more closely associated with the left side of the brain (see Figure 4-14 below). As the following discussion points out, specific kinds of experiences can contribute to other areas of the brain taking over some of the language functions. For example, deaf people who learn a sign language are learning to communicate using the visual system in place of the auditory system. Manual sign languages have grammatical structures, with affixes and morphology, but they are not translations of spoken languages (Stevens 2008).

Neuroscientists have investigated how the visual-spatial and language processing areas each come together in a different hemisphere of the brain, while developing certain new functions as a result of the visual language experiences. In the brains of all deaf people, some cortical areas that normally process auditory information become organized to process visual information. Yet there are also demonstrable differences among the brains of deaf people who use sign language and deaf people who do not use sign language, presumably because they have had different language experiences (Neville, 1984, 1995).

The literature provides studies that show that memory is neither a single entity nor a phenomenon that occurs in a single area of the brain. There are two basic memory processes: declarative memory, or memory for facts and events which occurs primarily in brain systems involving the hippocampus; and procedural or non-declarative memory. The latter is memory for skills and other cognitive operations, or memory that cannot be represented in declarative sentences. This occurs principally in the brain systems involving the neostriatum[48] (Squire 2004). Figure 4-13 below shows the taxonomy of

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[48] The neostriatum was identified as important for gradual, feedback-guided learning that results in habit memory (Mishkin et al. 1984)

mammalian long-term memory systems. The taxonomy lists the brain structures thought to be especially important for each form of declarative and non-declarative memory. In addition to its central role in emotional learning, the amygdale is able to modulate the strength of both declarative and non-declarative memory. According to Tulving (2002), declarative memory can be divided into semantic memory (facts about the world) and episodic memory (the capacity to re-experience an event in the context in which it originally occurred) (Squire 2004).

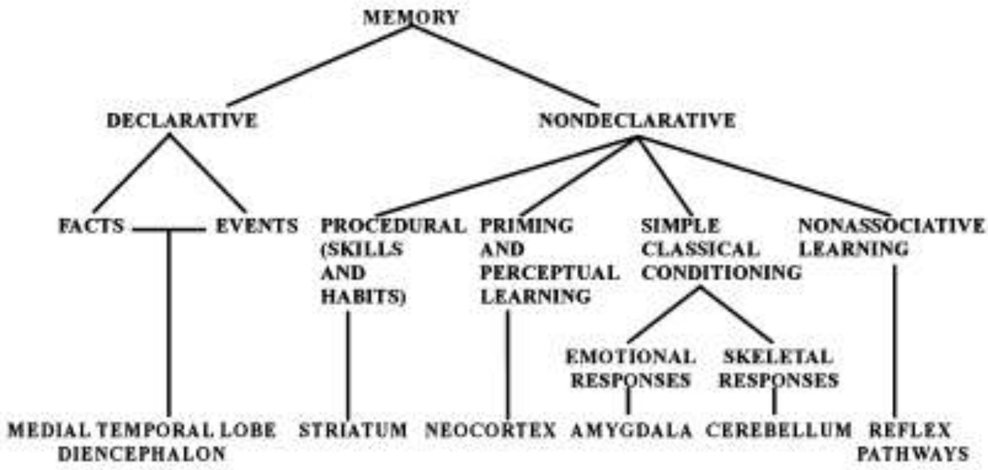

Figure 4-13: A taxonomy of mammalian long-term memory systems (Source: Squire 2004)

Different features of learning contribute to the durability or fragility of memory. For example, comparisons of people's memories for words with their memories for pictures of the same objects show a superiority effect for pictures. The superiority effect of pictures is also true if words and pictures are combined during learning (Roediger 1997). Obviously, this finding has direct relevance for improving the long-term learning of certain kinds of information.

If one summarises these findings, then classes of words, pictures and other categories of information that involve complex cognitive processing on a repeated basis activate the brain. This activation sets into motion the events that are encoded as part of long-term memory. Memory processes treat both true and false memory events in a similar manner and, as shown by imaging technologies, activate the same brain regions, regardless of the validity of what is being remembered. Experience is important for the development of brain structures and what is registered in the brain as memories of experiences can include one's own mental activities.

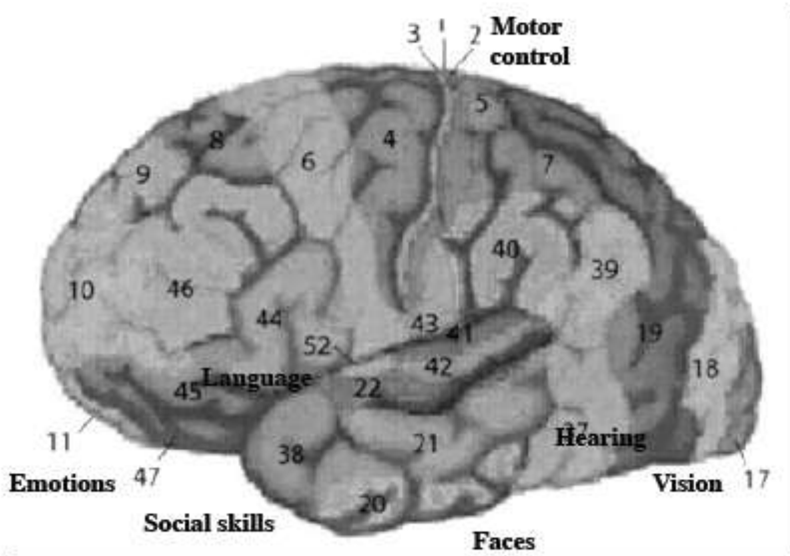

Figure 4-14: Brain Model and Language (Source: Stevens 2008)

The model clearly illustrates the part of the brain that is closely associated with language processing and function.

Section 4.5 provides key questions that have stemmed from the literature and brain model theories, which are relevant for LD students, and in particular, the individual case study of the thesis.

4.5 KEY QUESTIONS ARISING FROM BRAIN MODELS THEORY

If we assume the following are true:

- The functional organization of the brain and the mind depends on and benefits positively from experience.

- Development is not merely a biologically driven unfolding process, but also an active process that derives essential information from experience.

- Research has shown that some experiences have the most powerful effects during specific sensitive periods, while others can affect the brain over a much longer time span.

Then how can we answer the following question in relation to education with ICT and LD?

- How can these be applied to explain the learning outcomes with respect to a particular area like graphics and multimedia?
- How does ICT help with the acquisition of skills and application of the various software packages like Photoshop, 3D Studio Max, Adobe Premier, sound production and video production for students with learning difficulties?

Before I discuss ICT and other related issues such as its impact on teaching and learning (formally) and teaching and learning models or paradigms for LD students, I would like to include a section on Learning Styles Theories from Kolb (1984) and Gardner's multiple intelligences theory. Even though some debate abounds regarding their validity, they are nonetheless universal in educational policies and instruction and hence, it is worthwhile to include these in the dissertation.

4.6 LEARNING STYLES THEORIES

4.6.1 Introduction to Learning Styles Theories

This study recognised that one important area to be analysed was that of David Kolb's learning styles model with respect to experiential learning [ELT]. This model dates back to1984 and acknowledges the early work on experiential learning of other researchers in the early 1900s including Rogers (1995), Jung (2005) and Piaget (1974). The learning styles and experiential learning theory have been acknowledged by many academics and stages as significant concepts towards the understanding of learning behaviour and learning outcomes. This model has also assisted in curriculum design by fostering the students learning processes. For example, the multiple intelligence theory of Gardner (1983) has been applied in many educational teaching programs or curricula in schools – even in the last few years (2007-2010), a program which is called **i-learning** is based on the multiple intelligences theory of Gardner, and is offered to individual and LD students in Victorian government schools. The basic concepts of the experiential learning theory or learning styles model are summarized below and these will be referred to in the discussion particularly with reference to the individual case study.

4.6.2 David Kolb's Learning Styles Model and Experiential Learning Theory (ELT)

It was mentioned in the section on Brain Models, that learning is influenced by behaviour and the environment that the students work in. In particular, it would be helpful here if we digress a little and review two significant theories or models. These are respectively:

- Gardner’s Multiple Intelligences (Gardner 1983) and
- Kolb’s Learning Styles Model and Experiential Learning Theory (ELT) (Kolb 1984).

In general, both of these models have been acknowledged by academics, teachers and trainers as fundamental concepts towards our understanding and interpreting human learning behaviour patterns. The thesis identified a critical review of the Cognitive and Learning Styles Literature through Citation Analysis by Desmedt et al. (2002) that has investigated all publications since 1972 (AERA[49] 2002). The review analysed some of the criticisms of the relevant taxonomies and theories. The main points were linked to the following areas: inconsistency, exhaustiveness, distinguishing criteria, scientific impact, bias, and context.

An alternative organisation or approach was proposed that addressed the above points and introduced un-ambiguity, clear distinguishing criteria, objectivity, scientific impact and relevant information about the context.

The analysis showed that the cognitive style research field is larger and much more differentiated than the learning style research field. The former is less specific and formulated at an abstract level, whilst the latter is a smaller research field and the context is especially related to education. For example, Kolb has been identified with the learning style literature (Desmedt et al. 2002). Figure 4-15 shows a comparison of the cognitive and learning style models.

49 AERA= American Educators Resources Association

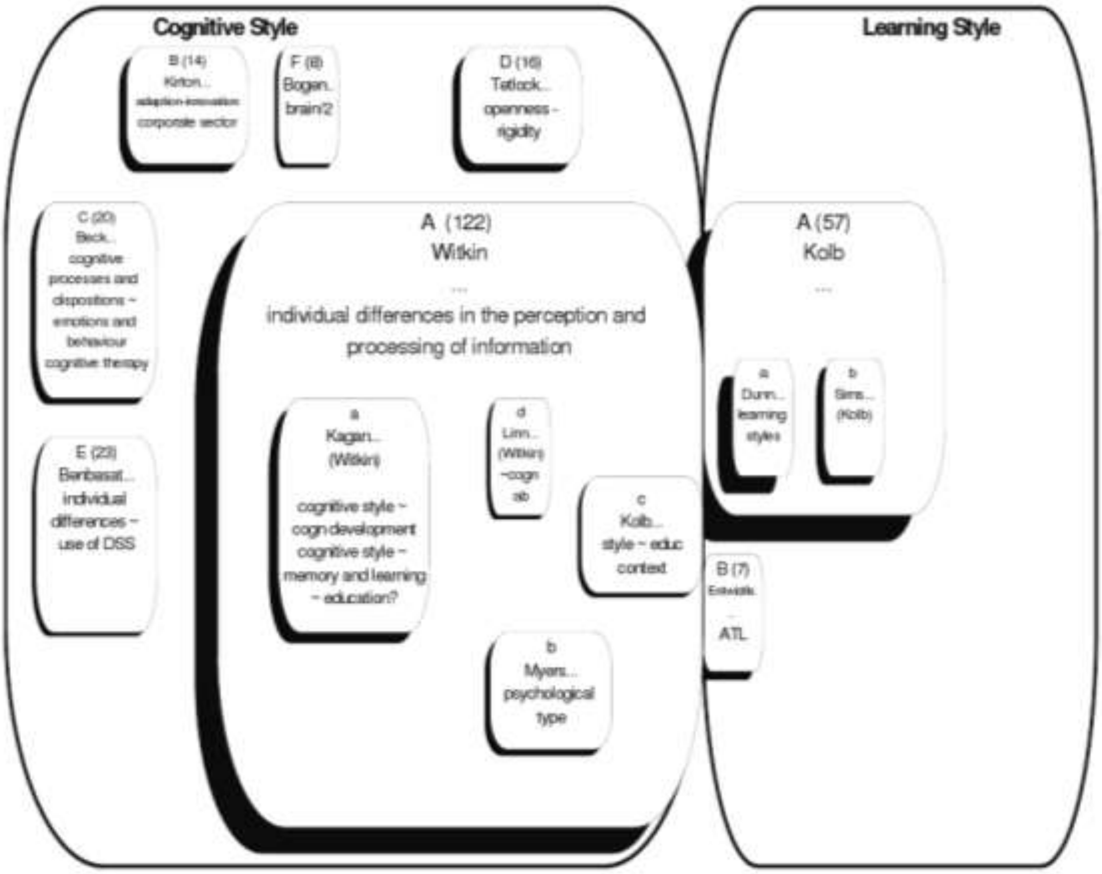

Figure 4-15: Cognitive style and learning style model (Source: Desmedt et al. 2002)

Although the study proposed further analysis that would incorporate the impact of scores of the journals in which the authors published, it argued positively that the expected criteria for an alternative organisation was satisfied through their clustering method or approach of specific publications or authors. This method provided clear distinguishing criteria. The thesis has therefore adopted these criteria and assumed the validity of learning style research. The next section discusses the key concepts of Kolb's experiential learning theory (Learning Styles Method).

4.6.3 Kolb's Experiential Learning Theory (Learning Styles) Model

According to Kolb (1983), there are four distinct learning styles (or preferences) which are based on a four–stage learning cycle. This model can help us to understand individual differences in learning and in particular experiential learning. The cycle of learning has four stages in which "*immediate or concrete experience*" provides the basis for "*observations and reflections*". The latter are assimilated and filtered into "*abstract concepts*" and subsequently produce new implications for action that can be "*actively tested*" and create new experiences.

This model therefore works on two levels - a four-stage cycle:

1. Concrete Experience - (CE)
2. Reflective Observation - (RO)
3. Abstract Conceptualization - (AC)
4. Active Experimentation - (AE)

and a **four-type definition of learning styles**, (each representing the combination of two preferred styles, rather like a two-by-two matrix of the four-stage cycle styles, as illustrated below), for which Kolb used the terms:

1. Diverging (CE/RO)
2. Assimilating (AC/RO)
3. Converging (AC/AE)
4. Accommodating (CE/AE)

Figure 4-16 below, provides an updated diagram or model for Kolb's learning styles.

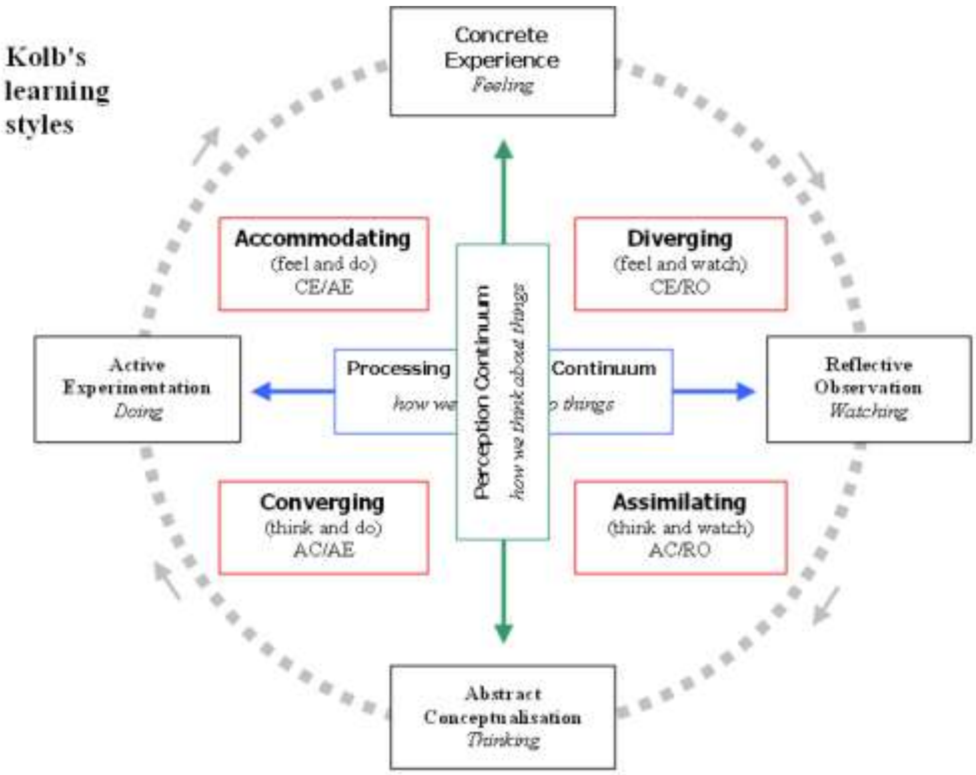

Figure 4-16: Kolb's Learning Styles Model (Source: Kolb 1984)

4.7 BRIEF DISCUSSION ON LEARNING STYLES

Kolb explained that different people naturally prefer a certain single different learning style. Various factors influence a person's preferred style: notably in his experiential learning theory model (ELT) Kolb defined three stages of a person's development and suggested that our propensity to reconcile and successfully integrate the four different learning styles improves as we mature through our development stages. The development stages that Kolb identified are:

> *"Acquisition - birth to adolescence - development of basic abilities and 'cognitive structures'*
>
> *Specialization - schooling, early work and personal experiences of adulthood - the development of a particular 'specialized learning style' shaped by 'social, educational, and organizational socialization'*
>
> *Integration - mid-career through to later life - expression of non-dominant learning style in work and personal life"* (Kolb 1984).

Whatever influences the choice of style, the learning style preference itself is actually the product of two pairs of variables, or two separate 'choices' that we make, which Kolb[50] (1995) presented as lines of axis, each with 'conflicting' modes at either end:

Concrete Experience - CE (feeling) **-V-Abstract Conceptualization - AC** (thinking)

Active Experimentation - AE (doing)**-V- Reflective Observation - RO** (watching)

A typical presentation of Kolb's two continuums is that the east-west axis is called the Processing Continuum (how we approach a task), and the north-south axis is called the Perception Continuum (our emotional response, or how we think or feel about it). These learning styles are the combination of two lines of axis (continuums) each formed between what Kolb calls 'dialectically related modes' of 'grasping experience' (doing or watching), and 'transforming experience' (feeling or thinking) shown in Figure 4-17 below.

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[50] Kolb 1995, Brain Plasticity and behaviour, Hillside, NJ Erlbaum.

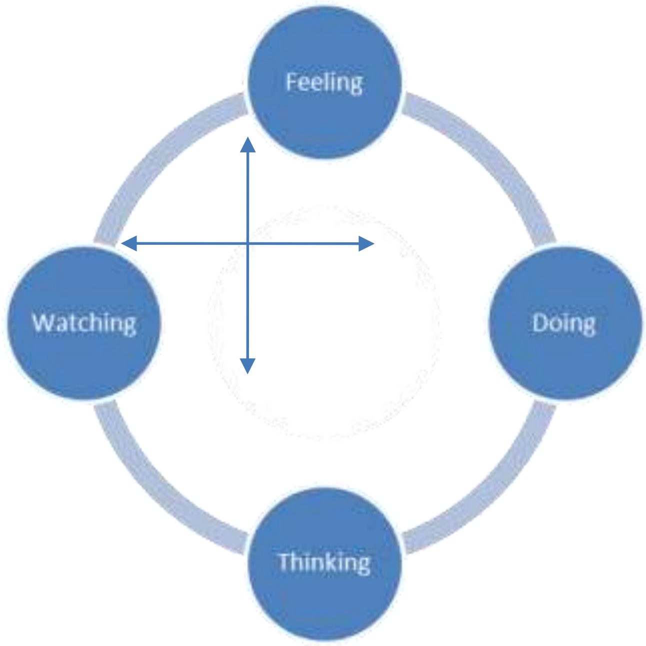

Figure 4-17: Processing & Perception Continuums (Source: Kolb 1984)

4.8 HOWARD GARDNER'S MULTIPLE INTELLIGENCES THEORY

Another way to view the capacity or set of intelligences is to follow Gardner's (1983) intelligence types, capabilities and perception. A summary of these is presented in Table 4-2 below to complement the discussion on learning styles.

Intelligence type	capability and perception
Linguistic	words and language
Logical-Mathematical	logic and numbers
Musical	music, sound, rhythm
Bodily-Kinesthetic	body movement control
Spatial-Visual	images and space
Interpersonal	other people's feelings
Intrapersonal	self-awareness
intelligence type	capability and perception
Naturalist	natural environment
Spiritual/Existential	religion and 'ultimate issues'
Moral	ethics, humanity, value of life

Table 4-2: Gardner's Multiple Intelligences (Source: Gardner 1983)

4.9 OTHER LEARNING STYLES

There are other learning styles models that have integrated Kolb's and Gardner's ideas. One of these is the Visual Auditory Kinesthetic learning styles model (VAK)[51] which is similar to Fleming's Visual Reading. Auditory Kinesthetic model. Fleming[52] claimed that visual learners have a preference for seeing (think in pictures; visual aids such as overhead slides, diagrams, handouts, etc.). Auditory learners best learn through listening (lectures, discussions, tapes, etc.). Tactile / kinesthetic learners prefer to learn via experience—moving, touching and doing (active exploration of the world; science projects; experiments, etc.). Its use in pedagogy allows teachers to prepare classes that address each of these areas. Students can also use the model to identify their learning style and maximize their educational experience by focusing on what benefits them the most (Fleming 1995).

In addition, there are also studies that link a mix of intelligences which is reflection of their brain type and dominance. According to Aujla & Beninger (2001) it is possible to measure brain function and energy consumption in the brain, like for example, in brain scan technologies such as PET and MRI. Sylwester (1995) discussed the importance of brain development and the implications for education and the learning sciences.

4.9.1 Visual-Auditory-Kinesthetic Learning Styles (VAK)

Although now somewhat questioned (Claxton 2009, Pashler[53] et al. 2009), the VAK learning styles model provides a very easy and quick reference inventory by which to assess people's preferred learning styles, and then most importantly, to design learning methods and experiences that match people's preferences:

- **Visual** learning style involves the use of seen or observed things, including pictures, diagrams, demonstrations, displays, handouts, films, flip-chart, etc.

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51 VAK concepts theories were first developed by psychologists and teaching specialists such as Keller, and Montessori in the 1920s. VAK originally concerned with the teaching of dyslexia, where conventional teaching methods were not effective.

52 Lifestyles were critiqued by several authors, one of whom is Claxton (2009). The full lifestyle literature was mentioned in Desmedt et al. (2002) in Section 4.6.2.

53 In fact Pashler provides discussion about the relevance and credibility of learning styles in Pashler et al. (2009), "Learning Styles Concepts and Evidence".

- **Auditory** learning style involves the transfer of information through listening: to the spoken word, of self or others, of sounds and noises.
- **Kinesthetic** learning involves physical experience - touching, feeling, holding, doing, and practical hands-on experiences.

The word 'kinesthetic' describes the sense of using muscular movement - physical sense in other words. Kinesthesia and kinesthesis are root words, derived from the Greek kineo, meaning move and aisthesis, meaning sensation. Kinesthetic therefore describes a learning style which involves the stimulation of nerves in the body's muscles, joints and tendons (Claxton 2009).

4.10 HONEY AND MUMFORD'S VARIATION ON THE KOLB MODEL

Various resources refer to the terms 'activist', 'reflector', 'theorist', and 'pragmatist' (respectively representing the four key stages or learning steps) in seeking to explain Kolb's model. In fact, 'activist', 'reflector', 'theorist' and 'pragmatist' are from a learning styles model developed by Honey & Mumford (1983), which although based on Kolb's work, is different. Arguably therefore the terms 'activist', 'reflector', 'theorist' and 'pragmatist' effectively 'belong' to the Honey and Mumford theory.

Peter Honey and Alan Mumford developed their learning styles system as a variation on the Kolb model whilst they were working on a project in the 1970s. Honey and Mumford described their system by the following:

> *"Our description of the stages in the learning cycle originated from the work of David Kolb. Kolb uses different words to describe the stages of the learning cycle and four learning styles..."*
>
> *And, "...The similarities between his model and ours are greater than the difference"* (Honey & Mumford 1983).

The reader should note here that there are four Honey & Mumford key stages/styles, which incidentally are directly mutually corresponding and overlaid, as distinct from the Kolb model in which the learning styles are a product of combinations of the learning cycle stages. The typical presentation of these styles and stages would be respectively at north, east, south and west on a circle or four-stage cyclical flow diagram (see above).

1. **'Having an Experience'** (Stage 1), and **Activists** (Style 1): 'here and now', gregarious, seek challenge and immediate experience, open-minded, bored with implementation.
2. **'Reviewing the Experience'** (Stage 2) and **Reflectors** (Style 2): 'stand back', gather data, ponder and analyse, delay reaching conclusions, listen before speaking, thoughtful.
3. **'Concluding from the Experience'** (Stage 3) and **Theorists** (Style 3): think things through in logical steps assimilate disparate facts into coherent theories, rationally objective, reject subjectivity and flippancy.
4. **'Planning the next steps'** (Stage 4) and **Pragmatists** (Style 4): seek and try out new ideas, practical, down-to-earth, enjoy problem solving and decision-making quickly, bored with long discussions (Honey & Mumford 1983).

There is arguably a strong similarity or correspondence between the Honey & Mumford (1983) styles/stages and the corresponding Kolb learning styles. These can be summarised with the following relationships:

Activist ⇔ Accommodating

Reflector ⇔ Diverging

Theorist ⇔ Assimilating

Pragmatist ⇔ Converging.

In order to complete the discussion on brain models, an area that deserves a brief introduction and is relevant in the thesis, is Cognitive Load Theory.

4.11 BRIEF DISCUSSION ON COGNITIVE LOAD THEORY

Cognitive Load Theory (CLT) provides a framework for designing instructional materials.(Goldman 1991) The basic premise of CLT is that learners have a working memory with very limited capacity when dealing with new information (van Merriënboer et al. 2005). In examining the human cognitive architecture, and according to Sweller et al. (1998), humans possess a working memory (limited capacity) where the information is being held and processed, and a long term memory (large capacity), where cognitive schemas are stored for later use.

From CLT perspective, human expertise come from knowledge stored in these schemata, not an ability to engage in reasoning with many elements that have been organised in long-term memory (van Merriënboer 2005, p149). Schema construction takes place in working memory and then transported to long term memory. When learning new material students must attend to and manipulate relevant pieces of information in working memory before it can be stored in long term memory.

Therefore, it is significant to examine the ease with which information can be processed in working memory, i.e. the cognitive load[54] imposed on working memory. The instructional designers should focus on two tasks: a) reduce extraneous cognitive load and b) encourage learners to apply available resources to advanced cognitive processes that are associated with germane cognitive load. Cognitive load theorists argue that the answer to inefficient, minimally-guided instruction is direct guidance and scaffolding (Kirschner et al. 2006). Evidence from controlled studies supports strong instructional guidance rather than constructivist-based minimal guidance during the instruction of novice to intermediate learners (Kirschner et al. 2006, p83).

The observations and data from Concord[55] also confirm this view. Furthermore, for the individual actor in the case study, reducing the extraneous cognitive load and concentrating on intrinsic and germane cognitive loads, has facilitated significant progress in the learning outcomes at TAFE. An application of Lowery's (2000) horizontal curriculum approach, namely, reducing the different areas of the curriculum and focusing on a specific area such as graphics, provides, I contend, an explanation of the results achieved by the actor in the third case study.

54 There are three types: Intrinsic cognitive load, Extraneous cognitive load and Germane cognitive load.

55 Further details are given in Chapter 7.

4.12 SIGNIFICANCE OF BRAIN MODELS TO CASE STUDIES IN THE PRESENT STUDY

The above models and theories are relevant in this research, and especially to the individual case study, as this will analyse the extent to which ICT can be used as a vehicle to promote learning and foster the skills and knowledge of the student in the case study, who was assessed several years ago with a developmental delay, or learning difficulty. One specific area that is investigated is to determine the effect of ICT on the learning outcomes in graphics. The individual student in the third study studied concepts that involved Screen and Print Graphics, and Multimedia. Further details of the method of investigation and results are provided in Chapters 6 and 7 of the dissertation. Extracts from official transcripts and results will be tabulated from a portfolio of assessments in a course that was undertaken at TAFE, in Chapter 7.

4.13 OTHER RELATED RESEARCH

Further research into the implications of learning styles for the design and development of a web based course were carried out by Moallem (2002). The study examined the major proponents of learning styles theories like Kolb (1983), Witkin (1997), Sternerg (1997), Zhang (2002) and Felder & Silverman (1988) with web design development. The Felder- Silverman approach was used because it proposed a special index called the Index of Learning Style (ILS). The model was used to integrate learning style theory into the design of a course, where the course needed to balance the learning tasks and activities by accommodating all learners with consideration of the four dimensions in the model (these were active/reflective, sensing/intuitive, visual/verbal, sequential/global) (Felder & Silverman 1988). The results showed that 80% of the students thought the course challenged their theory skills and addressed their needs as well as learning styles. This model will be revisited in Chapter 7 where various observations and results will be analysed. Figure 4-18 shows a Venn diagram of the relationship between LD, Learning and ICT. This is explored further in the ensuing sections below.

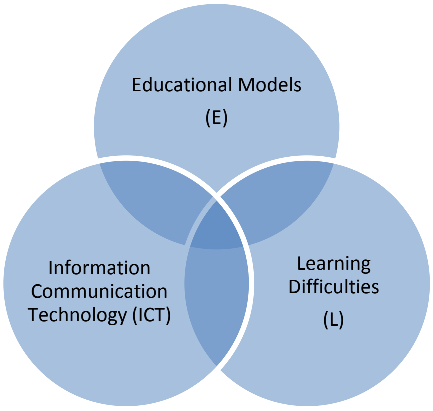

Figure 4-18: Venn diagram – Intersection of ICT, Learning, and LD

Figure 4-18 illustrates the intersection of Educational Models, ICT and LD. From the figure we can see that these are not mutually exclusive and hence it would be appropriate to discuss these in the ensuing sections of this chapter.

International developments in education are relevant to Australia, PISA[56] (OECD 2004, 2005) and Gannon & Sawyer (2007). Australian educators look at these trends to gauge the standard of teaching and learning and benchmark our educational standards to the rest of the world. I have selected a few examples from other countries to demonstrate that the issues and factors that confront LD education are common to those in Australian schools.

The first is a study by Wilson-Strydom et al. (2005) which looks at an examination of the issues for ICT integration in South African Classrooms. According to this study, the adoption of ICTs in education continues to pose challenges both globally (John & Sutherland 2004) and locally, in South Africa (Hodgkinson-Williams 2005). In particular, a White Paper on e-Education summarised the challenges and these fall into three main areas:

- *"Participation in the information society;*
- *Impact of ICTs on access, cost effectiveness and quality of education and*

[56] PISA = Programme for International Student Assessment

- *Integration of ICTs into the learning and teaching process"* (DoE 2003:8).

The second is the Becta (2001) report that details a range of inclusive activities and tools for special needs students in the UK:

> *"Multimedia technology can provide hearing-impaired pupils with access to information in a more immediate and visual form than was previously possible. The opportunity to create multimedia presentations can enable students to experiment with different methods of combining sound and vision. Where appropriate, the sound output can be linked to the enhanced amplification used by the pupil. These sounds become more meaningful when heard in conjunction with moving images on screen"*
>
> (www.becta.org.uk/inclusion/sen/technology/access_technology/hi.htm).

Apart from Becta (2003, 2004, and 2005) studies, the literature provides other relevant studies from the UK. For example, Liu et al. (2007) discuss the "Bridging of ICT and Special Educational Needs" (SNE) using metasynthesis as the analytical tool. They express the concern that ICT itself could create significant barriers for learners and teachers. This concern was also shared by Seymour (2005) from Australia. The study presents an overview of the ICT challengers and the role specific committees like the Joint Information Systems Committee (JISC) have in supporting appropriate access to electronic information services for those with disabilities. The following three main areas are summarised in their study:

> *"ICT may assist learners with disabilities with empowerment to access to their environment and opportunities for personal development which are otherwise denied them. ICT can be a vital tool in supporting advocacy and self-advocacy for people with learning disabilities and can be the means of bringing marginalized people back into their communities.*
>
> *Assistive technologies may include specialized training services, voice interfaces, picture-based email programs and adapted Web browsers.*

Wearable intelligent devices may also assist learners. For example, a wearable data glove has been developed that translates Sign Language and transmits this information wirelessly to an electronic display.

Personal support technologies may benefit individuals in the classroom to remain on task, remind them of pending assignments and provide access to information on the computer or the Internet. The effectiveness of computer-based learning techniques for students with cognitive disabilities has been documented" (Liu et al. 2007).

A very comprehensive source that covers the global perspectives of LD was found in Hallahan et al. (2007). A recent comprehensive literature review on the UK scene is provided by Fisher et al. (2008) with emphasis on technology and special needs Education. Studies from several other countries will be discussed later in this chapter, as these relate to specific aspects such as the impact of ICT on teaching and learning and, pedagogy and ICT integration in the curriculum. Apart from these another significant aspect or factor in the adoption of ICT that has been highlighted is leadership. This will be undertaken in the case studies to determine the significance and role of various actors in the education of LD students.

4.14 OVERVIEW OF OTHER RELEVANT IMPORTANT CONCEPTS IN THIS CHAPTER & STUDY

I have introduced various concepts in the dissertation such as the definition and prevalence of LD, barriers to its adoption, local and global perspectives on the use of ICT and last but not least, the impact of ICT on the learning outcomes. The sections below provide detailed discussion and evidence of the models that have been adopted for ICT, the impact of ICT to teachers and students learning outcomes. The research findings include studies from Australia and New Zealand, Europe (OECD) and the UK. I have also included recent studies from other countries like South Africa, Malaysia and Thailand. The chapter is concluded with a summary of the most significant learning models.

4.15 THE ICT IMPACT REPORT – EUROPEAN SCHOOLNET

In their executive summary on the impact of ICT in education in Europe, Balanskat et al. (2006) reported that the use of ICT in education and training has been a priority in most European countries during the last decade, but progress has been uneven. A small percentage of schools in some countries have embedded ICT into the curriculum and demonstrate high levels of effective and appropriate ICT use to support and transform teaching and learning across a wide range of subject areas. Most schools in most countries, however, are in the early phase of ICT adoption, characterized by patchy uncoordinated provision and use, some enhancement of the learning process, some development of e-learning, but no profound improvements in learning and teaching (Balanskat et al. 2006). This report summarised the main findings from European case studies, international and European comparisons and evaluation of specific national interventions, evaluations of national ICT programmes or initiatives according to the following considerations: impact of ICT on subjects, attainment levels, resources, investment and infrastructure.

Although not peer-reviewed, the report further provided a thorough analysis of the impact of ICT on learners, teachers, and parents and so on. In particular, it covered a literature analysis of review studies that were conducted by various researchers in the UK and OECD: Underwood (2006), Ramboll Management (2006), Higgins (2005), Harrison (2002), Becta (2006), and OECD (2004).

4.15.1 Research on Impact of ICT to Learning Outcomes

The Becta (2006) ICT Impact Report (European Schoolnet, Balanskat et al. 2006) has provided both quantitative and qualitative studies for the impact of ICT on learning outcomes. The main findings showed a statistically significant positive association between ICT and higher achievement in national tests. In particular, PISA tests showed a link between performance in maths and use of computers and use of interactive whiteboards improved the performance of low achieving students in English (Harrison 2002, OECD 2004, Underwood 2005, Higgins 2005 and Machin 2006).

In addition, studies provided *qualitative* evidence that ICT can impact on learning outcomes based on opinions and perceptions of teachers, students and parents. According to Balanskat et al. (2004) pupils, teachers and parents considered that ICT had a positive impact on pupils' learning. Kessel (2005) argued that teachers were becoming more and more convinced that the educational achievements of pupils improved through the use of ICT, for example a study by Ramboll Management (2006) provided evidence that pupils' subject-related performance and basic skills (calculation, reading and writing) improved with the use of ICT in Nordic countries. The findings also supported the view that both high as well as low-achieving students benefited from ICT innovation.

It should be noted that all the studies showed that ICT has 'secondary' impacts on the learners. These findings are presented below and the source is acknowledged.

A very high percentage (86%) of teachers in Europe stated that pupils were more motivated and attentive when they were exposed to computers and the Internet in class. However, in some countries there were a substantial number of teachers, who denied that there was much of a pedagogical advantage of computer use in class (Empirica 2006). This last point was also supported in a study by Law (2006), where the study focused on the challenges of ICT learning that are underpinned by its pedagogical rather than its technical nature. It was also found that ICT caters for greater differentiation (especially in primary schools), with programs tailored to individual pupils' needs (Ramboll Management 2006).

ICT has a strong motivational effect and positive effects on behaviour, communication and process skills and teamwork. These findings were also supported by Lopez (2006) and Kessel (2005). Furthermore, ICT offers assignments better suited to their individual needs and makes it easier to organize their own learning through the use of, for example, digital portfolios (Balanskat et al. 2004).

Multimedia and interactive content on interactive whiteboards is engaging and motivating, particularly for primary students and students pay more attention during lessons. Moreover, students assumed greater responsibility for their own learning when they used ICT, working more independently and effectively (Higgins 2005).

A view that was expressed for teachers was that they considered pupils worked more in cohesion with their own learning styles, resulting in a favourable impact on both academically strong and weak students. A worthwhile observation was that students with special needs, or behavioural difficulties, gained in different ways from the use of ICT. ICT use in schools was a factor that helped minimise the social divide by smoothing out the digital divide (Ramboll Management, 2006).

The impact of ICT was also investigated by the Scottish Executive Education Department. The he report indicated that attitudes to ICT were in the main, positive, but there were reservations about the benefits in the classroom overall. The problems and concerns, like professional development for teachers, support for ICT and inconsistencies across platforms and applications were also reported. The students' performance levels did not show a significant change and there were 'skills gaps' amongst the students. One of the main arguments was the positioning of ICT in the curriculum- should it be a single subject/unit in its own right, or as a means to learning within other subjects and contexts (Condie et al. (2002)? It is also relevant to mention here that this question was addressed by many other researchers including those from Australia (Baskin et al. 2006). I will take up this point in my case studies to explore how an early adopter[57] (Concord School) and a late adopter (Macedon Ranges Special School), according to Rogers (1995), introduced ICT in the curriculum (Bates 2007).

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[57] These terms relate to Rogers's (1995) definition of early and late adopters of adoption.

4.15.2 The Impact of ICT on Teachers and Teaching

There is considerable evidence of the impact of ICT on teachers and teaching, not all positive. The sections below examine the trends and views of teachers and the impact of ICT to learning for LD students in Australia, the UK and some other parts of the world.

In the UK, studies have demonstrated that teachers gain a positive attitude towards ICT through government interventions, and training programmes. These have led to a 'routine' use of embedded ICT (Ramboll Management 2005 and Higgins 2005). On the other hand, an overwhelming majority of teachers in Europe (90%) use ICT in their lesson preparation (Empirica 2006). According to Higgins and Harrison, teachers use ICT to plan lessons more efficiently and more effectively due to a more collaborative approach and the sharing of curriculum plans with colleagues and managers (Higgins 2005 and Harrison 2002).

Several studies have concentrated on the effective exploitation of Information Management Systems (Lytras 2005). This leads to increased and formalised cooperative planning between teachers, which results in a positive impact on teaching practices (Underwood 2006). However, there is not a positive view or picture about the use of Learning Management Systems or Virtual Learning Environments. It was considered that there was potential to use these in a more significant way, rather than the manner in which they were used, namely, predominantly for administrative purposes (Kessel 2005, Underwood 2005 and Ramboll Management 2006). The embedded ICT approach over a longer period of time resulted in increased use of ICT by teachers and subsequently, increased their confidence to a significant extent (Ramboll-Management 2006, Underwood 2005).

Research into specific ICT uses, indicated that the supply of laptop computers to teachers generated a positive attitude towards their work. Furthermore, with structured approaches for Internet research, students develop search and research skills that are transferable across the curriculum (Becta 2006). In terms of the infrastructure, Broadband is a major factor in increasing collaboration between teachers. Given a reliable and high-capacity broadband in the classroom, there is an increase in the quality and quantity of educational activities that can be explored (Underwood 2005). Recent technologies, like interactive whiteboards, make a difference to aspects of classroom interaction (Higgins 2005).

4.15.3 Teachers' Competencies and General use of ICT

The most significant results from several studies in the UK arrived at the following conclusions:

- National competence development programs have had limited impact on teachers' pedagogical competences. School leaders estimate that the impact of ICT on teaching methods in their school is low (Ramboll Management 2006).
- Teachers use ICT to support existing pedagogies and ICT is used most when it fits best with traditional practices ICT can enhance teaching by enhancing what is already practiced or introducing new and better ways of learning and teaching , as for example, e-learning (Underwood 2006). The greatest impact arises when teachers are experienced users and who from the start had already progressed with the integration of ICT in their teaching. Teachers who perceive a highly positive impact of ICT use ICT in the most project-oriented, collaborative and experimental way. It has been reported that teachers' basic ICT skills have increased dramatically with a significant proportion of ICT being employed in science, mathematics, computer science and vocational education (Kessel 2005), (Ramboll Management 2006) and Empirica 2006).
- The role of the teacher is more dynamic and flexible as he/she tends to become more of an advisor, critical dialogue partner and leader for specific subject domains (or facilitator) when ICT is used in the classroom (ENU 2004).
- The impact of ICT is highly dependent on the method that is used. The impact of a specific ICT application or device depends on the capacity of the teacher to exploit it efficiently for pedagogical purposes. In addition, factors beyond the teacher's control influence ICT uptake, e.g. institutional cultures, leadership, the curriculum and assessment (Ramboll Management 2006, Ramboll Management 2005).

ICT needs to be exploited further to create learning environments where students are more actively engaged in the creation of knowledge rather than just being passive consumers (Kessel 2005; Ramboll Management 2005, 2006). This is the next step as Web 2.0 technologies and social networking are introduced in teaching and learning in the future (Becta 2008, Leeson 2008).

4.15.4 Summary of Literature Findings on Impact of ICT from the UK & Europe

A summary of the key findings from the UK and European studies is shown in Table 4-3 below.

Reviewed Studies	Comber (2002)	Harrison (2002)	Higgins (2005)	Eurydice (2005)	Eurydice (2004)	Kessel (2005)	Machin (2006)	ITU (2004)
Scope	15 schools	60 schools 700 pupils	122 primary schools 68 teachers 72 pupils 184 lesson observations	Primary schools (150 schools per target population) Secondary schools (OECD, Pisa 91091 students)	Primary schools (150 schools per target population) Secondary schools (OECD, Pisa 91091 students)			120 schools
Timeframe	Two school terms	1999-2002	2002-2005	Pirls data from 2000/2001 PISA results 2003	Pirls data from 2000/2001 PISA results 2003	2000-2005	1999-2003	1999-2003
Methods of measuring impacts								
Questionnaires and interviews of students'/teachers'/parents' perceptions- assessing impact	x		x			x		x
Lesson observations	x		x					x
Use of ICT and relative gains in national tests (statistical analysis)		x	x					
Spending on ICT, changes in policy and pupil achievement (statistical analysis)							x	
Analysis of national/ international data bases				x	x	x	x	
Case study analysis	x							
Records of ICT use			x					
Maturity Models								
Action research								
Identified impact areas for learning and learners								

Table 4-3 : Overview of the main impact areas by study (Source: Becta 2006)

4.16 ICT & LEARNING OBJECTS

A survey by Freebody et al. (2008) examined the use of the Learning Objects of the Le@rning Federation (TLF) Project[58] and arrived at 13 different categories regarding the perceived benefits with ICT usage in the classroom. The report detailed the views of teachers, school leaders, principals and other sector personnel about the use and effectiveness of ICT in Australian and New Zealand schools. The main questions of the survey for teachers were related to skills and application of LOs, their frequency of use and the levels applied in the curriculum. The analysis further considered the factors that enable teachers to adopt new digital and online technologies in their classroom. These findings are shown in Figure 4-19 below.

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[58] TLF was established in 2001 by MCEETYA to provide online curriculum resources to schools in specific curriculum areas: Innovation, LOTE, Literacy, Mathematics and Numeracy, Science and Studies of Australia. It also provided a high-quality digital learning portfolio of learning items online for all Australian and New Zealand schools.

The Learning Objects were defined by the TLF as files or modules of learning material that allowed teachers and students to interact and engage in the activities that were made available through access of digital repositories via appropriate metadata descriptors.

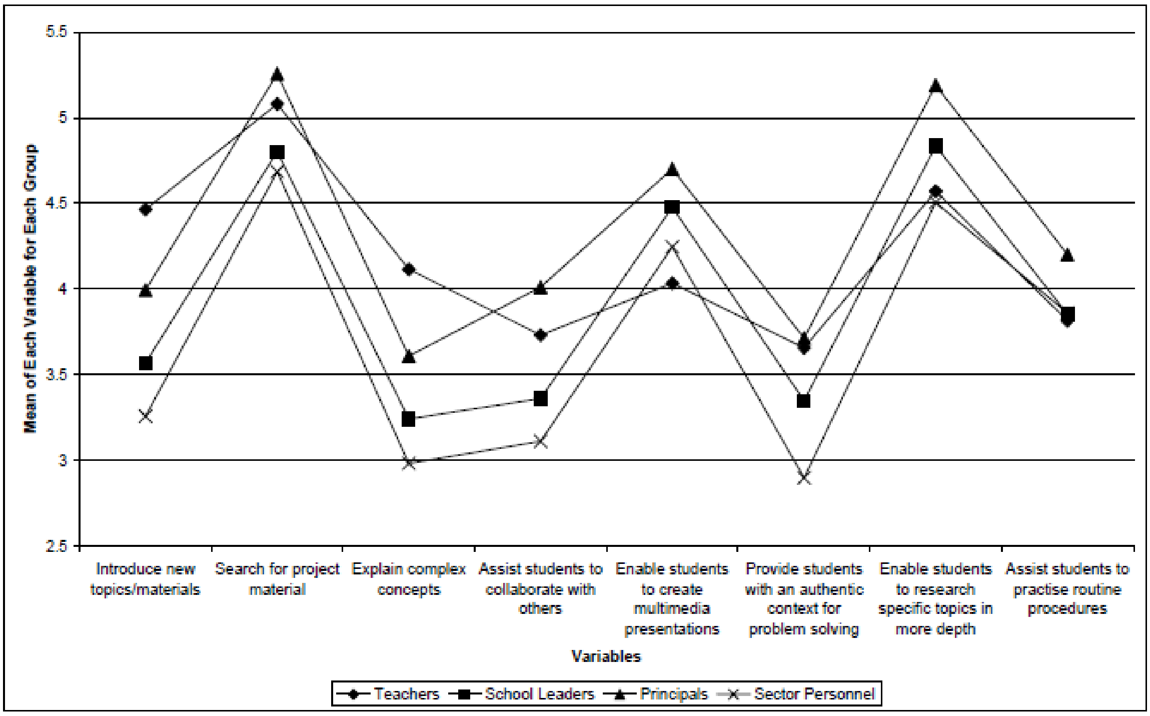

Figure 4-19: AUS & NZ Survey of Learning Objects in Schools (Source: Freebody et al. 2008)

Freebody et al. (2008) further stated that:

"the differences in estimated benefits nominated by all four groups of respondents for mainstream classrooms, compared with those nominated for non-mainstream classrooms are also worth noting. It is evident that, in considering students in non-mainstream classrooms, respondents reinterpreted two variables – access to materials from other cultures and access to new research materials – in terms of their communication benefit rather than their benefit for learning" (Freebody et al. 2008).

This is significant for this research as the report identified possible students in non-mainstream settings (defined in the survey as learning disabilities, non-English speaking background and perceptual or intellectual impairment) may need more in-school ICT-based stimulus and to look for new and cross-cultural materials. According to the summary of the report, this may also be due to the fact that respondents considered that relative to using non-ICT-based strategies, teachers would have more difficulty especially in the case of non-mainstream students.

One of the significant areas that were addressed by the survey was the "Factors enabling teachers' adoption of new digital/online technologies in their teaching". The respondents were asked to assess the importance of a range of factors from literature and case-study components of earlier evaluations of TLF materials. The study identified 14 separate variables[59] conducted in an earlier study by Freebody et al. (2008). The means for the four groups are shown in Figure 4-20.

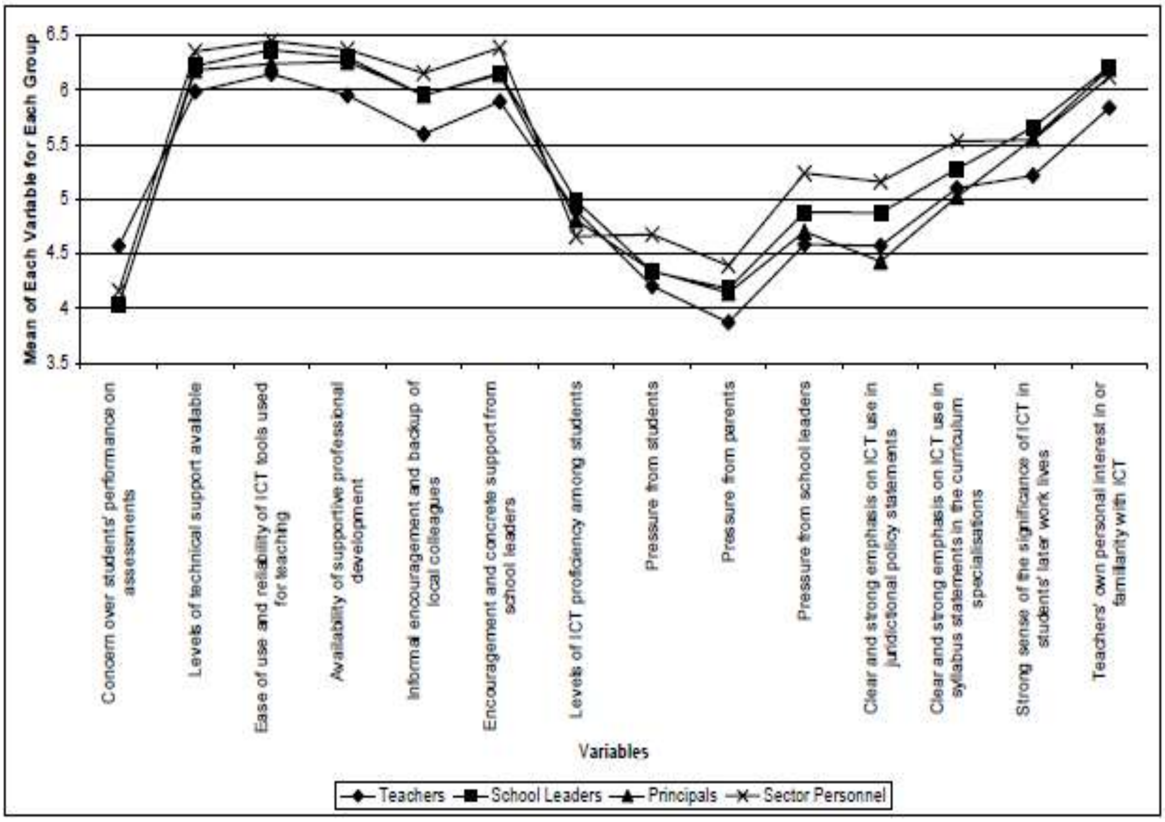

Figure 4-20: Means of the four groups of educators for their judgements of the factors affecting adoption of ICT in mainstream classrooms on 14 separate variables (7-point scale) (Source: Freebody et al. 2008).

The above findings will be compared to the results from the present study. In particular, the views of leading actors will be investigated to determine how they rate the effectiveness of the TLF Project, especially for LD students. Evidently, there are many views and arguments common to Australian and overseas researchers concerning the use of ICT. Therefore, it would be worthwhile to provide further discussion on this topic. The next section presents discussion from the literature concerning the factors that affect the adoption of ICT from Australian, Asian and UK studies.

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[59] These ranged from ease of use of ICT to emphasis in syllabus and are shown in Figure 4-20 below.

4.17 ICT & LD – OTHER CONSIDERATIONS

4.17.1 Factors that Affect the Adoption of ICT in Education

The literature identified the following main points about the use of ICT in the classroom.

- Innovative use of ICT facilitates student centered learning (Drent 2005)
- Facilitates co-operative learning
- Facilitates communication and problem solving (Drent & Meelisen 2007)
- Engages the thinking and other important processes (Grabe 2001)
- We need to identify specific computer skills and how computers should be used for teaching and learning (Dooling 2000).

Mumtaz (2000) provided a summary of the literature on factors affecting the adoption of ICT in education. The main categories were as follows: (a) factors that discourage teachers to employ ICT (for example, lack of teaching experience, lack of professional development, lack of support, lack of specialised ICT teachers, lack of resources, lack of funds and shortage of time to develop curriculum that integrates ICT); (b) schools and government policies; (c) factors that encourage teachers to employ ICT (Cox 1999); (d) the role of the teacher in relation to ICT and its effect of pedagogy and ; (e) the willingness of teachers to integrate ICT into their teaching. These factors were also highlighted by Florian et al. (2004), Lau (2008), White (2005), OECD 2005), Newhouse et al. (2002), Kozma (2005), Becta (2003), Becta (2004), Shaddock (2007) and Afshari et al. (2009).

As was previously discussed, the Victorian Education Department introduced a project called “The e-Potential” in an attempt to gauge the ICT skills of all teachers employed by the Department. Figure 4-21 below provides a snap shot matrix of the relevant skills under investigation and consideration.

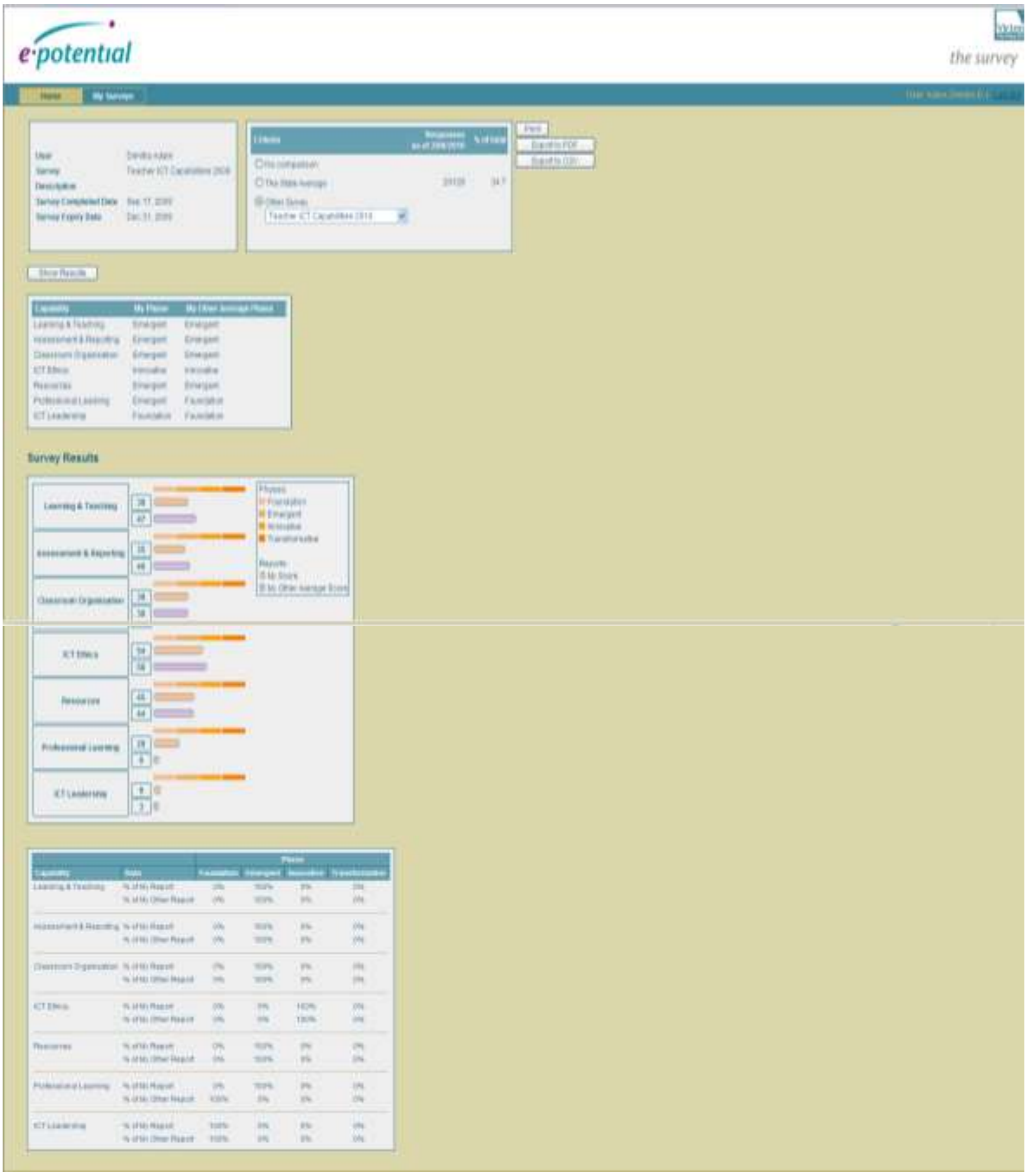

Figure 4-21: e-Potential skills matrix results (Source: http://epotential.education.vic.gov.au/continuum.php)

The e-Potential ICT Capabilities Resource supports teachers developing their skills to integrate ICT into their classrooms. This resource enables teachers to see and use the potential of ICT for powerful learning. Teachers can assess their skills via the online survey to ascertain where you are in the Continuum of ICT Capabilities. They can access a bank of interactive resources, a journal and planning tool to support their ongoing professional learning. In this way they can establish and enhance professional learning goals by using the resources as classroom ideas to support and implement their goals. The project allows teachers and school leaders to benchmark themselves against other teachers in the state of Victoria. The continuum and survey tool provide teachers and School leaders with a framework for ongoing planning and professional learning (DEECD 2008).

4.17.2 Other Factors: Technological, Cultural & Social Factors

The current literature shows that there are significant factors which affect the application of ICT in all schools. A study by Usun (2004) reported on how cultural factors affected distance education in Turkey. The study identified that cultural and political factors play a significant part in the adoption of an innovation. The Victorian government's Skills Task Force Report, and the Deakin Report (Blackmore et al. (2003), provide a review of impact of disadvantage (like Koori culture), gender and leadership on adoption of ICT. The latter report states:

"Teachers need to develop skills in their disciplinary area and across the curriculum in utilising ICT in ways that are attendant to both the operational and the cultural dimensions of digital literacy. Teachers need to learn about technology at the same time as they learn with and how to use technology in order to challenge their own assumptions about both ICT and learning. Teacher professional development should be informed by a strong pedagogical and curriculum focus on problem solving together with action research projects that explore how to make judgements about the efficacy of using ICT" (Blackmore et al. 2003 , p 27).

EPortfolios is another important innovation with ICT. The ePortfolio provides learners with a space to record reflect and present information about themselves and progress in their learning outcomes. These are artefacts which require management and are subject to issues like privacy and security, standards and compliance, particularly as these may be used as evidence of skills acquisition and knowledge for future employment. They may contain rich digital content (such as word documents, pdf files, video footage, and audio casts) which need to be used in a proper manner. Its implementation for LD students' needs careful planning, policy and standards to ensure that positive effects from ICT are not negated by the new challenges of technology (Seymour 2005, Leeson 2008)

Factors that relate to the school environment and teachers have also been identified. For example, Afshari et al. (2009) provides a very detailed analysis of how teachers use ICT in their classroom in Malaysia. The analysis shows that some of the most significant factors relate to the provision for professional development and adequate funding for the appointment of a suitable ICT coordinator who would provide the necessary support to both staff and students in the school. There are several other factors which need to be considered for a successful adoption of ICT in the curriculum. For example we need to consider the following questions:

- What is the role of the teacher? (Moseley & Higgins 1999)
- What is the function or scope of ICT?
- Does ICT change the nature of the subject?
- Is ICT used as a tool for teaching another artefact in the classroom?

There are several studies ranging from Australia, USA, the UK and Europe, which reveal the level of adoption of ICT in mainstream classroom as well as the special classroom environments in special needs schools. The latter should be noted as this is one of the limitations of the literature and it has been mentioned earlier in the dissertation in the summary of significance (Becker 2000, Becta (2003, 2004, 2005, and 2006), OECD 2000, MCEETYA 2000, MCEETYA 2007, Meiers 2009, Finger et al. 2005, Calnin 2006, and White 2008).

4.17.3 FACTORS AFFECTING TEACHERS' USE OF ICT

As mentioned earlier, I have worked as a secondary teacher in the 70s and 80s and as a tertiary teacher from the 90s till the present time. During this time I observed reluctance from teachers to use ICT in their classroom for various reasons, one of which was the fear of they may be replaced by the computer and lose their job. Of course, this has not happened in normal mainstream classrooms and definitely cannot take place in a special needs classroom, where the need and demand for the physical presence of the teacher is paramount.

Research studies in the past decade have shown that computer technology is an effective means for widening educational opportunities, but most teachers are reluctant to use technology as an instructional delivery system or integrate technology into their curriculum. Studies revealed that some of the factors that influence teachers' decisions to use ICT in the classroom could include non-manipulative and manipulative school and teacher factors, which are interrelated. The success of the implementation of ICT is not dependent on the availability or absence of one individual factor, but is determined through a dynamic process involving a set of interrelated factors (Afshari et al. 2009, Somekh 2008, Webb & Cox 2004, Cuttance 2001 and Freebody et al. 2008).

The impact of technology is one of the most critical issues in education (Webber 2003). The use of information and communication technology (ICT) creates a powerful learning environment and it transforms the learning and teaching process in which students deal with knowledge in an active, self-directed and constructive way (Volman & Van Eck 2001).

Other studies have reported that ICT is not just regarded as a tool, which can be added to or used as a replacement of existing teaching methods. In fact, ICT is seen as an important instrument to support new ways of teaching and learning. According to Watson (2001), ICTs do not change pedagogic practices themselves. Thus it should be used to develop student's skills for cooperation, communication, problem solving and lifelong learning (Voogt 2003). An example of how ICT was used pedagogically in ways that transform schooling was provided by the Apple Classroom of Tomorrow (ACOT) Project in USA (Sandholtz 1997). The aims of ACOT were to put technology into the hands of teachers and students and radically change the learning experience. The Project had a vision of constructivist teaching and inspired teachers with support and workshops and introduced them to the latest technologies[60].

Lau and Sim (2008**)** described a list of parameters that might be applied in determining the extent of ICT adoption in secondary schools. These include: teachers' characteristics; parent and community support; availability of vision and plan about the contribution of ICT to education; level of and accessibility to the ICT Infrastructure;

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[60] As a pioneer in computer education, I had first hand in setting up a classroom with Apple IIE computers in the early 80s. In addition, my role was to provide in-service and training to staff and administrative staff of the school, as well as the teaching of the new technologies in the curriculum. It should be noted that Victorian schools at the time were limited for funds and any efforts to introduce new technologies were hindered by lack of understanding and fear of computers.

availability of time to experiment, reflect and interact; available support to computers-using teachers in the workplace; school culture and computer attributes (Lau et al. 2008).

4.18 ADOPTION & INNOVATION OF ICT FOR LD STUDENTS

According to Rogers (1995), the characteristic of an innovation as perceived by individuals in a social system affects the rate of adoption. Further, Rogers (1995) identified five innovation attributes that may contribute to the adoption or acceptance of an innovation: relative advantage, compatibility, complexity, observability and trialibility. The relationship between an innovation's attributes and adoption has been examined in a number of diffusion studies. For example, Albirini (2006) found that the computer attributes were significantly correlated to teachers' attitudes towards computers.

Albirini's study accentuated the importance of computer attributes in the process of computer adoption in developing countries. Also, Dillon and Morris stated that:

> *"innovations that offer advantages, compatibility with existing practices and beliefs, low complexity, potential triability and observability will have a more widespread and rapid rate of diffusion"* (Dillon & Morris 1996, p. 6).

This suggests that if teachers perceive ICT as a beneficial tool, compatible with their current activities, easy to use and have observable outcomes, they will demonstrate positive attitudes towards ICT. Other factors related to the following: level and quality of training for teachers and school Principals; attitude towards computers; computer competence and effective training programs; and suitable models for integrating technology into teacher training programs. (Caldwell 2005, Jung 2005, Finger et al. 2005, Meiers 2009, Shaddock 2007, Becta 2006, OECD 2001, Leeson 2008, Yuen 2003, Jones et al. 2008, Freebody 2005, Rumpagaporn 2008, Phelps 2002, Triantafillou 2007, Baskin et al. 2006 Seymour 2005, Cox et al. 2003, Bangkok 2004, Flanagan et al. 2003, Schiller 2003b, McDougal et al. 1997)

There are literature reviews on the factors that influence the adoption of ICT in the classroom. For example, in a review by Mumtaz (2000), research findings of the past 20 years provide evidence about the positive effects of use of ICT on learning. One important finding is that of a slow uptake in schools (Cox et al. 1999) and this is in line with my own observations and experience of the use of computers in the curriculum in the last two decades. White (2008) identified how computer technologies and ICT have influenced teachers and the curriculum in Australia. The research classified two main factors which were inter-related, non-manipulative and manipulative school and teacher factors (White 2008).

I would like to conclude this section by noting that practising teachers' uptake of ICT-studies revealed a number of factors which influence the use of ICT in the classroom. For example, access to resources, quality of software and hardware, ease of use, incentives to change, support and collegiality, school and national policies, commitment to professional learning and computer training (information potential). The study suggests that for successful implementation of ICT, we need to adopt a holistic approach.

4.19 EDUCATIONAL MODELS USED IN ICT & LD

The literature identified certain areas that relate to the main elements of teaching and learning with ICT. The emergence of the Internet has enabled a shift from the constructivist approach to a more collaborative and interactive learning platform. The model by Schunck (2001) certainly provides evidence of this shift, where the teachers are no longer regarded as the masters of knowledge but rather they become the facilitators of knowledge. This approach has a significant shift to curriculum planning and design (Flanagan & Jacobson 2003). According to Webber (2003) the use of ICT creates a dynamic learning environment and it transforms the teaching processes as it empowers the students with their own individual learning (Shunck 2001).

Another example of the shift in learning and teaching paradigm is provided by Bangkok (2004). In this study the teachers become effective agents in the use of technology in an effective manner in the classroom. A recent study by Afshari et al. (2009) provides a very succinct argument about the objectives that distinguish the use of ICT in education.

These are listed as follows: the use of ICT as *object* of study; the use of ICT as *aspect* of a discipline or profession and; the use of ICT as a *medium* for teaching and learning.

For completeness these characteristics or objectives can be briefly explained by the following terms and definitions:

A. Object- This relates to learning about ICT and it enables students to use ICT in their daily life.
B. Aspect- This refers to the development of ICT skills for professional or vocational purposes.
C. Medium- This focus' on the use of ICT for enhancement of the teaching and learning outcomes (Drent & Meelissen 2007).

The literature provides studies where an individualized approach has been applied to enhance behaviour and special skills like money, mathematics, history and so on with LD students (Fernell 1996, Browder 1998, Bulgren 1998 and Van-Luit 1999). The literature also describes studies on adolescents with LD (Deshler & Ellis 1996; Dillon 1985). Studies specific to individual reading and natural language include those of Kircaali (1998), Johnson (1998), and Swanson (1999).

In general, studies relate to mainstream classroom teaching and management strategies (McIntosh 1993). Wang & Walberg (1987) describe the theoretical approaches to the education of mildly handicapped children as follows: The Psychological Approach, The Sensory-Neurological Approach, The Ecological Approach, and The Behavioural Approach (Morrison et al. 1985).

Fuchs (1996) provides an analysis of models of classroom instruction that relate to students with LD. The main categories come from Morrison (1985) and Mercer et al. (1981). Mercer et al. (1981) supports the view that LD students should be provided with individualized programming[61] that relies on the social constructivist-transaction model. The alternative to this is the comprehensive programming model. In this model,

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[61] Instructional program which students work on appropriate tasks over time that is motivating. It may occur with various instructional arrangements. (Mercer et al. 1981)

consideration of curriculum decisions occurs in terms of an overall program for students with LD as groups. Other programs, or models, include the segregation of environments (or interventions) or school clinics (Danielson; Klinger 1998; Kerns 1998; Lloyd 1998).

Kinzer (1994) argued that traditional models of instruction: (1) have failed to adequately teach our mildly disabled students, (2) lack diverse representational forms to minimise the use of multiple knowledge sources and (3) inadequately provide shared, grounded, contextualised experiences that can be revisited during instructional situations.

Prior (1996) supported the view that there was a shortage of studies that have evaluated the relative efficacy of different remedial teaching methods. There are few data on the best approach to teaching the skills of reading or mathematics to all children in the classroom. Keogh & Speece (1996) discuss the limitations of research on schooling effects. They stated:

> *"because there have been relatively few longitudinal studies, possible long-term effects of schooling of children with learning disabilities and the impact of school at particular times are not well understood"* (Keogh & Speece 1996, p5).

Bedini et al. (1993) discussed leisure skills instruction for adolescents with severe developmental disabilities. A person's quality of life may be enhanced by the acquisition of leisure skills that leads to increased level of activity and more interactions with peers as the approach creates an option for a rich environment where the participants enjoy learning (Wall & Dattilo 1995), (Wall et al. 1999). I wish to point out that this is important to observe, particularly, as I am interested to find out how LD students progress from school to work, and in general, their life. This topic is discussed further in Chapter 9.

Other approaches found in the literature include: "Structured Teaching Approach" (Panerai et al. 1998), "Anchored Instruction" (Love 2005, Kinzer et al. 1994), "Direct Instruction" (Kenny 1980) and the "Zachman Approach" (Abdullah 2007). These along with some of the most commonly used teaching paradigms are summarised in Table 4-4 below.

Another significant area is the games literature. This contains examples in which the main elements – motivation, self-esteem, independence and practical reasoning were considered in game design Wood (1987), Quinn (1996) and Pillay (2000). Dempsey (1993) reviewed the gaming literature and his findings showed that games promoted motivation[62], improved practical reasoning, aided in complex problem solving and were also used for attention reducing training. Dempsey found support for the contention that games lead to an enhanced ability to apply knowledge.

Recent advances in technology opened up new avenues to assist LD students with their learning. The following have been applied in the teaching and learning environment for LD students: Virtual reality, Sound training, Multimedia, WWW, IWBs and online learning.[63] Several studies have reported on the ongoing trials, and given the wide range of special needs, it is very difficult to design individualized systems to cater for such differences- this is the challenge that designers for adaptive tools and technology are faced with. (Toomey 1994; Kinzer 1994; Salzman 1999; Billie & Thompson 1999; Abbott et al. 2001; Becta (2005, 2008); Standen et al. 2005 and Lopez 2006).

One needs to consider issues such as accessibility, privacy, ergonomic design and the need for suitable standards (such as BOBBY). Zyjicek & Powell (1997), Stephanidis et al. (1995) and Paciello (1997) designed suitable tools for disabled people to access the Web. Their design included a conceptual model for WWW for visually impaired users. In this, they looked at the significance of the following components: search algorithm, results page, Web site and page. Assistive technology has become very significant for LD students (Americans with Disabilities Act 1996), (Eklund 1999, Seymour 2005, and Eliada 2007).

[62] Learning Games facilitates cognitive processes such as making inferences and lateral thinking. For example, moving from novice to expert status in playing computer games, cognitive processes may be enhanced. (Doolittle 1995)

[63] Spectronics is a company in Australia that specialises in adaptive technological products for special needs students.

There is an increasing demand towards greater participation with online learning, especially in Australia (DEECD 2008; IEFTS 2001) and individualised computer–based components, like the mouse and keyboard, which are supplied by companies specializing in adaptive technologies.

One of the recent developments in this area is the use of symbols or widgits (Abbott et al. 2002 and Lloyd et al. 1997). The Widgit Literacy Symbols (WLS) can support a child for literacy and text with the ultimate aim to attain cognitive levels commensurate with age. The WLSs can be used in conjunction with Picture Communication Symbols (PCSs[64]) to access the environment in the school, express their ideas and thoughts with other communicative partners as well as access the curriculum (Eliada 2007). It suffices to say that these are very rich objects with several attributes or characteristics that represent real world/life objects[65]. This is an area where more research is warranted (Eliada 2007).

[64] The PCSs can be used for a child with cognitive challenges who finds it difficult to recognise symbols.

[65] An example of a PCS is the well-known program Board Maker, which was used at Macedon Ranges.

4.20 TEACHING/LEARNING PARADIGMS

The educational paradigms that are referred to in this thesis are summarised in Table 4-4 below. Table 4-5 gives an overview of Theoretical Models of LD from the 1950s to recent years and it is adapted from Poplin[66].

Teaching learning Paradigm	***Source***	***Description***
Behaviourist	Morrison (1985)	Learning based on behavioural approach.
Constructivist:	Mercer (1981)	Possible use of ICT to scaffold higher mental processes.
Direct Instruction	Kenny (1990)	Goal based, questions at a low cognitive level, teacher chooses material that is appropriate for students level.
Thinking Curriculum	Clark (2005)	Brain compatible curriculum.
Structured Approach	Panerai et al. (1998)	Method of teaching LD students using intervention techniques and modifying the curriculum.
Anchored Approach	Love (2005)	Allows teachers and students to work co-operatively from a shared experience- cognitive apprenticeship.
E-Learning	Eduworks (2002)	Encompasses a wide set of applications and processes which use all available technologies, media and the Internet.
i-Learning	DEECD (2008a)	Program that allows students to develop personal goals to improve their learning outcomes.
Situated Cognition	Lave & Wenger (1991)	Students interact and learn from the environment, learning is situation/context specific.
Student Centred Learning Environment	Dewey (1956)	Learners apply problem solving techniques. Technology often used to afford individualization and scaffolding.
Distributed Cognition	Hutchins (1995)	The knowledge resides in the group, artefacts support learning and group work is fostered.
Flexible Learning	Doolittle (1995)	Provides choice on what, when, where and how people learn. It supports different styles of learning including e-learning. (This is also referred to as Blended Learning)
Games Learning	Pillay (2000)	Learning through the application of games and simulations.

Table 4-4 Summary of teaching and learning paradigms (Constructed from the literature)

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66 Poplin, M. S. (1988). The reductionistic fallacy in learning disabilities: Replicating the past by reducing the present. Journal of Learning Disabilities, 389-400.

	Medical Models (1950s)	Psychological Process Model (1960s)	Behaviour Model (1970s)	Cognitive/Learning Strategies (1980s)
Emphasis	Neurological pathways	Prerequisite for academic success	Academic product of consequent behaviour	Information processing and meta-cognition necessary for academic success
Aetiology	Brain damage or dysfunction	Minimal neurological dysfunction	Lack of learned behaviours or learned non-adaptive behaviours	Insufficient strategies or study skills with which to process information necessary for school success
Diagnosis	Largely neurological	Soft neurological signs psychological process testing	Discrepancy between IQ and academic achievement, criterion-referenced tests and observation of specific academic and social school tasks	Discrepancy between IQ and academic achievement, with cognitive skills tests and/or observation of specific strategies
Assessment	Academic assessment, largely anecdotal case studies	Psychological process; some basic academic skills	Testing of student behaviour against task analysis of skills, examination of reinforcement contingencies	Testing of student behaviour and processing against known cognitive and/or learning strategies used by successful learners, often task analysed
Instruction/ Treatment	Extremely structured clutter-free environment; motoric and other neurological training; some basic skills emphasis; some medication	Psychological or psycholinguistic training with less emphasis on actual academic skills; medication, sensory integration and/or modality training	Direct instruction using task analysis of skills (behaviours) and application of reinforcement principles	Direct instruction in strategies used by successful school learners, also use of principles of reinforcement, particularly self-management and self-talk
Goals	Function in community	Function in school; less community emphasis	Almost exclusively school-related goals, some social but primarily academic mainstream	Almost exclusively school-related goals. Some social but primarily academic mainstream
Some major figures	Werner, Strauss, Lehtinen, Cruickshank	Kirk, Frostig, Minskoff, Kephart, Barsch, Wepman	Lovitt, Carnine, Jenkins, Haring, Bateman	Torgesen, Hallahan, Deshler, Schumaker, Alley, Meichenbaum, Feuerstein, Wong

Table 4-5: Overview of Theoretical Models of LD

4.21 LIMITATIONS OF THE LITERATURE

There were no studies that were previously conducted using analysis from first hand data. Most studies had identified research in mainstream classroom in both local and overseas schools. An earlier study in 2000[67] was limited to the use of ICT in schools. It did not address the current depth and integration of ICT, the infrastructure and the impact on the learning outcomes by its adoption for LD students. Given the wide range of disabilities it is difficult to carry out research in a specific setting where its content is based on technology. The present study has been conducted in a very specific environment where its curriculum had a strong ICT focus. Another point to mention that is related to this study is that each of special schools had a particular specialized education focus and yet ICT was a common thread.

A significant area that was not addressed in the literature is the school-to-work transition for LD. There are limiting data from ABS and OECD about the trends for LD students and this remains a significant issue. The literature in the early part of the research provided few, if any, examples of how ANT was used in educational settings. No research was recorded where ANT was applied to an educational environment with LD students. We need to discuss both human and non-human factors in socio technical studies.

The literature was vague on the design of e-learning models for LD students, even though recent studies have identified the need for more precise models to be applied to the LD field to improve the learning outcomes. The present study has been conducted over a significant time period and therefore some triangulation can now be performed.

In the last few years studies have emerged which identify and stress the need for further work in areas which the global education community is converging towards. This is an area which requires further collaborative study, both nationally and internationally as LD is a universal issue.

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[67] The literature identified the DETYA (2000) national case study for LD and ICT in Australia. Concord School, which is one of the schools in my case studies, was selected to participate in this national study. (Information provided by courtesy of Principal, Concord School)

4.22 SUMMARY

The chapter presented several models that link LD, ICT, Brain Models and Educational Paradigms. These can be viewed by the following overall Venn diagram in Figure 4-22 which shows that ICT, LD, EM and BM are not mutually exclusive entities, but that they have something in common. Undoubtedly, the constructivist or student centred approach to teaching and learning for LD students encompasses the intersections that are illustrated by the diagram. Finally, such a model would assist in the research design and analysis of the data, as this provides a clear signal or argument that a holistic approach must be followed in the present study. This model will be reviewed in the final chapter of the dissertation where other models, such as Petri Nets, will be considered in arriving at the final design of the e-learning model for LD students.

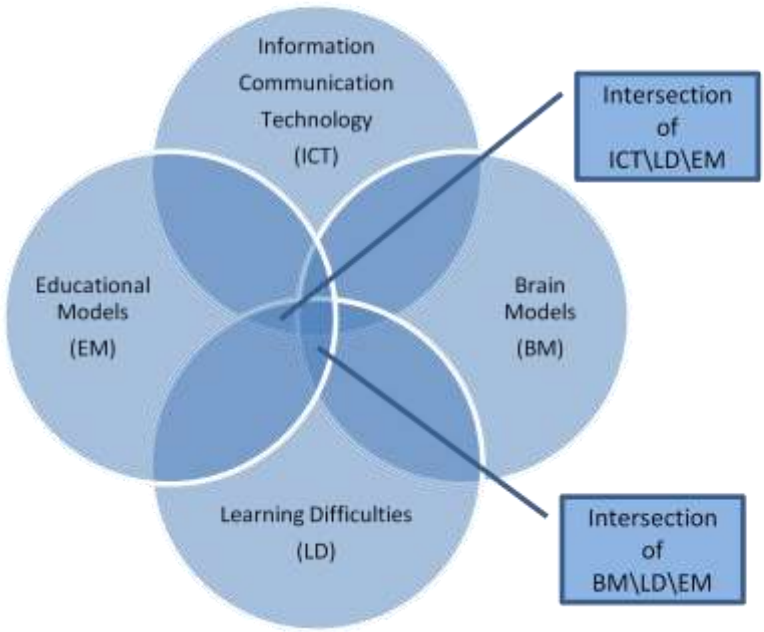

Figure 4-22: Model for the relationship of LD, EM, ICT & BM (Constructed from the literature)

EM relates to sections: 4.2, 4.3, 4.19 and 4.20

LD/ICT relates to sections 4.3, 4.15 and 4.18

LD relates to sections: 4.2, 4.3 and 4.15

EM/ICT relates to **s**ections 4.5, 4.17, 4.18, 4.19 and 4.21

EM/LD: relates to sections 4.2, 4.3 and 4.19

BM relates to sections: 4.4, 4.6, 4.12 and 4.13

BM/LD: relates to sections 4.2, 4.4, 4.6, 4.7 and 4.8

BM/LD/EM relates to sections: 4.4, 4.6, 4.7 and 4.8

ICT/LD/EM relates to sections: 4.2, 4.3, 4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and 4.20

EM/LD/BM/ICT relates to sections: 4.4, 4.6, 4.7, 4.16, 4.17, 4.18, 4.19 and 4.20

[4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9.4.10,4.11,4.12,4.13,4.14,4.15,4.16,4.17,4.18,4.19,4.20]

The next chapter discusses the main concepts of ANT formally, although some of these were introduced earlier in the dissertation.

CHAPTER 5

5 METHODOLOGY - ACTOR-NETWORK CONCEPTS

Learning is not attained by chance; it must be sought for with ardour and attended to with diligence.

Abigail Adams (1744 - 1818)

5.1 SPECIAL SCHOOLS & ICT INNOVATION - OVERVIEW

The implementation of ICT in special schools necessitates change in the way the schools operate and I have argued that it should be studied in a holistic manner. The dictionary defines the process of innovation as "*the alteration of what is established*; something newly introduced" (Oxford 1973) and "*introducing new things or methods*" (Macquarie Library 1981). It thus involves getting new ideas accepted and new technologies adopted and used. This chapter describes a research approach to the study of technological innovation in special schools that is based on actor-network theory (Latour 1986, Latour 1996, Latour 1997, Callon 1999, Callon 1986, Law 1999, Tatnall 2002). The study investigated the level of adoption of ICT in small to medium special schools: one is fairly progressed with ICT technologies, whereas the other is evolving and developing its application of ICT to adopt new standards so as to enhance its environment and relationships (for example, social networking) that are currently accessed via Web 2.0 technologies (Leeson 2008).

5.2 OVERVIEW OF ACTOR-NETWORK THEORY CONCEPTS

A central concept underpinning Actor-Network Theory[68] (ANT) (framework) is the existence and understanding of an actor. An actor is the term used to represent any entity that has an effect on the phenomenon under investigation (Callon 1986a), (Law 1992). It is any entity able to associate texts, humans, non-humans and money (Callon 1992). Accordingly, it is any entity which more or less successfully defines and builds a world filled by other entities with histories, identities, and interrelationships of their own. (Callon 1992) An actor is an abstraction which enables the analysis of the situations where heterogeneous entities are encountered (Law 1992). The social or technological approach is essentialist and deterministic in nature, whereas ANT is anti-essentialist and non-deterministic.

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[68] Callon (1999) stated "most important is that ANT is based on no stable theory of the actor" in his speech ANT & The Market.

The concept of an actor allows sociologists to write about the situatedness of innovation and technology without the need to use demarcations separating the social from the natural or sociological conventions from technological ones. The abstraction frees the analysis from the boundaries of disciplines, thereby allowing the observer to resist the need to reduce complex phenomena to a few well-defined political, social or technological categories, (Callon 1986a).

It should be noted that Actor-Network Theory has been applied to several fields including the field of technology. Law & Hassard (1999) have applied ANT to Organizational Analysis where they describe how Actor-Network Theory (ANT) can contribute to the evaluation of information technology. Wenn (2005) applied ANT to investigate the evolution of Internet and State Libraries, whilst Deering (2008) used ANT in a study on "The adoption of information and communication technologies in Rural General Practice: A socio technical analysis". Other areas where ANT was applied include Online teaching (www.aare.edu/03pap/wel03198.pdf), Rural ICT Implementation in South Africa (Rhodes 2004), and in the implementation of a new technology at a prominent US research university (Warzynski 2006).

ANT studies in the field of education include Bigum (1998) who provides a suitable application of ANT in his paper '**Solutions in search of educational problems: Speaking for computers in schools**', an investigation of a Knowledge–based system in a tertiary curriculum by Gilding (1997) and Tatnall (1999) who also provides a study with ANT in Education and Technology in exploring the innovation of a programming language, namely Visual Basic, in a tertiary teaching environment. Further examples include the studies of Hull (1999), Law (1999 a) and Walsham et al. (1999), and recently, the study by Simpson (2000) where ANT was used to investigate the impact of ICT in education in Queensland Education Department schools. There are also examples of how ANT was used to analyse the information systems infrastructure (Cordella 2008) and a study that involves the examination of the critical factors for a model related to teacher-teacher assistant successful collaboration, for students with LD in Australian mainstream schools (Shaddock 2007).

5.2.1 Actor-Network Theory

I will start the discussion with the following main question: *How can we treat both human and non-human actors equitably and in the same way*? This can be answered by following Callon's definition of ANT, namely that *actor-network theory is based upon three principles: agnosticism, generalised symmetry and free association* (Callon 1986). The first principle, agnosticism, requires that analytical impartiality is demanded towards all the actors involved in the project under consideration, human or non-human. An important element of ANT is generalised symmetry and this offers to explain the conflicting viewpoints of different actors by use of an abstract and neutral vocabulary that works the same way for human and non-human actors. According to Law, neither the social nor the technical elements in these 'heterogeneous networks', (Law 1987) should be given any special privilege or explanatory status. In addition, the principle of free association requires the elimination and abandonment of all *a priori* distinctions between the technological or natural, and the social (Callon 1992, Singleton 1993).

> *"ANT was developed to analyse situations in which it is difficult to separate humans and non-humans, and in which the actors have variable forms and competencies"* (Callon 1999 :183).

In summary, under the principles of agnosticism, generalised symmetry and free association, actor-network theory provides impartiality towards all actors under consideration, whether human or non-human, and makes no distinction in approach between the social, the natural and the technological. The following extract from Callon provides a clear explanation of this concept:

> *"The rule which we must respect is not to change registers when we move from the technical to the social aspects of the problem studied"* (Callon 1986 :200).

The ensuing sections discuss the features of ANT, attributes of Actor–Networks, actants and sociology of translations. A brief introduction into the formal concepts is presented in Section 5.3.2 below.

5.2.2 Features of ANT

A feature of actor-network theory is its dislike of large scale, 'obvious', tautological answers to problems; answers like "the thing doesn't work because it couldn't have worked" (Latour 1996 :121) or, in the terms of this study, 'ICT was adopted in special schools because it was appropriate or "ICT was adopted because the technology was available and there was sufficient skill to make its adoption inevitable". It prefers instead to look at the interactions enabled by the actors themselves. Further to this, it insists that apart from the capacity of actors to negotiate and enrol other actors, no *a priori* assumptions are made about the matter under investigation and attempts an understanding on the basis of studying the set of complex negotiations and trade-offs performed by the actors. It has no problem with complexity because it is through this complexity that it is able to avoid having to resort to large scale 'answers'. Law warns against the process of explanation by labelling, noting that any attempt at naming does analytical work. It "*strains to perform simplicity*" (Law 1997 :12) and pushes entities towards singularity. He warns that as complexity is lost in the process of labelling we should be loath to resort to it.

Formally, in actor-network theory, an actor is any human or non-human entity that is able to make its presence individually felt (Law 1987) by the other actors. An actor is made up *only* of its interactions with these other actors (de Vries 1995), and (Law 1992) notes that an actor thus consists of an association of heterogeneous elements constituting a network. Callon (1986) argued that an actor can also be considered, at times, as a *black box*, as we do not always need to see the details of the network of interactions that is inside it.

5.2.3 Other Attributes of Actor-Networks

ANT also attempts to do away with binaries like far/close, macro/micro and inside/outside (Latour 1997). The point is not whether the various elements of a network are in close physical proximity or not. Rather it is how they are interconnected that matters. In considering macro/micro distinctions Latour (1997 :3) maintains that one network is never 'bigger' than another, but simply 'longer' or more intensely connected. Concepts like outside or inside make no sense as a network is made up only of interconnections; it has only a boundary without an inside or an outside. What is important is whether or not a connection has been established between the elements. In

ANT the passage of time also loses much of its importance and becomes just a consequence of the formation of alliances between actors rather than a fixed explanatory framework (Latour 1991). Latour argues that for every '*socio-technical imbroglio*' (Latour 1988) two dimensions are involved in the formation of its definition: the number of people who are convinced that it can be considered as an uncontroversial black box and what sorts of translations it must undergo to convince still more people of this.

Once a network is formed however, that is not the end of the story as networks are always unreliable and can become unstable. Callon (1987) further proposes that entities become strong and stable by gathering a '*mass of silent others*' to give them greater strength and credibility. A network becomes durable partly due to the durability of the bonds that hold it together, but also because it is itself composed of a number of durable and simplified networks.

> *"The solidity of the whole results from an architecture in which every point is at the intersection of two networks: one that it simplifies and another that simplifies it"* (Callon 1987 :97).

In ANT, materiality and sociality are seen as producing themselves (Mol 1994), but networks are fragile and transient things and are only able to extend their life and become more durable by being inscribed in material form (Dent 1996). Entities that compose networks are often converted into inscriptions or devices (Callon 1986) such as documents, reports, academic papers, models, books, mobile devices and computer software programs. Latour uses the term '*immutable mobile*' to describe these things which, when they are moved around, remain stable and unchanged (Singleton 1993, Mol 1994). An immutable mobile helps to extend the network by enrolling new actors.

> *"Strength does not come from concentration, purity and unity, but from dissemination, heterogeneity and the careful plaiting of weak ties"* (Latour 1997:2).

Latour (1997) remarked that actor-network theory is not about *traced* networks, but about the activity of network *tracing*. He maintained that a network could not exist independently of the act of tracing it, and that it should be thought of not so much as a thing, but as the recorded movement of a thing. He contended that there was no difference between the explanation of some project, and telling the story of how a heterogeneous engineer (Law 1987) mobilised actors and a network subsequently surrounded itself with new resources. He noted the following on networks:

> *"... by their very growth they become more and more of an explanation of themselves"* (Latour 1997 :8).

5.2.3.1 Actants - Another concept in network membership or enrolment

In order to free up our discussion and consider the mix of human and non-human actors with equal status and power we will introduce the term actant. All actants enter into networks (Brown et al. 1999) (relationships) and bring together all the socio/technical actions which transform ideas into objects. According to Latour there are two roles that can be played by the actant, intermediary and mediator roles. The first relates to links that are not always permanent (they are dispensable, may be open to manipulation and often very flexible). The second relates to strong entities which add to and remain in networks, for example the ICT coordinator in one of the special schools. He described mediators as "*actors endowed with the capacity to translate what they transport, to redefine it, redeploy it, and also betray it*". (Latour 1993) This approach helps in looking at intermediaries who make connections and mediators who translate these connections into a form which builds the network into an object. Thus, the actants can be viewed this way by identifying and separating them according to the role they play /have in the research field or site. One actant may enrol another into the network (for example, the laptop provided an immediate attraction and engagement to the students) so that allies are created and the network is strengthened (Callon 1999). Table 5-1 provides a summary of the terms and definitions that are employed in ANT.

Term	Definition
Actant	A general term used to refer to both human and non-human artefacts that can be acted on and move the action on to some other. Actants are heterogeneous entities that form a network. This term is used by the more "radical" ANT theorists to indicate that both human and nonhumans should be treated equally. (See actor below).
Actor	An actor is an actant that has been given a character either by the person doing the analysis or by some other actant in the situation being studied. Usually an anthropomorphic designation.
Black Box	A network or network element that has become "frozen" or accepted as a complete artefact in itself. Black boxed artefacts can have varying degrees of irreversibility.
Delegate	Actants that stand-in-for or speak for particular viewpoints. These viewpoints may have been inscribed in them.
Enrolment	Enrolment is the means by which a set of roles is defined and accepted by the actants. These can be via "multilateral negotiations, trials of strength, tricks" etc. (Callon 1986, p. 211).
Immutable Mobile	An element or inscription that does not change or changes very little as it moves through space and time.
Inscription	An actant that has certain properties, policies or viewpoints embedded in it. So that it may act as a delegate for one or more actants.
Irreversibility	The degree to which an association of elements in the network cannot be "undone" or reversed.
Material heterogeneity	Networks are composed of a variety of social and technical, human and nonhuman actants. All elements are treated as having a similar status.
Obligatory Passage Point	Almost acting as the only doorway out of a room, an obligatory passage point is a place or procedure that actants in a network must pass through or interact with to become part of the network.
Stabilised	A network is said to be stabilised if the actants have reached some kind of accommodation or agreement and become assimilated into a network.
Translation	A translation is the product of continual negotiation during which the actants reach a set of compromises that allow them to become allies in the actor network.

Table 5-1: Summary of ANT terminology (Source: Latour 1993, Callon 1986, Law 1997, Walsham et al. 1999)

5.2.4 ANT & Sociology of Translations

Actor-network theory, or the '*sociology of translations*' (Callon 1986 , Law 1992), is concerned with studying the mechanics of power as this occurs through the construction and maintenance of networks made up of both human and non-human actors. It is concerned with tracing the transformation of these heterogeneous networks (Law 1991) that are made up of people, organisations, agents, machines and many other objects. It explores the ways that the networks of relations are composed, how they emerge and come into being, how they are constructed and maintained, how they compete with other networks, and how they are made more durable over time. Further, it examines how actors enlist other actors into their world and how they bestow qualities, desires, visions and motivations on these actors (Latour 1996). As the main proponents of ANT, Law and Callon state:

> *"Our object, then, is to trace the interconnections built up by technologists as they propose projects and then seek the resources required to bring these projects to fruition"* (Law 1988 :285).

5.3 ANT, LD & ICT INNOVATION

Special schools are complex socio-technical entities and any research into their curriculum needs to take this complexity into consideration. Based on these challenges and complexities the thesis adopted a research approach based on actor-network theory to carry out analysis of the impact of ICT on teaching and learning in schools for LD students. I contend that ANT can be usefully employed in many socio-technical situations involving technological innovation and ICT adoption in special schools, and sought relevant actors and networks to facilitate my data analysis and investigations.

5.3.1 Actor-Network Theory and Innovation Translation

One view of the adoption of an ICT innovation by special schools suggests that decisions are made primarily based on the perceptions of the characteristics of the technology concerned. Innovation diffusion (Rogers 1995) uses this approach and is based on the following elements: characteristics of the innovation itself, the nature of the communications channels, the passage of time and the social system. Using this sort of approach the researcher would probably begin by looking for characteristics of the specific technology to be adopted, and the advantages and problems associated with its use. The next step would be to suggest that the adoption, or non-adoption, of this technology by a special school is due largely to these characteristics. I contend that while there may be some validity in such an approach, it is unlikely to obtain the complete explanation as it would miss other influences such as inter-personal and inter-school interactions and the backgrounds of the people involved (actors) in the process.

I argue that actor-network theory (ANT) has much to offer in a situation like this. A researcher using an actor-network approach to study innovation would concentrate on issues of network formation, investigating the human and non-human actors and the alliances and networks they form. The research would investigate how the strength of these alliances may have enticed the small school to make the adoption or, on the other hand, to have deterred them from doing so (Tatnall 1999; Gilding 1997 ; Tatnall 2000 ; Tatnall 2002). While some research approaches to technological innovation treat the social and the technical in entirely different ways, actor-network theory however, proposes a socio-technical account in which neither social nor technical positions are privileged.

Actor-network theory argues that interactions between actors are heterogeneous and denies that purely technical or purely social relations are possible. It considers the world to be full of hybrid entities (Latour 1993) containing both human and non-human elements. Change, in the ANT view, results from decisions made by actors, and involves the exercise of power. Latour (1986) argues that the mere possession of power by an actor does not automatically lead to change unless other actors can also be *persuaded* to perform the appropriate actions for this to occur.

In actor-network terms the innovation needs to *translate* (Callon 1986) this piece of technology into a form where it can be adopted, which may mean choosing some elements of the technology and leaving out others. What results is that the innovation finally adopted is not the innovation in its original form, but a translation of it into a form that is suitable for use by the recipient special school (Tatnall 2002).

5.3.2 Introduction to Formal Concepts of Innovation Translation

There are several special terms that are applied in the ANT framework, and it would be useful to define these here, as several have been employed in this study. Callon (1986) outlines the process of innovation translation as having four 'moments' and these are defined by the following:

- **Problematisation:** in which an actor attempts to define the nature of the problem and the roles of other actors to fit the proposed solution.
- **Interessement:** is a series of processes that attempt to impose identities and roles, defined in the problematisation, on the other actors.
- **Enrolment:** will then follow leading to the establishment of a stable network of alliances.
- **Mobilisation:** occurs as the proposed solution gains wider acceptance and an even larger network of absent entities is created (Grint & Woolgar 1997) through some actors acting as spokespersons for others.

It can be argued that research on special schools should be practical, and that innovation diffusion theory (Rogers 1995), in giving considerable weight to the persuasive powers of the characteristics of technologies, is not best suited to explaining the manner in which special schools adopt information technology. In many instances a special school principal will adopt ICT because of policy, or because he/she knows that another school is using it.

Innovation diffusion, an essentialist approach, is likely to ignore important effects from intraschool interactions, the nature and size of each special school, the inter-school interactions, interests of particular individuals or organisations (teachers, parents, school principals, students, Education Department), and the nature and size of special schools. On the other hand, actor-network theory, in examining alliances and networks of human and non-human actors (actants), provides a good foundation from which special school adoption and use of ICT can be researched. The ANT approach will be further outlined in the case studies, particularly in respect to the identification of actors, their associations and networks. The reader should note that the research questions that were discussed in Chapter 1 of the thesis were in fact modelled and framed in ANT.

5.4 ACTORS, NETWORKS, BLACK-BOXES AND TRANSLATIONS

ANT considers any human or non-human entity that can "*make its presence individually felt by the others*" (Law 1987) to be an *actor*. While it is clear that a human entity may be able to do this, to those new to actor-network theory it is not as obvious that a non-human can also do this. The answer is to think of what lies behind an actor. If we consider the local school as an actor, for example, then behind this actor we could find school operational staff, an ISP, a web site, software, modems, computers, web browsers, telephone lines and many more things. Therefore, when looked carefully, an actor itself consists of a network of interactions and associations. An actor is made up *only* of its interactions with these other actors (de Vries 1995), and Law (1992) notes that an actor thus consists of an association of heterogeneous elements constituting a network.

An actor like this can, in many ways, thus be thought of as a *black box* (Callon 1986), the contents of which we can chose not to worry about. The details of its composition are then just a complication we can avoid having to deal with. We can consider this entity just as an actor, but when doing so it must be remembered that behind each actor hide other actors and that it has, more or less effectively, drawn together or '*black-boxed*' (Callon 1987). When the time comes to open the lid of the black box and look inside, it will be seen to constitute a whole network of other, perhaps complex, associations.

In this study, each of the schools I visited had their own Educational Technology and Learning Plan and was interested to adopt e-learning[69]. In particular, this plan was to be integrated into the main curriculum. They each attempted to translate e-learning into a form which they could adopt, and each attempted to choose certain elements or components from the plan and leave some others out. Hence, each school tried to translate the technology into a form that was suitable for their students' learning outcomes. The key actors have been included in the main table (Table 0-1) at the start of this dissertation. The reader would find it useful to review this table before continuing further into this chapter.

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[69] See Appendix F

In each of these instances, the actor-network approach therefore offers a useful explanation of why a particular e-learning (ICT) initiative was or was not adopted. On the other hand, an innovation diffusion approach to investigating each of the potential adoptions would have looked for explanations for the uptake, or lack of uptake, primarily in the characteristics and properties of the technology in each case. It would not have considered, as particularly important, the human and non-human interactions described here. In this thesis, the decision to adopt, or not to adopt ICT, has more to do with the interactions and associations of both human and non-human actors involved in the research study, and not just characteristics of the technology. Given that an essential aspect of ANT is its treatment of complexity, the next section provides some important concepts that provide support for the application of ANT framework for my thesis.

5.4.1 How Actor-Network Theory Handles Complexity

A major issue in this study was how to understand the complexities of ICT innovation. A common method of handling complexity in all subject areas lies in simplification, but in this case the danger with simplification is that it runs the risk of removing just those things that constitute the description I want, by concealing the parts played by many actors (Suchman 1987). Clearly, though without any detail, understanding of ICT adoption tends to be superficial and lacks the necessary detail which would allow a more holistic account. Of course some simplification is necessary in order to represent the infinite possibilities of any complex situation and all research methodologies offer ways of simplifying complex social phenomena. The question here is which details to include and which to leave out and who is to decide. In this respect, an appropriate research approach needs to ensure that complexities are not lost "*in the process of labelling*" (Law 1999 :9).

It is a feature of actor-network theory that the extent of a network is determined by actors that are able to make their presence *individually felt* (Law 1987) by other actors. The definition of an actor requires this and means that, in practice, actors limit their associations to affect only a relatively small number of entities whose attributes are well defined within the network (Callon 1987). This simplification is only possible if no new entities appear to complicate things, as the actor-network is the context in which the significance and limitations of each simplified entity is defined (Callon 1986). If a new element is added or if one is removed, then some of the other associations may be changed as it is the juxtaposition of actors within the network that is all-important.

> *"The simplifications are only possible if elements are juxtaposed in a network of relations, but the juxtaposition of elements conversely requires that they be simplified"* (Callon 1987 :95).

In a school environment we can identify many components (teachers, students, policy, etc.) that can be considered as an object (Parsons and Wand 1997) with its own properties, methods and actions. In common with the encapsulation of objects in object-oriented environments the actors, or '*heterogeneous entities*' (Bijker, Hughes et al. 1987), encountered in actor-network theory, have attributes and methods and may themselves be composed of other objects or actors. So, when looked into carefully, an actor itself consists of a network of interactions and associations. In the same way a network may be simplified or thought of as a 'black-box', to look like a single point actor (Law 1992).

> *"... if a network acts as a single block, then it disappears, to be replaced by the action itself and the seemingly simple author of that action*" (Law 1992 :385).

The entry of new actors, desertion of existing actors, or changes in alliances can cause the 'black boxes' (Callon 1986) of networked actors to be opened and their contents reconsidered. A network relies on the maintenance of its simplifications for its continued existence. These simplifications are under constant challenge and if they break down the network will collapse, perhaps to re-form in a different configuration as a different network.

An actor is not just a 'point object' but an association of heterogeneous elements themselves constituting a network, so each actor is also a simplified network (Law 1992). An actor can, however, in many ways also be considered as a black box, and when we open the lid of the box to look inside it will be seen to constitute a whole network of other, perhaps complex, associations (Callon 1986). In many cases details of what constitutes an actor - details of its network - are a complication we can avoid having to deal with all the time.

We can usually consider the entity just as an actor, but when doing this it must be remembered that behind each actor there hide other actors that it has, more or less effectively, drawn together (Callon 1987). This means that any changes affect not just this actor, but also the networks it simplifies (Callon 1987). It is, likewise, also often possible to 'punctualise' (Law 1992) a stable network and so consider it in the form of a single actor. Whenever possible it is useful to simplify, to an actor, a network that acts as a 'single block' to make it easier to deal with. An actor then:

> *"... can be compared to a black-box that contains a network of black-boxes that depend on one another both for their proper functioning and for the proper functioning of the network"* (Callon 1987 :95).

The important thing to note about the use of black-boxing for simplification is that the complexity is not just put into the black box and lost as it is always possible and indeed necessary, to periodically reopen the black box to investigate its contents. The complexity is punctualised (Law 1992 :385), but not lost.

5.5 USES OF ANT AND INNOVATION TRANSLATION THEORY

As it can be observed, actor-network theory offers advantages over the other methodologies considered in its handling of the complexities due to the contributions of human and non-human entities, of avoiding the difficulty of needing to find a dividing line between these, and in its ability to avoid having to assign either humans or the technology an 'essence'. Although ethnography and case study methodology are both useful in handling complex situations, neither is especially useful in tackling socio-technical problems, and neither can manage the notion of technological-human hybrids which is a key feature of actor-network theory.

A pure ethnographic approach would restrict any explanation of the reasons for adoption of ICT in special schools by only the 'social context' (Callon 1986) and exclude the possibility that some of the explanation might lie in the technology itself. It would not allow the technology other than a passive role, and allowing some of the actors to give agency to the role the software and hardware play. Simple case studies are also considered to be situated in a particular social context, and issues of how technological entities interact with this social context are considered only from the perspective of the case.

Although there have been several other studies of curriculum innovation, such as Nespor (1994), Gilding (1997), Bigum (1998), and Busch (1997), which have used a translation rather than a diffusion model, such studies are relatively rare. A survey of the literature revealed no other studies on LD and ICT adoption were introduced largely through the actions of a single person rather than as part of Departmental policy that make use of an innovation translation approach. Use of this approach thus makes this study significant and quite different to most others.

Actor-network theory has been used to investigate the success of a number of technological innovations and, in particular, to describe a number of notable failures. I presented several examples earlier in this chapter, of how and where ANT was used, and the list that follows extends the range of studies considered.

Law (1986; 1987) has used actor-network theory to describe the successful Portuguese exploration down the African coast to trade in India, and the unsuccessful TSR2 project (Law 1988; 1988; Law & Callon 1992) to build a revolutionary military aircraft in Britain. Callon (1986) has used it to describe the 'domestication' of scallops in St Brieux Bay, Brittany and the failure of the Renault car company to develop a successful electric car in France (Callon 1986).

Singleton and Michael (1993) have written of the part played by general practitioners in the UK Cervical Screening Programme. Grint & Woolgar (1997) have used ANT, and other approaches, to explain the Luddite rebellion and the events surrounding introduction of weaving technology into the United Kingdom in the early nineteenth century. Bigum (1998; 1998) has described the introduction and use of computers in schools and Gilding (1997) on how university students build expert systems. Busch (1997) has applied actor-network theory to medical school curriculum and Lundberg (1997), Mol & Law (1994) and Prout (1996) to hospitals and other things medical. Star and Griessemer (1989) have applied it to projects in museums, and Vidgen & McMaster (1996) to car parking systems.

Latour (1988) has used actor-network theory to discuss the achievements of Louis Pasteur, some of the processes undertaken by scientists in their research and their laboratories (Latour 1987), the simultaneous invention of the Kodak camera and the mass market for amateur photography (Latour 1991), and analysis of the conception and ultimate failure of the revolutionary Parisian public transportation system known as Aramis (Latour 1996).

More specifically, innovation translation has been used to describe the fate of a range of innovations, a selection of which will now be mentioned. A book review by Pinch (1998) describes Simmie's (1997) examination of how changes occur in regional economies. An innovation translation approach to the formation of attitudes by farmers and 'field-level bureaucrats' on issues of farm pollution is discussed by Lowe & Ward (1997), and in the same book (Goodman & Watts 1997) an article by Whatmore & Thorne (1997) investigates the globalisation of coffee marketing. A review of this book by Kayatekin (1998) argues that although the actor-network approach to innovation translation used in these papers, and several others, offers valuable insights, it is still somewhat controversial and problematic. Other general examples of the use of an innovation translation approach include a description by McMaster et al. (1997) of the failure of the IT Department in a UK City Council to adopt a structured systems design methodology.

In one of the few papers on the use of actor-network theory in curriculum innovation, Busch (1997) contends that to sustain educational change requires developing policies that consider the enrolment of both human and non-human actors in a new network to support the change. Gilding (1997) gives another example in his study of how university students came to understand the building of knowledge-based systems, concluding that both the teacher and the students extended power to the technology by roles they assigned to it.

Although not directly related to curriculum innovation Nespor (1994) uses actor-network theory to describe how an American university made use of its physical space in different ways to mobilise the communities of Physics and Management.

5.5.1 Criticisms of Actor-Network Theory

There appear to be several main criticisms of actor-network theory. To begin, there is the criticism (Grint & Woolgar 1997) that it is not always sufficiently clear where the boundaries of a network lie or whose account of a network is to be taken as definitive. Grint and Woolgar (1997) note that the analyst's story seems to depend on a description of the 'actual' network as if this was objectively available. Radder (1992) expresses some concern with what he sees as the goal orientation of ANT; its tendency to look towards stabilisation, black-boxing, and control. He asks of the nature of the stabilisation process, and questions from whose point of view it is seen, pointing out a tendency in ANT to look at things from the viewpoint of the 'winners'; the successful actors. He argues that a bias to do this is built into ANT's definition of an actor as:

> *"... any element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own"* (Callon & Latour 1981 :283), quoted from Radder (Radder 1992 :181)*)*

Under this definition, Radder contends, there are only winning actors. A second criticism relates to ANT's treatment of human and non-human actors. A critique by Collins & Yearley (1992) claims that:

> *"The deprioritization of social that gives an autonomous voice to 'things' disguises the fact that these voices in actuality depend upon the mediation of human actors" (*Collins and Yearley (Collins & Yearley 1992) quoted from Singleton and Michael (Singleton & Michael 1993 :231)).

They suggest that ANT concedes too much to realist and technical accounts. In reply, Callon and Latour (1992) claim that technological artefacts are implicated in the very fabric of the social and are "social relations viewed in their durability and cohesion" (Singleton & Michael 1993 :231).

Also in relation to its treatment of human and non-human actors, Lee and Brown (1994) propose that actor-network theory's very liberalism and democracy mean that it has no 'Other'. Whereas much of sociology has put anything non-human or non-social outside its disciplinary boundaries and made it 'Other', ANT has not. They assert that ANT's success in challenging the human/non-human dualism puts it at risk of:

> *"... stretching the Nietzschean world view*[70] *and the discourse of liberal democracy to cover everything"* (Lee & Brown 1994 :774).

and in doing so risk the production of "yet another ahistorical grand narrative and the concomitant right to speak for all" (Lee & Brown 1994 :774).

Thirdly, Grint & Woolgar (1997) argue that ANT retains a degree of residual technicism in its need to sometimes refer to 'actual' technical capacities of a technology. They quote Callon's (1986) analysis of the attempts at building a French electric car, in which they claim that he makes reference to the 'unfortunate tendency' of the catalysts to become quickly contaminated. They note that the anti-essentialist approach of actor-network theory would point to this 'actual property' being treated as a construction.

Brey (1997) claims that by assigning properties and effects to technologies, actor-network theory has some similarities to the social shaping approaches and suggests that the notion of inscription (Akrich 1992) could be seen as a metaphor for the 'politics of artefacts' (Winner 1977; 1985). Despite these minor reservations, however Grint & Woolgar (1997) note that actor-network theory points to the possibility of an understanding of technology that does not rely on the presence of a 'god within the machine'.

Further criticisms of ANT (Scott 1991) can also be found, but most are only partial, many cover approximately the same ground, and some reflect only a limited reading of the ANT literature. None of the criticism is sufficiently serious; however, to deter me from basing the methodology of this study on the use of actor-network theory, and some of the criticism, as I will argue, is a useful basis for reflecting on my analysis.

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70 In the Nietzschean world view all categorisations of things in the world are considered to be solely the result of human activity. This would apply to categorisations such as that of humans versus non-humans.

An investigation of the complex socio-technical processes by which the specific content of an ICT adoption is concerned, legitimised and kept up to date, is the subject of this study. It involves an investigation not just of the formal statements of content that appear in documents like Departmental Policy, but the 'messy reality' (Hughes 1983) of the selection of content by individual teachers from subject to subject and from term to term. It is specifically concerned with the adoption and integration of ICT by the special schools in their curriculum. In an area such as this, an area so dependent on the use of technology, actor-network theory offers considerable advantages over other approaches, and hence it is the analytic framework that has been adopted in this study. This is an actor-network study in innovation/adoption; a study in technology innovation/adoption by translation.

5.6 ANT FOR THIS RESEARCH STUDY

In putting together a teaching curriculum, a teacher must reduce students (and other actors) to a few salient attributes and associations. Students are redefined in terms of the role(s) they play within the teacher's network. A student becomes someone who will select a topic of interest from SharePoint[71], write about it, change the colour of an image, or its attributes, or work in a particular way. Students become members of the teacher's network and are assumed to have certain associations with the technology. The teacher assumes they will use the technology in particular ways, thereby assigning the technology a particular role. For example, in a personal development class, or Office Skills learning environment, the teacher assumes the technology takes on the role of being a device which facilitates student earning in some way. For example a word processing program, facilitates the writing process and corrects the grammatical errors. Teachers adopting this stance assign the word processing software the role of an actant.

The first step in the analysis was to identify the actors which were a part of the students' networks. The task was to identify those entities the students considered had reduced to a single entity and association. While some actors were easily identifiable, others were more difficult to identify. I was not only looking for physical entities but also patterned

[71] SharePoint collaboration software helps simplify business intelligence, content management, search, and sharing for intranet and internet sites. This helps students with file sharing, Web publishing, online chats and provides them access to school Intranet and other resources.

effects of associations which the students enrolled as actors, for example, the computer technology has multiple levels of grammar which may be enrolled at any level of a single actor.

The second step in the analysis was to identify and describe different moments in which actors adopted or were given specific roles. In the first instance, this meant looking at descriptions of the students' work and identifying specific roles, different actors, including the technology, were assigning each other. Role identification led me to consider competing enrolments that existed within the students' network. It also highlighted some of the differences in role assignment that existed between the students, the author and ICT. This analytical step highlighted the enrolments and counter enrolments that existed within the students' networks. For example, the level of LD differed in the class and this made the study more challenging as the author became an actor and was aligned with their networks.

Having identified different enrolments among the actors, the next step was to consider how these enrolments were stabilised, that is, what actions did particular actors undertake in order to ensure that other actors within the networks accepted or acted in accordance with their assigned role? It was also important to consider how other actors may have been disassociated or marginalised through the actions of particular actors. In other words, how did the actions of one actor attract another while marginalising a third actor?

It quickly became apparent that not only was I a part of the students network, but I also attempted to engineer the students as part of my network. Learning and teaching became a competition between, and reconciliation of, different networks where certain actors, at different times sought to stabilise their own network, at times using enrolments unacceptable to myself or ICT. This led to an analysis of different programmes of action (Latour 1991) which were used to load an actor's definition of their network. Programmes of action are a series of (set of) interessements geared to enlisting an actor, which has displayed counter enrolments (Latour 1991).

5.6.1 The Search of Actors

The main aim of the analysis was to observe and work with the students in class or on an individual basis, to determine their attitude towards using ICT in their curriculum. The students' conduct was now seen to be a patterned effect of these associations (Law 1992). My first obvious task was to think about the participants and materials students enlisted during normal classroom periods. In addition, I was looking for other actors such as teachers, parents and leaders of the school community.

Therefore, my initial task was to examine the various student description of their work, the intermediaries they had put into circulation and my accounts of the students' work, in order to identify particular actors which were a part of the students' assignment work. The simple question was to determine how ICT may have contributed to the students' understanding of their project work. This meant looking for anything which the students enlisted and which, at times, enlisted the students as they worked with technology on a daily basis.

5.6.2 The Students Network

It is impossible to describe the full detail of each student's actor world and only some elements of the students' network are described. The main point is that each students' network as different as they brought together different resources. Such networks differ in origin largely because the students exhibited different skill levels and knowledge of ICT tools. The resources presented students with different problems and led them to develop networks of varying complexity. The effect of the students' enrolment of different resources is discussed in more detail in Chapter 7 & 9. The students' networks also differed in enrolment, organisation, utility, significance and purpose but these are properties more aligned with the discussion of blackboxing and enrolment which is discussed in the following chapter.

From the perspective of this study, the students were a part of an actor world centred on particular learning tasks and skills. The project work meant students had to select actors from their content or medium like SharePoint. In ANT terms, they enrolled intermediaries (actors) from other networks thereby extending their content related networks, and in some cases their knowledge of the area. Their explicit enrolment of materials and other people as they engaged in their daily work meant that, they at the very least, drew upon pre-existing actors within their content related network and, at times , new actors from other representations of the field in which they chose to work for their projects (usually, VCAL projects).

The textual and visual resources students used included reference and text books, personal laptop, SharePoint, and the Internet. In addition, to using various immutable mobiles (textual and visual resources), some students enrolled one or more other people in order to complete their project. These students used their peers and teacher assistants (aides).

5.7 A NOTE ON METHODOLOGY

The methodology for analysis in this study tests a holistic approach to investigating technology within the classroom. Concepts such as actor, which constitute anything which the heterogeneous engineer has given a role and therefore an identity, means that initially, anything or anybody may be included as part of the actor world in the classroom. The capacity to blackbox any entity, together with the reality that such blackboxing is often only tenuous at best, means the researcher is given conceptual tools which allow him to probe any associations (s)he believes are relevant. No actor is ruled out or precluded from study. This approach has significant implications for the way we study the use of technology in classrooms. Actor-network based studies require the researcher to follow the actors (Callon et al. 1986a, Goguen 2000), to ask questions of the people, materials and technology the students use (Cooper & Law 1995). Such questions raise issues about the curriculum, especially in regard to the use of technology, as well as the student learning, classroom practice, and a host of topics that are often discussed as if they were separate issues or at least could not be considered as interrelated as ANT accounts allow.

The advantage of using Actor-Network Theory to analyse the students' work is that any association the students form, may be subject to analysis. The actions of the teacher, students and computer hardware and software as well as other actors are all under scrutiny. This provides ANT and methodologies derived from it, with considerable utility within educational research. ANT is therefore appropriate not only for studies of student learning with computer technology, but it is also appropriate for studies of curriculum relating to learning with and about computer technology. In fact, the nature of an ANT inquiry into an education setting makes it difficult to omit curriculum issues form learning issues, from technological issues, from policy issues. Just as the case for Grounded theory, it is often a pragmatic issue as to when the inquiry ceases.

5.8 A NOTE ON IDENTIFICATIONS OF ACTORS

Although Tables 01 - 04 at the start of the dissertation display a fairly detailed list of actors, it should be noted that many of these actors were identified through relationships and interactions of other actors over a considerable time period. If we recall, from Chapter 5, that an actor was defined as something that can be acted on, or moves an action on to some other entity, then we will see relationships between objects that allow us to classify them as actors in the story being told. I used this approach and followed the early actors, and identified many other actors, relationships and their networks.

5.9 LIMITATIONS

The study is limited by the assumptions underlying Actor-Network Theory itself as well as the practicalities associated with identifying and analysing emergent networks. ANT omits the effective component of learning. There is no concern with motivations, anxieties, and feeling of dedication, pleasure, frustration and susceptibility. However, the frustration students experience when attempting to connect to the Internet to find out information about their VCAL projects was noted in their actor-networks.

There are also practical problems with analysing the messy realities of networks and the methods of association that exist within them. Particular incidents must be disentangled. They are observed in a complex social setting and the researcher’s task is to try and isolate actors and their role assignment. At time it is difficult holding one’s perspective in that one attempts to look at specific associations from the viewpoint of what each actor does. ANT is limited by the researcher’s capacity to isolate and describe all the observations. It is often not a straightforward issue in deciding who or what will be an actor, how they define other actors and the strength of the connections they have with those actors. Technology needs to be given a greater voice when classrooms and students are researched using computers. The software currently in use in classrooms is more complex than that used in the current study. Many interfaces, such as that for the operating system, Windows, now include added functionality and adaptive functions/controls that can support LD students. As such, in studying such technology it is clearly a gross simplification to blackbox and regard its role as one of context or a fixed variable in which the only significant variables are students and teachers.

5.10 WHY ANT IN THIS STUDY?

The main benefits of using ANT to frame this study are: (1) the holistic approach as this breaks the boundaries of technology, educations and LD, and (2) the equal treatment of humans such as teachers, students etc., and non-humans, such as laptops, curriculum, school policy, classroom environment, etc.

5.11 SUMMARY OF RESEARCH METHODOLOGY

In this study, I have followed a holistic approach to explore the impact of ICT to learning approaches and outcomes for students with LD. It was appropriate to adopt a constructivist approach that provided scope for the analysis and identification of various actors in the learning community. The methodology used a combination of ethnography[72] and ANT as an analytical framework, as it used a non-essentialist and non-deterministic approach to account for the contribution of both humans and non-humans (e.g. computers). In summary, the following main points provide the rationale for my methodology selection:

- Those who have undertaken ANT studies of science and technological studies have often drawn from the ethnographic tradition (e.g. Law 1992).
- The study needed analysis of the interactions of children and technology (i.e. human and non-human actors), and ANT was suitable as it places equal weight on the role that each of these play.
- A social approach would have placed more weight on the social aspects and assign a more deterministic role to human actors.

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[72] This allowed me to observe, interview, and participate in the learning community so as to gain a real insight on how special needs students learn and also how they apply ICT skills in the classroom.

- A technical approach gives a more important role to the technology and regards the social as merely context. ANT overcomes this by using a socio-technical approach that places human and non-human actors on an equal footing analytically.
- Boundaries[73] were not set in advance with ANT as these were determined during the study and analysis, not before.
- It has been applied to more general environments in education by Gilding (1997), Bigum (1996), and Tatnall (1999).

Actor-Network Theory was applied to this research endeavour, since I wanted to analyse contextual factors which contributed from the students', staff, and parents' understanding of the technology. Both human and non-human elements (actors) within the school community network constitute networks in themselves, which may be implicated at any time. The next chapter provides a discussion of the methods and techniques and presents the overall research design.

[73] These include Education, Technology, Sociology and Psychology.

CHAPTER 6

6 METHODS AND TECHNIQUES

The wisest mind has something yet to learn.

George Santayana (1863 - 1952)

6.1 SYNOPSIS OF METHODS AND RESEARCH DESIGN

As with any research study, one of the main challenges is the nomination and selection of the research methods. ***Is it quantitative or qualitative***? According to Tesch (1990) a quantitative research study would purely employ statistical techniques. However, when dealing with human and non-human aspects we have to follow a systematic method in deciding the appropriate research method to analyse the data, if that is possible. Tesch (1990) makes the following important statement about qualitative research:

> *"When we talk, therefore, about the analysis of qualitative data, we are not dealing with a monolithic concept like statistics. No one has codified the procedures for qualitative analysis and it is not likely that anyone ever will. Qualitative researchers are quite adamant in their rejection of standardization. Whenever they describe their methods they are usually easier to point out that this is just one way of doing it, which others should feel free to adopt as much as they see fit, and modify and embellish it according to their own needs and ideas. Thus, the notion of qualitative analysis is fluid and defies definition. It is applied to a wide variety of principles and procedures. The only agreement we would find among qualitative researches is that analysis is the process of making sense of narrative data"* (Tesch 1990, p4).

According to Creswell (1998) an explanation of when to use qualitative and quantitative research methods relies on how the research questions are framed. If the research questions asked *how* or *what* because they are seeking descriptions of *what* is going on, then we should employ qualitative research methods. If, on the other hand, the questions are seeking to qualify things, are seeking straight forward factional information asking things such as *how many, who, how much, where, or when* then they are more suited to quantitative enquiry (Williamson 2000).

The research questions which were introduced in the early part of the dissertation will be presented in this chapter, and upon examination of these the reader would notice that the principal and other supplementary research question are prefixed with *how* or *what*.

6.2 RATIONALE OF METHOD

In the early part of this dissertation I provided a synopsis of my research study aims which included the major research question "*How do e-learning models form and stabilise when web based technologies are introduced to support learning communities involving students with learning disabilities?*" Undoubtedly, this was a challenging task in the early phase of the research process, namely the formulation and framing of the major research question and the selection of an appropriate method that should be pursued to form a conclusion. The method chosen, of course, would have a strong bearing on data collection and analysis of results (Creswell 1998, Leedy 1997, Tesch 1990 and Patton 1990).

Qualitative research is a subjective process, as the researcher may bring his/her own knowledge and experience (bias) to the data collection. The analysis and the report writing which may in turn be affected by this bias (Agar 1986, Bochner & Ellis 1996, Darke & Sharks 2000). As it would be expected, the researcher is involved in the project with certain biases and preconceptions in the form of beliefs, knowledge, experience, values and prior assumptions. Accounting for this, I have followed Schultze (2000) to acknowledge my bias in the selection of the study. However, as stated earlier, I believe that I have followed my ethical commitment, protocols and responsibility to make the reader aware of my background and personal involvement. The research framework and protocols have ensured impartiality and objectivity in collecting and presenting my observations and data in this study. As will be described later in the chapter, the research process is an iterative one where the questions one asks, the data one collects, and the themes that emerge are part of an evolving process.

Denzin & Lincoln support the view that this is a fluid process in that it draws on new tools and techniques as the need arises. A successful researcher should be self-reflective by engaging in the task at and review the methodologies being applied to the research task. (Denzin & Lincoln 1998)

6.3 MY OVERALL RESEARCH FRAMEWORK

LD-definition/context-Global, Australia special needs

Participant Observer (Tas)

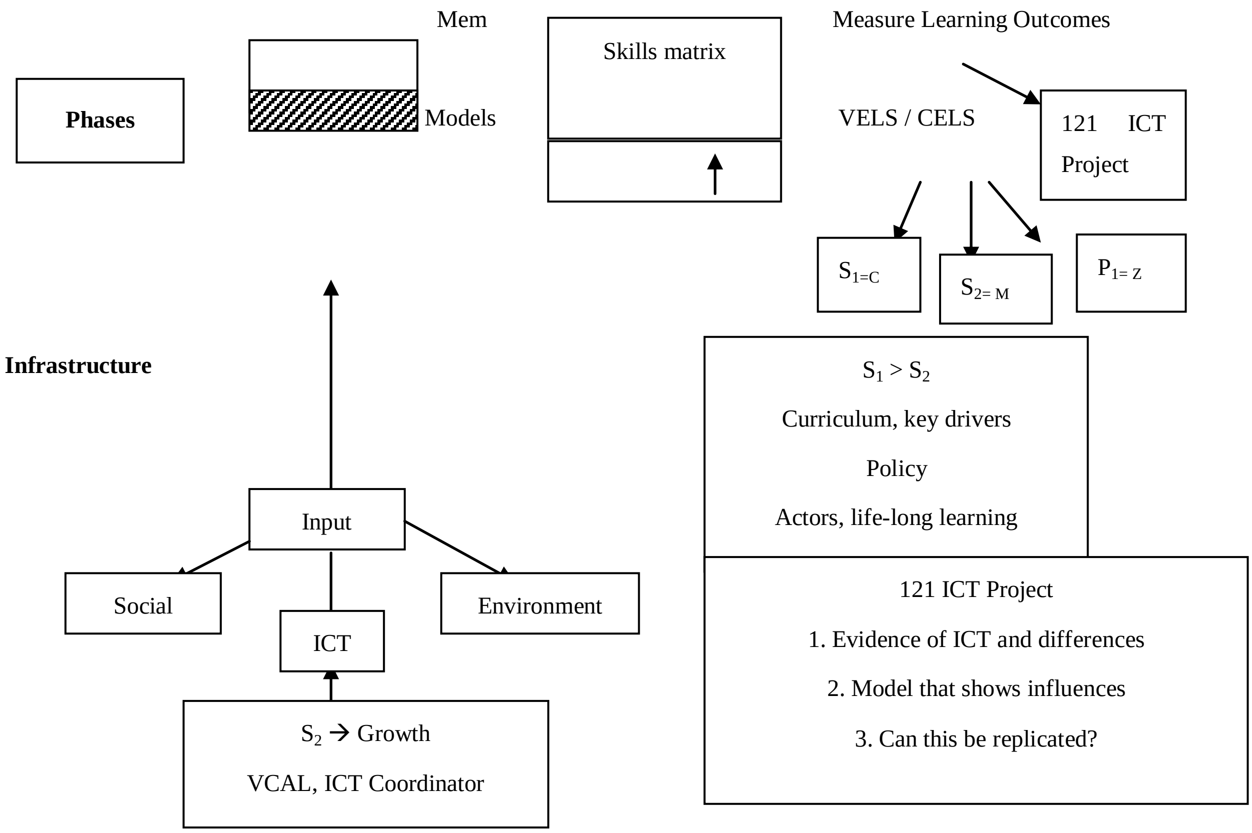

Figure 6-1: Research framework

The figure illustrates the phases and considerations in the study. The lack of primary data was a significant factor in setting up the research fields in the different special schools, and the individual case study, in order to gather relevant data for the thesis. The key element in the early part of the research was an analysis of the infrastructure for an effective ICT environment. The study was conducted at Macedon Ranges and was carried out in a holistic manner. In the figure above, Macedon Ranges = S_2, Concord = S_1 and Individual study = P_1. The figure also shows the presence of the 121 ICT Project at Concord. This was a very significant project as it provided a large volume of relevant and rich data for the thesis.

6.4 DATA COLLECTION

6.4.1 Data Collection Methods

Creswell (1994, 1998) recommends several field activities for the data collection. I have summarized many of these in Table 6-1. The table shows the main tasks and approaches undertaken for the data collection in my study.

Data Collection Activity	**Members of a culture**
What is traditionally studied	LD education
Site/individual	Special schools and individual study
Typical access/report issues	Gaining access through the gate keepers, Security clearance, Giving confidence, protocols.
Type of material collected	Participant, observatory, interviewers, artefacts, documents, policy documents
How is information recorded?	Field notes, journal entries, Interviews, surveys, questionnaires Observational protocols, digital voice recordings
Common data collection issues	Field issues, Flexibility, Reactivity, Reciprocity Going native, Divulging private information Meetings.
How is information stored?	Field notes, Transcriptions, Computer data bases, USB Memory sticks, digital storage media.
Sampling-follow the big net approach	Select individuals opportunistic sampling
Forms of data	Gather field notes as observer participant
Interviews	Conducts instructed interviews, Open ended notes Transcribe material
Documents	Keep journal, online documents Have participant keep a journal Collect personal letter from participants Analyse public documents Official menus, records, policy documents, photographs, video tape, Email, Notes, Official letters, Vic gov ICT Policy, Curriculum of special schools, e-learning/technology plan, CELS : indicators for achievement, Cultural Portrait , Concept Map, Artefacts School Annual Magazines/ Brochures
Audio-visual	Examine physical evidence Photographs, Collect sounds, Multimedia service Collect email, Notes

Table 6-1: Data collection activities (Source: Creswell 1994)

6.5 THE RESEARCH APPROACH

Teaching is very important, as is technology, but we need the integration of people, machines and paradigms that can be employed to study the interactions of all parties (actors) concerned. In this study I needed to explore the interactions of several other areas/fields[74] (1) with technology and humans. Following Creswell (1994, 1998), Tesch (1990) and Patton (1990), I chose a holistic ethnography (Tesch 1990, p63) as my qualitative research approach. Since I also needed to account for the interaction of human and non-human elements in the research environment, I chose ANT as my analytical framework for data analysis. As this study involves ICT innovation in special schools, I will argue that a research methodology must be suitable to technological advancement. It must take into consideration the complexity arising from the interwoven contribution of both human and non-human entities. These include[75] students, teachers, parents, office staff, specialist staff, organisations, policy, software companies, assistive technologies, student classrooms and Internet.

6.5.1 Research Approach in the Field of Study

The thesis has investigated three case studies. The first involved a special school that was used to set up the scene and work on the infrastructure of ICT, the second was an advanced setting of ICT with a dedicated project to work as a participant observer on a regular basis and gather research data; and the third was an investigation based on an individual LD student. A common objective for all three was the investigation of school- to-work transition and or higher studies.

As was described in Chapter 5, ANT asserts that the world is full of hybrid entities (Latour 1993) containing both human and non-human elements, and that nothing is purely special or purely technical. One might question, for instance, which of the contributions to a piece of software (such as 3D Studio Max[76]) are due to some aspect of the computer hardware (memory), and which are solely the result of human interactions

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[74] For a full list of Actors the reader should refer to the main table of Actors at the beginning of the dissertation.

[75] This can be supported by the research approach described by Tesch (1990). The fields comprise Education, Technology, Psychology, Sociology and Anthropology.

[76] 3D Studio Max is a software animation package made by AutoDesk[T]

(modelling and design skills). As Latour contends, a major difficulty in considering how technology and society interact is the lack of suitable words, providing we consider both as acting separately. According to Latour, we should remove the division and consider both human and non-human contributions when dealing with socio/technical issues (Latour 1991).

I wish to highlight that this was a qualitative research based in an educational setting and according to Shulman (1988); a research methodology encompasses a group of methods which share the characteristics of a "*disciplined inquiry*". The most commonly used approaches in educational research involved the quantitative methods of experimental, quasi experimental, correlational and survey research, case study, ethnography, philosophical and historical inquiry methods (Shulman 1988, Jaeger 1988 and Tesch 1990.

In this study I was influenced by Creswell (1994) and Tesch (1990) and decided to follow a holistic approach in exploring the impact of ICT on learning approaches and outcomes for students with LD. I believe that it was appropriate to adopt a constructivist approach that provided scope for the analysis and identification of various actors in the learning community. The methodology that I used is a combination of ethnography[77] (3) and ANT as an analytical framework, as this uses a non-essentialist and non-deterministic approach to account for the contribution of both humans and non-humans.

An ethnographic study involves spending a considerable length of time (often 6 months or more) in the field and results in the description of the cultural behaviour in a group or individual. Case study research however, is the "*in depth study*" of a case or cases that results in the identification of themes and a detailed description of the case (Creswell 1998, p65).

In considering the questions mentioned above, it was obvious that I needed to cover issues such as the role and views of parents in the school, leadership, teaching and

[77] This allowed me to observe, interview and participate in the learning community so as to gain a real insight into how special needs students apply ICT in the classroom.

learning approaches, curriculum design, the views and ICT skills of staff, department policy and infrastructure issues, including access and safety on the Internet. There are also questions to be directed to the school community stakeholders, regarding their perceptions of the impact of ICT on the learning outcomes. It would therefore be appropriate to model my data collection, analysis and reporting techniques from ethnography as this would provide rich, thick descriptions of complex situations, in order to foster the search for patterns within the field being investigated (Geertz 1979) over an extended period of time.

The analysis entails thick descriptions of the social settings, actors and events, along with pictures of the setting and analysis of the same for patterns and themes (Creswell 1998). It was necessary, in this study, to become a participant observer and noting that no one method is associated exclusively with ethnography, I also adopted a case study research approach, especially as I was interested to investigate the individual case, along with the two other cases from the special schools. In adopting this approach, I enhance the holistic research approach by augmenting the ethnographic observations and interviews with other sources of data. In doing so, the context that results is the adoption of ICT and the use of web-based and Internet technologies in the LD students' classrooms.

The method applied to the research provided real insights from schools that can be adapted to my own setting. This can be justified in terms of my own personal motivation.

6.5.2 The Role of the Researcher

According to Goguen (2000) Actor-Network Theory requires the researcher to attend to what those involved do, to be interested in what interests those involved, and to try and understand what they believe and why they act the way they do. '*Actor-network theory focuses attention on the socio-technical networks that (others) create to get their projects done, emphasizing that no one acts alone …*' (Goguen 2000, p.2). It should be noted that the researcher plays a significant role in this setting and hence as participant observer some bias will be demonstrated. It is not possible to display complete impartiality, given the background that was described in the earlier section.

The sections below are included for completeness as these provide the main qualitative research techniques/methods that have been adopted in this thesis, namely ethnography and case study.

6.5.3 Ethnography

The framework of anthropological studies is the concept of culture. Ethnography consists of attempts to describe culture, or aspects of it (Bogdan & Biklen 1992). The purpose of ethnographic research in education lies in the description of socio-cultural activities in order to uncover social, cultural and normative patterns (Burns 1994). Ethnographic research involves building a picture of the way of life of some identifiable group of people (Wolcott 1988), and is a classical sociology that had its origins in anthropology whose main use was in the study of exotic cultures (Tesch 1990). It has evolved from educational anthropology, which was an established method for qualitative research in Educational Studies in the 1960s and 1970s (Tesch 1990).

Ethnography represents a holistic way of studying human life (Tesch 1990) in the sense that the ethnographer participates, for an extended period, in the lives of the people being studied, watching to see what happens and collecting whatever data may be available (Hammersley and Atkinson 1983; Jacob 1987). It makes extensive use of less structured and more 'creative' (Douglas 1985) interview techniques than does the anthropological sociology from which it is derived. Goetz and LeCompte (1984) summarized the main aspects of ethnography according to the following main characteristics:

> *Ethnographic research strategies elicit phenomenological data and represent the world view of the participants being investigated.*
>
> *These strategies are empirical and naturalistic.*
>
> *Ethnographic research is holistic, seeking to construct descriptions of total phenomena within their various contexts.*
>
> *Ethnography is multimodal or eclectic; researchers use a variety of techniques to collect data* (Goetz & LeCompte 1984, pp. 3-4).

Ethnography is a search for patterns and meanings and why people behave or follow their own individual ways (Shipman 1988). In fact, Wolcott (1988) noted that anthropologists always studied human behaviour in terms of cultural context, looking for how this relates to a generalised description of the way of life of an interacting group. He further noted that this interacting group of humans is always notably 'strange' to the observer, based on the presumption that the researcher's capabilities for observing, recording and analysing are enhanced in unfamiliar settings. Ethnography is open-ended and organised to maximise the chances of being able to observe the unexpected. Wolcott noted that researchers making use of ethnography in education faced the problem of:

> *"... trying to conduct observation as though we were in a strange new setting"* (Wolcott 1988 :190).

On the other hand, Goetz (1979) defined ethnography using the term '*thick description*', and ethnography provides these rich, thick descriptions of complex situations in order to foster the search for patterns within the culture or field being investigated. Hence, the final ethnographic report concentrates on the patterns it reveals, rather than the complexity itself. The focus of ethnography is the study of "*human behaviour in a cultural context*" (Wolcott 1988 :188) and it pays little heed to the role of non-human entities except where they relate as artefacts which may affect human behaviour. In an ethnographic account, ICT would be relegated to the status of a simple artefact and not permitted any active role in the innovation process. Grint & Woolgar (1997) comment that one way out of the problem of dualism in ethnographic studies, is to make the distinction between the technical and non-technical the object of study itself, by using:

> *"... the interpretive/ ethnomethodological strategy of turning the dualism into a topic to be studied rather than just a resource to be drawn upon"* (Grint & Woolgar 1997 :67).

No one method is associated exclusively with ethnography, which makes use of a variety of techniques, including participant observation, interviewing, and analysis of written resources (Wolcott 1988). It uses these techniques in an attempt to discern patterns through the study of regularities (Tesch 1990). Wolcott notes, however, that no anthropologist would ever rely solely on a single observation, instrument, or approach, but would make use of methodological triangulation (Stake 1995 :114) and obtain information in many ways wherever possible (Wolcott 1988).

Figure 6-2 shows the connections of ethnography and other related areas or fields of research that it applies to. These are referred to as regularities by Tesch (1990, p63).

The Research interest is in....

The discovery of Regularities

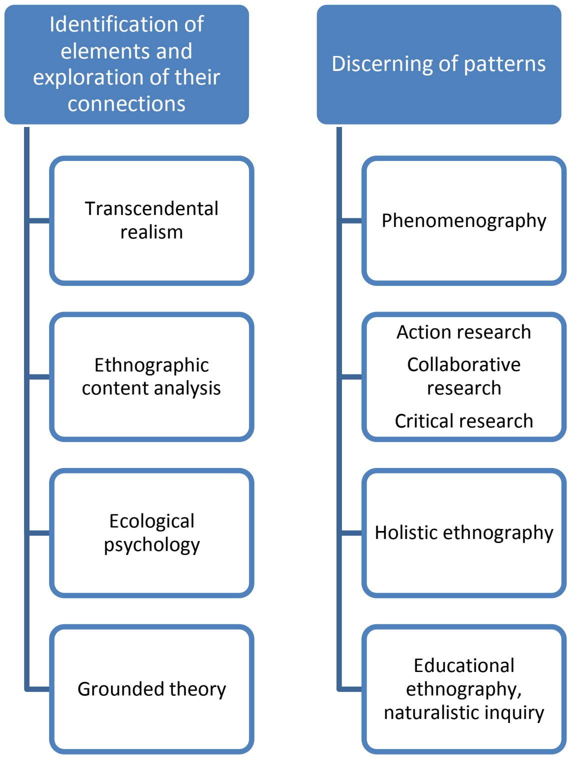

Figure 6-2: Qualitative research areas for ethnography (Source: Tesch 1990).

6.5.4 Case Study Methodology

A case study involves the detailed examination of a single setting or a particular event (Merriam 1988), and its main concern is with the detail and complexity of the case, which it treats as a bounded system (Stake 1988). It focuses on the unity or totality of this system, which is regarded as complex and dynamic. The aim is to focus on a case, and not a whole population, in order to gain an understanding of its complexity. Along these lines, a classic definition of case study research is offered by Goode & Hatt (1952):

> *"The case study then is not a specific technique; it is a way of organizing social data so as to preserve the unitary character of the social object being studied"* (Goode & Hatt 1952 :331).

Yin (1994) regarded a case study as the preferred method for examining questions that ask *how* or *why* of contemporary events, or when the relevant behaviours cannot be manipulated. He stated that "*case studies use many of the same techniques as a history, but add direct observation and systematic interviewing*". Either a single case or multiple cases may be examined. Case study evidence can be derived from documents, archival records, interviews, direct observation, participant-observation or physical artefacts (Yin 1994). As with most other forms of research, case study analysis usually consists of a search for patterns, in the multitude of data that has been collected (Stake 1988). Researchers can reach new meanings about cases both through direct interpretation of individual instances, and through the aggregation of instances until something enlightening emerges about the case. The purpose is to make it understandable (Creswell 1998).

The goal of a case study is particularisation, rather than generalisation (Stake 1995), and the primary aim of performing a case study is not to see how the case under investigation differs from others, but simply what it is and what it does, with the emphasis being on interpretation. Stake (1995) lists three different kinds of case study: *the intrinsic case study* where there is an interest in learning about the case itself, *the instrumental case study* where the purpose is to understand something else, and *the collective case study* in which several instrumental cases are studied so as to gain a better understanding of something else. He contends that a case should be treated as an integrated system in which it does not matter if the purpose is irrational or the parts work well together. The important thing is that the case is seen as a complex, functioning thing (Stake 1995). Two sorts of issues are considered in a case study: *etic issues* which are brought by the researcher from outside, and *emic issues* brought by the actors and arising from within the case (Stake 1995).

In formulating a case study it is necessary to set boundaries[78], then to seek out certain issues or themes, and in this way it differs from ethnography which is open-ended. The case study boundaries are set by the researchers and also by others who care about the system (Stake 1988). These boundaries can be reset during the study as the case becomes better known, but the study will always be bounded. Although bounded,

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[78] As mentioned earlier, an advantage of using ANT is that I do not need to set any boundaries in the field of my research study, as these will be accounted for through the action and association /networks of the actants.

however, the study can be large or small and Burns (1994) speaks of a continuum ranging from the individual subject right up to the ethnographic study.

6.6 RESEARCH DESIGN

I employed appropriate techniques for a field or ethnographic study with participant observation. The context was school based and actors were identified from educational and other environments[79]. The research was carried out with the support and access to facilities of state government schools[80] following Ethics approvals from the University Ethics Committee and DEET. The research setting consisted of a heterogeneous group of students at two special schools, and an independent study, namely my son. An ethnography framed by concepts drawn from ANT as an analytical tool, was applied to an investigation of various factors that came into play within the learning of these groups. The section below discusses the aims of the research and the main research question with the adoption of ICT in the curriculum of LD students along with several associated sub-questions that are framed in ANT. These were presented earlier in the introduction of the thesis.

6.6.1 Aims

As stated in Chapter 1, the aim of the study was to examine the place of ICT and e-learning models in an environment involving learning disabled students. This study was concerned with how computer (including Web and Internet) based technologies are used in a specific learning community. Consequently I[81] aimed to develop an understanding of the Web based technology and ICT that is employed for a particular group of teachers and learners in this setting. In addition, I explored the use of Actor-Network Theory as a holistic way of analysis in practices in an educational setting. In order to achieve these general aims, the following major research question was pursued.

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[79] For example, RCH and Multimedia Victoria.

[80] Note that permission was granted by the Principal and ratified by the Department of Education.

[81] First Person. I have used first person in line with Creswell (1994), as this is the most appropriate approach with studies such as the one investigated in this thesis.

6.6.2 Major Research Question

The major research question for the thesis was:

How do e-learning models form and stabilise, when Web-based technologies are introduced to support learning communities involving students with learning disabilities?

6.6.3 Sub-questions

In addition to the main research question, it was also necessary to consider the following sub-questions for the proposed study in accordance with the ANT approach or framework:

- *How do teachers and students negotiate (Callon 1986b) with innovation such as Web-based technologies in order to achieve particular learning outcomes?*
- *How do the human and non-human (Latour 1986) aspects of the socio-technical network, that staff and students construct involving these Web-based technologies, lead to positive outcomes?*
- *How is the technology integrated into the teaching and learning curricula? (Lave & Wenger 1991)*
- *What are the implications for the transition into further education, work placement or training for students with LD?*

In particular, I have also explored the following complementary questions arising from the literature with respect to LD students:

- Does ICT help students with special needs in teaching and learning, and if so, how?
- What are the factors that enable the students to facilitate their learning and improve the academic outcomes?
- What teaching and learning models and policy (metrics) would provide better outcomes
- How can ICT be used as an enabler for good pedagogy for this learning community?
- How can brain model theories be applied to explain the learning outcomes with respect to a specific area like graphics or multimedia?

- How does ICT assist in the acquisition of skills and application of various software packages such as Photoshop, 3D studio Max, Adobe Premier, Sound and Video production?

As was stated in Chapter 1, in this study I was also particularly interested in the following research question:

How can the internet be used as a tool to facilitate and evaluate the specific set of learning criteria as proposed by Bulgren (1998), Torgesen et al. (1983), Pillay (2000), Quinn (1996), and Lloyd et al. (1998)?

The first phase of the research examined the main elements related to role playing, games theory, concept maps, and virtual reality, in an attempt to identify key actors. As mentioned earlier, Lloyd and Forness (1998) applied an approach that was based on meta-analysis effect size[82] in order to determine the relative weight on the learning outcomes, and intervention metrics for students with special needs. Figure 6-3 shows the original conceptual framework or model that was used in the early research phase. This model was later revised to include recent aspects and phenomena of ICT like Web 2.0 technologies and e-learning of students for special needs, as were discussed in Chapter 3.

6.7 ANALYSIS OF ICT SKILLS USING THE SKILLS MATRIX

The second phase was the adoption of an existing e-learning model, namely that of Schunck et al. (2001) to carry out an analysis of the students' ICT skills in the special schools. The instrument that I proposed, and was adopted, following its acceptance by the relevant key actors, was the "*Skills Matrix Model*". This model allowed me to investigate and identify the standard of ICT skills at different times and arrive at conclusions about significant changes to the learning outcomes. The Skills Matrix instrument is included in Chapter 7. Samples of surveys and questionnaires have been included in Appendix D. These include student surveys, parental survey, questionnaires of main actors: the principals, ICT coordinator, team leaders, and teachers in the

[82] Effect size- Effect sizes are especially important because they allow us to compare the magnitude of experimental treatments from one experiment to another. The formula is provided in the Glossary.

specific project in the schools. Ethnographic techniques such as participant observations, analysis of other peoples' surveys, own surveys, interviews, examination of work produced by students (artefacts, e.g. individual study (Z) portfolio) have been applied to collect data for the thesis. This was a pioneering task into special needs education and curriculum, as well as an investigation of ICT adoption by special schools. Figure 6.4 below, illustrates the early research plan that was based on this framework.

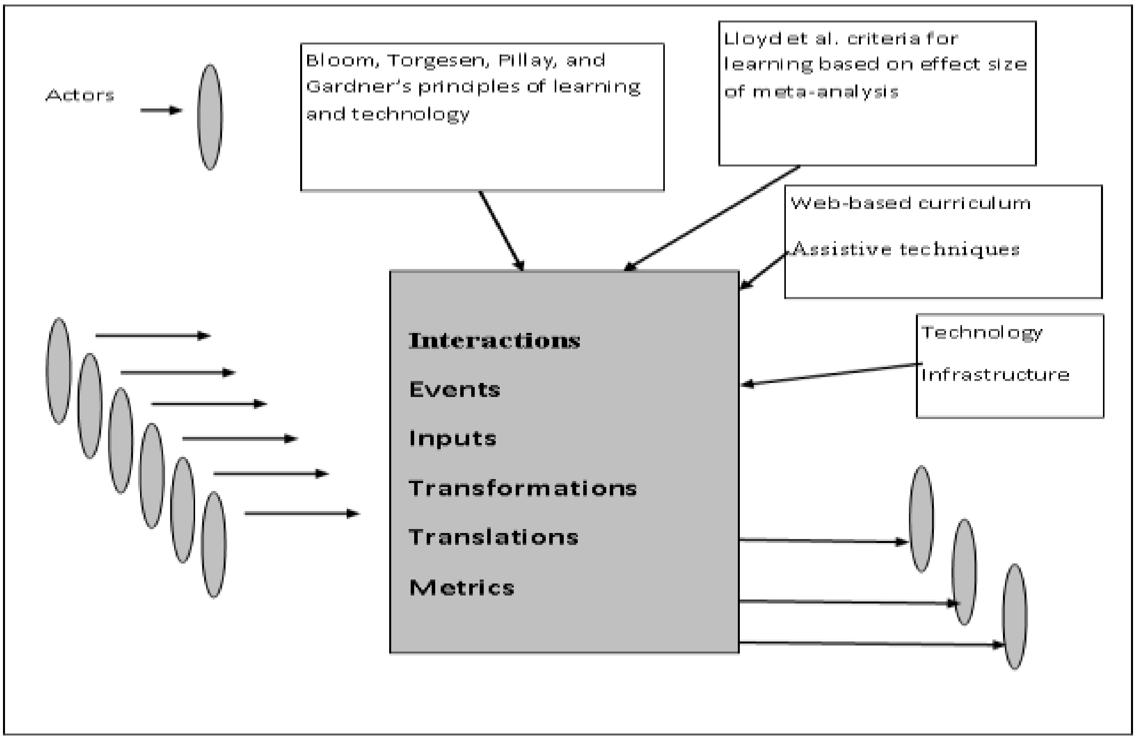

Figure 6-3: Early Conceptual Framework - Actors and interactions

The study was conducted at Macedon Ranges and Concord special schools in the outer metropolitan area around Melbourne. The central focus, and the site where I performed most observations and data collection, was Concord School, in Bundoora, Victoria. A specific project called 121 ICT was piloted at the senior part of the school. The first school, Macedon Ranges, opened the "gate" for my research. The school principal was keen to allow me to observe classrooms with the aim of analysing how ICT was used in the curriculum. As well as this, the school also supported the ethics application that was required by DEET to allow me access to conduct research in Victorian government schools.

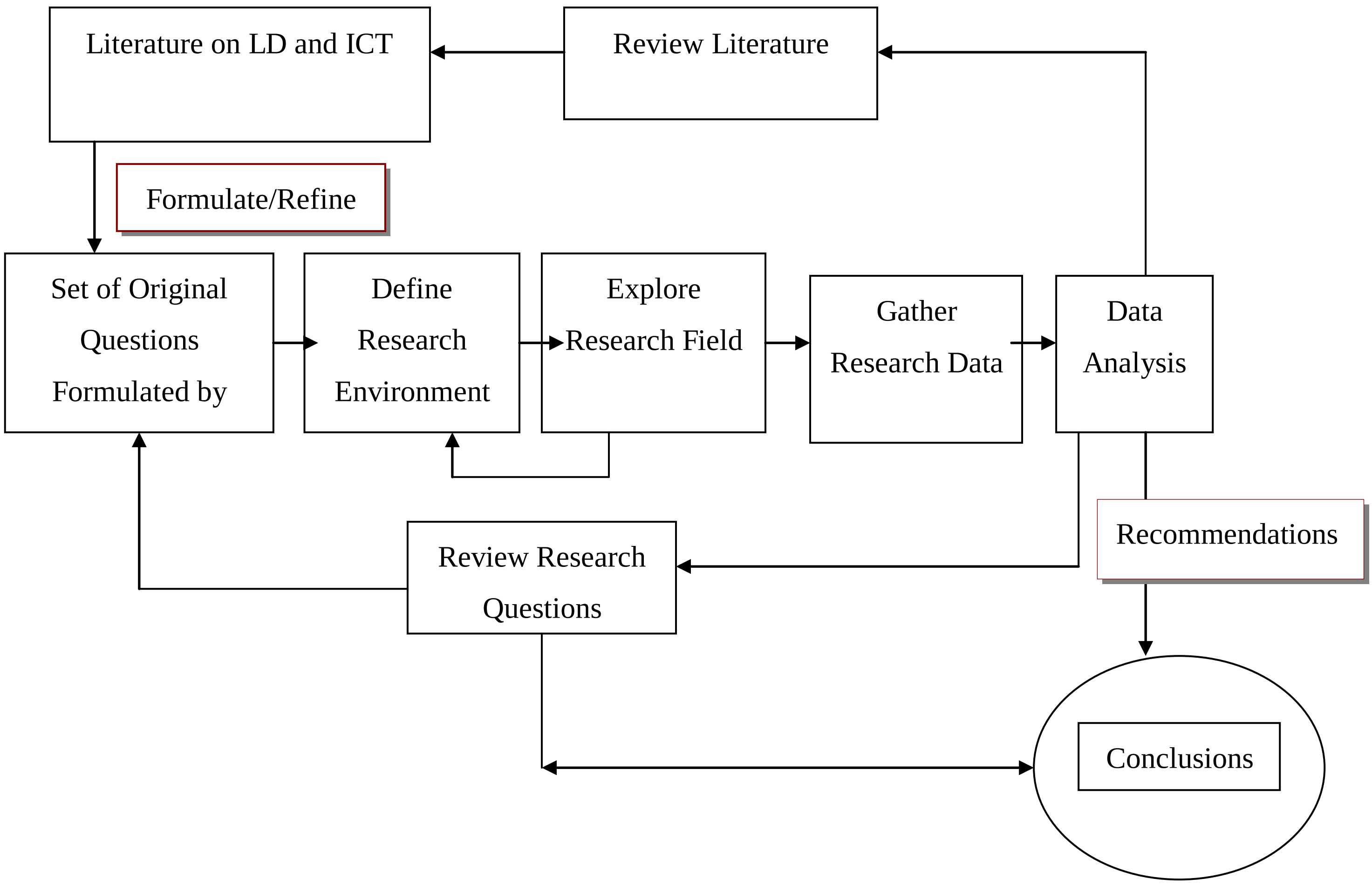

Figure 6-4: The Early Research Plan

6.7.1 The Research Process

The research process was an iterative one and Figure 6-5 shows that the research process involved more than just data gathering, data analysis, and writing in that order.

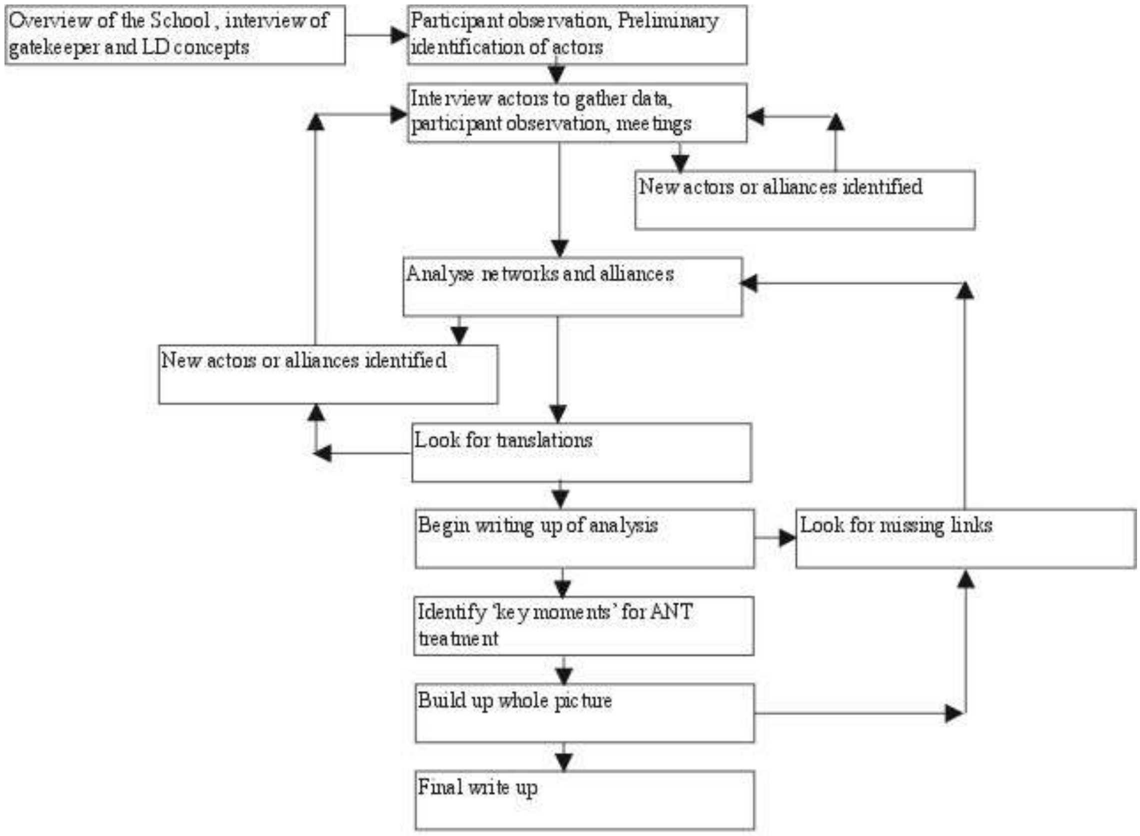

Figure 6-5: The research process (Adapted from Tatnall (1999))

The other source of data for this study was from an individual study that involved my own son. The data have been selected and are provided in an objective manner. These have been documented and selected from primary, secondary school and also tertiary (TAFE) studies from a significant time period. My bias has already been acknowledged earlier in the dissertation.

6.7.2 Time Phase for the Research Process

I have detailed the phases and the actual schedules are included in Appendix E. The major data collection took place in the period from February 2004- November 2007. This was not a smooth process as it had its challenges and frustrations. I was disillusioned with my progress and the problem of not being able to collect sufficient data from the first school due to a number of reasons. However, as mentioned earlier, I had moved to another special school which had a strong ICT focus in its curriculum with a specific objective to work on a definite project, namely the 121ICT project. I faced great challenges in 2005 with my own son's education, and this made me more determined to continue with the research task and explore ideas and methods which I could later apply in his education.

6.8 THE APPROACH TO MY RESEARCH

I adopted a qualitative approach as this enabled me to capture the views of subjects to be documented and explained. It has also enabled me to be an actor and form my own network of actors through various interactions and enrolment[83]. This was a complex study with challenges and difficulties ranging from meeting the "gatekeeper" to a complete shift of the research site (centre of calculation in ANT) with a very diverse range of situations and contexts involving people, computers, policy, software, data, parents, specialist organisations and Internet. In adopting ANT to inform my research I have drawn from the tools of qualitative research such as ethnography and case study.

6.8.1 ANT Analytical Framework and other Research Tools

Traditionally, research in educational setting has been conducted using quantitative methods and tools. However, the complexities of the educational environment and the need to capture the "thick descriptions" introduced researchers to qualitative techniques of data gathering and analysis, for example case study and ethnography (Gephart (1969 p9), Lincoln and Guba (1985 p36) and Tesch (1990)). As was stated earlier in the thesis, the present study is complex as it encompasses several boundaries. Considering that one of the boundaries is technology, I have followed the principles from "sociology of translations[84]" or ANT (Callon 1986, Law 1992) to overcome the boundaries and the justification for the selection of the appropriate research approach. This approach was taken by previous researchers (Bigum 1996, Gilding 1997, Busch 1997, Nespor 1994 and Tatnall 2000). These studies were conducted for curriculum innovation in secondary and tertiary schools where investigation of knowledge based systems, innovation of programming language such as Visual Basic, and aspects of educational

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[83] This refers to ANT terminology (Callon 1986)

[84] This was discussed in Chapter 5, Section 5.2.4

change and policy were reported. As mentioned in the introduction of this thesis, it should be emphasised that there were no studies reported in the literature which explored the impact of technology on learning through a holistic approach.

In the selection of data analysis, I use the narrative approach as a way of organising what we want/need to say in a story (Pentland 1999, Horsfall 2001). The story connects the events that took place, and this allows us to be imaginative and creative when we select and organise the "events", "*facts" and "findings*" (Horsfall 2001). Whilst Actor Networks have their basis in semiotics and are often used to create deeply descriptive reports, I have also found it valuable to represent concepts and ideas with models. I needed another way to represent my interpretations of the data using spread sheets, concept maps, and graphical models, such as Petri Nets.

Data analysis involved thematic analysis of interview and focus group data with reference to the key concepts of ANT– Actors, Interests, Networks, Stability, Alignment, Translation, Enrolment of Actors, Inscriptions, Irreversibility and Black Boxes (Appendix F provides a brief description of these key terms, which guided the analysis); triangulation of data from different sources; and perception and member checks.

CHAPTER 7
7 DATA ANALYSIS & DISCUSSION

Never seem more learned than the people you are with. Wear your learning like a pocket watch and keep it hidden. Do not pull it out to count the hours, but give the time when you are asked.

Lord Chesterfield (1694 - 1773)

7.1 INTRODUCTION

This chapter presents significant observations and data for the thesis. It contains data collected from the Macedon Ranges and Concord special schools, as well as data and observations from the individual study. The observations described in the sections below cover both the early phase, as well as the latter part of the research study, based on my own involvement and participation with the 121 ICT Project at Concord School. I adopted Creswell's approach in gathering data. In order to assist the reader, the thesis adopted the journal survey approach as described in Creswell (1994, 1998) and Tesch (1990), in my engagement through the ethnographic approach. I have maintained field notes and minutes of meetings held in relation to the 121 Project and policy documents and these can be found in the Appendix.

I have presented data from my observations separately for each school, however, a comparison is also provided to enable the reader to draw conclusions from these observations about the impact of ICT adoption and engagement in the schools. The results are analysed and discussed from ANT perspective.

7.2 EARLY OBSERVATIONS - MACEDON RANGES

7.2.1 Early Observations at Macedon Ranges

Table 7.1 contains a summary of early observations at Macedon Ranges in this study. The table shows the key actors and observations during normal class periods for a range of classes and age groups in the school. Other useful data include the range of software tools that were incorporated in the curriculum and the level of support provided by the Education Department of Victoria.

Actors	**Carole** (Class teacher and school educational committee member) **Helen** (Made me aware of different aspects and references to earning difficulties) **Jenny** (.AP. Explained how computers were used by staff members) **Philip** (Assisted with the approach to participate in the classroom and advised me on school to work transition program) **Peter** (Principal- main actor who was very enthusiastic and supportive from first meeting.- facilitator) **Marilyn** (Inter 2) **Joanne** (Inter 2)
Activity	Games used to stimulate interest in class and provide independence for physically disabled students with normal intellectual motor function.
Observations	• **Use of computers as an aid to learning** • **Production of text** • **Language support acquisition** • **Syntax semantics and morphology** • **Development of skills in word association** • **Engagement of students in digital games e.g.; soccer** • **Use of tools (COMPIC, Board Maker and digital camera) to make books**
Comments	The schools obtained software through an exchange program from the Software Rolling Fund from the Education Department.
Issues	Attitude of students towards the level of the games activity.
Specific Observations #1	Joanne's Class Inter 2 This was a small group of intermediate students (aged 14+). I chatted with a few students: Ben, Barry and Teagan and watched them play the Magic School Bus on Mars. This allowed me to see how puzzles were used in this setting to engage students and help them to improve their perception of space, time, age and personal attributes.
Specific Observations #2	Class: Exit team- 5 students, Teachers: Lynn/Phil Activity: The students were able to use and access the computer, email and internet
Specific Observations #3	Class: Personal Development, Teachers: Joanne/Lydia Activity: The teacher went over group rules "Be respectful" "Look and listen to the person you are talking to" "Consider each other's space" "no put downs-respect each other's views" "share responsibility for the group" This was followed by a game activity-change places Some of the students appeared to react in a negative manner as they remarked that the game was "babyish". Games: hangman, Families: jobs bin, wood
Specific Observations #4	Class: Prim B Aged 8-11 (10 students), Teachers: Helen/Chris (volunteer parent) Software used: COMPIC Several of the students were very talkative/inquisitive towards me
Specific Observations #5	Teachers: Carole, Jeremy Demonstrated Software: Board maker, COMPIC, Maths Rabbit, My Personal Tutor
Special Observation Comments	The teachers explained that computer activities were used as a reward on a daily basis. These were seen as supportive tools, provided social behaviours patterns and mathematics drill exercises to reinforce harder concepts. As well as these, I observed that programs like Encarta were also available; however, these were regarded as academic and challenging to the group. It was mentioned that some students owned their own computer and were able to play these activities at home. Some programs (like Bat and Ball) with picture graphs were also used for hand eye coordination. The students had access to Acorn, MAC and PC computers-this was necessary given the variety of special needs in the school.

Figure 7-1: Early Observations at Macedon

Amongst the software programs used, there were several that were provided by the Education Department's Software group, but the school's computer coordinator explained that other more relevant and suitable software programs had to be purchased from local computer shops.

I was introduced to some of the communication symbols or signs shown in Figure 7.2 below.

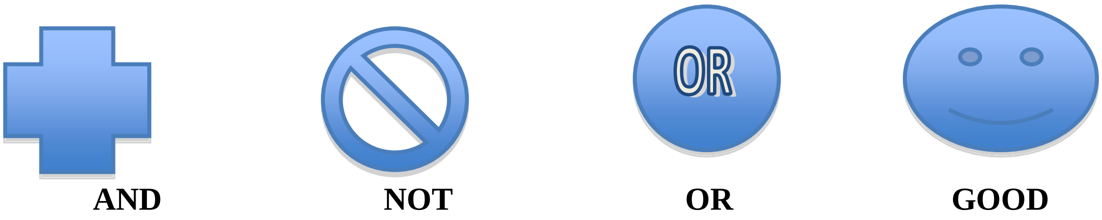


Figure 7-2: Logical signs for communication

These and many other signs were used to help students with learning difficulties-reading dyslexia etc.

In the early phase of this study, whilst trying to set the context for the research, the goal was to assess the ICT skills of a group of students that I was granted access to[85]. Table 7.1 below was used as the instrument to measure their skill levels and ICT competency. The results are shown in Figure 7.3 and these clearly illustrated the enormous gap that existed amongst the students in their ICT skills. The range of learning difficulties which were revealed included recognition of function keys, movement of the mouse and more significant issues such as computer crashes. The aim of this exercise was to apply the Schunck & Nielsson (2001) e-learning model in a specific class to see whether the standard of skills remained static or changed significantly over a defined period of time. This was quite a significant event in my research endeavour, as I came face to face with LD students and was unable to provide assistance to them. In spite of my teaching

[85] **Macedon Ranges was a small special school as was discussed in Chapter 3. However, there were a significant range of physical and cognitive disabilities that sometimes restricted the observations to only certain classes.**

experience in secondary and tertiary levels, I faced the challenge to search for tools and methods that would be appropriate for their needs. The challenge had only begun.

General Computer knowledge and skills survey **Name: ________________**

Knowledge of hardware and software terminology	• **Identify hardware components, peripherals and their purpose**
	• **Identify icons, windows and menus**
	• **Start and shuts down computer and peripherals**
	• **Uses mouse**
	• **Inserts and ejects disks, CD Rom**
	• **Uses software from a disk, hard drive or CD Rom**
	• **Create names/renames folders and files**
	• **Starts application and creates a documents**
	• **Names, saves, save as, retries document**
	• **Prints documents**
Troubleshooting	• **Restarts a frozen computer**
	• **Identifies printer problems**
	• **Delete files**

Table 7-1 Early survey of ICT skills at Macedon Ranges

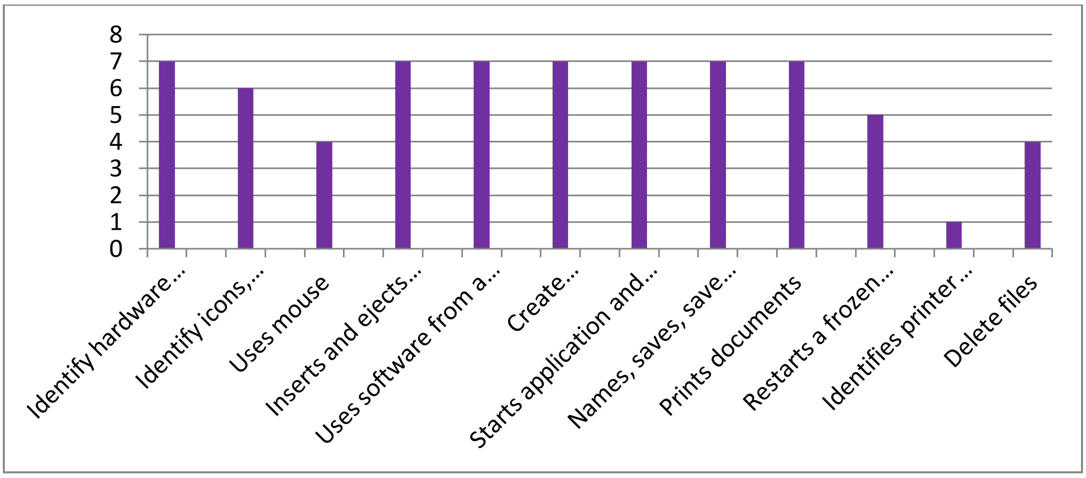


Figure 7-3: Results from the early survey at Macedon Ranges

The survey revealed that there were certain students with severe physical disabilities in the group. For example, several students needed help with the CRTL ALT and DEL keys on the keyboard. A few students needed direction as to how to shut down the computer and the order that the various keys had to be used. In general, the survey revealed that the students were familiar with their environment and were able to relate to and use technology in a comfortable manner. The results showed that the students had great difficulty with hardware troubleshooting (See Figure 7-3 above).

7.2.2 Other Data from Student Questionnaires

The students were provided with an opportunity to respond to open ended questions. These were “My technology skills” and “Uses of technology”. I have included a few sample replies in Figure 7-4 so the reader may gain an insight to the standard of ICT skills with this group of students. It should be highlighted that the group was heterogeneous in LD- there were both physical and cognitive disabilities present in the group.

Peter

my technology skills

Computer words

Hard drive
keyboade
monater
cd drive
cd buner

Uses
Emales
games the 2IMS
Internet
Sach egin2
save files
copy and paste
keyboade
mouse
burn cds
use word
pomnt
down Loade
Listen tomusic
wacten moves on the net
open files

BEN

my Technology skills:

Computer words
MOUMUC
Delcon cheein
DVD Bonic
Keyboard
GaCAi
HeQbac doing
laigH
CD Bonin

USES

Music
eHRCnhilW
games
DVD, DC, Bonic
laigH
inechWi
paclw
WoOillW
KeHWor
MOUMUC
DeeiGH
SieHW

Jessie

mytechnology Skills:
computer Words
Keyboard
game
mouse

USES:

Only with help
games
ringting letter For People
music on the computer
us a mouse

Figure 7-4: Examples Students" ICT Skills

7.2.3 Later Observations

In 2004, the school principal appointed a new IT Coordinator as the previous one had departed from the school. I was keen to investigate the infrastructure and contacted the school to meet with the IT Coordinator and the network support person. This person was employed by the Department on a part-time basis and helped the staff and school administration with any computer related problems.

The support person provided me with information which made me aware of some of the technical issues involved in setting up and running video conferencing services. From Renee (actor) I was able to contact Robert, the IT Manager in the Department. Robert provided me with information and support on setting up and configuring the video conferencing server. Robert however, explained that the support was very limited. My objective at this stage was to set up a simple (low quality) communication link between classes so that students could exchange ideas by communicating through the Local Area Network (LAN) and the Internet.

On 20th May 2004, a meeting took place with the author, Renee, Eleonora (the new IT co-ordinator) and an IT Manager from Yukon, Canada (Ron). He accompanied his wife on an exchange schools program.

Following that meeting, I gathered all necessary programs and tools (like Web cameras), and with the help of my research assistant I began to design and set up a video-conference session. I tested the session and (later) I introduced this to the class with the assistance and cooperation of the classroom teacher. I was very pleased and delighted with the results as I observed students with learning difficulties from different classrooms exchange messages with each other and have fun. This was my first experience of observing students with learning difficulties participate in an activity with determination and strong enthusiasm. Undoubtedly, this made a strong impression on me and forged my objectives for the rest of the research.

Whilst I discovered that some teachers from Victorian Secondary Schools had trialled video conferencing, I believe that the time and effort that was dedicated to the project was very worthwhile, as it made me aware of both the potential and limitations this had on the students with special needs. These concerns and views were also expressed by Seymour (2005) in her own personal investigation and experience in using ICT, as well as the education of students with learning difficulties.

The next step in the research was to determine the most appropriate infrastructure that would support the interconnections and communication between the two schools. Unfortunately, due to a number of reasons, this next step was never completed. It became apparent that in order to proceed and collect further data, I had to approach another school that was using computers and other related technologies in the classroom.

In fact, the move was very smooth as I had already made contact with another school by meeting with the principal and its IT Manager a couple of years earlier when I was invited by the Principal (of the first school) to join him in for a visit to the second school. The school Principal was very enthusiastic and extremely supportive as he made my entry into the school and classrooms very easy and introduced me to a special project-the 121 ICT Project. This became the most significant project for my study as it provided further scope and data for this thesis which is discussed in subsequent sessions in this chapter.

7.3 PREVIOUS RESEARCH STUDY AT CONCORD

A national government project, DETYA (2000), included the study and role of educational technology in Australian schools. As previously mentioned the study sought to identify best practices for the use of ICT in a selection of schools in the whole of Australia. These schools were selected on the basis of suitable criteria, involving current ICT programs, and supported by funding from government resources. The period of study was 12 weeks and the teachers were asked to maintain a journal of the activities that were undertaken in the classroom. The project was titled, *'Technology for Learning: Students with Disabilities*' (Ministerial Advisory Committee: Students with Disabilities 2000). The core research questions investigated were:

> What are the current processes used by teachers to implement learning programs for students with disabilities using computer-based learning technology?

What are the critical components of such processes?

The findings of the DETYA (2000) study support the view that technology by itself does not make a difference, however, the integration of technology or ICT with effective teaching and learning strategies does enable students to enhance their learning in a considerable manner (Holzberg 1994). There are several aspects that were identified as key inhibitors in schools, and several of the most significant were: staff training, computer literate staff, staff release time, external disability support staff, parents as carers, rural and remote settings, and teacher attitudes to technology and ICT.

In comparison to the present study, the data gathered and analysed from Concord in the earlier study, involved a limited group of students and teachers. The present study has a much wider scope in that it investigates a selection of senior (Transition) students trained to reach VCAL learning outcomes, as well as school-to-work transition activities with local business organisations and TAFE. This study examines these inhibitors or blockers closely and tries to develop strategies towards the application of a robust e-learning and technology oriented model in the pilot project called 121 ICT Project. The details of this project are discussed in Section 7.4 below.

7.4 TRANSFORMATION OF CONCORD SCHOOL'S VCALPROGRAM VIA IMPLEMENTATION OF 121 ICT

7.4.1 Concord School, Transition Centre

The Concord School Transition Centre caters for approximately 60 to 70 students from Years 10, 11 and 12. There are three learning programs delivered in the Transition Centre, each of which offers an applied learning curriculum. In Year 10, students complete the pre-transition learning program. This program has been specifically designed to prepare students for their post-compulsory schooling. In Years 11 and 12 there are four class groups of approximately twelve students each. Students in three of the class groups complete their VCAL (Victorian Certificate of Applied Learning) award. The fourth class completes a special needs Learning Framework (SLNF) learning program (Concord School 2003). Both VCAL and SNLF are completed over two years. The SNLF was developed by Transition Centre staff at Concord School to meet the needs of the high support students.

7.4.2 The One-to-One ICT Initiative

In this section I will focus on the implementation of a One-to-One (121) Information and Communications Technology (ICT) initiative in the Transition Centre. In simple terms this required the school to invest in a computer (lap-top or desk-top) for each student, as well as other accompanying software and hardware (including an interactive whiteboard) for VCAL students.

The 121 ICT initiative was the initial phase of the project implementation. It was in direct response to a vision proposed by the teaching team in the Transition Centre (Davies & Davies 2005). The 121 ICT implementation plan was devised during discussions at a section planning day. Teachers made the decision that a significant way to improve teaching and learning practices – which assist personalised learning (Hargreaves 2004), would be via establishing 121 ICT learning classrooms. In this vision, the VCAL teachers identified the need for all students to have access to a computer during all their learning time. The initial proposal was for one classroom to act as a pilot program – with other classes accessing 121 ICT over the following four year planning cycle. This would form a core part of the Transition Centre's Strategic Plan for 2006 to 2010.

The Blueprint from the Victorian Department of Education and Training (DET) for Government Schools required the achievement of literacy and numeracy levels, participation in and outcomes from education, across the population for all Victorians from wherever and from whatever background, that has not yet been achieved anywhere in Australia and seldom elsewhere in the world (State Government of Victoria 2003: Introduction). The 121 ICT project offers opportunities for students to use technology that would demonstrably improve their literacy output, access and exposure to technology as well as increase student engagement. Information technology was a targeted area for improvement in the Victorian Government's Flagship One strategy as part of its Blueprint for Government Schools (State Government of Victoria 2003). The rationale that was presented to Concord School Council reflected these ideas which were the result of the initial visioning process, as well as further team workshops amongst teachers (Harris 2005).

7.4.3 Charter Priorities and the 121 Initiative

121 ICT linked directly with the provision and assessment in the VCAL program. One of the charter priorities was to improve access to the VCAL program for students in the Transition Section. Improving access meant enabling more of the students to meet the requirements of more units of work, and thus, attain a VCAL award. The VCAL students demonstrated that they experienced learning success and engagement when they were given access to technology. It was the lack of on-going access to such technology that was a primary area of concern and needed to be addressed. Teacher observation regarding student behaviour and students' expressed learning preferences over a twelve month period in 2004-5 had significantly raised the teams' awareness regarding students' need to access ICT. This need had reached a tipping point (Gladwell 2001) and could have led to significant and sustained transformation in student learning (Caldwell 2005).

It was thought that 121 ICT would improve the delivery of the Victorian Certificate of Applied Learning Program, and thus support improved student learning. At Concord School a Foundation Level VCAL Program was offered over two years. The students completed a range of VCAL and Certificate of Transition Education (CTE) units as well as TAFE (Technical and Further Education) course work, as part of their VCAL Program. The VCAL Program at Concord School was to undergo significant change in 2006. The Victorian Qualifications Authority (VQA) had approved the introduction of new literacy and numeracy units at foundation level. In 2005 only four VCAL units were offered at Concord School whereas the following year up to ten were to be offered – including three Industry Specific Skills units, which were Vocational Education and Training (VET) certificates. For each VCAL unit of work a student completed, the VQA required the development of portfolios of evidence for units of study. In 2005 the VCAL students at Concord School developed electronic portfolios and it was hoped that access to 121 ICT would further support the students' skills and abilities in this area. The culture of continuous improvement in DEET policy promoted change as part of Victorian State School cultural practice (State Government of Victoria 2003). The driving force behind this change was not to continuously re-invent education but to build upon existing best practice (State Government of Victoria 2003). The Transition

Team believed that the integration of a 121 ICT program reflected the Schools' commitment to a culture of continuous improvement.

The implementation of 121 ICT classroom environments would also require the development of a new shared curriculum and a new pedagogical focus (Davies and Davies 2005). This would necessitate moving away from autonomous teaching practices and incorporating new approaches to teaching (Southworth 2005), including a teacher commitment to personalised learning for students (where learning experiences are student directed). Sustained transformation would require that staff commit to undertaking the necessary professional development required in order to prepare for these changes (Southworth 2005). Teachers would also be required to share information and teaching resources in a professional learning team and on a school based VCAL resource bank (Hargreaves 2005). It should be noted that discussion pertaining to sharing the professional learning with the wider education community (the method by which this would occur was to be negotiated) also took place.

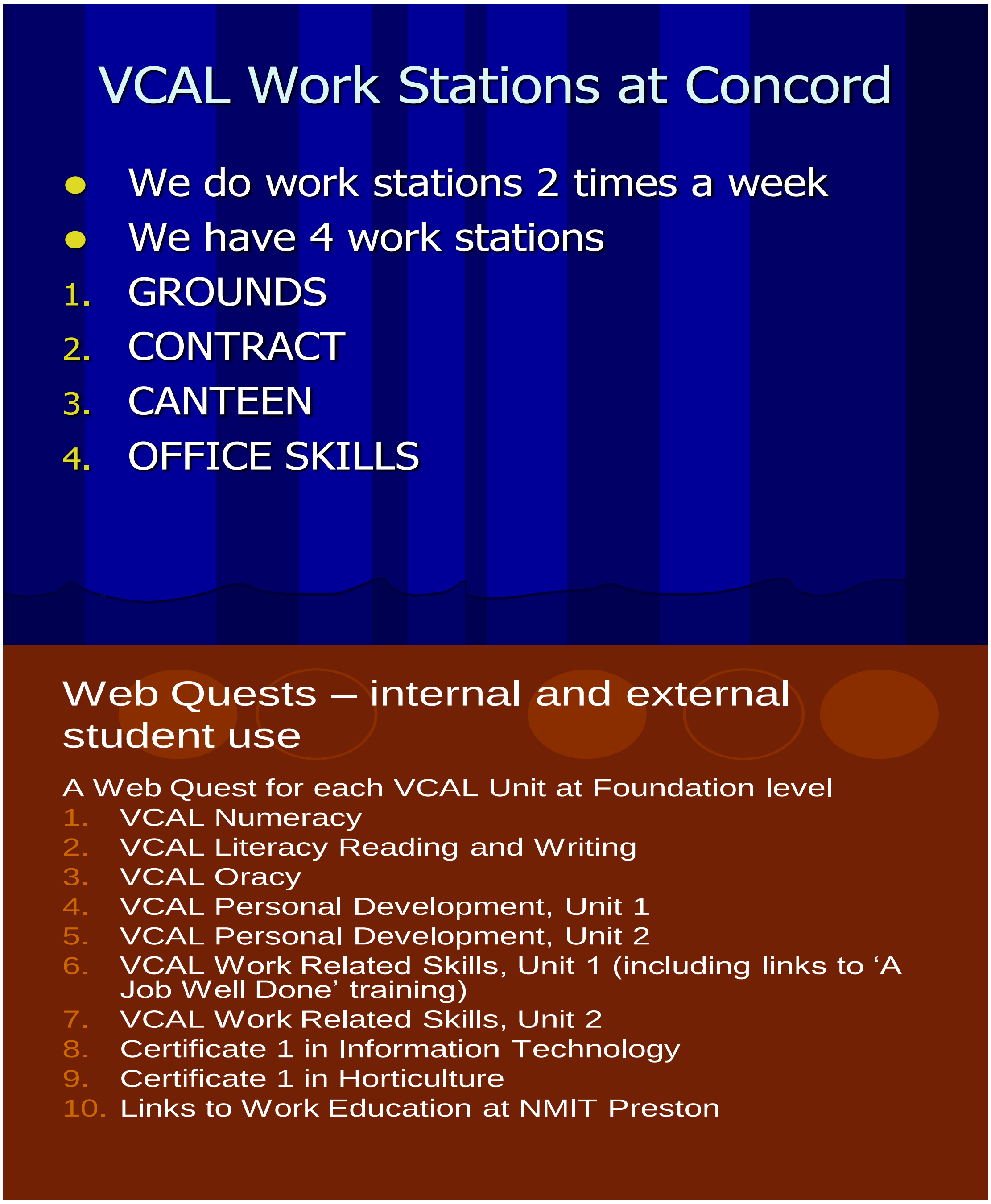
7.4.4 Inclusion of Key Stakeholder Groups

It was essential to include the students themselves in the change process being embarked upon (Davies & Davies 2005). As the driving force of change initiatives were concerned with improving student learning outcomes (State Government of Victoria 2003) it was of critical importance that students had a part in driving that change. Each of the key stakeholder groups had been invited into the change process via questionnaires, discussion groups, meetings and sharing of information (via the school newsletter for instance). This had encouraged all members of the school community to share their ideas about how to maximise the use of a 121 ICT environment by, for instance, asking parents what their needs would be, inviting students to express their ideas and linking teachers to create a shared process (Harris 2005). The Leadership team at Concord supported staff by providing professional training not only in technology skills, but also in pedagogy.

Many partnerships needed to be established between members of the Concord learning community in order for the 121 ICT initiative to be successful. The nature of the partnerships varied. Some partnerships were to be defined by fiscal relationships, others by ensuring clear and constant communication between stakeholder groups. Of particular importance were the links between technology staff and VCAL teaching staff. Fundamental to the initiative was expert technological support to assist teachers as they learned new skills and teaching processes. Technological expertise was also required to maximise functionality of any new technology implemented.

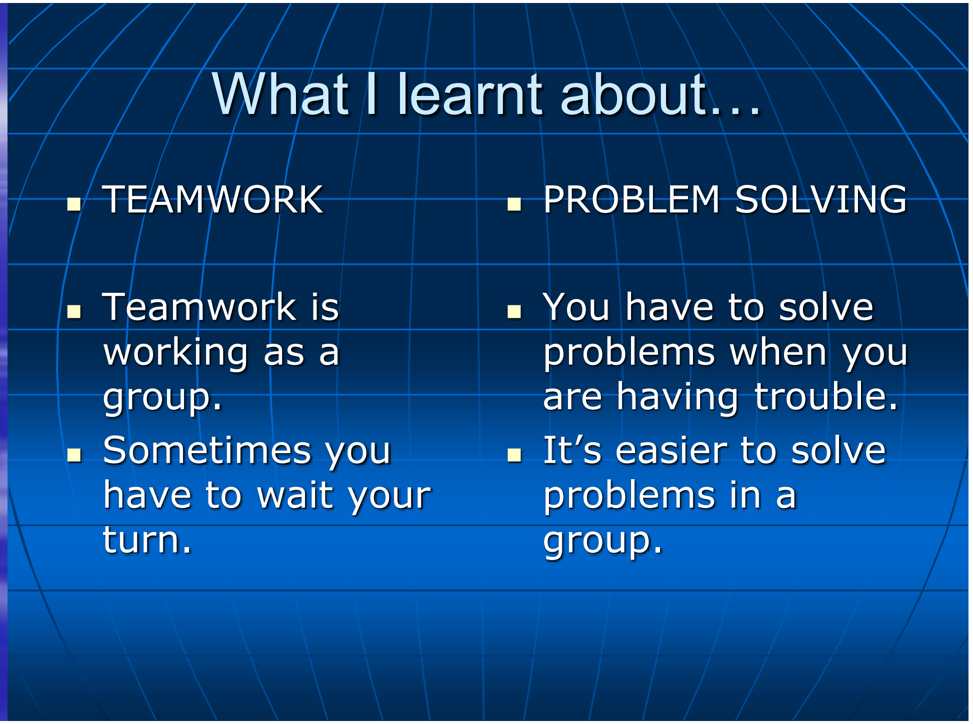
7.4.5 Sample Curriculum Material from Concord

An example of the curriculum is shown in Figure 7-5. Other examples of activities are included in Appendix B.



STRAND	DOMAIN	DIMENSION	KEY ELEMENTS OF STANDARDS
Inter-disciplinary Learning	Communication	Listening, viewing and responding	• Practise being attentive listeners and viewers. • Use questions to clarify meaning and extend interaction.
		Presenting	**Students make regular short presentations to groups or the whole class communicating their ideas on a single topic or personal experience** • Present a talk on a given topic • Use strategies for improving presentations (e.g. varying volume and pace, and making eye contact with the audience) **Students make short presentations to the wider community** • Present information on a topic that has been researched in class using the given criteria
	Design, Creativity and Technology	Investigating and Designing	
		Producing	
		Analysing and evaluating	
	Information and Communication Technology (ICT)	ICT Skills	
		ICT for Creating	**Students create multimedia products** (a Power Point presentation)
		ICT for Communicating	**Students can use a search engine to locate information from websites** • With assistance, locate internet icon • Locate internet browser • Locate and identify address bar • Type in web address from given sample • Navigate to and use search engines
	Thinking Processes	Reasoning, Processing and Inquiry	• Questioning and wondering are encouraged, recorded and shared, and become the basis for further learning. • Develop skills in making accurate observations about animals and people. • Develop own explanation for observations, and question accuracy for others explanations.
		Creativity	• Use a variety of thinking tools. • Practice ordering and sequencing ideas, and use a variety of thinking tools to recognise patterns in surrounding events and objects.
		Reflection, Evaluation	• Test the effectiveness of creative solutions against given criteria. • Prompted by questions, begin to reflect on individual thinking.

Figure 7-5: ICT Curriculum at Concord (Courtesy of Concord School)



Reflections from the Graduation of the 121 ICT Pilot class

7.5 A CHANGE OF THE RESEARCH FIELD- THE COMMENCEMENT OF THE 121 PROJECT AT CONCORD

Journal #	Session #	Date	Class Observed	Teacher

Concept Map

CELS: indicators for achievement

Journal	Session	Date	Meeting Held

E-learning/technology plan

Journal #	Session #	Date	Class Observed	Teacher

ACTORS

Principal	
Teacher X	
Teacher Y	
ICT Coord	
Researcher	
School Council	

Figure 7-6: Templates for Journal entries

7.5.1 Data Collection in 121 ICT Project

Data was collected by attending and observing specific classes on a regular basis at Concord. This was facilitated through a Special Studies Program (SSP) from Victoria University, in Semester 1 2007. I followed Creswell (1994) in devising and using my own journal entries to maintain records of data from my observations of classes, meetings and informal gatherings with key actors. Figure 7-6 above shows typical journal templates that were used during the observations.

Whilst the first school, Macedon Ranges, was visited from 2003 to 2005, the second, Concord, was approached in the second half of 2004. I began my research in February 2005 and started my observations of the 121 ICT Project immediately. I became a team member and worked closely with a class of senior students, who were referred to as the Transition Group. The group showed varied ability in LD or handicap. The project was a significant step to providing the state of the art "hands-on" resources to this group of students. For example, several months later, each student was provided with a Laptop to use and carry in class or to take home. (Appendix B provides details of the project schedule and milestones.)

The research was conducted in a very supportive manner. It should be noted that funding was also provided by the School of Information Systems from Victoria University. The funding facilitated the analysis of ICT infrastructure. In addition, the School of Information Systems provided several PDAs and digital voice recording equipment called Dragon[86].

The school principal gave access to all available data at the time. With the introduction of VELS[87], the school introduced its own system called CELS- Concord Educational Learning Standards. The students were assessed in the main domains of knowledge[88]

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[86] Dragon is a voice recognition software package registered by Nuance Software Co.

[87] VELS – Victorian Education Learning Standards

[88] Domains of knowledge originated with a curriculum innovation from DEET, see Appendix G for further information.

and in particular, data were provided to the research that showed an analysis of the key indicators for each class in ICT for teaching and learning.

The 121 ICT project was later extended to include many other groups in the middle section of the school (see Appendix B). The original concept had surpassed expectations with the introduction of Social Networking programs. The main observations highlight the strong self-esteem and engagement by the Transition students. Other data were collected by the ICT Coordinator to determine the standard of teachers' ICT skills. In fact at this time, the Victorian Government introduced the ICT e-Potential[89] Project to diagnose the various ICT skills of teachers in schools and the level of application of ICT within the curriculum.

7.6 SUMMARY OF PRIME ACTIVITIES AND ACTORS IN THE TWO SPECIAL SCHOOLS

I became an actor in this process whilst endeavouring to discover the impact and existence of other actors, and actor networks or ensembles. Using participant observation, I had become an observer and participant at school meetings and regular class sessions that involved technology and computer programs through the Web. In addition to these observations, I had interviewed key actors and collected relevant documents in order to identify further actors and their networks. Table 7-2 provides a summary of the main work and results during the study period from 2002 -2007 and describes actions and actors in both special schools. Table 7-3 shows a comparison of the two research fields (or centres of calculation in Callon's terms).

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[89] **ePotential was discussed in Chapters 3 and 4 of the thesis.**

Purpose of meeting	**Scheduled Dates**	**Outcome**	**Recommendations**
Discussion of 121 Project	Feb 2005 -Aug 2005	Pilot work commenced with a particular group of senior students- Transition class.	Extend the pilot Project to other groups in 2006. Received SSP leave to follow on in first half of 2007 both schools.
Discussion of curriculum	M: Mar 2002 – Nov 2004 C: Feb 2005 – Nov 2007.	Discussed curriculum and in particular ICT use in schools.	Explore specific classes and the specific 121 Project
Discussion of School Policies	M:Feb 2002 – May 2004 C: Mar 2005 - Nov 2007	Received data from the schools about demographics, policy and other relevant information.	Analyse the policy for the Learning and technology Plan to see how the e-learning plan for the school was implemented.
Discussion of Surveys	M: 2004 Staff, students, parents X: Principal July 2007 C: Principal, staff, parents, students - May 2007	Sufficient Data collected for the study from M and C.	Discussed in Chapter 7 Data are compared for M and C in Ch. 7
Discussion of School links	March 2004	Approved	Set up video conferencing between a school classroom and the library at M
Discussion of ICT curriculum	M: Mar 2002 and July 2007. C: Feb 2005 –Nov 2007 .	M: Principal and ICT coordinator provided access to classes using ICT and informed me of updates with the e-learning plan. C: Principal, IT Manager and specific 121 project leader held regular meetings to maintain progress with the project.	M: The school enhanced its ICT infrastructure and employed an ICT Coordinator to support teaching and learning and also, to update the e-learning plan and resources. The school introduced VCAL in its senior curriculum. C: ICT was adopted across the curriculum and the school offered VCAL for its senior (Transition) students. This was a very strong aspect of the curriculum where ICT was integrated with a strong focus on learning with technology. The school supported its own internal wireless network and provided a “state of the art” ICT centre open to all students.
School Council’s approval for the research study.	M: Dec 2001 – Feb 2002 C:5 Feb 2005	Approved, following ethics approval from DEET in 2002. Approved	Started my early investigation of actors and an analysis of the infrastructure to support ICT in the school. Commenced work on 121 ICT Project

Table 7-2: Main activities and actors at Macedon Ranges & Concord

	Macedon Ranges	Concord
Network Infrastructure	Fragmented and supported by department on part time basis	Robust network supported and administered locally by the school
ICT leadership	Early change in role, appointment of teacher with some ICT knowledge. Recently, ICT co-ordinator appointed on on-going basis.	On-going co-ordinator appointed, involved in curriculum design and supported all staff and students.
Equipment –H/W	Command driven early systems, now graphical user interface with windows	Most up to date state of the art equipment in place.
Equipment – S/W	Upgraded operating systems	On-going operating system with windows
Website presence	Recently implemented website	Very active website for both in and out of the school community: this has been operating for some time now
Role or status of ICT	Employed and taught in some areas of the curriculum	This is seen as strength of the school-the provision for the ICT centre with very modern architecture, building and up to date technology.
Role or status of school	General curriculum	Leading in ICT education presented at various conferences including AEFSA 2006
Special Edn qualifications	Almost all staff possessed special education and training qualifications	Not all staff were qualified in special education and training
ICT qualifications	Varied qualifications. Observations showed limited extent of technology	Adequate number of staff exhibited competencies to apply ICT in teaching and learning.
ICT surveys	None	Yes, 2000
Links with other schools	Yes (check documents for names of sister schools)	Yes
Demographics	Started at 47 and increasing to 90	250+ steady
Senior classes **VCAL**	Commenced in 2007.	Operating for several years now in the Transition groups
Transition to work program	Limited	Operating with local post-secondary institutions such as NMIT, local employers (check brochure)
Assessment policy	VELS introduced	CELS introduced as an extension to VELS (check attachments received from school)

Table 7-3: Comparison of Fields- Macedon Ranges & Concord

7.7 DATA FOR INDIVIDUAL STUDY - SUMMARY OF EVENTS & ACTORS

Table 7-4 shows a summary of the most significant events and the prime actors for the individual student in this study.

DOB 21/9/89

Event	Actors	School / Org	Comments	Period
Diagnosis	A1, Doctor		Developmental delay	1993
Early support	B1	Broady Insight	Home observations	1993
Hearing Tests	C1	RCH		1994
Intervention-speech pathologist	C1			1995
Language support	D1	ALPHINGTON	PRE-PREP 6 MONTHS	1995
Psychological assessment	E1	PEGS	PREP – Y11	1996
Reports	B1.D1.C1.E1. A1			
Teacher Aide	F1	PEGS	PREP – Y8	1999-2004
	G1	PEGS	Y9 – Y10	2005-2006
	H1	PEGS	Y11	2007
	I1	TAFE		2008-2010
Jobs support	J1	Jobs West		2008-2010
Psychologist	K1		Working on independence and communication skills	
Activities	Swimming Golf Squash Karate Tennis Technology		Likes computers, digital devices, iPods, mobile phones, cars, Internet	
Achievements	Concert Band Musical instruments Driver's License		Guitar, Violin Clarinet 2007	2005-2007
Courses	Box Hill	TAFE	Dog Grooming short course Box Hill TAFE	2008
Certificates		PEGS	Y11	2007
Cert IV Diploma Diploma		TAFE TAFE TAFE	Graphics & Print Media Diploma in Games & Digital media (in progress)	2008 2009 2010

Table 7-4: Summary of events and actors for Field Z

7.7.1 Portfolio Data

The Portfolio details a variety of documents and samples of the standard of work that was attempted and completed to a satisfactory level. Figure 7.7 below illustrates this standard of work. Table 7-5 provides information regarding the range of tasks, ICT skills and overall completion standard, which were experienced by the actor in Z. Appendix C contains further details regarding Assessment tasks, Award Certificates and samples of work and artefacts.

Assessment Task	**Software Application**	**Skills Used**	**Task Completion**
Magazine cover	InDesign	Formatting, printing	Completed
Sound editing	Audition, audacity	Music and sound mixing	Completed
Image production	Illustrator		Completed
Character design	Photoshop		Completed
Animation 2D	Flash		Completed
Animation 3D	3D Studio Max		Completed
Forms	Visual Basic	XML	Completed
Menu	XML, Java Script	Roll over, drop down	Completed
Website	Dreamweaver		Completed
eLearning	PowerPoint		Completed
Movie production	Premier	Movie chapters	Completed
Web design – Car book	Dreamweaver, FrontPage		Completed
Script writing			Completed
Storyboard			Completed
Games design			Completed
Work experience			Completed

Table 7-5: Summary of ICT skills for Z

Figure 7-7: Sample Project artefact from Individual Study (Z)

Games Design using 3D Studio Max- 30 second skating animation at TAFE.
This project was completed by actor in Field Z in one of the assignment tasks.

7.8 OTHER DATA FOR THIS RESEARCH

7.8.1 Surveys from Concord

The research study carried out parent and student surveys, and the results were analysed and presented in the sections below. The results overall reflect a very positive level in technological skills and these are further reflected in the individual school data analysis that was based on Concord Educational Learning Standards (CELS); these were an extension of VELS.

The data collected from students, based on the ICT Skills Matrix, included the following main categories.

- Knowledge of Hardware
- Knowledge of Software terminology
- Operation and Care of Hardware and Software
- Trouble Shooting
- Other ICT Skills

In addition, these were further subdivided into specific technological or ICT skills or areas which are shown in Table 7-6 below.

ICT SKILL/AREA	Current Skill. I can:	Always	Sometimes	Beginning
KNOWLEDGE OF HARDWARE	Name 3 hardware components			
	Solve problems			
	Name 2 external devices CD/DVD, USB			
	Name two drives at school: R,S			
	Turn ON/OFF PC/Laptop			
KNOWLEDGE OF SOFTWARE TERMINILOGY	Connect to Internet			
	Start a program e.g. WORD, POWERPOINT for windows			
	Identify Menus			
	Start other programs e.g. games, SharePoint			
	Find where my documents are saved			
OPERATION AND CARE OF HARDWARE AND SOFTWARE	Use Function keys			
	Use Mouse or mouse pad			
	Insert and Eject disks and CD ROM			
	Use software from Network, e.g. games			
	Use software from Hard Drive at home			
	Use software from CD or DVD e.g. music, photos			
	Create folders and Files			
	Rename Folders and files			
	Delete/copy files and Folders			
	Start Application and create document			
	Name/Save/Save As document			
	Retrieve documents- Recent document			
	Print documents			
	Use Email			
	Retrieve lost document (search files)			

TROUBLESHOOTING	What happens when PC freezes?			
	Identify printer problems at home			
	Connect to Internet from home			
	I can tell different file formats from their ending e.g. .DOC, etc.			
	I can identify two different types of printers (Colour and B/W)			
	I can search for specific files or folders			
	I can install an operating system like Windows XP at home			
	I can start an Anti-Virus software program at home			
	I understand what an anti-Virus program does			
	I can use an anti-Virus program			
	I can restart a frozen computer in class			
	I can restart a frozen computer at home			
	Use a computers to solve problems			
	I know several main websites for special purposes, like : Google			
	Yellow Pages			
	Search for deleted files			

OTHER ICT SKILLS	Demonstrate good listening skills			
	Communicate clearly and effectively			
	Obtain meaning from print			
	Write to meet my needs			
	Give and follow instructions			
	Use private and public phones			
	Use Email Use Mobile phone			
	Access the internet			
	Use computer programs to develop my skills			
	Use computer programs to improve my work			
	I know what video conferencing is			
	Search for information on the internet			
	Use the internet for research purposes			
	Discuss information found on the internet			
	Use operating system functions			
	Be a responsible internet user			
	Aware of privacy issues			
	Aware of security issues/concerns			
	I can change fonts, colour Know about Blogs I can spell check my email			
	I can set up a website or Blog			
	I work with sound and images applications, e.g. Gimp I can insert a photo I can insert a Clipart I can use tags on photos			
	I can use an IPod			

Table 7-6: Skills Matrix

7.8.2 Results from Student Survey

The overall results from the 5 categories are shown in Figure 7-8.

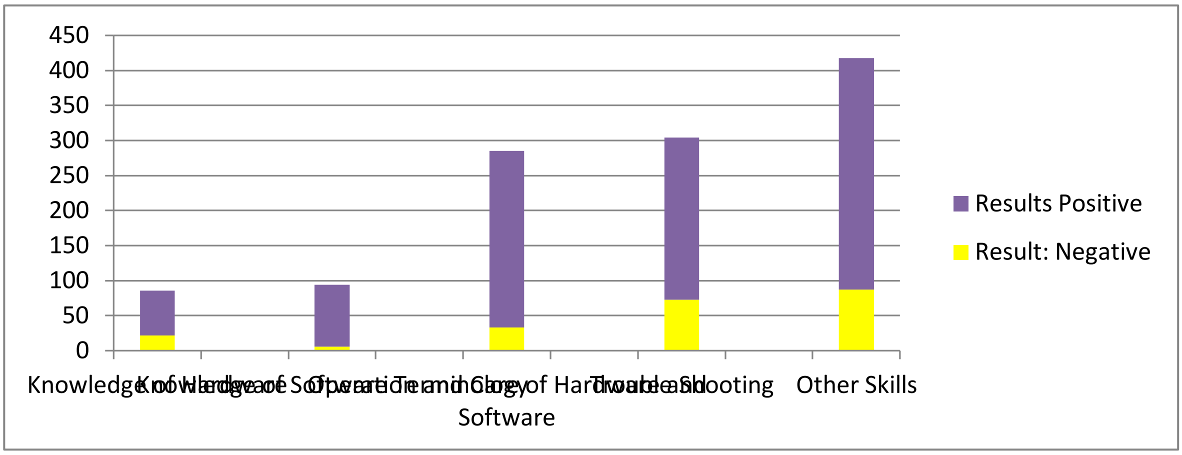


Figure 7-8: Results from Student Survey Based on the ICT Skills Matrix

The results from the individual categories and specific skills within the category are shown in Figures 7-9 -7-13.

Knowledge of Hardware Skills

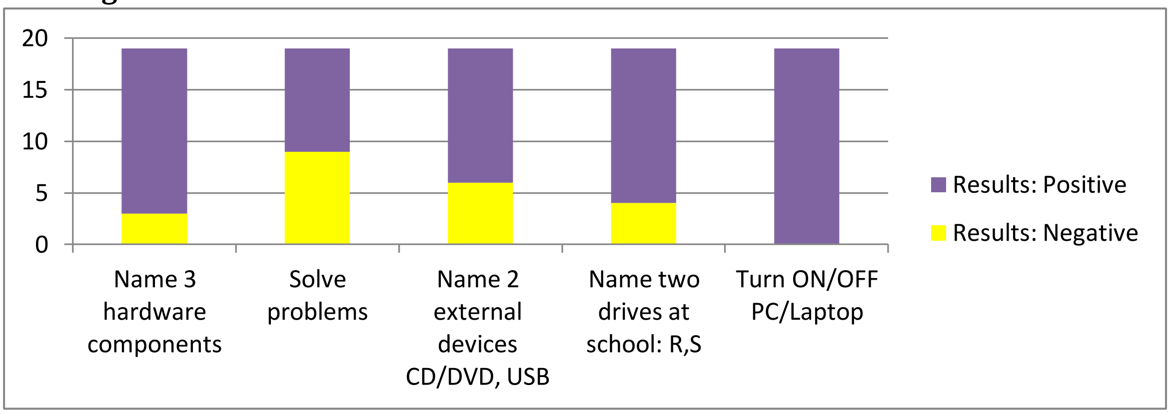


Figure 7-9: Results from Student Survey Based on Knowledge of Hardware

Knowledge of Software Terminology

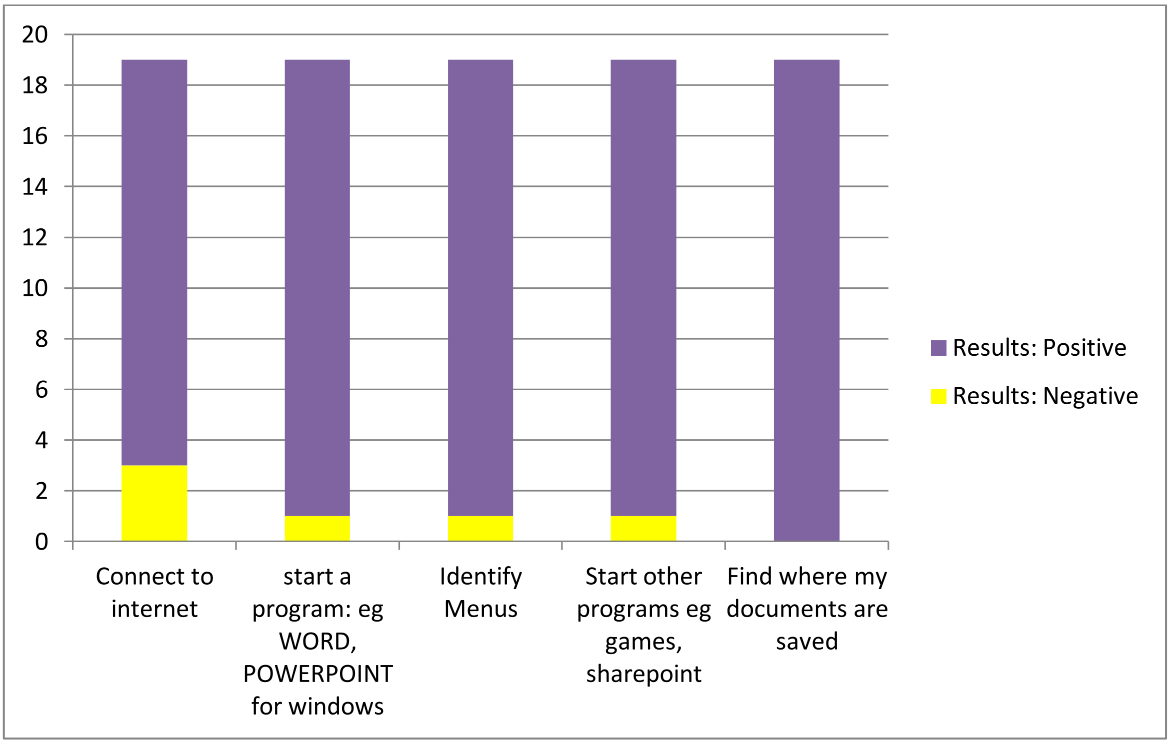


Figure 7-10: Results from Student Survey Based on Knowledge of Software Terminology

Operation and Care of Hardware and Software

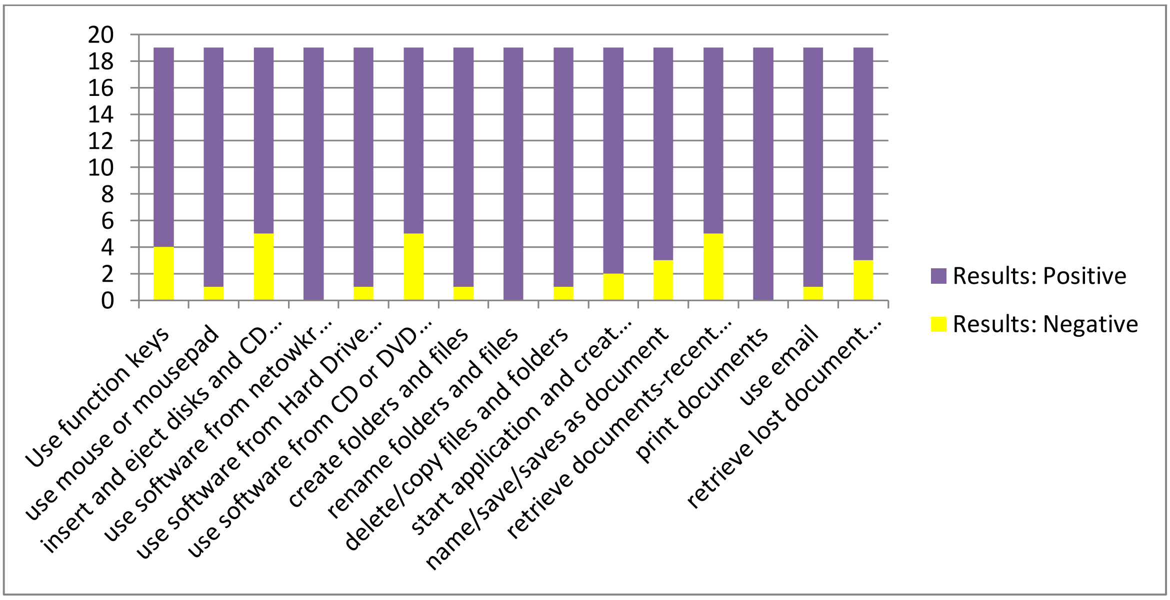


Figure 7-11: Results from Student Survey Based on Knowledge Hardware and Software

Troubleshooting

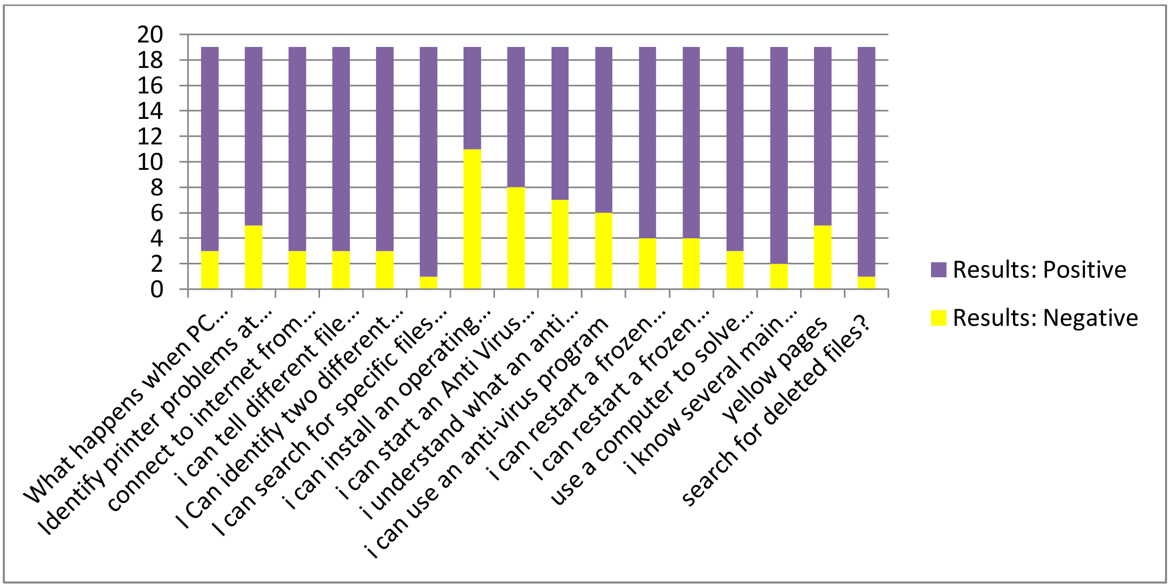


Figure 7-12: Results from Student Survey Based on Troubleshooting

Other ICT Skills

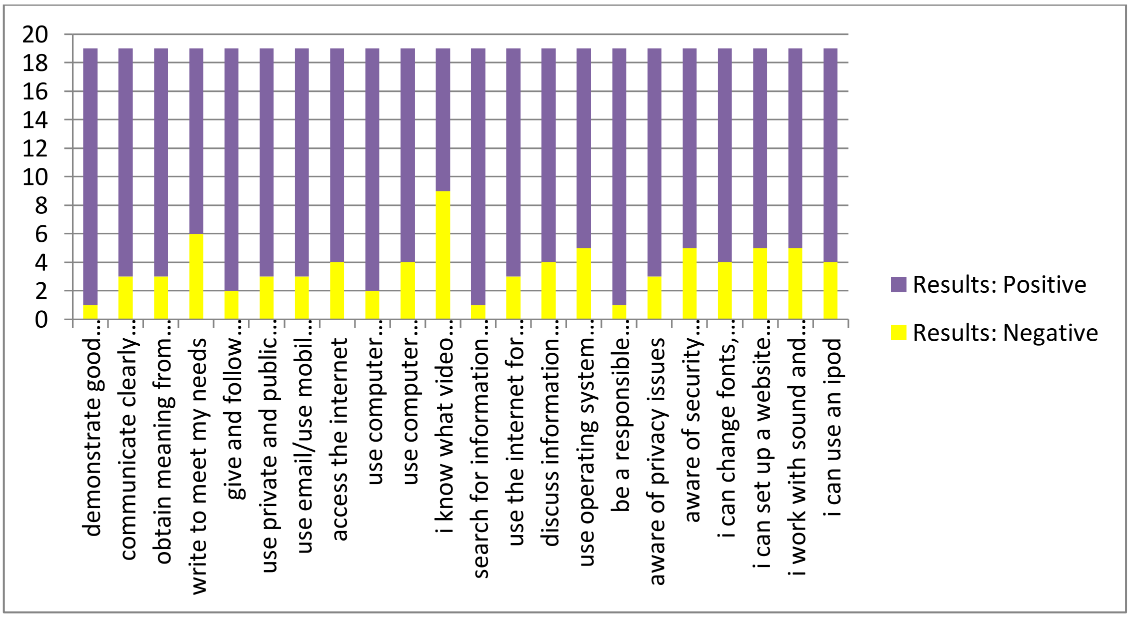
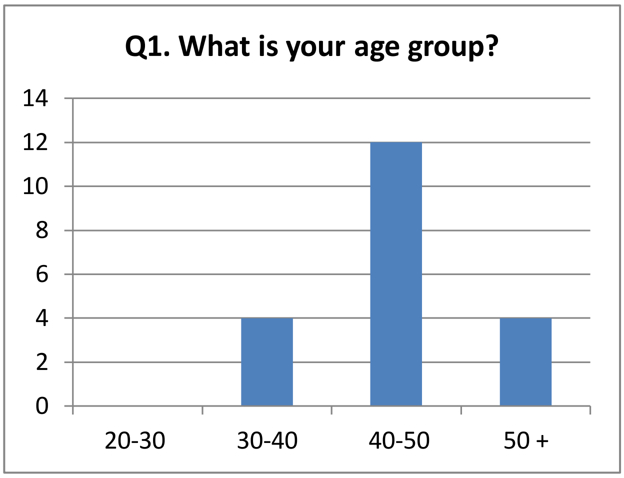


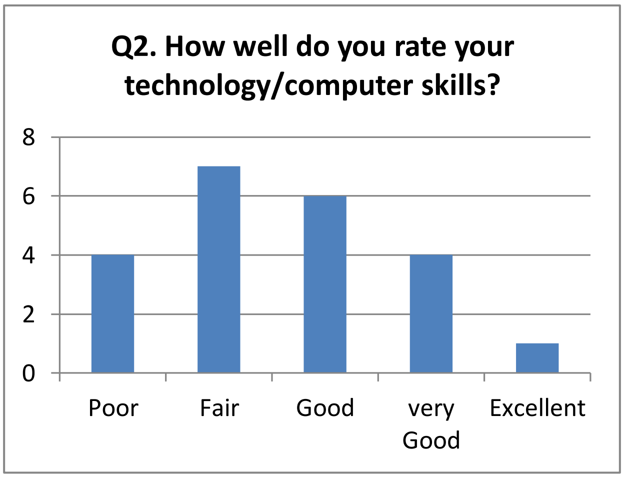
Figure 7-13: Results from Student Survey Based on Other ICT Skills

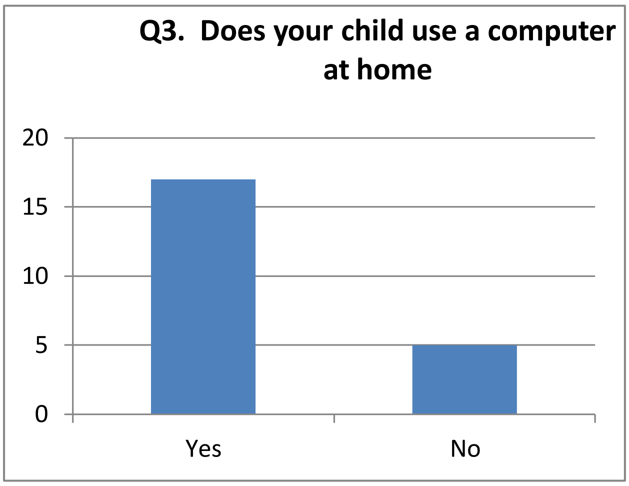
7.8.3 Results from Parent Surveys

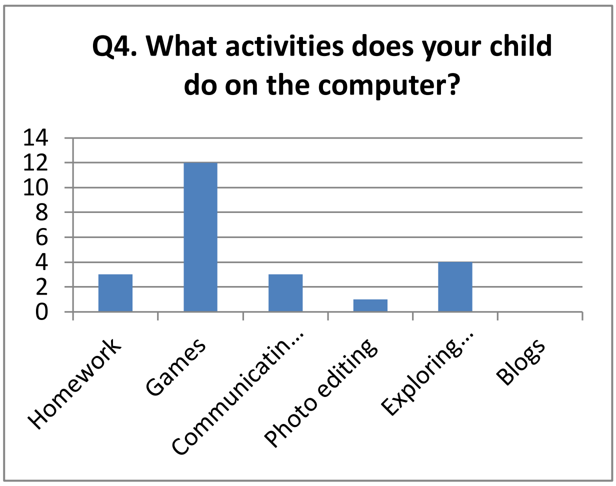
I was interested in this research study to obtain the ICT Skill level and applications of the internet from the parent community. The questionnaire is listed in Appendix D of the thesis.

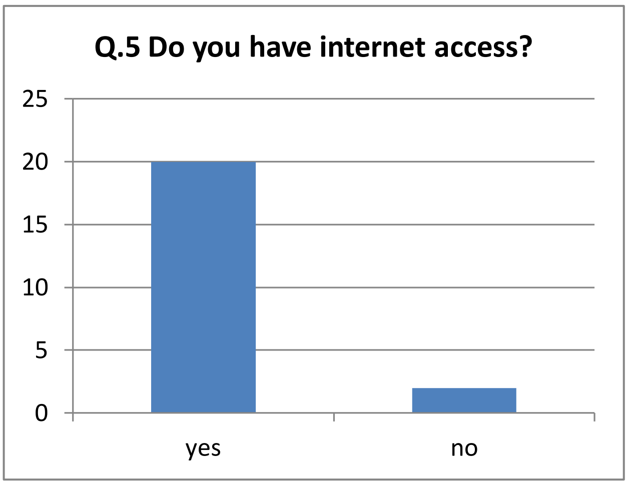
The main results are displayed below in Figure 7-14 and in addition, the main responses from the respondents are also provided at the end of these results to assist with the discussion.

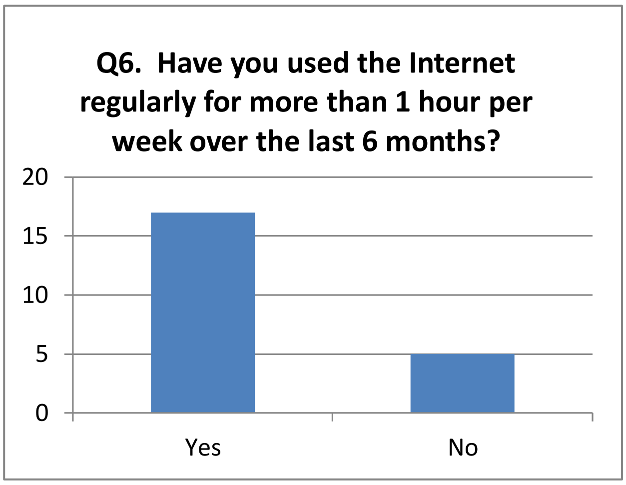


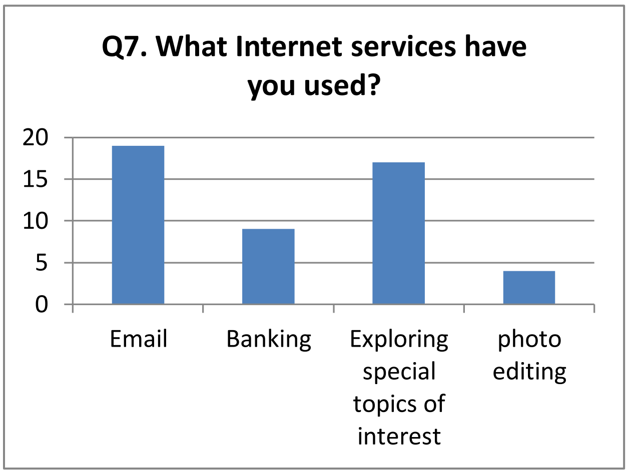


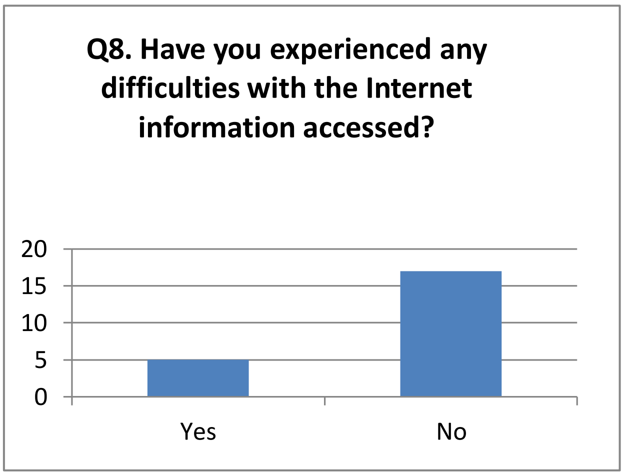


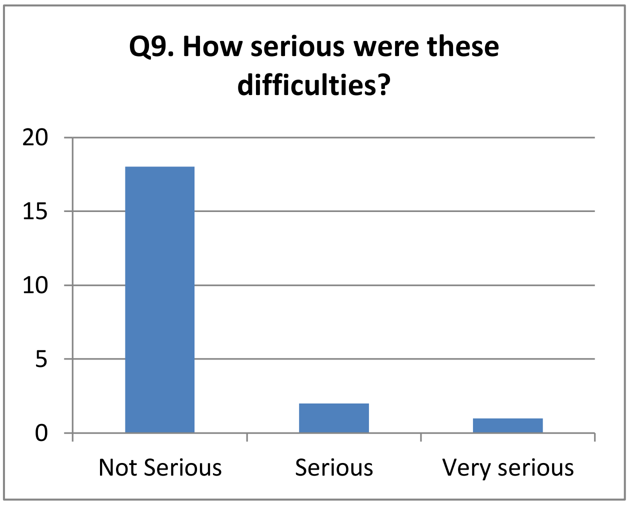


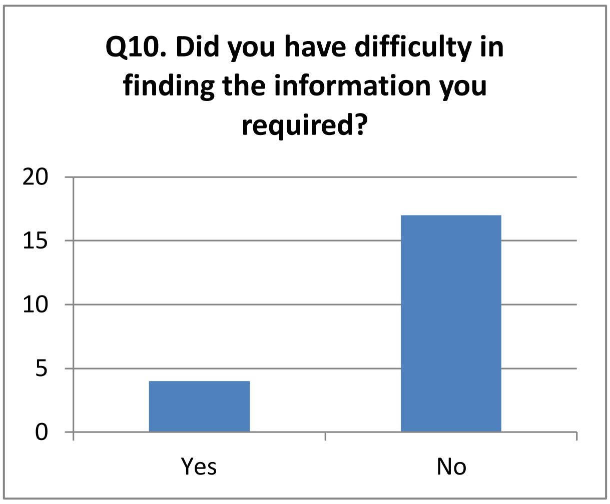


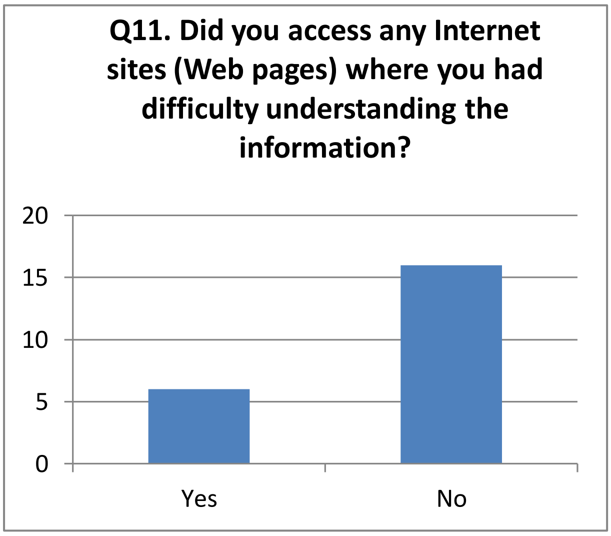


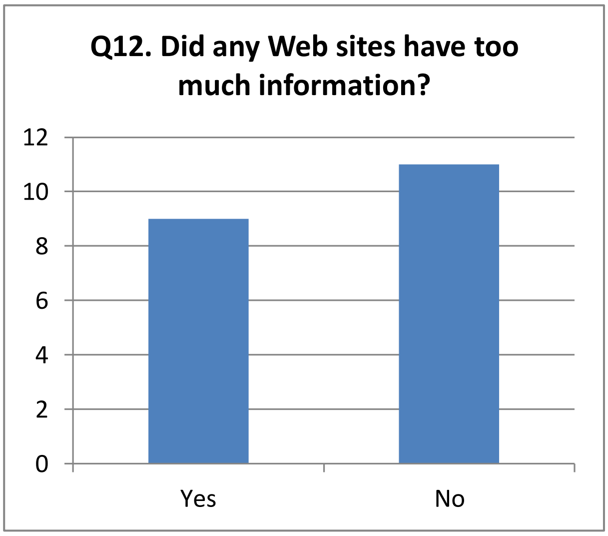

Q7. What Internet services have you used?
20
15
10
5
0
Email
Banking
Exploring special topics of interest
photo editing

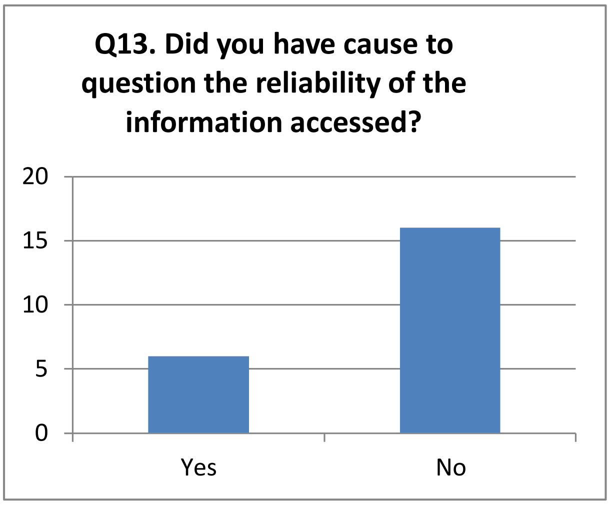

Q8. Have you experienced any difficulties with the Internet information accessed?
20
15
10
5
0
Yes
No

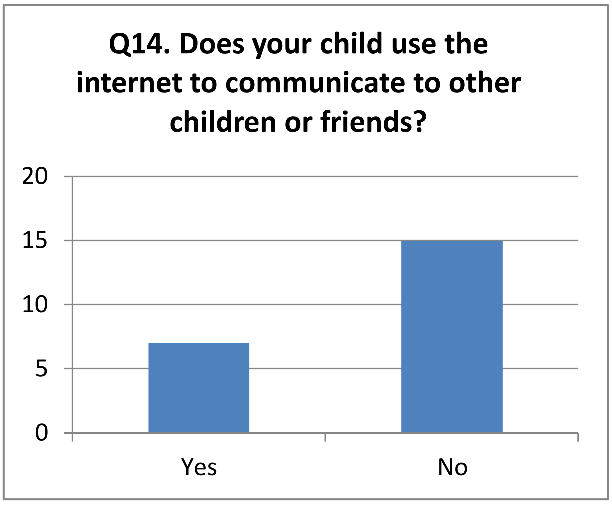

Q9. How serious were these difficulties?
20
15
10
5
0
Not Serious
Serious
Very serious

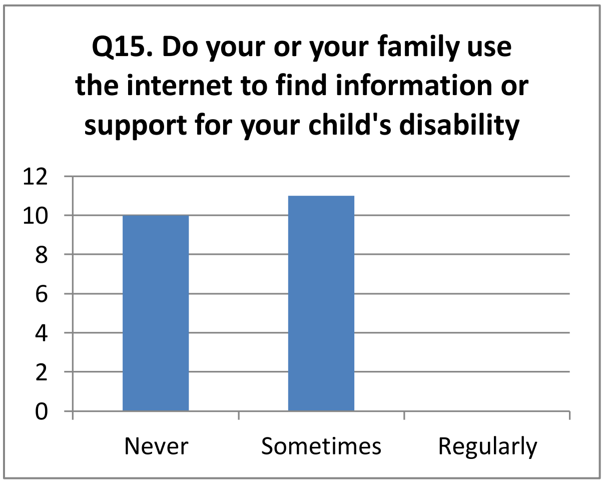

Q10. Did you have difficulty in finding the information you required?
20
15
10
5
0
Yes
No

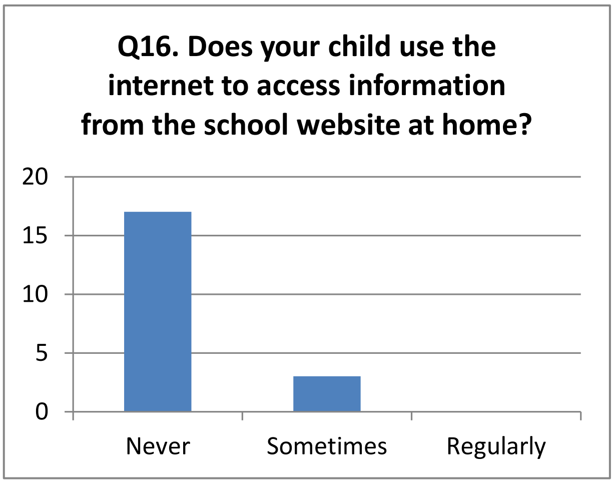

Q11. Did you access any Internet sites (Web pages) where you had difficulty understanding the information?
20
15
10
5
0
Yes
No

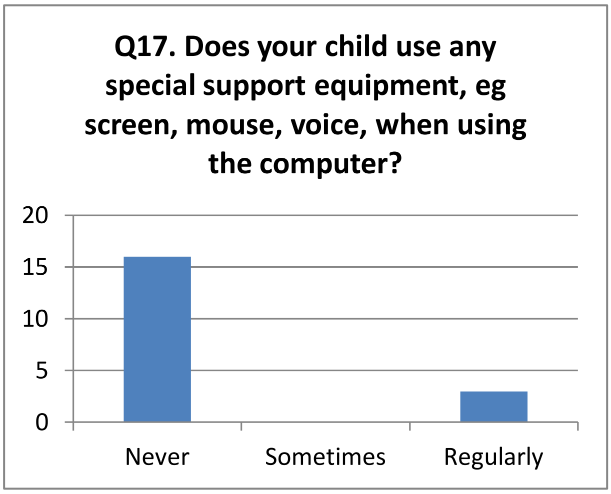

Q12. Did any Web sites have too much information?
12
10
8
6
4
2
0
Yes
No

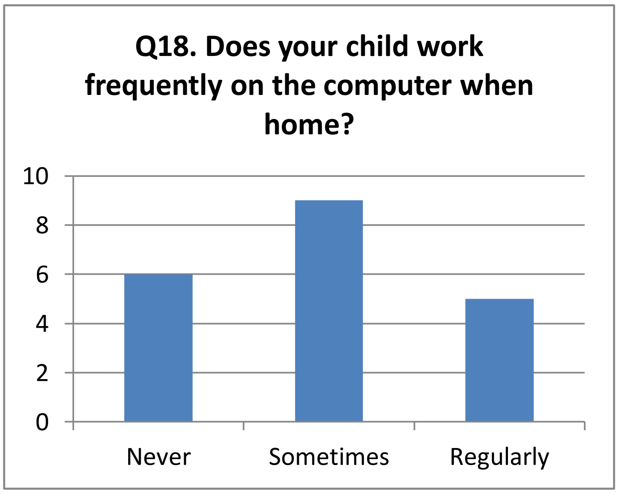

Q13. Did you have cause to question the reliability of the information accessed?
20
15
10
5
0
Yes
No


Q14. Does your child use the internet to communicate to other children or friends?
20
15
10
5
0
Yes
No


Q15. Do your or your family use the internet to find information or support for your child's disability
12
10
8
6
4
2
0
Never
Sometimes
Regularly


Q16. Does your child use the internet to access information from the school website at home?
20
15
10
5
0
Never
Sometimes
Regularly


Q17. Does your child use any special support equipment, eg screen, mouse, voice, when using the computer?
20
15
10
5
0
Never
Sometimes
Regularly


Q18. Does your child work frequently on the computer when home?
10
8
6
4
2
0
Never
Sometimes
Regularly

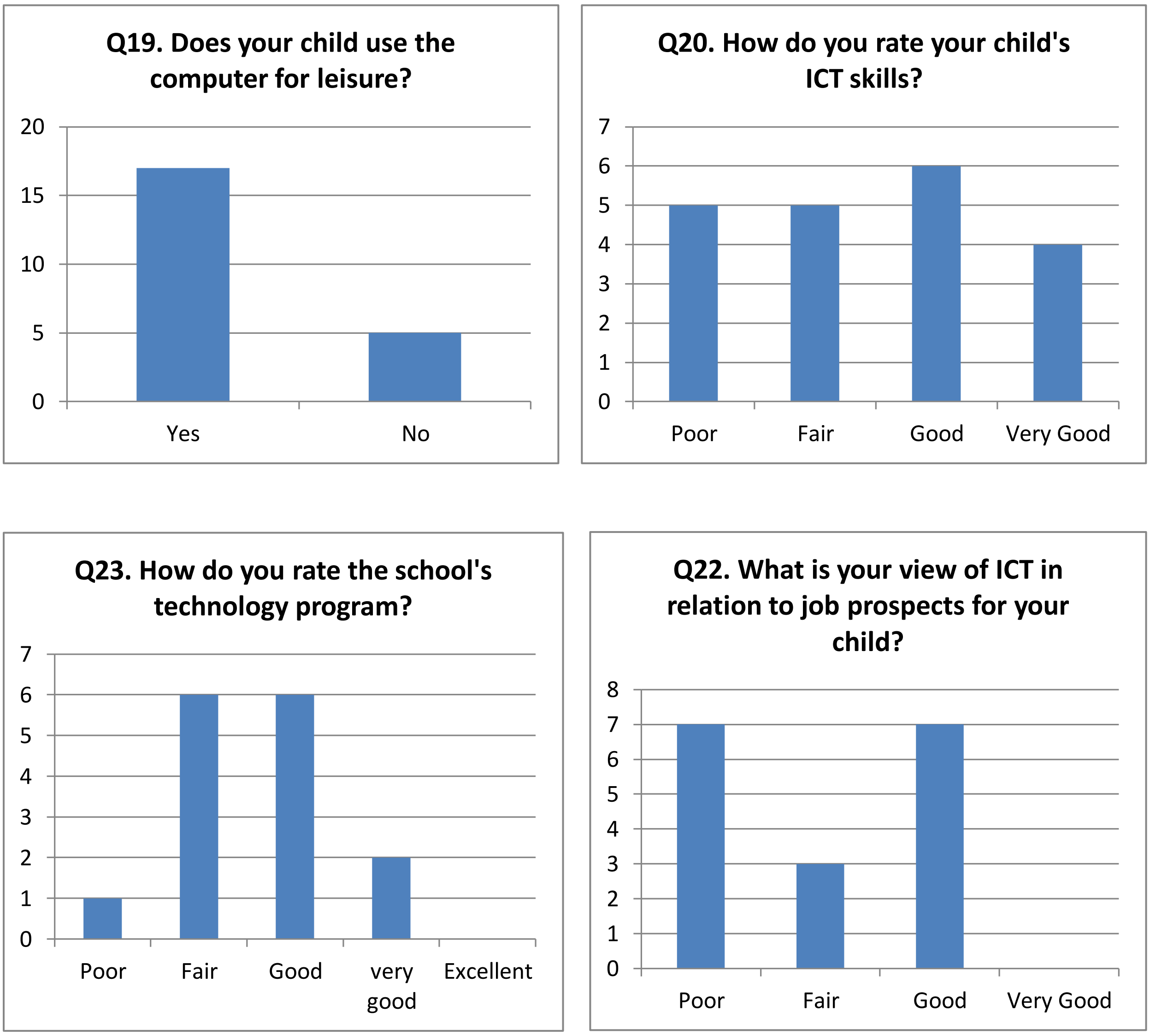


Figure 7-14: Results from parent survey

7.8.4 Responses to Open-Ended Questions from the Parents' Survey

The parent respondents provided the following responses to the open-ended questions:

Q 21. What skills are needed when the child leaves school?

"Full support"

"Able to read screen, fix problems as it occurs"

"Be very skilled at computers"

"Have good understanding of various computer programs, source information, look up bus tables, concert tickets, movies, starting times etc. independently"

"Connect with voice programs"

"Be confident in using computers for information tool, not just for games"

"How the computer can help him in any type of job he may apply for at anytime"

"Competent at communicating and leisure"

"Learn to read"

"Be able to get on the Internet and find a job"

"Use it to communicate with friends, e.g. msn messenger"

"Gain independence in writing, and money skills"

"Whatever able to learn"

Q 24. How does the technology program help your child?

"Provides confidence, very useful information, spelling, solving problems, skills for the job, and skills for the home"

"Better communication"

"Ability to use laptops and programs not at home"

"Competent use of computer"

"Better use of the Internet"

"Access files, games, and care of the equipment"

"Keep up to date, get information"

"Help with reading, spelling"

"More confident"

"Learn skills"

"Cope with changes"

"Build confidence"

Q25. Any other comments?

"Do not want computers to rule our lives"

"She is very good on the computer, it gives her confidence"

"XX's limitations limit the degree to which she can use ICT, great learning tools as she is a very visual child, and she likes to be alone often"

"Not being able to read makes it difficult to use technology"

7.8.5 Data from Questionnaire of Main Actors

The main actors that were identified in the research field were listed in Table 7-7 of the Thesis and these were interviewed. The Questionnaires are included in Appendix D. The main finding from these Questionnaires was that ICT played a very significant part in the curriculum and this was evidenced further by the recognition of the school as a leading school in the state (Victoria) in this particular area, namely ICT.

Actor	**Role**	**Leadership**	**ICT Impact**	**Curriculum**	**View of ICT in education**
Principal	Leader	Very Strong	Positive Contribution	Enforced or implemented curriculum	Very strong view on ICT with strong beliefs of impact for life learning, early adopter
ICT Co-ordinator 1	Co-ordinator with very strong skills	Team leader	Very strong role and extended 121 ICT beyond the pilot phase	Implemented ICT across curriculum. Applied Web 2.0 technologies	Strong view of ICT and impact on learning outcomes, strong innovator
IT Manager	Co-ordinator	Team leader	Active role in program	Involved in policy development	IT managed, enforced security processes
Class Teacher 1	Team Leader	Curriculum Leadership	Strong Actor in 121 initiative	Curriculum Innovator	Very positive, early adopter of ICT
Class Teacher 2	Team leader	Adhered to policy	Integrated into curriculum	Implemented curriculum	Positive, emergent user of ICT
Class Teacher 3	Team leader	Adhered to policy	Used ICT	Implemented curriculum	Positive emergent user
Deputy Principal	Leader	Strong leadership	Supportive role	Prime actor in implementation	Positive view
School Council	Direction	Strong	Positive view	Effective involvement	Positive view
Parents	Supporting	Varied	Varied views	Welcomed adoption of ICT in curriculum	In general good adopters of ICT
Students	Learning	Personal development	Positive impact	Integrated in VCAL	Very strong and happy to use
Departmental Policy	Supportive	Supportive	Admin (CASES 21) Sofweb	Support at school level	e-learning technology plan provided

Table 7-7: Summary of Prime Actors and their impact on ICT in the School

7.8.6 Summary of Leading Actors

Table 7-8 provides a brief summary of the actors and their networks. A more detailed discussion and analysis is presented in section 7.11 below.

Beliefs	The main actors displayed strong beliefs about the school and its curriculums for special needs students.
Attitudes, interests & Motivation	There was strong motivation and interest to extend the 121 Pilot beyond the single classroom. The ICT co-ordinator was highly motivated to introduce social networking programs in ICT VCAL.
Interests & Agendas	The interests and agendas of the actors in the Transition section were very strong and demonstrated a brain compatible curriculum approach with the students.
Networks and Stability	The networks were very stable as was demonstrated by data and observations.
Alignment	All actors showed a strong alignment with respect to the adoption of ICT in the curriculum of the school.
Translation of Interests	Actors in the 121 ICT Project were able to convince and implement the project with the full support of all actors and their networks. The implementation and extension of the 121 Pilot demonstrates a clear translation of interests of ICT use in the school.

Table 7-8: Summary of Leading Actors at Concord

7.9 SCHOOL DATA

The school conducted its own data analysis and identified the standard of its senior students by comparing several years since 2003. The analysis included the percentage of students who completed the VCAL modules, for example the percentage in Personal development, Numeracy, Literacy and Information Technology, as well as Work Related Skills. The following figure, Figure 7-15, shows the trends in the period 2003-2006.

7.9.1 VCAL Data

<u>Note</u>: The *Victorian Certificate of Applied Learning* (V.C.A.L.) is a hands-on option for Years 11 and 12 students, offering practical work-related experience and learning.

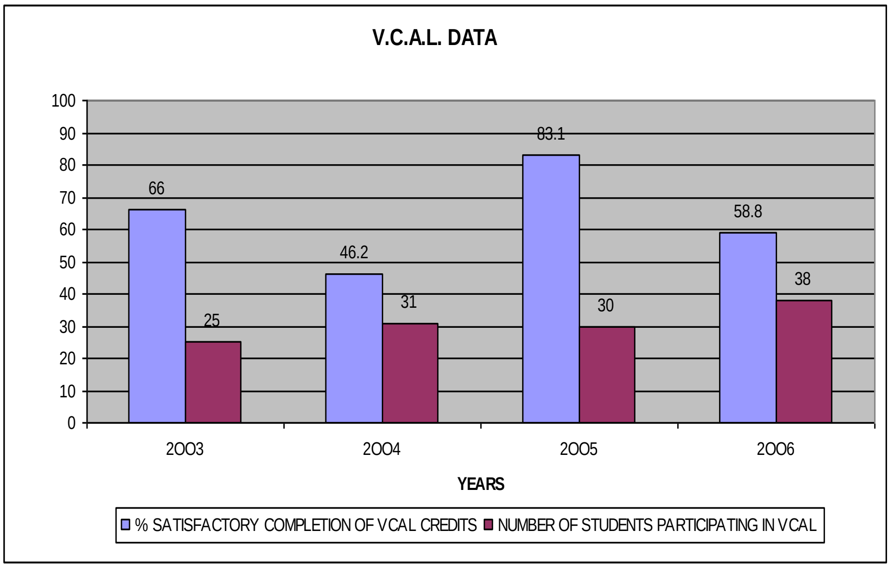


Figure 7-15: Percentage of students who completed the V.C.A.L Modules

7.9.2 Transition Program

The school further carried out data analysis for its senior program, Transition Program, to identify the overall percentage rate of students who completed the six modules: Literacy, Numeracy, Technology, Independent Living, Travel Education and Consumer Skills. The data are sumarized in Table 7-9 obtained from the school.

Concord Transition Program Modules	**Percentage (%)**									
Overall, the student has made the indicated level of progress in the following modules:	**Not Assessable**		**Not Apparent**		**Beginning**		**Consolidating**		**Established**	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Literacy	0	0	0	17	10	18	30	20	60	45
Numeracy	0	0	0	34	10	15	30	16	60	35
Technology	0	0	0	6	0	18	20	34	80	42
Independent Living	0	0	0	9	0	25	60	25	40	41
Travel Education	0	0	0	7	0	17	10	20	90	56
Consumer Skills	0	0	0	15	20	18	70	28	10	39

Table 7-9: Transition Data

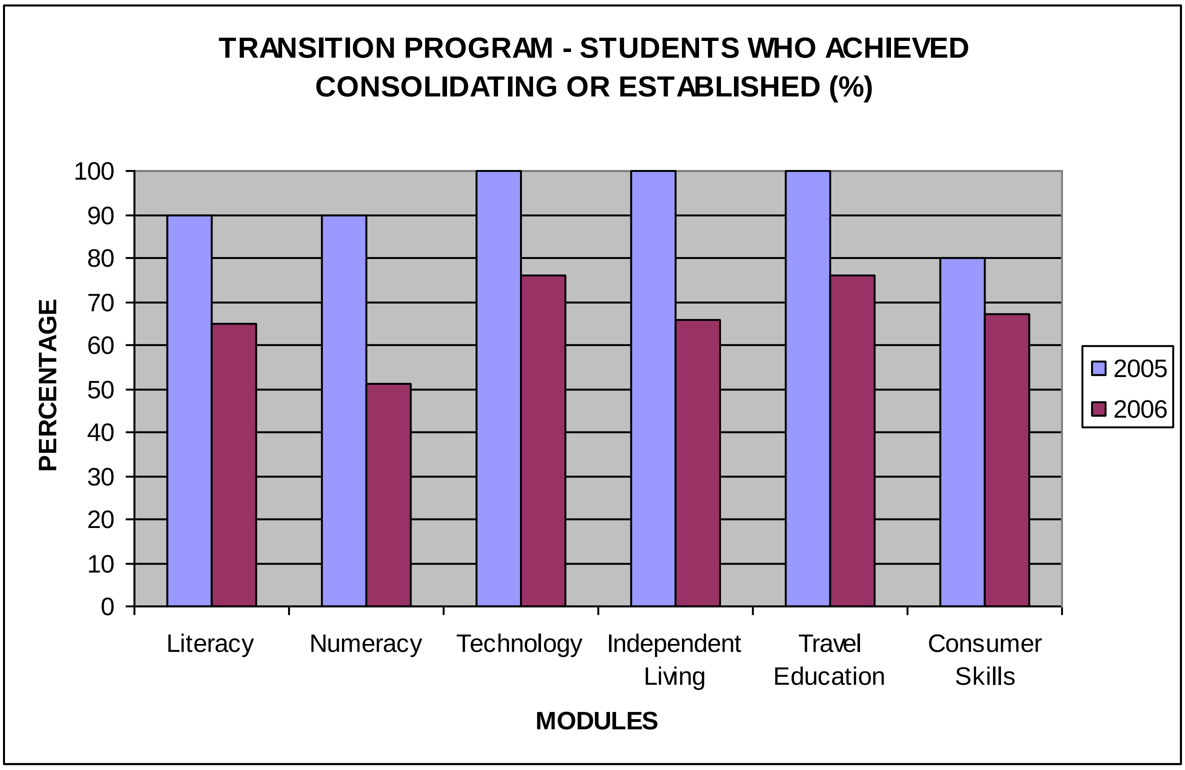


Figure 7-16: Transition Data - Modules Achievement

7.9.3 Year 12 Completion Rates

In addition to these, the school further provided data with respeect to Year 12 completion rates, from the period of 1997-2006 and these are reproduced in Table 7-10.

Year	Left During Year 12	Completion Year 12	% Completed	Total
1997	14	18	56	32
1998	10	17	63	27
1999	19	17	47	36
2000	11	15	58	26
2001	14	24	63	38
2002	7	19	73	26
2003	21	16	43	37
2004	25	20	44	45
2005	3	15	83	18
2006	1	23	96	24

Table 7-10: Y12 Completion Rates

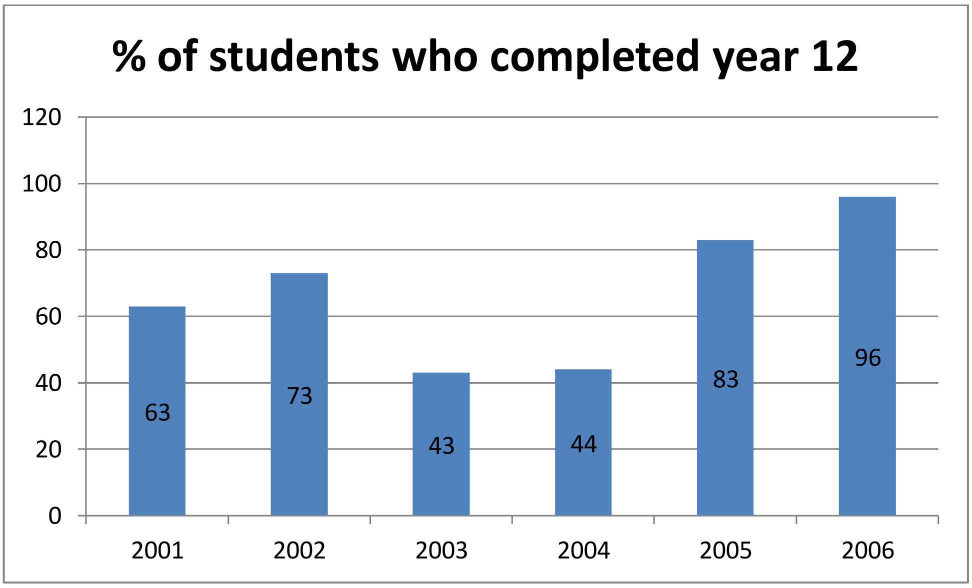


Figure 7-17: Percentage of students who completed year 12

7.9.4 Progress Outcomes in Curriculum Domains

The School carried out a teacher assessment of progress in the VELS domains: Science, The Arts, Mathematics, Health & PE, English, I.C.T and Civics. This analysis is reproduced here for the reader to gain an insight into the overall percentage of progress with ICT in the school curriculum. (Table 7-11

Assessment of Victorian Essential Learning Standards Domains (%)								
INDICATORS	**No Progress**	**Little Progress**	**Satisfactory Progress**	**Good Progress**	**Very Good Progress**	**Excellent Progress**	**Good to Excellent Progress 2005**	**Good to Excellent Progress 2006**
Science	0	0	13	83	4	0	91	97
The Arts	0	0	24	71	5	0	91	76
Mathematics	0	1	22	65	11	1	86	77
Health & PE	0	1	14	76	8	1	86	85
English	0	0	16	63	19	2	84	84
I.C.T.	0	0	14	77	9	0	89	86
Civics	0	0	17	77	6	0	N/A	83

Table 7-11: Assessment of VELS

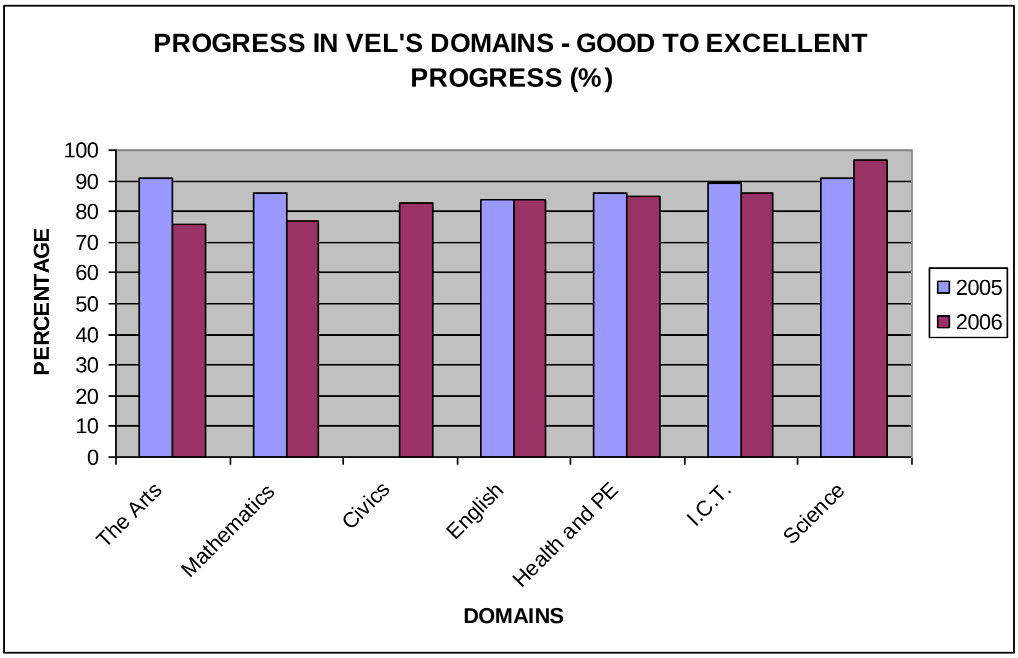


Figure 7-18: Progress in Domains

Table 7-11 and Figure 7-18 have been reproduced here with the kind permission of Concord School. The data presented here clearly demonstrate the relative strength of ICT in the school. This is fairly significant and its main feature is that it is integrated throughout all school programs, senior and middle school. The school provided additional data from its own analysis of the CELS indicators in the various domains and these are shown in Figure 7-19 below.

7.9.5 Information and Communications Technology (ICT)

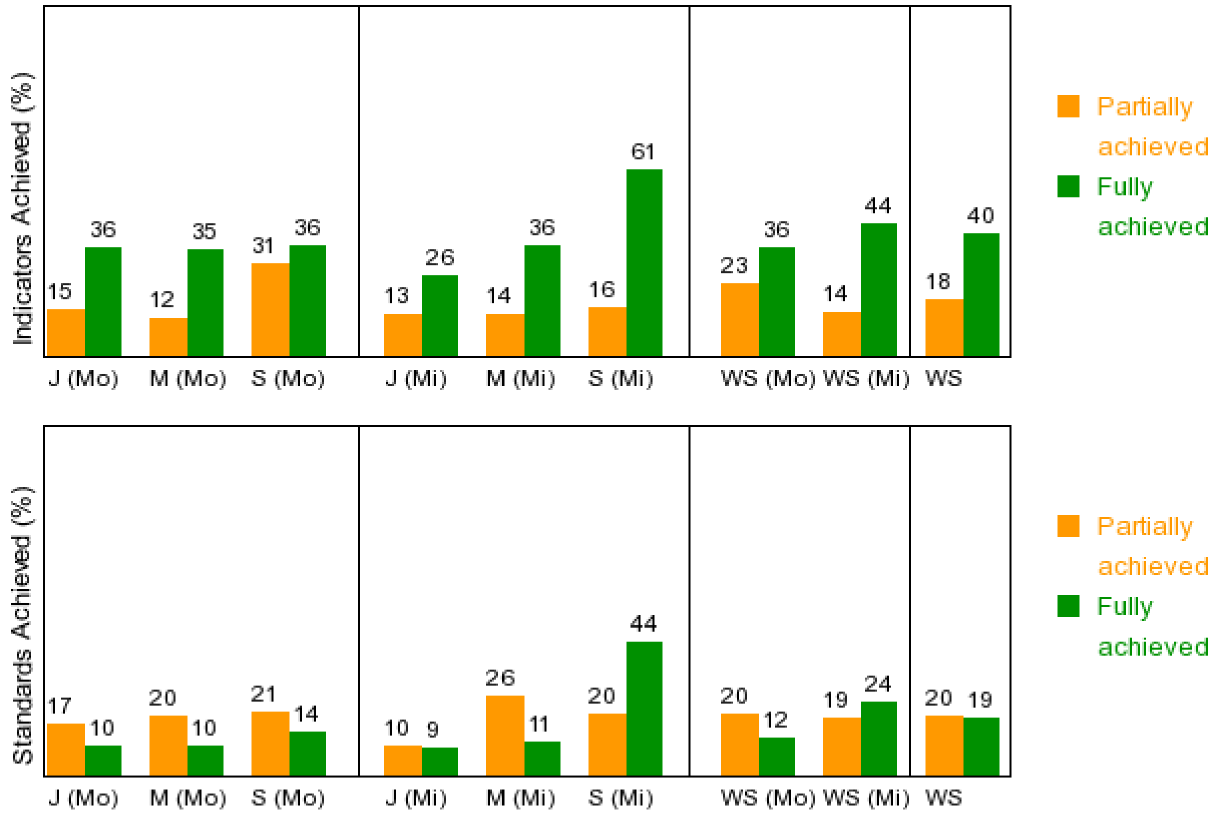


Figure 7-19: Information and Communications Technology Indicators and Standards Achieved.

The following sequence of figures, summarized as Figure 7-19, illustrates important data that were collected and analysed by the school for ICT usage. The data provided specific indicators which relate to significant skills and knowledge in this particular Domain of knowledge as it relates to the Victorian Education Learning Standards (VELS). The main indicators for this analysis involved:

- Students use ICT tools
- Students use the correct terms to name ICT equipment
- Students use ICT to acquire new knowledge and skills
- Students save visual evidence to a folder and retrieve the files
- Students apply simple formatting techniques and editing functions
- Students create multimedia products
- Students initiate and compose messages
- Students locate information on an intranet

- Students can use a search engine to locate information from websites

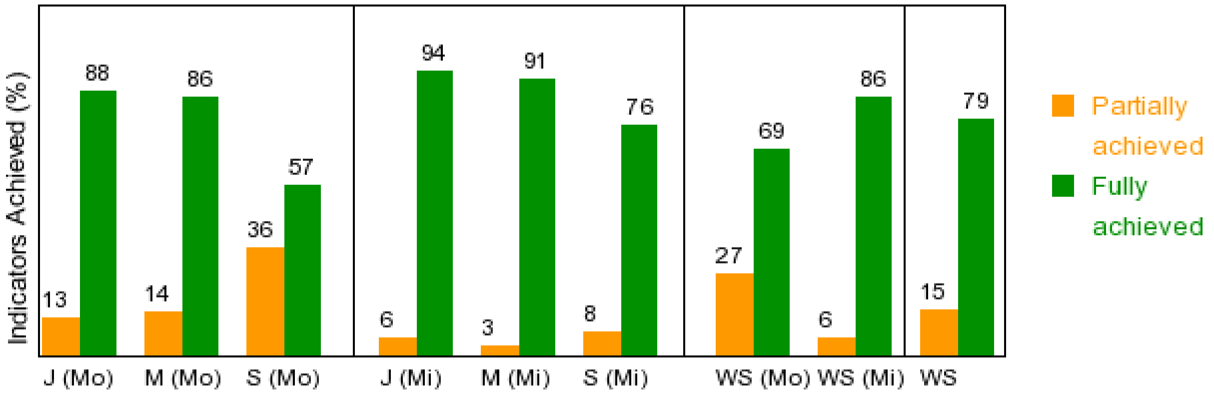
It should be noted that the results from CELS in the ICT domain correlate with those obtained from the Skills Matrix analysis, in this study. These were presented in Section 7.8.2 above.

Information and Communications Technology (ICT)

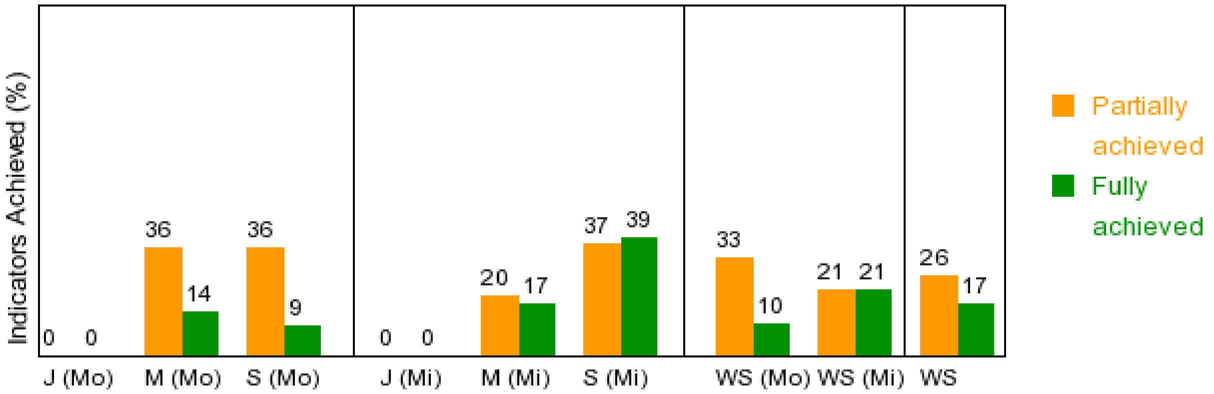
ICT skills

Students use ICT tools

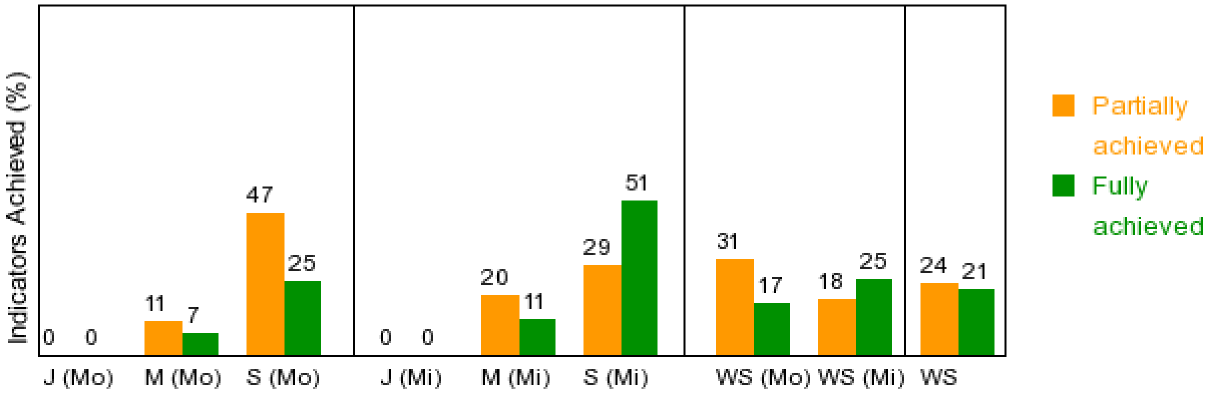
Recognise and use basic computer components (e.g. mouse, monitor, keyboard)



Recognise and use other computer components (e.g. disk drives, scanner, ports, motherboard)

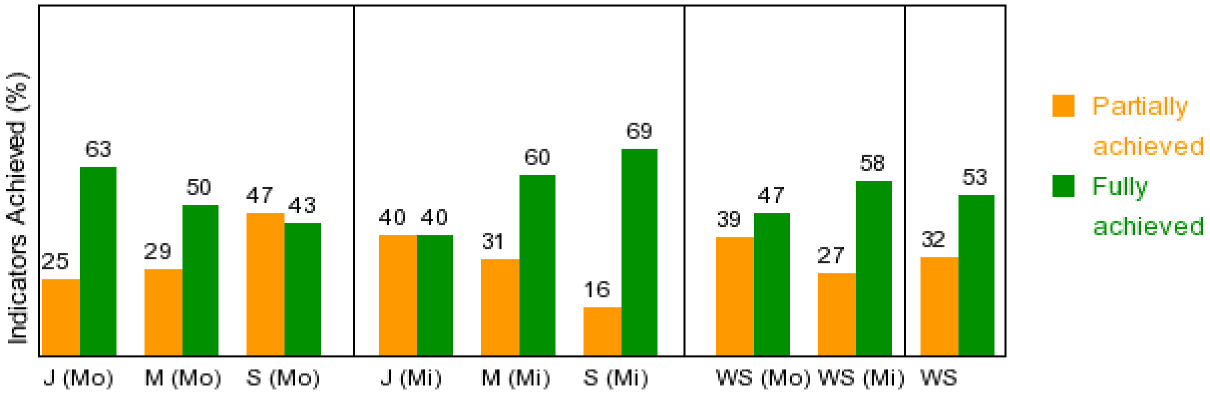


Recognise and use peripheral equipment (e.g. camera, video)

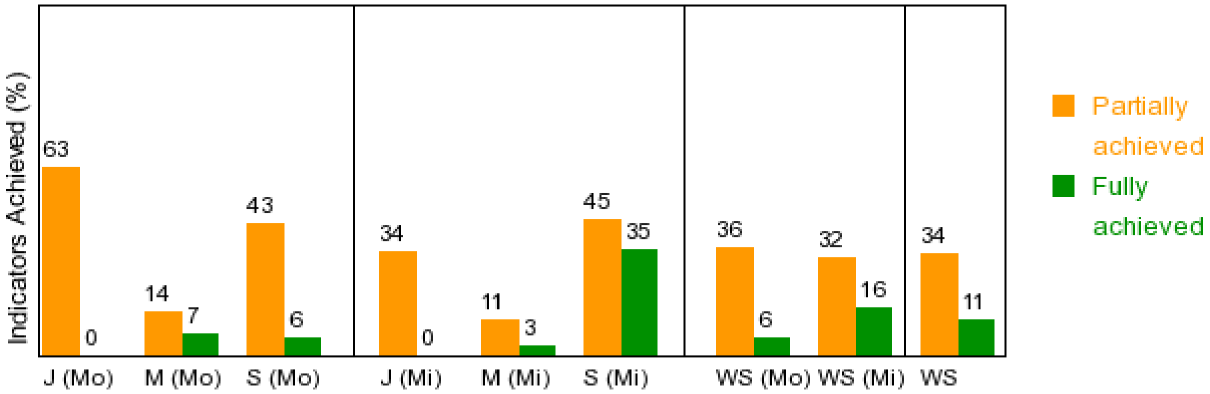


Students use the correct terms to name ICT equipment

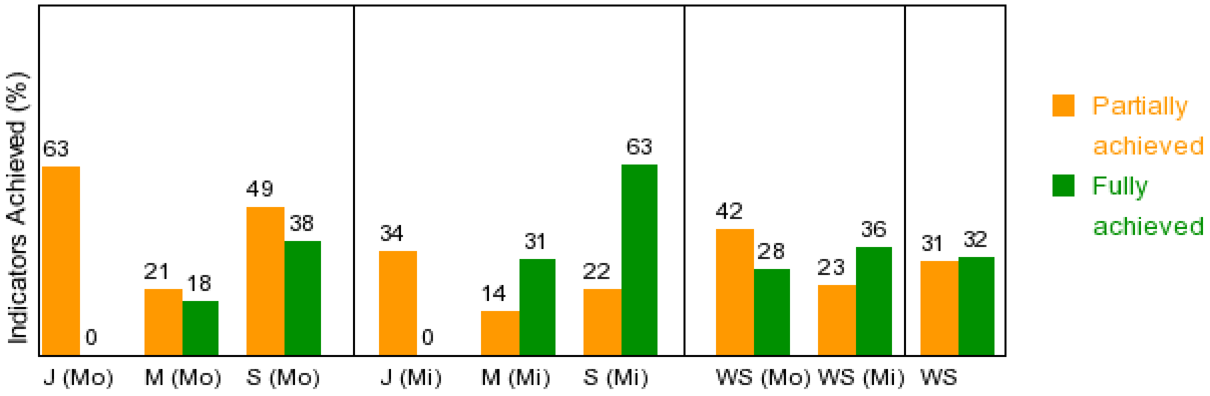
Identify or name basic computer components (e.g. mouse, monitor, keyboard)



Identify or name other computer components (e.g. disk drives, scanner, ports, motherboard)

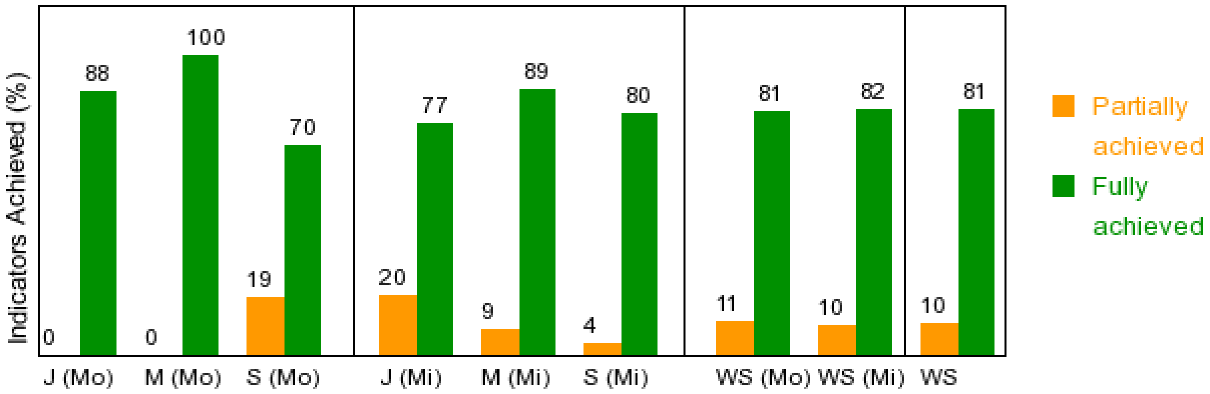


Identify or name peripheral equipment (e.g. camera, video)

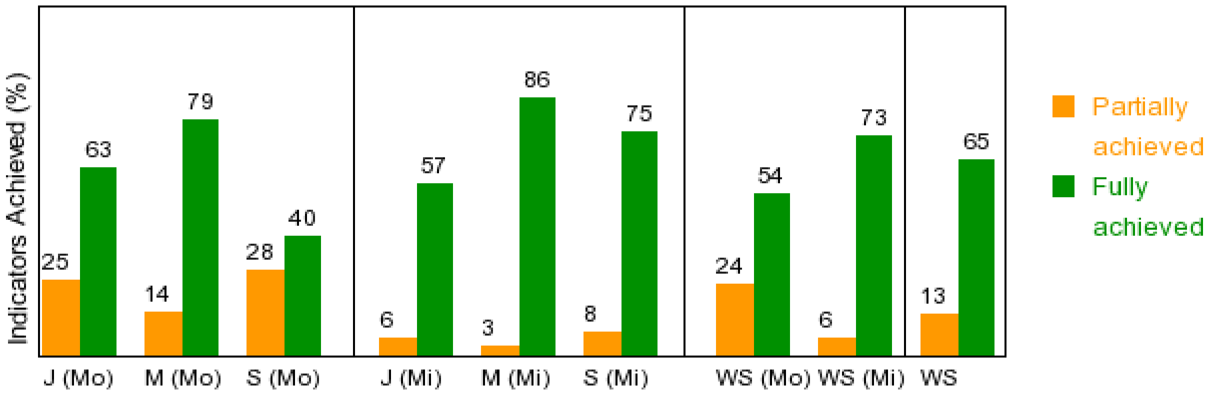


Students use ICT to acquire new knowledge and skills

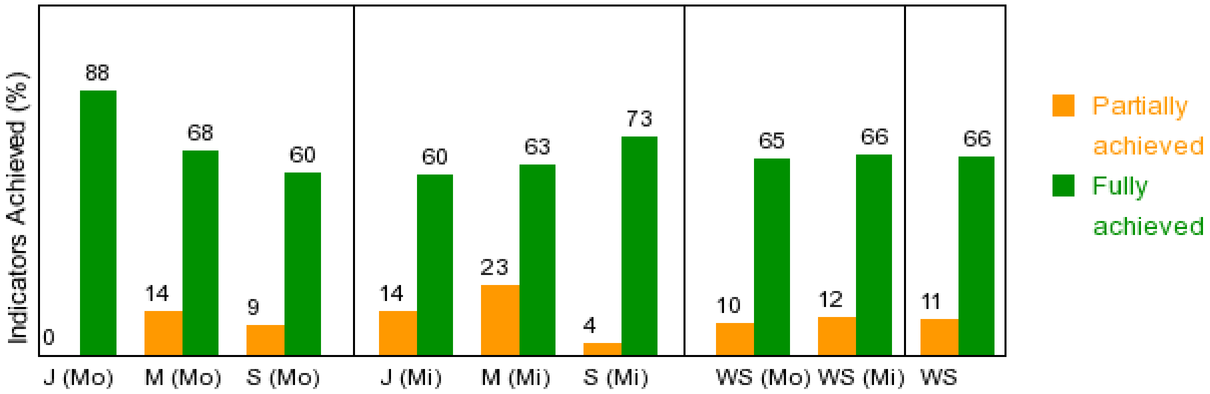
With assistance, log on to the network



Independently log on to the network

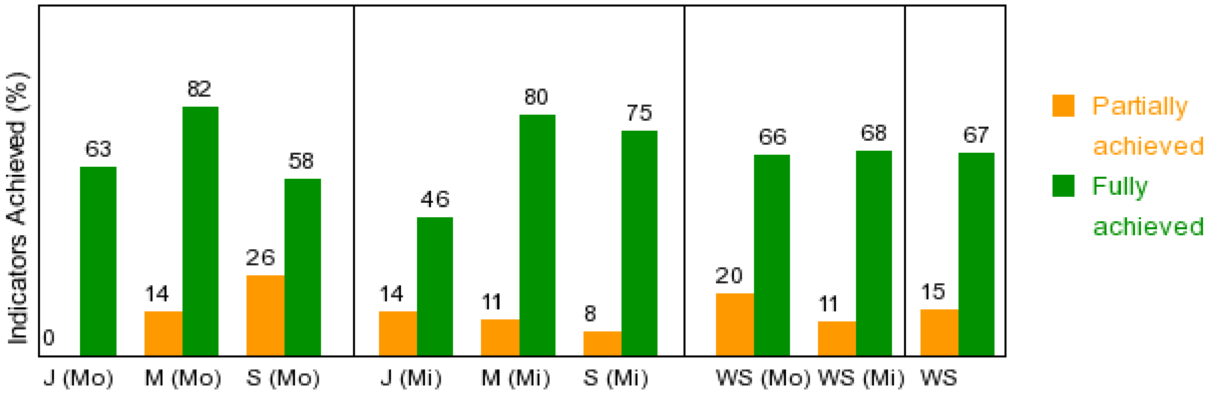


Navigate, open, use and close programs



Students save visual evidence to a folder and retrieve the files

With assistance, save a document into own folder



Save a document into a folder at a specified location

Figure 7-20: List of ICT skills and indicators from CELS at field Y (Source: Concord School)

7.10 RECENT ICT DEVELOPMENTS AT CONCORD - WEB 2.0 TECHNOLOGIES

Web 2.0 tools and activities use the 'Internet as a platform' (O'Reilly 2005) by constructing knowledge and learning skills through learning networks. Web 2.0 tools facilitate connections by enabling common points of interest to be communicated and pursued. Some refer to this as the 'long tail' which acknowledges that "small sites make up the bulk of the Internet's content; narrow niches make up the bulk of the Internet's possible applications" (O'Reilly 2005). By using student directed collaborative tools we empower students to find content and pursue personal interests using the Internet. By introducing these tools and teaching students to use them we are essentially giving them a voice, allowing them to make choices and create an online presence through content creation. In using open web based standards, such as RSS[90] and XML[91] and open API[92] web services, complimentary software can share data in rich ways. In future years, this may well be the key criteria for introducing new technologies and systems, as teachers and administrators become more familiar with working within networked environments.

7.10.1 The School's Overall School Philosophy and Aims

Concord School has a senior curriculum that focuses on Personal Learning. Collaborative web based tools, such as tagging web pages with Scuttle (Special Program), provide scaffolding in:

- Communication
- Stimulating interest
- Encouraging reflection and discussion about learning
- Encouraging celebration of learning
- Giving everyone a voice
- Dynamic change
- Tagging as authoring
- People make connections to others through their content
- Just in time learning

---

[90] **RSS: Real Simple Syndication**

[91] **XML: Extended Markup Language**

[92] **API: Application Programming Interface**

By promoting online learning networks, Staff at Concord acknowledge and celebrate diversity among the students and encourage self-directed learning based on interests.

7.10.2 Constraints that Inhibit Full Application of the Web Learning Platform

Concord School has attempted to provide all social networking web services and tools via an intranet. The main reason for this was to ensure the privacy and security of the students. There is a wide range of suitable open-source software that makes this possible, such as Word press blogging software, Scuttle social bookmarking software, ccHost audio remixing software and Gregarious feed reader. Unfortunately, some software the school would like to use is not yet available and (for these) it has sought to write its own. Much of the open source software is still developing, as in fact are the wider technologies that support the sharing of data between websites. Open standards encourage the use of common open standards between different websites are still in their infancy.

If privacy and security concerns can be overcome and Internet applications could be used, there are other pitfalls to be aware of. The reliability of service, the life of the service and the security of the service all need to be considered. Recently Google Video announced that it would shut down and that all the videos uploaded to Google Video would soon be unavailable. Also, YouTube has recently had a major problem with spam in its comments. Other less known services may simply close down without notice or may be slow to use during peak times and suffer frequent outages.

7.10.3 Resources Required to Implement Strategies for the Adoption of Web 2.0

The introduction of Web 2.0 technologies at Concord School attempts to integrate with existing practices but also to make them richer tasks for the students and easier for the teachers. For example, in beginning to use web based photo sharing to construct student digital portfolios. Students and teachers tag photos and then students create online photo albums for later use in their digital portfolios. This approach not only introduces skills and practices, but also reduces the workload for teachers who had previously organised the resources for use in the student digital portfolios.

7.10.4 Social Software and Collaborative Learning at Concord School

As mentioned earlier, Concord School has introduced and trialled the use of social software and networked learning activities and practices. The following list provides an overview of the activities and the software used by VCAL students:

1. **Lumil** is a photo focussed social networking site and service that can be run privately on a schools network. Photos can be browsed by tags (keywords), albums, owner or date. When photos are uploaded the rich metadata that digital cameras embed is transferred with the photo. Photos in Lumil stay available to students and are easily accessed beyond the year in which they were taken. Value can be added to the photos by adding additional tags, comments and annotations or by organising in custom albums. Photos can be accessed by other websites and programs via RSS or by the API. Concord is using Lumil to manage it digital archive. Lumil is currently in closed-beta but will be available as open-source January 2008.
2. **WordPressMU** is an open source multi-user blogging platform that enables students to have their own blog. At Concord, student's blogs are used to reflect upon learning, celebrate learning and encourage communication. WordPressMU has many inbuilt technologies such as RSS, plugins, API, trackbacks and pingbacks that enable data exchange with other software. The school is trialling the use of WordPressMU for student digital portfolios. Currently WordPress is installed on the school's intranet and is not accessible via the Internet.
3. **ccHost** is open source software, created by Creative Commons, that allows resources to be uploaded, tagged, shared and re-mixed. ccHost is designed primarily for music samples but can be adapted to share any type of media. Concord School currently has two separate installs of ccHost, one for sharing music samples and songs, and one for sharing Scratch content.
4. **Urdit** is Creative Commons licensed music focussed social software, designed to enable students to create a simple and fun online presence on a school intranet. Students can find songs via tags or through other users. Users can create playlists, identify songs as favourites, tag songs, create a home page and leave messages for others. Urdit is in private beta and currently does not have an expected release date.
5. **Gregarius** is an open source web based feed reader that can be used to aggregate RSS content from blogs or other websites. Individuals or groups can use Gregarious.
6. **Scuttle** is an open source web-based social bookmarking website and service that can be run on a school's intranet. Students and teachers can use tags to identify webpages and other Internet resources. Users can monitor and share resources with other Scuttle users.
7. **Firefox** is an open source browser. Firefox has an architecture that supports third party add-ons that modify or increase its functionality particularly when using social software.

Social networking activities at each section of the school are shown in Table 7-12.

	Junior	Middle	Secondary	Transition
Using photo sharing social software to locate suitable photos for use in other work by searching with tags.	X	X	X	X
Using photo focussed social software (tagging and comments) to share artwork created with GIMP.			X	X
Using photo focussed social software to annotate photos to identify key information and demonstrate learning about horticulture.				X
Using photo focussed social software to share sound notes recorded at when the photo was taken to demonstrate learning and understanding.				X
Using photo focussed social software to create albums to identify and celebrate a range of learning activities and experiences.		X	X	X
Using photo focussed social software to comment on successful learning.				X
Using photo focussed social software to easily locate photos for student blogs (digital portfolios).			X	
Using blogs to celebrate and reflect on student learning.			X	X
Using ccHost to share scratch sprites, backgrounds and projects to encourage remixes and collaborative work.				X
Importing Scratch sprites, reusing and modifying the work of others.	X			X
Using ccHost to share audio samples to encourage networked and collaborative learning.				X
Using music focussed social software to develop social software skills and activities and create an online presence			X	
Searching music focussed social software using tags to find suitable music for use in other work.		X	X	X
Using a web-based feed reader to read aggregated student blog content to facilitate interaction.			X	X
Using social bookmarking software to share web resources and encourage networked learning.			X	X
Using shared scripts to scaffold use of social software and other Internet sites.				X

Table 7-12: ICT Activities at the school sections (Source: Concord School)

7.11 ACTOR-NETWORK THEORY: RESULTS FROM 121 ICT PROJECT

At Concord, the goal is to introduce new activities and practices, not to introduce any specific software or specific technology. An ANT approach to this investigation begins with the identification of actors (both human and non-human). The following actors have been identified using this process: leading teachers, students, parents, curriculum, technology, hardware, screens, social software, policy, ICT Coordinator, Team leaders, Principal, Department, buildings, rooms etc.

Actors	Teacher: Anna, Anne, Rhonda, Richard, Warren Assistant Teacher Students: Year 11, Year 12, Transition Researcher
Activity	Office skills, language skills, reading skills, numeracy skills, Internet search Email skills SharePoint use, tags, blogs, local government issues and rights Image manipulation e.g.: GIMP Logic concepts e.g. Mixing shapes, colours, objects with Scratch[93] Formatting documents e.g.: shapes, colours, objects Music/sound manipulations-Audacity
Observations	Students: Participation level, Engagement, Application Teachers: methodology used
Comments	Use of ICT in activity Awareness of local/global issues Skills involved in activity VELS- indicators for achievement E-learning technology plan VCAL content context
Issues	Transportation of laptops

Table 7-13: Results from activities of the main actors in the 121 ICT Project

The innovation was focused on activities and practices, but in order to introduce these activities and practices there is a need to implement some social software (photo sharing, ccHost, scratch), technologies (RSS) and skills (tagging, remixing). It is the introduction of this social software that constitutes the innovation and this is where actor-network theory can be applied. In particular with an innovation translation

[93] **Scratch is an MIT developmental program.**

approach we look to see whether the innovation is adopted in its offered form, whether it is *translated* into another form, or indeed whether it is adopted at all. The key to investigation here is to 'follow the actors' (Law and Callon 1988) and: "… to trace the interconnections built up by technologists as they propose projects and then seek the resources required to bring these projects to fruition" (Law and Callon 1988). It should then be possible to obtain some idea of how the new ideas, concepts and learning materials are adopted, or not adopted. What we are looking for is an understanding of the totality of this adoption and using ANT to help us achieve this.

I was involved in observations, interviews and questionnaires of students, teachers and parents. Following data collection I used ANT to analyse and determine the associations between the various actors to see how they come into play in determining the pattern of adoption (problematisation).

The study found that ICT innovation was introduced in an integral manner in the curriculum. The goal was not to introduce social software as such, but rather the associated individual activities and subjects or practices (sharing, communication, collaboration, tagging, publishing and remixing). The innovation's expected outcomes were to have students who can:

- Independently access online personal learning
- Independently communicate online
- Independently participate in online learning communities.

A summary of the various social networking software programs are shown in Table 7-14; the Social Software skills matrix.

	Tagging	Commenting	Reusing	Remixing	Aggregating	Uploading	Downloading
Lumil	X	X	X		X	X	X
WordPress	X	X			X	X	
ccHost	X	X	X	X		X	X
Urdit	X	X	X				X
Gregarius	X				X		
Scuttle	X		X		X		
Scratch			X	X			

Table 7-14: Miscellaneous programs used in ICT VCAL classroom

Intended students' skills and actions included publishing and sharing work, and collecting resources for themselves and others with tagging. Prior to using Lumil, students shared their GIMP work at the end of the session via the teacher's computer or exemplar work was printed out for display. By using Lumil almost all student work could be shared with the whole school. Blogging was well received by students and high-support needs students were able to create a blog around photos and videos as opposed to written posts. Students were able to locate and download sprites[94] and modify them in their own projects as well as creating a sprite that demonstrated an understanding of the life cycle of a plant. Students enjoyed finding new music and interacting with other students online. A tool that can help students with LD is Accessibar. This tool has a number of features that can help students with learning disabilities, including a very good screen reader that allows students to change text size and colour, as well as background colour. Other social software exists on the Internet that, due to privacy and security concerns, the school is unable to use and unfortunately there are not suitable open source alternatives that can be run on the school's intranet. (Adam et al. 2007)

[94] **Sprites are ready made objects with built in attributes to help the user in designing various objects.**

7.11.1 Summary of Programs Used By Prime Actor

Table 7-15 shows the programs that were used in VCAL ICT class by the ICT Coordinator:

Programs Used	Programs Used
File management	Social networking (blogs)
Image properties	Email- concepts/ethics
Social properties	Word processing skills
Sharing of resources-share point	Logic skills (research) (MIT program attributes of different people)
Motor skills-use plain paper to create characters and the important information image applications	VCAL. ICT – Cert I
Object attributes	Sprites
Pixels	Live Gallery
Animations	Games
Frogs	Scatter
Acid music	Mosaic
Creativity	Individuality
Album	Sideshows

Table 7-15: Activities and software programs used in ICT VCAL class by main actor

(See Appendix B for samples of relevant activities)

These programs provided students with an enriched set of ICT skills and knowledge. For example, Scratch, engaged students in working on logic, patterns and attributes for human and non-human objects. The students were able to participate in class activities and became aware of the skill needed to use the program. In some cases, working with the program was far easier for some students instead of working on a model using paper.

7.12 DATA COLLECTED FROM FIELD Z

Research Field Z

In collecting data from field Z it was necessary to review the Brain Models that were discussed in Chapter 4. In particular, it was considered that following Lowery (2000), a horizontal thinking curriculum approach should be applied to this particular case. Figure 7-21 below illustrates these considerations and highlights the main relevant areas that are a part of this analysis. Table 7-16 displays key actors and the associated skill or area provided by them for Z.

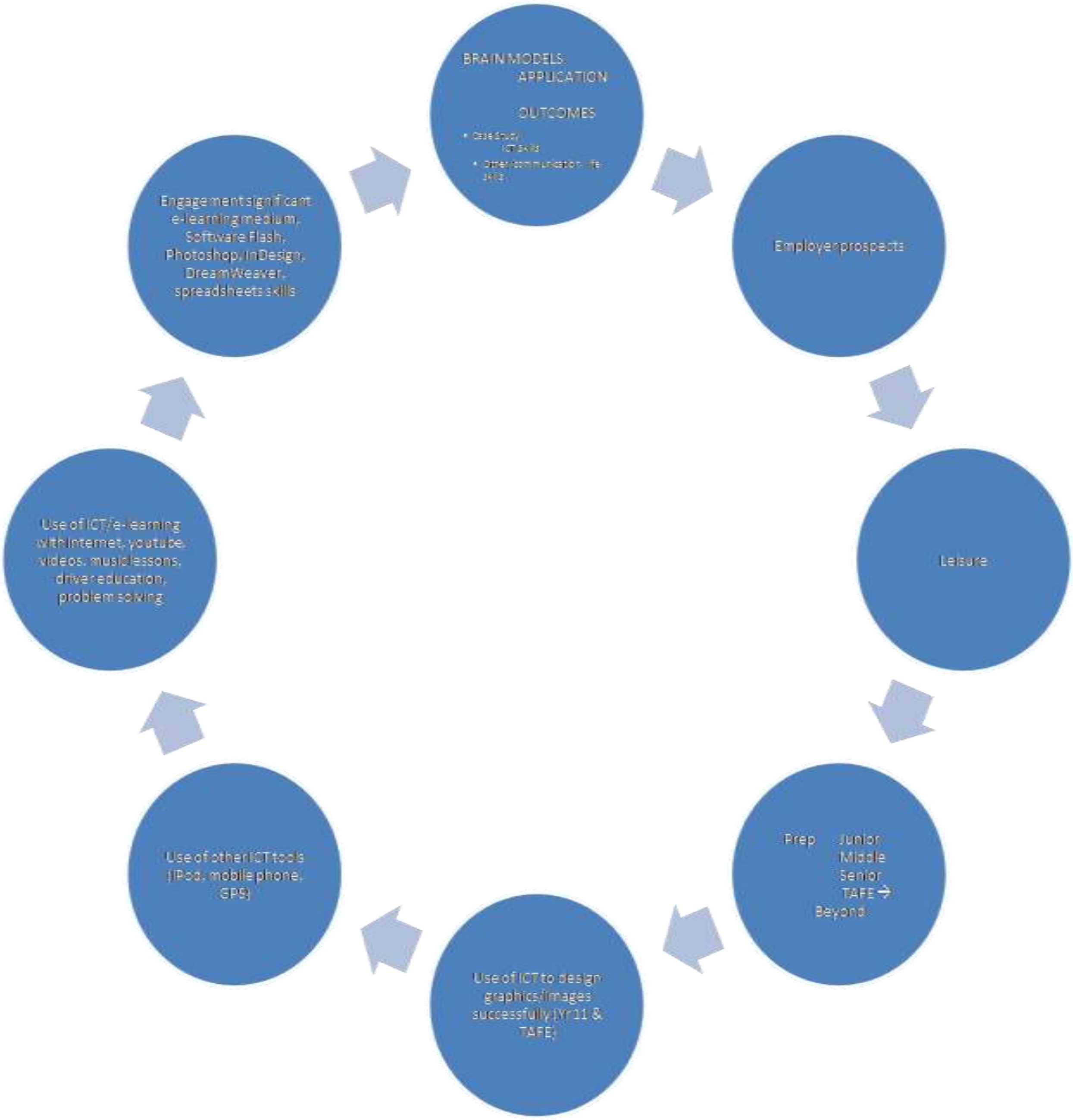


Figure 7-21: Learning & skills for actor in Z

7.12.1 Portfolio Data- Evidence from Studies for Actor in Z

Appendix C in the dissertation provides samples of artefacts and skills that were attained by the actor in the field Z. Table 7-16 below shows the main actors in recent years for the field of study Z. Appendix C provides the qualifications attained by the prime actor (student) in Z. The main units or subjects which were completed are provided in Table 7-17 below.

Actor	**Skill**
Richard	Building character 3Ds animations, skating
Sarah	Web Design
Federico	Drawings Student Diary
David	InDesign XML
Mike	JavaScript
Ben	Photo Gallery
Paul	Model, 3D Studio, Buildings etc. Photoshop
Admin	Enrolment, Graduation, Results
Rupert	Digital media Work experience-skills, motivation, creation Film/editing Audio editing
Jason	2D animation characters
Omar	E-Learning program design

Table 7-16: Actors in TAFE for individual study (Z)

The table displays some of the most significant units that were studied and completed satisfactorily and provides evidence of improvement and consolidation of the learning outcomes.

Year	**Subject**	**Description**
2008	CUFANM503A	Design Animation and Digital Visual Effects
2008	CUFDIG503A	Design E-Learning Resources
2008	CUFPM601A	Plan and Manage Film and Media Pre Production
2008	CUSSOU16A	Develop Sound Design
2008	CUFCAM601A	Direct Cinematography for Screen Productions
2008	CUFIMA04A	Create 3D Digital Animation
2008	CUFMEM08A	Apply Principles of Game Design to a Multimedia Product
2008	ICAITB137A	Produce Basic Client Side Script for Dynamic Web Pages
2008	ICPP494A	Develop Document Content and Structure
2008	CUFIMA04A	Author a Multimedia Product

Table 7-17: Units Studied by Actor in Field Z

The above units provide strong evidence of the impact of ICT in one specific field, namely the graphics field. The portfolio in Appendix C provides evidence to support the view that the actor performed relatively well in learning, extending and handling complex software packages like Adobe Photoshop, Illustrator, Dreamweaver, Flash and various other packages that manipulated both audio and digital media. There was an overall gain in knowledge and skills with digital data, media and their properties and print media. Table 7-17 shows that skills such as animation, transformation of images, colour contrast and some other attributes were learnt and applied. Figure 7-22 is a sample of the assessment tasks which were required at this level of study. (Further information on this is given in Appendix C.)

Assessment 02 Marking Sheet — **ICPMM65DA Create Web Pages With Multimedia**

Name: GEORGE ADAM Number: ADA07275046 Group: Cert 4 Multimed.

This document provides a grade and feedback for Assessment item 02 in the unit:

ICPMM65DA	Create Web Pages With Multimedia
PC Being Assessed	1.2, 1.3, 1.4, 2.2, 2.4

Planning Materials **Weighting**: 20 % **Due**: Week 4

DN

A Project Brief: This will be a half-page document that clearly explains:
- Who the web site is for (e.g. business/organization)
- The purpose of the web site (e.g. advertising, information)
- What the customers are looking for from the web site

A storyboard (a drawing and description of each page in your web site)
The storyboard will consist of four separate pages (A4 size) – one for each page of your website. Each page of the storyboard will include the following:
- The document title (e.g. Home Page) and html file name (e.g. index.html)
- Details of colours, fonts, headings and images
- Location of all hyperlinks and anchors
- The navigation options (menu)

Note: You can hand draw this storyboard. It is not necessarily your final design – rather, it is a planning tool. You can make changes later

Have cited 24/4/08

A prototype (on CD)
This is a working model of your web site containing the following:
- The navigation bar (menu)
- The four pages of your website correctly named and linked to the navigation bar.
- The pages will contain a text heading (e.g. Home Page) and text hyperlinks (if they are being used within the page). No other content or design elements will be present.

Submission Details:
- The three items must be personally submitted with a copy of the marking sheet in a folder with your name and student ID clearly marked.
- The Marking Criteria sheet needs to be signed on submission
- Emails will not be accepted for this assessment.
- All requests for extensions must be organized prior to the due date if a penalty is to be avoided.

By signing this document the student has read and accepted the Department's assessment item submission policy as outlined in the ICT Student handbook and that:
i. The content of this assignment is my/our own work. Where the content is not original acknowledgments have been noted;
ii. I/We have made a copy of any electronic or digitally prepared submissions as proof of completion.

Student Signature: G Adam Submission Date:

Teachers Signature: G Adam

trying to create but it a little difficult to follow

Kangan *Batman* TAFE Information Communication Technology 2008

Overall, terrific work!

Assessment 02 — Marking Sheet | **ICPMM65DA — Create Web Pages With Multimedia**

Grade	Marking Criteria
NN	• Project brief not completed and -or • Storyboard does not meet specifications and -or • Prototype not completed
PN	• Project brief satisfactorily completed and • Storyboard completed but does not include all the required detail (text, colours, images, links etc) and • Prototype completed but with errors
CN	• Project brief satisfactorily completed and • Storyboard completed with all required detail but information not clearly displayed or difficult to follow and • Prototype includes proposed navigation and functionality
DN	• Project brief clearly explains aims and purpose of the web site and • Storyboard completed with all required detail; well laid out; and easy to follow and • Prototype clearly demonstrates proposed functionality and navigation options
HD	• Project brief clearly explains aims and purpose of the web site and • Storyboard beautifully presented. All details of web site are included. Someone else could create the web site from this storyboard. and • Prototype clearly demonstrates proposed functionality and navigation options

Grade: DN

Comment: You have planned your website well. Your storyboard provides a good indication of the look you are trying to create but it is a little difficult to follow

Teachers Signature: Date:

Kangan Batman TAFE

Information Communication Technology 2008

Overall, terrific work!

Project Brief

The purpose of the website is to advertise to customers a business that sells videos and other products (games) on the internet.

The customers will be able to view the latest releases, check on a variety of products and look at the videos DVDs, etc , online from this website by providing the the necessary customers.

The website will offer the customers specific link options. It will also provide special links to specific movie producers like Fox,MGM,Warner Bros, TNT , HBO Pictures , Hallmark / Hall Of Fame , Disney and Sony , + Paramount Studios.

The website will provide a little bit about games on the products page. The games will be able games like e.g. PS2 games and Xbox 360 games on the products page to attract the uses to coming to my page. The users (Customers) can look at the game list and then go to the sales page and look the games.

The sales page will have a list where people can search movies and games, and old films from the sales page, as well as a variety of movie covers to attract the users from selecting the DVD's they want. After they go to the list and see the movie.e.g. If they want to see Die Hard 4, then they can go to the list and click Die Hard 4, and then click the button to watch that movie.

Figure 7-22: Sample Results from Assessment Tasks for actor Z

It is significant to explore these findings and observations further, and in particular to link with the literature on cognitive developments, concept maps and some other studies which involve graphics, like widgits which were discussed earlier in Chapter 4. The case study research applied voice recognition software and other tools to compare the training tolerance levels of this actor and the other two fields of research. It was noted that the training was achieved a lot quicker as the actor exhibited a higher level of reading and comprehension skills than the actors (students) at Macedon Ranges and Concord.

Consequently, it would be appropriate to apply the generative learning model to account for these results and observations. It is significant to summarise some of the capabilities of this actor. The actor demonstrated significant progress in the learning outcomes and this was evidenced by the qualifications gained so far and the following main points:

- The course enhanced ICT skills and increased the communication skills e.g.: email, communication and mobile communication.
- The course increased the self-esteem as the actor became more confident in searching the Internet and using it for the social networking environment and tools.
- The actor became very confident and independent in carrying out online research for study purposes and personal use.
- The actor used the evidence from the study portfolio to engage and seek work through the relevant agencies.
- The actor developed an interest in a special area (games design) and was keen to pursue further studies in this area- interactive screen and media, which are studied in TAFE –for prospective future career pathways.
- The actor identified and worked with other significant actors in this learning environment (with mentors[95]) and this increased his self-esteem and interest to pursue further studies. These mentors provided links to other actors and networks to follow in particular in sound and music studios or production which could provide a pathway for future employment for actor in Z.

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[95] Table 7-16 **shows the actors who are also mentors for the actor in Z.**

7.13 DISCUSSION OF RESULTS

The study investigated school policies and their implementation as well as general government policies in relation to students with disabilities and access to technology. Following Creswell (1994), Bailey (1994), and Tesch (1990) the data analysis will result in the development of narratives that identify networks and different types of associations with each other and technology and this will identify possible models for e-learning.

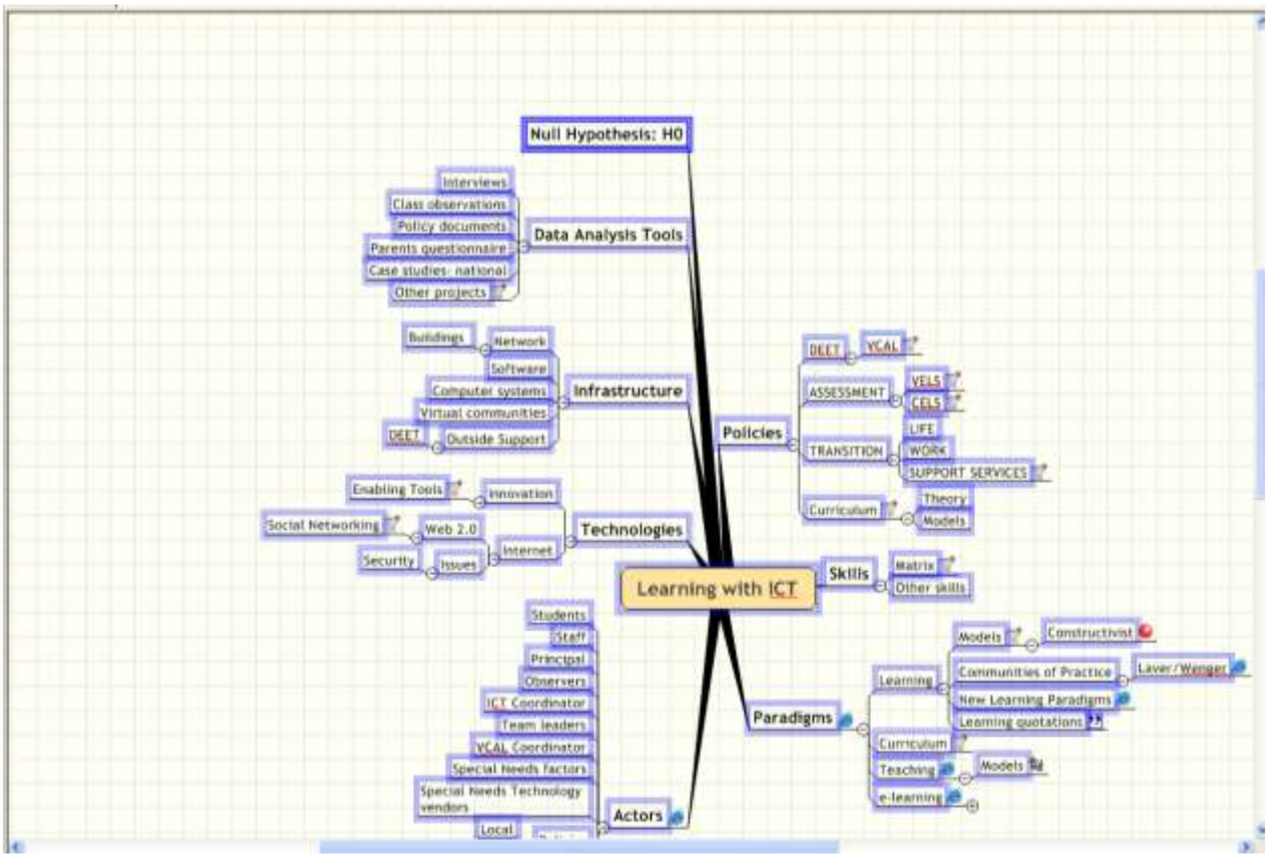

Figure 7-23: Following the Actors

The Skills Matrix was conducted with the senior (Transition) group of students and the results are displayed in Figure 7-10. The results provide evidence of a recognisable ICT skills standard for students at this age. Notable gaps identified were: the areas for trouble shooting, interactive technologies, such as video conferencing, use of important protection programs such as activities software, ability to work around problems at home like printer problems and awareness of security issues. The data results revealed that the students responded in a positive manner to a wide range of ICT skills as indicated by Figure 7-13. The results from the students' survey were consistent with my observations over a significant time period.

As participant observer actor (I contributed to the teaching and learning by delivering the teaching instruction on a number of occasions). And this allowed me to observe closely how the students interacted with one another, with the teacher and non-human actors, like laptops, software programs, e.g. word processing, audio, image processing (Gimp) and several other programs. Table 7-15 gives a summary of the various programs used.

In addition, I observed classes like Life Skills, in which the students were encouraged to develop and demonstrate self-independence, time management and communication skills. Furthermore, the students were engaged in activities like report writing and presentation, by applying their ICT skills that had been learnt from previous sessions. They worked on digital photographs and tried to use animation techniques by manipulating the attributes of the photo (objects) with suitable programs like Gimp. The pilot 121 ICT Project was extended to Yr. 11 Transition students and ICT skills were applied in Personal Development and Work Skills (VCAL studies). The school conducted its own data analysis of the skills by adopting the DEET VELS indicators for each Domain or area of knowledge. The results for ICT were presented earlier in this chapter.

7.13.1 Results from Parents

The main findings showed that children use a computer at home, most of the activities relate to games and leisure, the parents rated their ICT skill level with a mean rating fair-good and the average age group was 40-50. On the questions related to services used on the Internet, the common answer was email and next was topics of special interest. A significant proportion of the parents reported that they use the Internet to access information on LD to help their child. In addition, a number of parents also reported affirmatively to question 14 that their child was using the Internet to communicate with other children or friends.

Parents' response to **Question 16** [96]was largely negative, and this showed that at the time, there were difficulties in accessing school resources after school through the intranet.

The response to **Question 17**[97] indicated that adaptive devices (special menus, screen, and voice) were not used at home by the students. In relation to question 20, Parents rated their child's ICT skills fair to good and thought that the ICT technologies program in the school was good to very good. It was significant that the response to question 22, "***What is your view of ICT in relation to job prospects for your child?***" Parents' views were divided between Poor and Good. This shows that a large percentage of parents, like the researcher, hold the view that ICT can be an *enabler to lifelong learning* and could facilitate the *school-work transition* with a positive outcome.

The survey provided open-ended questions and these were aimed to explore the views and perceptions on the impact of ICT to their child's learning outcomes and future life/work. The following highlight the views of the parents in this learning community.

1. The respondents highlighted the following main concerns on the question concerning the technology program[98] and their child: *"better communication", "competent use of computers", "help with reading* and *spelling", "build confidence" and "provides confidence, very useful information for spelling, skills for the job and skills for the home".*
2. The responses on the question relating to skills[99] needed when their child left school were: *"full support", "be very skilled with computers", "be confident in using computers for information tools, not just for games", "be able to get on the internet and find a job", and "gain independence in writing and money skills".*

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[96] **Q16: Does your child use the internet to access information from the schools website at home?**

[97] **Q17: Does your child use any special support equipment, e.g. screen, mouse, voice, when using the computer?**

[98] **Q24: How does the technology program help your child?**

[99] **Q21: What skills are needed when the child leaves school?**

The survey also revealed the need to balance computer use with life skills. The following response sends a strong message from parents:

> ***"Do not want computers to rule our life".***

At the same time, the value of an actor like the computer can be seen from

> ***"She is very good on the computer, it gives her confidence".***

Furthermore, parents voiced the need for adequate adaptive tools:

> ***"XX's limitations limit the degree to which she can use ICT, great learning tool as she is a very visual child and she ..."***

Other responses like

> ***"not able to read makes it difficult to use technology"***

highlight the complexity of LD and the need to explore the impact of technology even further.

Collectively, the responses from the parents though, were similar to the arguments that were identified in the literature studies. This should not be surprising, as I have argued elsewhere in the thesis, the universality of LD and the dynamic nature of web-based technologies. These are rapidly evolving and enhancing and demand a regular update of skills to manage the learning and experiences (Seymour 2005).

7.14 ANALYSIS OF DATA USING ANT FRAMEWORK

The thesis will discuss the data in accordance with ANT innovation concepts, namely enrolment, alignment, translation, and problematisation of actors similar to Shaddock (2007).

Researcher-problematisations included policy, ICT e-learning plan, limits of school and the specific project. There was problematisation in getting other actors (Principal, ICT leadership committee) to accept my proposal and permit the conduct research. I needed to explore the focus on ICT in the school. School Council members voiced their opinion by saying "*we are using something good, but we do not know exactly how good it is*". The following is a summary of the actors and their networks. A more detailed discussion is presented in Sections 7. 14.1 to 7.14.4 below.

Leading teachers-realised problems in the 121 project and formed a network to get the project proposal accepted by the relevant committee by enrolling other actors (including the ICT Coordinator and Principal).

Parents-as actors they have their own voice and networks and problematise their own way via School Council, parents and support funding.

Principal-leadership actor, gate keeper, strong voice, power in the school council, insists protocols are followed, very strong view on the technology, user and role of technology on learning "his voice expressed in conference in 2008".

ICT Coordinator-another leading actor, recognised for his skills and knowledge. He was assigned the role to enrol other actors and extend the 121 ICT pilot to the rest of the school, innovator, introduced Web 2.0 technologies (blogs, etc.) and very highly regarded by other actors. He problematised[100] ICT curriculum by applying his ICT skills and demonstrated his knowledge by working on VELS/CELS. In addition, he possessed previous experience from working with specific DEET projects (Intel) to train other actors.

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[100] **Problematisation**: actor attempts to define the nature of the problem and the roles of other actors to fit the proposed solution.

Leading Teacher (1) (Actors) (Anna) - key instigator for 121 project (2005), willing user of ICT in classrooms, problematised the 121 ICT project and the necessary infrastructure for its delivery, high communication skills and very capable to mobilise other actors.

Leading Teacher (2) Actors (Ann) - highly trained actor in special needs, engaging ICT user (compare this with e-potential skills), problematised curriculum studies - integrated ICT in General VCAL studies.

The following terms in ANT were defined in Chapter 5 and are reproduced to aid the discussion here:

Mobilisation: the proposed solution gains wider acceptance and a layer network is created.

*Translation***:** for the technology to be adopted, actors choose some elements and leave others.

Mobilisation occurred for the 121 ICT project to be adopted at Y11 and other areas in the curriculum. Leading actors, ICT Coordinator, Principal, leadership teams and Transition Coordinator, accepted the proposal that was problematised in 2005 to start in 2007. Extended drivers include: actors, VCAL studies, parents and work organisations. The 121 ICT project was translated to other areas as its aims were adopted by the school community.

7.14.1 Brief Word on Data Analysis Using ANT Framework

The data are analysed below using ANT according to the following main tenets: Setting, Actors, Researcher, Students, Parents, Principal, Teachers, DEET, Networks, Beliefs, Attitudes, Interests and Motivation, Interests and Attitude of Actors, Networks and Stability, Alignment, Translation of Interests and Enrolment of Actors, Inscriptions and Precedence, Irreversibility and Black Boxes.

7.14.2 Macedon Ranges

Setting

This was described in Section 3.1.1.

Actors

The main actors are given in Table 0-1 at the beginning of the thesis. A list of actors was included earlier in this chapter in Section 3.1.2.

Researcher

My role was discussed in the early part of this chapter and also in Chapter 6. I would like to emphasise the pioneering aspect or role that I played in my investigations of the infrastructure and the support and role DEET played in the adoption of ICT in the School's curriculum. The Principal fully supported and endorsed my research activity and was strongly aligned with ICT adoption.

Students

The students were of mixed cognitive and physical disabilities. They ranged from elementary to secondary upper in age group. The latter were referred to as the Exit students group. The students were in general keen to use computer games to reinforce certain skills, like language, or numeracy and literacy, as was mentioned in the chapter earlier. They also demonstrated awareness of School rules and policies regarding conduct and assessment.

Parents: They were supportive for the initial ICT study and infrastructure.

Principal

The principal was the prime "gatekeeper" for this research study. He provided assistance for the study by allowing access to the school facilities and classes. He was very keen to see the how the research could assist the students of the school, however, the main problem that he saw was that I did not have an identifiable research project to focus on without interfering with normal classroom activities. It should be noted that although the principal was not available at a later stage when I conducted the questionnaire, the assistant principal, was very supportive and responded to my requests in an affirmative manner.

I have includes the principal's responses from a questionnaire in Appendix E. The responses clearly reflect his philosophy and view on the use and impact of ICT in the school's curriculum.

Teachers: Used ICT for reinforcement of skills and were all trained in special education.

DEET: Provided Technology and Learning Plan and IT support.

The Actors and their Networks

This section examines the data using key tenets of Actor-Network Theory to guide the analysis.

(1) **Beliefs**: to provide the best possible education to students with learning difficulties (special needs) and to offer opportunities to build lifelong skills through an integrated curriculum. The support structure of actors and their networks worked well with aides, parents, supports etc. It appeared that ICT was integrated in the curriculum; however, stronger emphasis was given to the school's administration system instead of teaching and learning for staff and students.

(2)**Attitudes, Interests and Motivation**: That all staff should be specially trained to work in this environment and the need to allow for growth as the school student population was growing very rapidly. Therefore, far greater resources would be needed by the school so that it can cater for more vocational oriented studies like VCAL. Computers were used as a supporting tool to prepare lessons and administrative purposes, like report writing. This has changed now, where a greater range of software and adaptive tools are employed in the classroom with the upgrade of Personal computers in the classrooms.

(3)**Interests and Attitudes of Actors:** The interests and attitudes of leading actors did not overlap with other actors. The view of technology was not shared in the first phase of the observations. Some staff were very comfortable with the programs/software they used in class as rewarding activities (even though the operating system platform was based on the Command line) using limited graphics programs on ACORN Personal Computers. These staff showed some resistance to change or to learn a new operating system (Windows XP) at the time. However, as mentioned above, these attitudes did not surface in the second phase of the observations in 2007.

The Department provided IT support to the school by employing technical staff on a P/T basis. The administrative system appeared to be up to date, was subsidised and supported by the Department's policy for ICT use in schools. Local suppliers, as well as the Department's Sofweb, were used to provide the relevant software and activities (games) for the school.

The students' attitudes varied, as they consisted of varied cognitive and learning disabilities. Some experienced joy with the activities, whilst others, reacted in a negative way towards these, as their perception was that these were not age appropriate and they found them "babyish".

(4)**Networks and Stability:** The actors and the networks for ICT varied in interest and its application. Recent networks indicate that actors have now aligned with ICT and the networks formed are strong and stable. With the provision of VCAL at the senior level, the school has enhanced its curriculum through the extension of ICT to its senior level of students (known as the Exits). This is a pragmatic move, as the school recognised the significance of VELS and wanted to benchmark the students learning outcomes and in doing so, offer the community adequate resources for LD pupils.

(5)**Alignment:** Over a period of time, actors have come to accept a common problematisation of what ICT has to offer the students in this school environment. The Department's policy, the formation of the e-learning program, and the appointment of an ICT coordinator with a specific role, are clear indicators that the school has moved to align in the right direction and be on par with similar schools. Clearly, the alignment of actors in this school has been demonstrated in the extension of curriculum and acceptance of ICT contribution to the learning outcomes.

(6)**Translation of Interests and Enrolment of Actors:** The leading actors (Principal, AP and IT Coordinator) have all been effective in this network to translate the agenda to adopt ICT in the school's curriculum in a major way, for example, the introduction of VCAL subjects at the senior section of the school. The infrastructure development, the growth of the school, and the support of actors, like the community, have translated the agenda, of the actors. In fact, leadership played a significant part in this process, although enrolment was slow at first.

(7)**Inscriptions and Precedence**

The following provided evidence of how ICT was employed in this School community: Departmental policy - e-potential, Principals beliefs, e-learning plan, curriculum extension, integration of ICT to improve the learning outcomes.

(8)**Irreversibility:** The school had enormous growth in student population and staff and expanded its physical resources, campus and support from the Department. The external relationships with overseas schools are very strongly entrenched in the school culture. In addition, the growth in the student population, curriculum initiatives, and Departmental support are all irreversible. The School has firmly enrolled ICT.

(9)**Black Boxes:** Staff qualifications in Special Education are a requirement at this school. DEET Policy and the Disability Act are "given". The parent's networks with strong beliefs and expectations are noted in the school community. The school provides for a range of disabilities, physical and cognitive and there is a firm belief that LD students should be catered for in a non-mainstream School environment.

Conclusion

The way in which ICT was used in the early part of the research indicated willingness by staff to use technology to support teaching and learning in a limited way. However, this position was improved in later observations. The school adopted a forward looking policy in its use of ICT by appointing a coordinator for ICT and extending its curriculum to incorporate VCAL studies. In doing so, the school provided an extended curriculum to be on par with other Special Schools and now applies benchmarking through VELS.

7.14.3 Concord

Setting

This Special School of 270 students is located within 20 kilometres of the centre of the capital city of an Australian state. The school was selected because of its reputed state of the art ICT facilities and efficient management of these facilities. It was an early adopter of ICT and Web based technologies using the Internet. The school community held a very strong view about the school and the school's leadership (primarily through its Principal) ensured the proper integration of ICT in the curriculum.

The school participated in a national case study in 2000 and evaluated the ICT of staff in 2003. The school community is mixed in terms of socio-economic status and ethnicity, with teaching staff being predominantly female. Several teachers had worked at the school for more than 14 years and the principal for a much longer time. The school has students of mild learning disabilities and the students attend the school on a normal time table from Monday to Friday. The school built an IT centre through the fundraising efforts of the principal and school council and this was maintained by a full-time IT manager. The IT manager participated in the curriculum, especially with the e-learning plan. Further discussion about the school was presented earlier in this chapter.

Actors

The Actor World of the Researcher

The application of actor-network theory to the current study brought into focus the importance of my actor world within the students' network. My actions, including the introduction of actors, and additional obligatory passage points influenced both the composition of, and the nature of, enrolment within the students' network. My influence (and lack of it) upon the students' translation of VCAL projects is discussed further in Chapter 9 of the thesis.

My network included the students', student notebooks or journals, project reports, colleagues, schools, computer networks, library resources, technicians, peers, heads of School, academic and popular journals, digital tape recorders, microphones, computer software including qualitative analysis software, voice recognition software, word processing software, PDAs, Pocket PCs, DEET IT resources, RCH and several speech pathologists, language support personnel, IT Managers, the school principals and so forth. From a research perspective, my network included Victoria University, my supervisor, DEET and other people and materials that I appropriated for the purpose of undertaking this research and my family. The main point is that the students probably never consider the teacher in isolation as some sole autonomous entity but they enrol the teacher together with various other elements of his/her network. They redefine the teacher through his associations with various immutable mobiles that he places into circulation in order to enrol the students into his network. My immutable mobiles consisted of the Pocket PCs, voice recognition software (Dragon) and my own Personal Tablet. This was carried with me in every classroom under observation including the ICT classes.

Technical objects were the most obvious and concrete example of immutable mobiles. It is amazing to notice the students' reaction to the Tablet PC when they saw it for the first time. For example, my early (involvement) and enrolment of the students and taking part in a lesson by actively delivering it, involved the connection of my Tablet to the school's wireless projector.

Students: Ten students were observed working with teachers and assistants from the senior (Transition) class in the pilot project called 121. Several classes from the Transition section of the school were observed in 2006 and 2007. The students were asked to complete a skills matrix questionnaire and their parents were invited to take part in the survey. The researcher worked with a few students, using voice recognition software, in a separate room from the normal classroom.

The students indicated an interest in ICT and showed that the assistants were able to help them with catching up with school work, looking up words in the dictionary, preparing oral presentations, working on the computer, working out things together and similar activities. The students were clear and accurate about who managed the school and the class they belonged to, and clearly identified with their home group teacher. In some classes, they were given responsibility to check the attendance roll, organise orders for the store and lunches. The students appeared happy to go from one class to the next and participated in the activities on hand.

It was observed that in certain activities that required physical or motor skills, some students were able to overcome these with the use of technology. For example, folding a blank sheet of paper to make an envelope, and then write their address in front of the envelope, was very difficult for some of the students. However, almost every student was able to use a laptop and a Word processing program to write the contents or message on the envelope. It was also apparent that some of the students demonstrated ICT skills beyond what was required in class, and because of this, they tended to show frustration with the teacher in class. The activities appeared to be commensurate with the standard of the students. The main activities observed included, Personal Development, Office Skills and ICT studies. The major part of the study was related to VCAL studies, where the students' daily work was aimed at completing the set tasks, and in addition, the program provided access to work and further study with the assistance of local organisations and tertiary institutions' programs. In terms of learning outcomes, the students were involved in activities that allowed them to become familiar with current events, national issues and disasters.

As well as this, the school implemented the Department's policy that was discussed earlier, VELS, to measure the academic standard of all students with special criteria or indicators. The results of these were displayed in Figure 7-19. The following statements represent the sentiments of the students' from their graduation and their experience in the 121 ICT Project:

- In TSA[101] we have been lucky enough to have a personal notebook each to use in class.
- We also have a projector, interactive whiteboard, digital video camera and other equipment to support our learning.
- We were the first class to have laptop computers and an interactive whiteboard.
- This year we will be finishing our VCAL course.

Parents: Parents of students from several classes were asked to respond to a questionnaire and the response rate was very high. The responses in general showed a positive attitude for the use of ICT in the classroom, and several parents indicated an awareness of the use of ICT in the curriculum by the school. Their responses showed that they felt there were still gaps in how technology can assist their child in both school

[101] **TSA – This was the 121 ICT Pilot class from the Transition Group of senior students from the senior section of the school.**

and life; however, they had identified a positive gain from ICT and acceptance of the school's work and curriculum. The following responses from the parents are repeated here as these depict their view about ICT and the school's curriculum.

> *"Provides confidence, very useful information, spelling, solving problems, skills for the job, and skills for the home"*
>
> *"Ability to use laptops and programs not at home"*
>
> *"Gain independence in writing, and money skills"*
>
> *"Have good understanding of various computer programs, source information, look up bus tables, concert tickets, movies, starting times etc. independently"*
>
> *"XX's limitations limit the degree to which she can use ICT, great learning tools as she is a very visual child, and she likes to be alone often"*
> *"Not being able to read makes it difficult to use technology"*

Principal: The principal fully supported the research and felt that the school could only benefit from an independent examination of the way ICT was used at the school and how it can be further used to support a specific project the 121 project. This was a key actor who displayed very strong leadership, and this was recognised and respected by the school staff, students, and other stakeholders. He was an early adopter of technology, and he held the belief that students with LD can be assisted by the use of technology or ICT in the classroom. An interview was conducted and he identified that the 2000 case study gave direction for ICT use, and reinforced, that what was going on was worthwhile. He sees strength of the school is in the strong bonds that it has with its students. His main contribution, apart from his strong leadership, also include his fundraising efforts to set up an excellent IT Resource Centre housing the latest technological equipment for its staff and students, as well as offering ICT training to teachers from other schools in the region.

Everyone in this school community had access to the principal – teachers, parents, assistants, students, ancillary staff – and the researcher. Furthermore, the principal was active and involved in the affairs of the school and was very keen to see the 121 ICT project implemented. The principal encouraged the project team to meet on a regular basis and report any issues to him. He was enthusiastic about innovation with technology and organised work on the infrastructure to get the classroom ready. Appendix B contains details of reports and agenda on this project.

The following quotes have been extracted from the principal's interview and the recent conference at the school with Web 2.0 technologies:

> *"I want to see the students to be active participants in their own learning that leads to specialisation in technology"*

> *"This empowers students (disabled or not) to control and self-manage their own learning at school and at home"*
>
> *"Hence, they become lifelong learners with access to technology and skills".*
>
> *"For example; some of the students can rebuild computers; they are working in technology fields.*
>
> *Technology provides skills so that they can be seen as normal workers.*
>
> *They have gained an understanding to take on the role beyond school."*

> *"focus on collaborative learning"*
> *"staff becoming aware of Classroom without walls"*
> *"Students becoming social and collaborative learners"*
> *"This pilot could become lighthouse for other challenges to construct of Education as we knew it"*
> *"Students are showing the way forward."*

Teachers: Several teachers were observed on a regular basis by the researcher and interviewed. They all demonstrated full support for the school leadership and vision. In addition, they were all very strong users of ICT, having their own laptop, using email, and also accessing the school's internal resources through a shared medium. They worked well with the students and implemented the school policy. They all agreed that ICT was an enabler for their students and that it would improve the learning outcomes, particularly since it was integrated in the curriculum. They showed adequate technical skills and willingness to adopt new technologies like interactive whiteboards and social networking technologies, such as blogs, RSSs[102] Wikis and digital portfolios. From a recent conference, the researcher was able to capture their views:

> *"not just about playing with a new toy - it's exciting because it connects you with others"*
>
> *"It seems that students are already educated and know about the virtual environment in some form or shape"*
>
> *"Yes and they are growing in an environment where the world is at their fingertips"*
>
> *"it is vital that staff be keeping up to these new skills and recognise that it is a constant process as web 2 is constantly evolving..."*
>
> *"teachers are not half as interested in this as students - herein lies a challenge"*
>
> *"This is an exciting step for students, teachers and classrooms as it is social and collaborative technology. It is never boring."*
>
> *"It is a whole new classroom that is not contained to that physical building of the school."*
>
> *"Is there a need to educate parents too? What has been their reaction to the initiatives at Concord?"*
>
> *"this would also be a great thing for groups of VCE teachers to discuss a text with kids too - might give this a go".*

Effectiveness of support staff evidence in classroom -time tabling constraints, the school relied on regular CRT staff to fill in for absentee staff. Support staff appeared to be aware of general school policy and handled classes in a satisfactory manner. Although, sometimes the demands and skill level was not adequately provided by the support staff under observation. This showed alignment with the school daily

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[102] **See Glossary**

organization, and policy, but lack of alignment with ICT requirements in class, as for example, ICT needs for the 121 classes.

DEET: Provided the policy for e-learning, software support and administrative support.

Policy Documents, Procedures and Protocols: The documents that were analysed included: The Annual School Implementation Plan, Annual School Report, ICT e-learning plan, ICT proposal, VCAL curriculum, 2000 National ICT case study, DEET e-learning Policy, curriculum material for senior classes of the school, software used in the classroom and the ICT Centre for students with disabilities, DEET projects on multimedia and videoconferencing, Multimedia Victoria Application, and RCH Annual Report.

The Actors and their Networks

This section examines the data using key tenets of Actor-Network Theory to guide the analysis (see Appendix F).

(1) **Beliefs**: Strong bonds with students, leader in ICT; ICT is an enabler for life skills for LD students. School office, staff, principal and teachers express strong commitment to the aims and policy and support the leadership structure. This belief system is frequently referred to by many of the actors and it affects day-to-day practice in the school, for example the office area provides a digital screen that welcomes people and shows the school motto.

> ***"To be the best I can be"***

The staff, principal, council and parents express commitment to promoting values for LD students. The school is focused on standards and has a vision for the role that ICT plays in the curriculum. There is a strong belief that ICT can be used as a vehicle to produce good learning outcomes and self-development. There is acceptance that LD students need to be equipped with lifelong learning skills facilitated with the use of ICT.

(2) **Attitudes, Interests and Motivation**: There is acceptance of the general principle that students with disabilities can be better served away from a mainstream school and that the interests of students are paramount. There is full acceptance by the actors about the role and application of technology in the school's curriculum. There is agreement

about the innovative approach that the school has taken part in, like the “thinking curriculum”, and the 121 ICT Project. Technology has been firmly enrolled.

(3) **Interests and Agendas**: The interests and agendas of the actors overlap considerably. The unifying objective across policy and all stakeholders is the improvement of the school experience and learning outcomes of LD using ICT. There are, however, some differences in the actors’ views about the ways to achieve this objective and these tensions are generally resolved by informal communication. Although students and parents value the support they receive from ICT, some teachers feel that their skills are not up to date to take full advantage of recent technologies like social networking. Actors from the 121 ICT Project were keen to see this translated into the other senior areas of the curriculum. It was noted that the school sought external recognition to benchmark its students’ academic knowledge and achievement.

DEET provided policy for ICT learning and resources for staff and the school’s administration. An agency (actor) called Sofweb provided the standard software programs to all schools and this school had access to these programs. A list of the programs is placed in Appendix B. DEET documents have highlighted the importance of ICT for the education of special Needs students. As noted earlier, the school participated in a National (DETYA 2000) survey. This experience helped the school to continue its vision in using ICT in the classroom as an enabler for lifelong skills.

(4) **Networks and Stability**: The networks that sustain the ways in which curriculum innovation via ICT interests and agendas at this school are strong and longstanding, and just as ‘interests and agendas’ are moulded by a strong commitment to the Special School philosophy and policy that focuses on the pastoral role of the school, so too are the networks among the main actors. Parents and teachers are closely linked, as are students and teachers. Although not uniform, the networks between individual teachers and ICT tend to be strong, and in some cases, long standing also. The networks involving the DEET, the consultants, and to some extent the principal, are strong, while the networks between DEET, staff, teachers and ICT are still in a developmental stage, like the ePotential and Ultranet projects.

(5) **Alignment**: Alignment refers to the way skills, practices, organisational arrangements and 'contracts' are mutually supportive. At the student/class level, the students and teachers tend to agree on the way students with disabilities should be supported with ICT. In addition, the principal and leading team members at the senior section of the school are aligned with the offering and delivery of VCAL subjects for their students. That is, the model and resources to sustain it are well aligned. As a result, the actors have assigned roles and have accepted (mobilised) the pilot project to several other areas of the VCAL curriculum. Finally, at a policy level, there is a strong alignment between the actors to produce better learning outcomes for their students, and in doing so, become a leading school at the national level.

(6) **Translation of Interests and Enrolment of Actors**: In Actor Network Theory, 'translation of interests' is about the ways in which agendas, interests and networks become aligned or non-aligned. The actors were assigned clear roles to work and implement curriculum innovation by integrating ICT into the teaching and learning. The pilot 121 ICT project strongly influenced the timetable and physical resources (a dedicated room was designed for this purpose), provision for the appropriate infrastructure, laptops, interactive whiteboard, wireless local area network and an IT manager's role. The e-learning policy and plan were translated in a comprehensive manner by the actors as their interests were accommodated. The agendas, interests and networks were strongly aligned.

(7) **Inscriptions and Precedence**: This heading refers to the ways in which particular 'voices' get precedence and influence what actually happens. There were a series of policy documents from DEET and the school. The school was keen to implement the VELS standard through its own equivalent method called CELS. The e-Potential policy, the 2000 national survey, and 2003 survey of staff ICT skills, as well as other annual reports and school-based data provided very strong evidence of benchmarking the school's performance and learning outcomes of its students.

(8) **Irreversibility:** The strong vision about the role ICT plays in the learning of students with LD is paramount in this environment and ICT has strongly been enrolled. The fundraising efforts, the ICT Centre, the Network infrastructure, the innovative ways of teaching and learning and the strong collaborative teams at the senior section of the

school, are irreversible processes. The school has established strong links with local business organisations and institutions, so that it can assist its students with pathways to work or further study. The practice should stand the school in good stead and is irreversible.

(9**) Black Boxes**: 'Black boxes' are inscriptions that are accepted virtually without question. In the case of this school, there is a philosophy that embraces success and to celebrate success via its motto "***To be the best I can be***". Another 'given' is the Disability Discrimination Act and school policy and vision. The school also sees itself as a school that can improve the academic outcomes for its students through the application of ICT. Furthermore, another "given" is the teaching philosophy that it has adopted – "The Thinking Curriculum".

Conclusion

The way in which ICT is used by teachers at this school to provide support for students with disabilities, illustrates how a powerful and pervasive philosophy and ethos, tightly aligned networks within the school community and an alert and sensitive principal have ensured the school community's satisfaction with a dynamic model of support for ICT adoption via the 121 ICT project. The model has developed and changed in response to need. The availability and type of resources have determined its shape. The model seemed to be based on curriculum (innovation) and (also) technology innovation, it is proactive; and its focus is on addressing the current needs of students, parents and teachers. For example, the inclusion of social networking concepts, like blogs, that was introduced in 2007. This enhanced the way ICT was used in the classroom with students engaging and producing work of higher standard and displaying stronger skills. The leadership of key actors like the Principal, ICT Coordinator, and several leading team teachers who worked in the 121 ICT project, all problematised the vision of integrating ICT in the curriculum. The research observations in the period 2005 -2007 concluded a successful translation and mobilisation of the pilot project through its extension to other curriculum areas and levels in the school. The documents from the pilot and the Social networking implementation testify to the way ICT was integrated successfully in the curriculum with positive learning outcomes.

7.14.4 Individual study (Z)

Setting:

This is an individual student who did not fit in either a special school or a mainstream school environment. Provision was made however, to cater for the student's individual learning needs in a private school setting. Evidence of the student's background was discussed in Section 7-7 earlier in this chapter and Appendix C provides relevant data with respect to the level of LD.

Actors[103]:

Researcher (parent), student, School, TAFE, speech pathologist, language support, educational psychologist, family, computers, software programs, games, mobile devices and Job Organisation.

(1)**Beliefs**: That ICT may assist with the education and opportunities for work and further study. LD problems could be overcome with the aid of ICT technologies. The private School would cater for his individual needs in an adequate manner.

(2)**Attitudes, Interests and Motivation:** The actors and their networks were interested to apply the most suitable teaching and learning styles for this actor (Z). The School network showed willingness to provide a modified program that would cater for the individual actor's needs. The family and actor networks were optimistic of the support the school would provide.

(3)**Interests and Agendas**: To produce better learning outcomes and to create future opportunities for actor (Z), (an individual student with late developmental delay) for study and work. There is ongoing effort and commitment to complete studies and seek future employment through the ICT skills acquired from the studies. The interest of the actors in the family of Z was to seek best practices or approaches through other actor networks and to problematise and translate these to the field Z.

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[103] **See tables** Table 0-3 **and** Table 0-4 **on page the early part of the Thesis.**

(4)**Networks and Stability**: The actors and the networks for actor (Z) varied in skills, interest and commitment. Recent networks in further studies at TAFE indicate greater challenges are emerging for this student. However, the networks formed are reasonably strong and stable. There is potential that the actor (Z) and networks from study, home and external bodies may establish a stronger alignment and become more stable.

(5)**Alignment**: All actors and their networks were aligned strongly to achieve the learning objectives for the student. All actors followed a mutually supportive policy and practice, to enhance the language and speech skills in the early phase, and to maintain the language and writing skills in the secondary school. The school network recognized that support was needed in the classroom and funding was granted for an aide for several years. This prime actor problematised the learning environment with subjects from the curriculum and provided the necessary negotiation for the student to gain some success.

(6)**Translation of Interests**: Actors from various areas recognized the student's potential in Music and provided an opportunity for the student to join the school concert band. The efforts of the various actors clearly showed a strong alignment to work with the student and allow him to gain success in some areas. Another area where the actors agreed to engage the student to a greater extent was ICT. The parents of the student were strongly aligned with the school's approach to help their child with his learning outcomes. Aligned with the agenda, all actors followed the objective to foster the academic outcomes for the actor (Z). The move to further study at TAFE provides greater challenges for the actor (Z) and other networks formed to complete a Post-Secondary Study Program.

(7)**Inscriptions:** Evidence from portfolio, Policy documents, School Reports, and Assessment material from TAFE is demonstrating strong evidence of improvement in learning outcomes with the application of ICT. Evidence from the Portfolio clearly shows a strong affinity with ICT for this actor, (Z). The school to work transition aims to provide a link for a job and this continues at the present time.

(8)**Irreversibility**: The actor's (Z) development and self-esteem have grown and these have been facilitated in some way by ICT. Skills aquisition and confidence as well as the application of complex software packages would not have been achieved without the belief and perseverance in this area. The actor's (Z) graduations, certificates and diplomas from further study are clearly irreversible. The skills and self–esteem gained should foster the actor's communication skills and enhance opportunities for future work and life.

(9)**Black Box**: The completion of Year 11 studies and continuation of further studies at TAFE, is an achievement worth noting for this actor (Z). The family networks and beliefs to assist this actor in gaining the best possible education are strongly warranted. Every child deserves the best possible educational environment. In the case of actor (Z) the environments have provided a suitable standard of application of ICT and teaching and learning methods.

Conclusion

The evidence gathered for actor (Z) and the networks provide strong evidence that further study in ICT has produced positive learning outcomes. The actors and networks related to work have shown an alignment, however, this is not very stable.

INTERLUDE

This chapter presented an ANT analysis of the data collected from Macedon Ranges, Concord and the individual study, Z. The next chapter will provide the discussion and recommendation of an e–Learning model for LD students, by examining Petri Nets and the opportunity cost for studying by LD students, as was presented in the New Zealand study by Petty (2005).

CHAPTER 8

8 PETRI NET MODEL FOR E-LEARNING & LD

The wisest mind has something yet to learn.
George Santayana (1863 – 1952)

In arriving at an e-learning model design, I drew from my knowledge of Petri Nets[104]. I am also interested to join the main ideas with a graphical model or concept. This was made possible by an examination of the graphical tools that I had used earlier in my Master's thesis, namely, modelling with Petri Nets for Data Communications Protocols. Although in some ways this is peripheral to the main thrust of my thesis, in this chapter, I will discuss an alternative approach using Petri nets to conceptualise the design of my e-learning model. The Petri Net concepts are not fundamentally different from those of ANT. For example, the places bear a strong resemblance to the actors in ANT, and the triggers or transitions, are analogous to the translations.

8.1.1 Brief Introduction to Petri Nets

Petri Nets were invented by Petri (1962). In simple terms, these are graphical objects with arcs and transitions. He and Lee (2007) applied Petri Nets to model the e-learning platform or environment. Other studies concentrate on the semantic aspects of e-learning (Ghaleb et al. 2006) and Park and Kim (2008) have analysed the different layers for e-learning and recommended the modelling with a suitable Petri Net. These studies are included here to support my rationale for a Petri Net recommendation of my e-learning model that was postulated in Chapter 3 (Figure 3-27, page 108). Although a full mathematical treatment of Petri Nets[105] is beyond the scope of this thesis, I believe that a suitable conceptual description of the model is within the scope of my research, and hence, I provide the discussion below of the basic concepts that are fundamental to the model design. I reiterate that the chief attraction of this area is the way in which the basic aspects of distributed systems are identified conceptually and mathematically, and

[104] Petri Nets are graphical tools that are used in modelling systems such as distributed systems, manufacturing systems, computer networks and so on.

[105] The reader is referred to Tadao Murata's comprehensive analysis and modelling with Petri nets in the References.

hence, it is most appropriate to build my recommended model for e-learning on this basis.

According to Petersen (1981), the guiding principles of Petri Net theory in formulating the basic notions of states and changes of states (called transitions) are:

(1) States and transitions are two intertwined but distinct notions that describe an even handed treatment.

(2) Both states and transitions are distributed entities.

(3) The extent of change caused by a transition is fixed; it does not depend on the state at which it occurs.

(4) A transition is enabled to occur at a state if and only if the fixed extent of change associated with the transition is possible at that state.

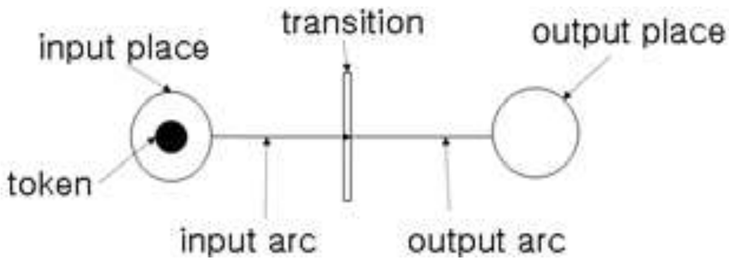

Figure 8-1: Basic elements of a Petri Net (Source: Petersen 1981)

Formally, Petri Nets are a mathematical modelling technique with graphical structure representation and applicable to many systems. As a graphical tool, Petri Nets can be used as a visual-communication aid similar to flow charts and networks. In addition, tokens (non-negative integers) are assigned to places to simulate the dynamic nature of the system. Thus if we include all attributes then, a Petri Net is a particular kind of *directed graph*, together with an initial state called the initial marking M_0.

The underlying graph of a Petri Net is a directed, weighted, bipartite graph consisting of two kinds of nodes, called places and transitions, where arcs are either from a place to a transition or from a transition to a place. An example of a Petri Net is shown in Figure 8-2 below, where places are represented by circles and transitions are represented by rectangular boxes. One of the early systems modelled by Petri Nets was the Simple Protocol in data communications. Figure 8-2 shows the places and transitions for the initial marking. By firing transitions, the system can alter its marking and thus reach a new state.

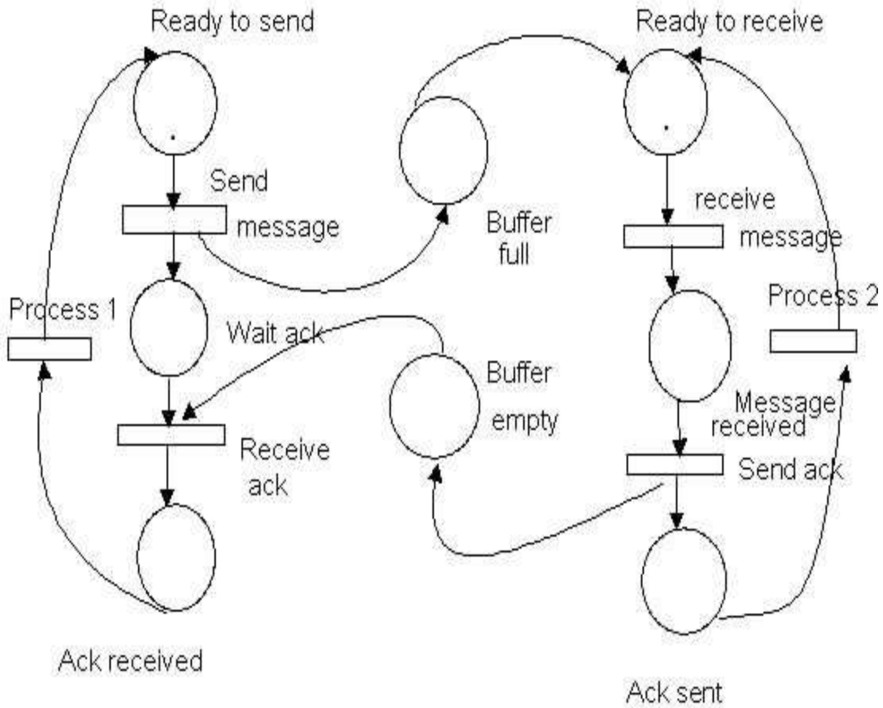

Figure 8-2: Petri Net Model of Simple Flow Control Protocol

In modelling, places represent conditions and transitions represent events. A transition (Murata 1989) has a certain number of input and output places representing the pre-conditions and post-conditions of the event, respectively. Tokens may model the resources or data items that are associated with a place or places.

As mentioned above, Petri Nets are tools for the modelling and analysis of the behaviour of systems. Petri Net theory allows a system to be modelled by a Petri Net (PN) that is a mathematical representation of the system. Analysis of the PN can then, hopefully, reveal important information about the structure and dynamic behaviour of the modelled system.

The next section provides the formal representation of a Petri Net and is reproduced from Murata (1989).

8.1.2 Petri Net Structure

A Petri Net is composed of four parts: a set of places P, a set of transitions T, an input function I, and an output function O. The input and output functions relate to transitions and places. The structure of a Petri Net is defined by its places, transitions, Input functions, and Output functions.

The formal definition of a Petri Net (Murata 1989) is a 5-tuple PN = (P, T, F, W, M_0) where:

$P = \{p_1, p_2, \ldots, p_m\}$ is a finite set of places,

$T = \{t_1, t_2, \ldots t_n\}$ is a finite set of transitions,

$F \subseteq \{(P \times T) \cup (T \times P)\}$ is a set of arcs,

$W : F \rightarrow \{1, 2, 3, \ldots\}$ is a weight function,

$M_0 : P \rightarrow \{0, 1, 2, 3, \ldots\}$ is the initial marking,

$P \cap T = \emptyset$ and $P \cup T \neq \emptyset$.

In general, this definition applies to simple nets known in the literature as Place Transition nets (PTN). In order to handle complex systems, another class of nets has been defined by various researchers; the high-level Petri Nets. To allow for data manipulation (Jensen 1991) and describe type concepts as in high-level languages, coloured Petri Nets have been defined. These allow places to contain tokens that represent different data value (colour).

8.2 PETRI NET FOR E-LEARNING

As mentioned above, a Petri Net is a graphical tool to model systems. The systems can move from one state to another via triggers or actions (called preconditions). This approach was used in ICT to model the operation of a computer which consists of several well known components, like memory, CPU, input/output devices and hard drive(s).

Petri Nets have been used in areas such as data communications protocol modelling (Adam 1993) and manufacturing. At the outset, I was interested to see if I could apply this modelling approach to the e-learning model that I proposed in Chapter 3. My view was that since the education of special needs people relies on policy, leadership, staff attitudes, parental beliefs, expectations and support personnel, it may be possibly to define an overall model that captures all actors and their attributes (networks).

I analysed the e-learning model that I postulated in Chapter 3 and arrived at the Petri Net shown in Figure 8-7 below. The reader can examine this model and look for various operations. For example, access to resources, (tools and learning objects) and so on, are based on certain criteria (preconditions). Similarly, assessment, teaching models and so on, can be argued to fit logically, into a Petri Net description.

The benefit of such a modelling approach is that we can treat the educational environment (special schools, principal, Department, staff) as the resources/places (with tokens) for our Petri Net. Furthermore, we can also incorporate an opportunity cost for LD as was proposed by Petty (2005), in a New Zealand study for the visually impaired. Thus the learning outcomes may be analysed and thus we can determine the overall impact of ICT in the curriculum. All students have the same opportunity to learn regardless of their individual characteristics.

8.2.1 Rationale for E-Learning Petri Net Model

Petri Net models were proposed for e-learning recently by He & Le (2007), Park & Kim (2008) and a similar model was also proposed by Fayed Ghaleb et al. (2006). The study by Ghaleb et al. analysed an e-learning model based on Semantic Web technology. The model includes various services and tools in the context of a semantic portal, such as: *course registration, uploading course documents and student assignments, interactive tutorial, announcements, useful links, assessment, and simple semantic search*. A metadata-based ontology is introduced for this purpose and added to the model. Although these elements may be a little too complex for LD students, I believe the concept of a portal with some modification with adaptive technology (and possibly widgits), may serve the LD students' community via the forthcoming Ultranet in the State of Victoria, Australia.

The literature provides studies of modelling e-learning with Simple Hierarchical Petri Nets. Hierarchical Petri Nets were developed in the late 70s by Valette (1979) and were refined to High-Level Coloured Petri Nets by Jensen (1991). Given the richness of the workflow processes, a Petri Net may be used to provide the theoretical framework for workflow management, since we can analyse the firing sequences by examining the places (pre-conditions and post-conditions), the transitions (actions), the tokens (process states) and the arcs in the graph (process actions or flows). In fact, He and Le (2007) have proposed a division of two layers: the Learning Process Layer and the Web Service Layer. Their model is shown in Figure 8-3.

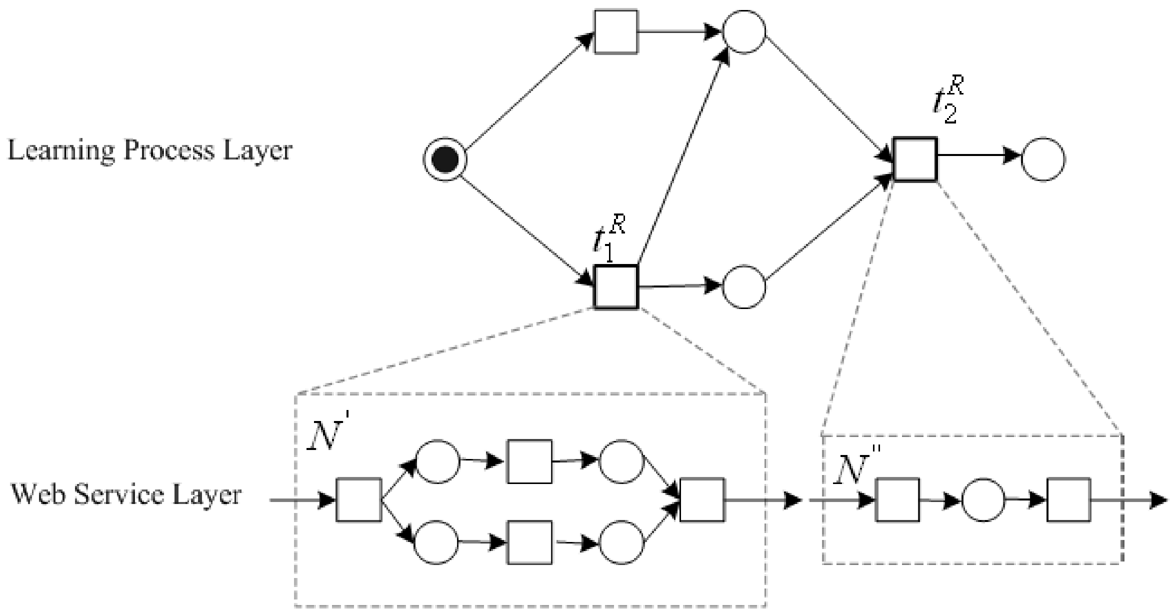

Figure 8-3: Modelling the Learning process with a Hierarchical Petri net (Source: He and Le (2007))

8.2.2 Learning Process Net

The Learning Process Net is defined by the relationship:

Learning process Net = (P,T,T^R,W,Pi, PO)

Where the following applies:

$P = \{P1, P2,...,Pm\}$ is a finite set of places representing the pre-condition and post-condition in a learning process.

$T = \{T1, T2,...,Tn\}$is a finite set of transitions representing explicit and implicit. The *Learning Process Net* is Learning Objects Structured Petri Net which describes the structure and mutual dependence of a set of learning objects, LOs. It allows us to model the context of each learning object in terms of preconditions (prerequisites) and post-conditions (learning objectives) (Risse et al. 2004).

In this model, one may assume that the *Learning Process Net* correctly models the mutual dependence of LOs, then, an LO can be completed successfully only if all preconditions are fulfilled (and generate the necessary post-conditions or results in other places). These relations can adequately be described by Petri Nets (Peterson 1981) where the LOs are modelled by transitions, and preconditions and post-conditions are modelled by places. The context between LOs is modelled by a set of places with token(s). It should be noted that the content of a message is not important as it is not known until run time. Figure 8-3 above, shows a hierarchical Learning Process Net. The target net N at the top has two refinable transitions. Here $t1^R$ has been refined with the attachment of Web services net N,' and $t2^R$ has been refined with Web services net N''.

8.2.3 Web Services Net

Web service behaviour is basically a partially ordered set of activities. Therefore, the transformation from the primitive activities to Petri Net is relatively straightforward (shown in Figure 8-.3a.) (Chi et al. 2005). Activity is modelled by transition and the state of the service is modelled by places. The arrows between places and transitions are used to specify causal relations. We assume that a Petri Net to model a Web service contains one input place (i.e. a place with no incoming arcs) and one output place (i.e. a place with no outgoing arcs). When a token is in its corresponding input place, this means that a Web service meets its precondition(s), whereas a token in the corresponding output place means that the Web service completes its activity. Structured activities are nested activities, for example: *sequence*, for defining an execution order, shown in Figure 8-3b; *switch*, for conditional routing, shown in Figure 8-3c; *flow*, for parallel routing, shown in Figure 8-3d and *while*, for looping, shown in Figure 8-3e.

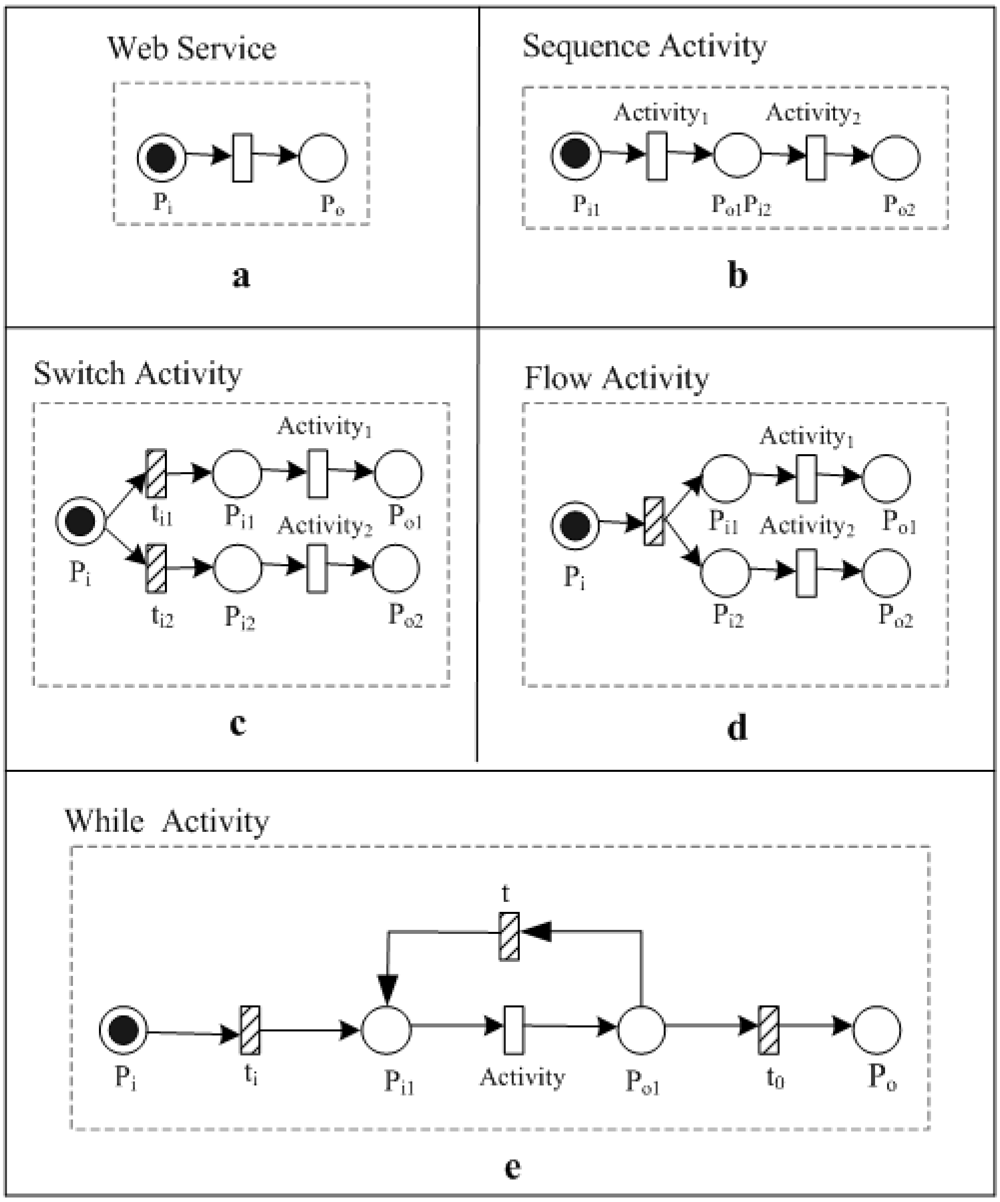

Figure 8-4: Petri net model for Web Service and sequence, switch, flow and while activity (Source: He & Le 2007))

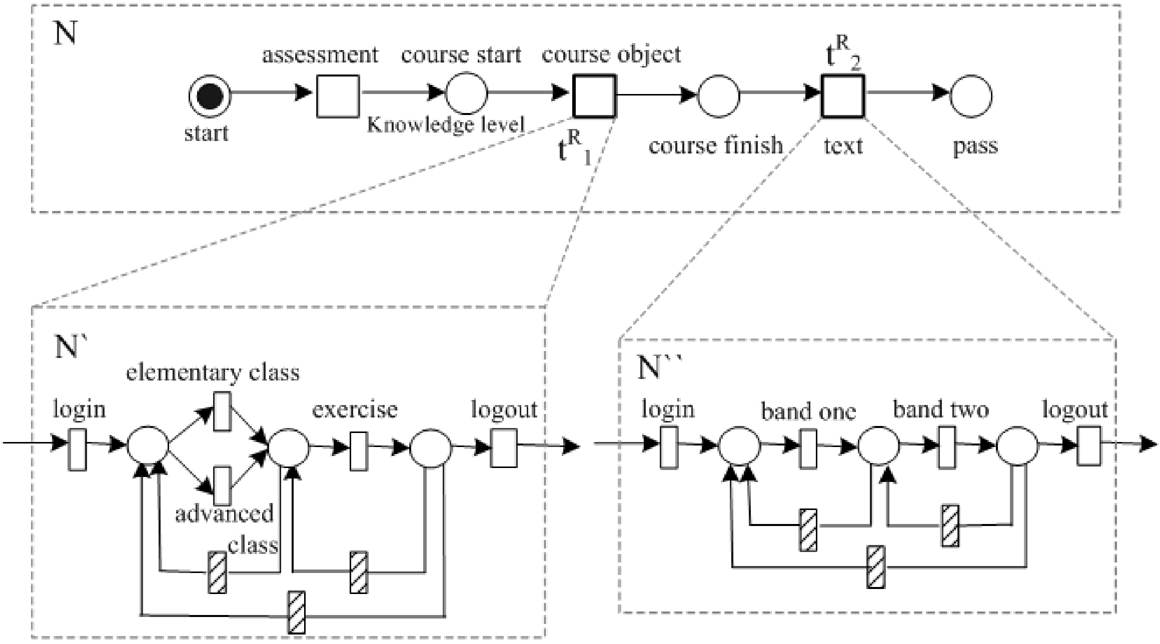

Figure 8-5: Example of Learning Process model by a Hierarchical Petri net (Source He & Le 2007))

An e-learning environment requires the learning process specifications and deployment of these to the Web Services layer. The model must allow for the individual variation of learners and their self-independence, and in addition, the cooperative attitude of each learner. The individualised customised learning or constructionist learning approach for LD students must optimise the environment by adjusting the weights for the various needs and abilities of the learners[106]. Furthermore, the modelling must allow for the following areas:

Cooperative learning and team organisation

Investigation of cooperative learning and planning

Self-centred individualised education

Co-operation co-work at the team level

Sharing of resources

Evaluation and self-examination of cooperative learning between teams.

[106] Various authors expressed a view on opportunity-to-learn (OTL). Marzano (2000) focussed on skills, content coverage and teaching. In Victoria, DEECD introduced VELS and these provide a range of indicators that can be used as components or contributors to OTL in the respective domain of knowledge. For example, Figure 7-19 in Chapter 7, at Concord.

A study by Park et al. (2008) examines the layers and relationships between layers for e-learning. The study focuses on customised cooperative learning as an approach to e-learning and then applies a Petri Net model to this form of learning. The e-learning environment is separated into three levels: processes, selected processes and sub-processes.

> *The processes displays basic processes to achieve cooperation learning under e-learning environment and selected processes displays that it can be missed, selected or utilised, depends on status of instructor. And sub-processes displays into sections for detail behaviours of processes or selected processes. Model of cooperative learning at e-learning is divided into 6 steps, education preparation and checking objective, cooperative learning and team organisation, investigation of cooperative learning and planning, self-centered individual education, cooperation co-work at the team, sharing product, evaluation and self-examination of cooperative learning between teams.* (Park and Kim 2008)

The above characteristic elements of the e-learning platform can be represented by the Petri Net model for e-learning and Cooperative Learning shown in Figure 8-6.

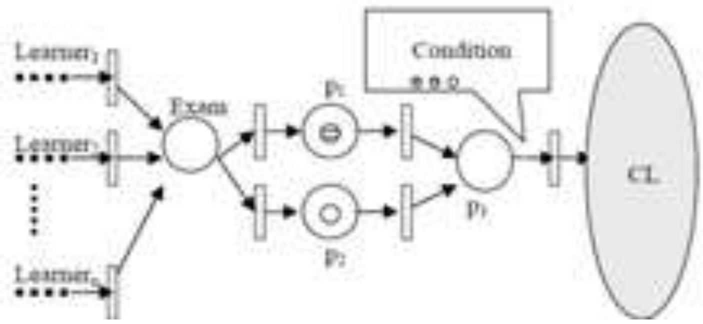

Figure 8-6: Cooperative Learning as Petri Net

8.3 PETRI NET MODEL DESIGN FOR E-LEARNING & LD

When modelling with Petri Nets, it is important to consider the conditions that must be satisfied by the Petri Net. These are referred to as the reachability, dead-marking and boundedness. I include their definitions for brevity in my discussion: *Reachability*: identifies whether it is possible for a learning process to achieve the desired results or not; *Dead marking*: used as a number to check for errors in the learning process design; *Boundedness*: this refers to the number of tokens in a place, either 0 or 1; otherwise this indicates an error.

As mentioned earlier, the study by Petty (2005) from New Zealand titled "**Using student perceptions to evaluate the effectiveness of education for high school students with vision impairment",** investigated the opportunity to learn parameters or metrics for the visually impaired. I have adopted the arguments provided in that study for my own e-learning framework model for LD students and the model is reiterated below.

The main parameters are defined below and an overall formula or expression is given from Petty (2005). I would like to summarise the main aspects of the model here.

The following variables of the Petty (2005) are revised for the proposed PN model for LD:

$\mathbf{S_i}$ = vector of student characteristics for student i, including individual and family attributes.

$\mathbf{P_i}$ = vector of provision for learner i, both mainstream (provided by the school) and specialised (provided by the resource teachers, teacher aides and DEET).

$\mathbf{O_i}$ = vector of opportunity-to-learn for learner i.

$\boldsymbol{\varepsilon_i}$ = the error term or random variation

Petty (2005) also defines the following relationship for the opportunity-to-learn for learner i:

$$\mathbf{O_i = \beta_0 + \beta_1 S_i + \beta_2 P_i + \varepsilon_i} \qquad \textbf{(1)}$$

The above expression shows the opportunity-to-learn is a function of the student characteristics and the educational provision that the student receives. If the independent variables are standardised to a mean of zero, β_0 is the mean opportunity to learn, β_1 is the factor by which the student characteristics are transformed, reflecting how they affect the opportunity-to-learn, and β_2 is the factor by which the provision is transformed to affect opportunity-to-learn.

However, as the provision is responsive to the student characteristics, we can express P_i (the provision vector) as a function of S_i (the vector of student characteristics):

$$P_i = \alpha_0 + \alpha_1 S_i + \varsigma \qquad (2)$$

Where α_0 is the mean amount of provision and α_1 can be interpreted as the amount of provision added for each "unit" of disability or special need. Greater level of disability, expressed in S_i (student characteristics), implies a higher value of P_i (provision). The last term ς is an error term associated with the provision vector. It can be argued that the student characteristics are affected by actors and their networks. Thus the provision may be affected by policy, school actors and networks, and therefore, the error term may be considered as a balanced indicator for the provision on LD.

Furthermore, combining (1) and (2) from above yields the following result:

$$O_i = \beta_0 + \beta_1 S_i + \beta_2(\alpha_0 + \alpha_1 S_i + \varsigma) + \varepsilon_i \qquad (3)$$

This can be simplified into the following form:

$O_i = k_0 + k_1 S_i$ **(4)**, where k_0 and k_1 are constants or weights that relate to the mean opportunity-to-learn and the adjusted weight or factor for the provision of the resource allocated to LD student i, respectively.

Clearly, in proposing an e-learning model for LD students, it would be beneficial to consider and explore the nature of the student characteristics (S_i), the provision (P_i) and the opportunity to learn (O_i). For example, the 121 ICT Project at Concord provided an opportunity for all students in the classroom to use a laptop in their day-to-day work. However, some of the students were also supported by specialist staff or teacher aides, and hence, the provision vector P_i would be different for each LD student as the student characteristics are different. In the Petty (2005) research study, the aim was to determine what P_i (provision) is needed in order to get the desired O_i (opportunity-to-learn), assuming that, S_i, the student characteristics were given. Accordingly, the aim is to make good use of resources and thus it is desirable to resolve the question “what is the best way to provide $\mathbf{P_i}$ in order to optimise $\mathbf{O_{i?}}$” Or given limited resources, determine how they should best be used in order to provide the highest amount of opportunity-to-learn, with given student characteristics.

My analysis and consideration, beginning in Chapter 3 and shown in Figure 3-7, has resulted to the Petri Net e-learning model shown in Figure 8-7 below. The model exhibits triggers (transitions) and places (resources) that are needed to enable the respective triggers (the firing rule).

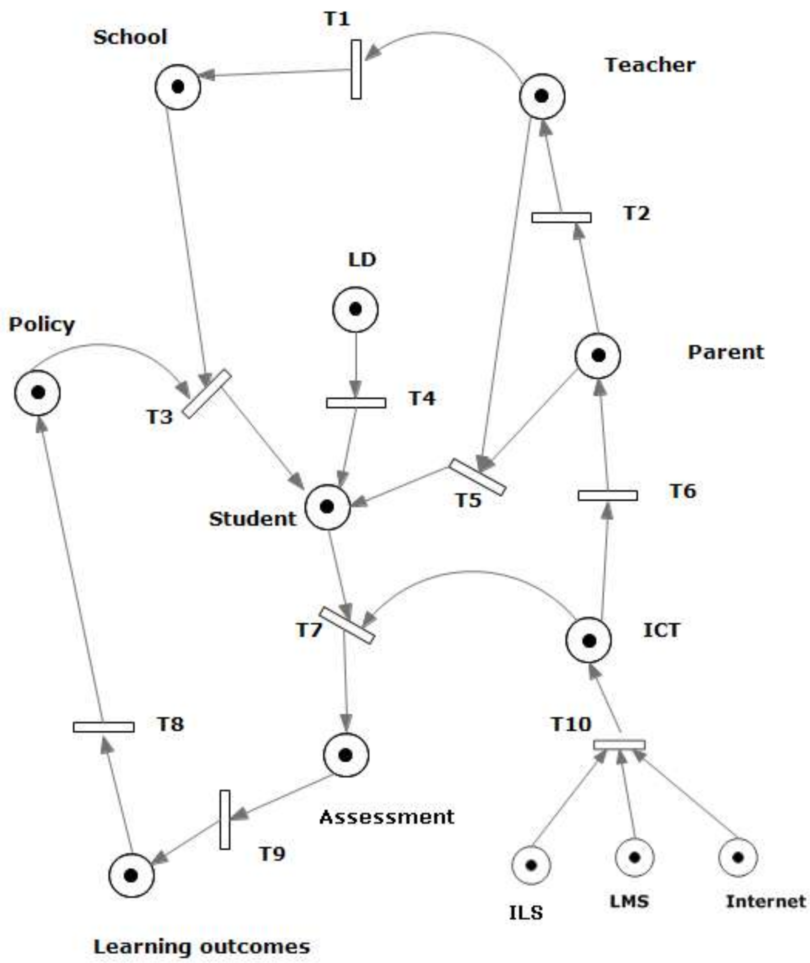

Figure 8-7: Petri Net model for e-Learning and LD

8.3.1 Petri Net vs. ANT Networks

The Petri Net uses triggers (transitions) by using resources (places), and consequently, generates new resources (tokens in places). In order for the transition to be activated, the preconditions need to be satisfied. As explained in the above examples, if the CPU is to execute a process, certain threads and other resources must be available, like memory, input devices and output devices for storage. In ANT, for a translation to take place, we need actors and their networks to be present and aligned in order for the innovation (proposal) to be accepted, and hence, adopted. In this comparison, I propose a logical correspondence between places (resources) and actors, and furthermore, between transitions and translations.

8.3.2 Analysis of Petri Net for e-Learning Model in this Study

The model consists of ten transitions (actions or triggers) $\mathbf{T_1}$-$\mathbf{T_{10}}$ and twelve places (resources) which are represented by **School**, **Teacher**, **Parent**, **Student**, **LD, Policy**, **ICT**, **Assessment, Learning outcomes**, **ILS**, **LMS** and **Internet**. The Petri Net model for LD e-Learning is designed to enable the firing of transitions provided the preconditions from the resources are satisfied. For example, $\mathbf{T_7}$ can only fire if the two places, **Student** and **ICT** have a token (resource). The result is the firing of transition $\mathbf{T_7}$, which generates tokens in a place called **Assessment**. This is equivalent to the actors and their networks in problematising the students' environment and trying to diagnose the skills and knowledge of a student with LD. It follows from the model, that the **Learning outcomes** (place) is affected by transition $\mathbf{T_9}$, which has a precondition **Assessment**.

The transition $\mathbf{T_8}$ is triggered by the precondition, **Learning outcomes**, which would impact **Policy**. Transition $\mathbf{T_3}$ requires input from places **School** and P**olicy** to enable its firing and its post conditions are shown by placing resources in the place called **Student**. The opportunity-to-learn metric may be resourced from the place called **Policy**.

The model shows the firing of three transitions $\mathbf{T_3}$, $\mathbf{T_4}$ and $\mathbf{T_5}$ must be satisfied (triggered) in order for resources (tokens) to be deposited in the place **Student**. This operation demonstrates the impact of policy, teachers, parents and LD on students.

Transition $\mathbf{T_7}$ is fired when students work with ICT and the post-condition for the place **Assessment** is affected by the addition of tokens. This models the positive impact of ICT on the learning outcomes that are reached via the firing of transition $\mathbf{T_9}$.

The Petri Net further shows the firing of transition $\mathbf{T_{10}}$ is enabled via a combination of e-Learning approaches that require preconditions (resources) from the places **ILS**, **LMS** and **Internet**. These three places may be replaced and enabled by an equivalent single place, **Web 2.0 technologies,** whose result (output) from the firing of $\mathbf{T_{10}}$ is indicated by the post-condition in the place **ICT**. The operation for the remainder of the transitions can be analysed in a similar manner and these are summarised below.

Summary of Model Operation

Transition	Preconditions	Post conditions
T_1	Teacher	School
T_2	Parent	Teacher
T_3	School, Policy	Student
T_4	LD	Student
T_5	Teacher, Parent	Student
T_6	ICT	Parent
T_7	Student, ICT	Assessment
T_8	Learning outcomes	Policy
T_9	Assessment	Learning outcomes
T_{10}	ILS, LMS, Internet	ICT

As described in Chapters 6 and 7, the students form their own networks, and so do teachers, parents, and DEET. Consequently, I contend that the Petri Net model presented in Figure 8-7 above can be viewed as a conceptual or logical representation of the interactions and associations of actors, shown in the above summary. The model displays the strong associations and influences or alignments that exist in the learning environment for LD students. If the impact of CT is to be examined, then we may apply the Petty (2005) model as discussed earlier in this chapter. If this is adopted, then the result will be a model that can be used a standard for evaluating the learning outcomes of LD students with the adoption of ICT. The model shows that if transactions $\mathbf{T_3}$, $\mathbf{T_4}$ and $\mathbf{T_5}$ all fire, then these generate tokens or resources for the place student. Therefore, these can be used as a way of measuring or assessing the opportunity-to-learn, as these directly can generate the student characteristics vector, $\mathbf{S_i}$.

This model has the potential to determine the opportunity-to-learn cost for each LD student, to analyse the use of ICT as an integral component in the curriculum and its impact on the learning outcomes or achievement for these students. It should be pointed out that there is anecdotal evidence on how computers were introduced in the curriculum. The evidence showed that leadership of prime actors, such as principals, played a significant part in the adoption of computers in the 80s, and hence, they affected the provision vector Pi for each student. As was mentioned earlier in the thesis, the provision vector was influenced by the DSP program in Australian schools in the 80s.

As was presented earlier in the thesis, one of the objectives was to propose a model that would determine the risk factors for learning of LD students. The e-Learning model presented here has the capacity to facilitate this objective. The Petri Net model in Figure 8-7 makes provision for this diagnosis, as it can be considered as the opportunity vector in the Petty (2005) model. The learning outcomes and the pathway(s) from school-to-work or further study is an area or field in the LD students' networks that must be accounted for by the proposed model. A careful examination of the model shows that transitions $\mathbf{T_4}$, $\mathbf{T_3}$ and $\mathbf{T_7}$ provide the triggers to analyse the risk factors for e-Learning and LD. In this way, it would be possible to diagnose LD and the provision for effective learning strategies and technologies, relevant to the individual characteristics vector $\mathbf{S_i}$ of each LD student.

8.4 REFLECTIONS BEFORE THE FINAL CHAPTER

The chapter presented a Petri Net model for e-Learning which is specific to LD students. The model contains the main elements of the teaching and learning environment and this can be applied to special schools which are ready to adopt the full potential of ICT. Given the results of this study, an approach that is recommended is to integrate ICT in the curriculum with an appropriate pedagogy (Jung 2005) or teaching and learning strategy/paradigm, such as the "Thinking curriculum".

The next chapter gives an overview of the research, discusses the main research question and sub-questions and several other relevant questions that have arisen during the course of the thesis. Furthermore, recommendations for further work and a conclusion bring the chapter and the dissertation to its final stage.

CHAPTER 9

9 OVERVIEW OF THE RESEARCH & CONCLUSION

Whenever you are asked if you can do a job, tell 'em, 'Certainly I can!' Then get busy and find out how to do it.

Theodore Roosevelt (1858 - 1919)

9.1 OVERVIEW OF FINDINGS

This research began with the objective to gather data and develop sufficient knowledge in order to propose an e-learning model for students with LD. As it was explained earlier, this interest arose from a personal interest working with students in the DSP program in the secondary schooling division of the Education Department in Victoria, Australia and the needs of my son. The work, and the projects, revealed the limited support from special educational consultants and the lack of a coherent policy to address disadvantage in both the mainstream and special schools.

In recent years and with the advent of ICT technological innovation, it became apparent that several questions needed to be asked and to explore the ways and means by which Web-based technology would facilitate the learning outcomes of students in this category. In addition, my personal family circumstances encouraged me to pursue this research study in an attempt to gain awareness and skills, to provide assistance and guidance, with the study plans for my son. Although some people may argue that I was biased in the study, I feel that this was not reflected in the data gathering and analysis. I was reflexive in my approach as I had applied the research methods and the knowledge in an objective manner.

The study explored curricula, adaptive tools, audio tools and dedicated software. However, my data analysis revealed that none of these were suitable in assisting LD students. For example, working with Dragon Naturally speaking, I discovered that the concentration span of the students was affected by the actual time involved to train the system and this led to difficulties in recording speech and playing recordings back in the classroom. The designers of such tools need to take many factors into consideration including content and context of speech sessions that could be used in the exchange of communication.

The Actor-Network Theory approach worked well as it identified the key players and thinkers in the special schools that were under exploration and investigation of their adoption of ICT. I think that it would be valuable if some form of triangulation could be followed, beyond this research, in order to collect further data regarding the analysis and significance of the key leaders (or actors) to explore the following questions:

*"**How would the projects continue or be affected if there was a significant staff turnover**"?*

"How have the ideas of 121 ICT Project been adopted by other schools, government and non-government"?

(For example, the Queensland Education Department has supplied individual students with ICT equipment)

*"**How can this action improve the educational outcomes**"?*

"Would the provision of such resources through policy guarantee better learning outcomes"?

In Victoria, the introduction of VELS provided a systematic way of using metrics and measurable targets with KPIs, and therefore comparisons may be made from one year to the next. Both of the special schools showed leadership in adopting this policy and one of them, Concord, further customised it to reflect the School's standards and curriculum. Figure 7-19 provides a summary of the KPIs with respect to ICT in the School.

A number of significant observations were made where a group of LD students displayed primitive motor skills, for example, paper folding in designing a letter case or envelope. However, when the same group of students were given a laptop, they were able to use ICT and special interactive developmental programs, such as Scratch from MIT, where the students were able to display skills with logic activities.

The research conducted an analysis and evaluation of Learning Management systems (LMS). Whilst most of these were designed by commercial business groups, it was evident that these require considerable configuration and customisation for LD. For example, Figure 3-18 provides details of a range of applications and their suitability for special needs. The need for individual customised constructive software and tools is imminent for students with LD. This imposes a lot of pressure on the teachers and clearly a proper training and support program is required to deliver to teachers the necessary knowledge and skill so that they can implement curriculum innovation and design. The Victorian government recognised this need and it introduced the E-Potential program for all teachers in schools (discussed in Chapter 4).

9.2 DISCUSSION OF RESEARCH QUESTIONS IN THE THESIS

1. ***How do teachers and students negotiate with innovations such as Web-based technologies in order to achieve particular learning outcomes?***

In answering this question, I explored the literature, carried out surveys, and conducted personal interviews with key and leading actors. My early observations and results indicate that teachers approached ICT innovation with caution and reservation as they felt that it did not address the full range of special needs. In addition the teachers expressed the view that the software programs, the support as well as the professional development were not adequate for the teaching and learning needs. Data and observations from Macedon Ranges clearly demonstrated this situation in the early phase of the study, however, due to ongoing developments; the situation has improved considerably now.

The school appointed an ICT Coordinator and it introduced VCAL to its senior classes. Apart from these changes, the school had experienced a significant growth in its population from 2002 to 2007. The students used the technology as far as possible with gaining language reinforcement as was reported in Chapter 7. However, the infrastructure limited the extent of usage, like Internet access. A conclusion that is drawn from the research is that the teachers were using the technology at the time to support or augment the learning outcomes. However, the students' skills were found to be at an introductory level and this did not facilitate the full use of the wide range of resources that were available from the Department's Web site. This was supported by my investigations of the infrastructure that I was able to explore with the IT divisions of DEET (key actors, were identified and included in Table 0-1 in the dissertation)

My observations and results from Concord showed that the infrastructure (actor) plays a very significant role in the negotiation for the innovation/adoption of ICT by teachers, students and their parents. All actors (stakeholders) negotiated and their network translates the innovation. At concord, the role of technology (actor) was recognised and adopted readily. The technological changes did not threaten the teachers and they showed willingness to enrol and adopt ICT.

The leading actors demonstrated strong capacity in problematising ICT projects (like 121), training for other actors in the region and also training actors from different levels in the school. The actors and their network displayed strong acceptance to technology that was demonstrated by the pervasiveness of ICT across the curriculum. The adherence of DEET policy and application of benchmarking techniques such as VELS[107] clearly demonstrate the strong and effective negotiation that took place in this field.

In conclusion, the research results clearly identified critical elements (actors) who were capable of enrolling other actors, exhibited strength in problematising projects related to ICT and these were translated throughout the school curriculum (integrated ICT in teaching and learning areas) to enhance the learning outcomes. The VELS bench-marking indicators show a very positive trend about the impact of Web based technologies on the learning outcomes. The E^5[108] curriculum model was introduced in 2008 as an innovation by DEECD in Victoria. The school adopted the model and applied it to its Web 2.0 technologies with enthusiasm as was demonstrated in the school's Conference in 2008. The voice from the Principal and leading actors strongly echoed the need for the active classroom or the classroom without walls. Lopez (2006, 2010) supports the view that LD students may benefit by adopting the four research-based principles: instruction designed around authentic tasks, opportunities to build cognitive strategies, learning that is socially mediated and engagement in constructive conversations (Cobb-Morocco 2001). The ICT environment that is now enriched with laptops and IWBs provides a strong ground for motivation for the students of the school. The students' interaction within the context of IWBs features makes lessons

[107] These were referred to as CELS Concord.

[108] E^5 Instructional Model: Engage, Explore, Explain, Elaborate, and Evaluate.

more enjoyable and interesting- and hence resulting in improved attention and behaviour essential to learning. The voice from the 2005 Transition 121 ICT pilot project class strongly demonstrates this without any doubt. This curriculum model with an innovative approach to adopting ICT is strongly recommended for LD.

2. ***How do human and non-human aspects of the socio technical network that staff and students construct involving these technologies, lead to positive outcomes?***

The results from the case studies demonstrate the power of both human and non-human aspects of the socio-technical network that staff and students construct. The voice from the students in the 2005 graduate reflects this power: "*We were the first to use a laptop and a whiteboard in the school".*

The Laptops that were introduced on a one-one basis in 2005 in the Pilot 121 ICT project showed how powerful these were when the students' engagement and self-esteem rose to a high level at that time. The laptop needed its space, care and storage and these were demanded on a daily basis from each student. The students respected and appreciated their allocated laptop and took good care. Another important observation was the use of the interactive whiteboard.

As part of its design, the infrastructure was to provide a connection for each laptop to an interactive whiteboard. This was quite an innovative technological step, as I observed students presenting their work and sharing ideas via the interactive whiteboard. They were able to run PowerPoint presentations on their activity[109] and research. The non-human actor, the interactive whiteboard, became an elite object, and the group in the 121 Project gained an elite status, as they were the first to be given this privilege. The teacher (actor) was able to convince the network (Principal, IT Coordinator, School Council) of other actors through her own problematisation of the infrastructure that was

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[109] IT activities: The students engaged in several activities like visits to CERES, Collingwood farm, school days, tornados, and used word and power point to report on their activities. This was also an integral part of their VCAL assessment unit.

needed in order to provide that necessary objects (actors) for a successful transition and implementation.

In conclusion, and based upon the evidence gathered from research data, I found both human and non-human actors have a significant role to play for positive outcomes. These include self-esteem, increased awareness of technological tools that are used in class, strong engagement and enhanced communication skills.

Answers to questions 3 and 4 are detailed in the following section. The section summarises most of the questions that were posed in the thesis and are crucial to the research and my conclusions.

How do e-learning models form and stabilise when Web-based technologies are introduced to support learning communities involving students with learning disabilities?"

The research sought answers to a wide range of primary and secondary questions. I will deal with these in the ensuing sections. In particular, I have also explored the following complementary questions arising from the literature in relation to LD students:

Does ICT help students with LD in teaching and learning, and if so, how?

Yes, by integrating ICT in the curriculum and making access easy like the 121 ICT Project at Concord.

What are the factors that enable the students to facilitate their learning and improve the academic outcomes?

The research identified leadership, infrastructure, consistent policy from within the school and DEET as well as parental awareness and support.

What teaching and learning models and policy (metrics) would provide better outcomes? For example the literature identified the following metrics: self-esteem, motivation, communication skills, independence and participation level ACER (2005), Becta (2003) and OECD (2003, 2005). The teaching philosophy at Concord, mainly the Thinking Curriculum, is a very effective way of teaching LD students. This fostered self-esteem, motivated the students and improved their communication skills via ICT.

The metrics that are used include VELS Indicators as a national benchmark of the learning outcomes.

How can ICT be used as an enabler for good pedagogy for this learning community? (MCEETYA 2005)

ICT is embedded in the curriculum and the beliefs of staff and school community at Concord. It is a strong vehicle and enabler for good pedagogy as it reinforced the communication skills, engagement and a clear indicator and facilitator for school to work transition.

How can the Internet be used as a tool to facilitate and evaluate the specific set of learning criteria as proposed by Bulgren(1998), Torgesen et al. (1983), Pillay(2000), Quinn (1996), and Lloyd et al. (1998)?

The internet is an agent (actor) that facilitates the interaction and engagement of LD students in the classroom and also out of school. Evidence of this was provided from data analysis in Chapter 7, in particular the survey from the parents at Concord. The skills matrix analysis of ICT skills demonstrated an effective and meaningful way of evaluating the learning criteria. The power of the internet clearly is demonstrated through the introduction of the Ultranet in Victoria. Future research will identify the links and relationships and impact to the learning outcomes from this infrastructure.

3 ***How is technology integrated with the teaching and learning curriculum?***

The research found that the most effective manner that teachers implement programs using computer-based technology is to integrate the technology in the curriculum. In doing so, the special needs students gain lifelong skills and enhance their self-esteem and communication skills. These views or findings are also supported by the literature (Williams et al. 2006, Moyle 2005, Caldwell 2005, Harris 2005).

The research found that leadership, infrastructure and policy at Departmental and school levels are critical for the successful adoption of ICT in the curriculum and again these findings are in agreement with the findings from the literature in Chapters 3 and 4. The teacher plays an effective leadership role that facilitates the teaching and learning environment that is appropriate for LD students' needs.

The scope of ICT is that it is an enabler for good pedagogy and also sets a pathway for the transition from school to work or further study. ICT can enhance the delivery of a subject through appropriate methods and tools. It does not change the nature of the subject, however it has the capacity to integrate and consolidate several areas from the field of study or curriculum, for example, VCAL. ICT is further used as a tool for teaching another artefact in the classroom. This study found that ICT was applied to teach image refinements, certificate designs or artefacts in Office Skills, for VCAL studies at Concord.

What role have special aides played in the learning environment in the field of research Z?

Teacher Aides (Actors) provided brain compatible activities to foster skills and knowledge that would prepare or set up the actor in Z for further studies.

Could the e-learning paradigm be extended to include a virtual community?

In their teaching and learning model, Schunck and Nielsson (2001) clearly intended that the Knowledge Base be accessed (at least partially) over the Web, but I was also interested to find answers to the following additional questions:

Infrastructure plays a significant part and it needs to be provided and supported by Departmental policy.

Could a teacher from one special school interact in this way with students from another School?

These questions can be answered in an affirmative manner, as long as the leadership and the relationships are strong between the special schools. The technology has developed rapidly over the period of my study and it is now possible to link the schools through a complex network infrastructure, namely the Ultranet. This is planned to come into operation in August 2010.

Technology can be harnessed by providing adequate professional development to staff in the school community.

How can technology support VCAL and CTE module learning outcomes?

ICT is an enabler and facilitator for learning and integrating concepts, for example students in the 121 ICT Project were able to link their work from excursions, images and text and also conduct research on current events, like Tsunamis, Local By-laws in the Council and current affairs. This was made possible through a medium called Share Point.

How can we increase student participation in the 'virtual (global) community'?

We can increase student participation in the virtual community by developing their ICT skills and knowledge through strong engagement. This was achieved in the pilot 121 ICT Project at Concord.

9.3 KEY QUESTIONS FROM BRAIN MODELS THEORY

How can brain model theories be applied to explain the learning outcomes with respect to a specific area like graphics or multimedia?

The 121 ICT Project showed that brain compatible activities may lead to positive outcomes. These outcomes were evaluated and measured with a benchmarked instrument that was mentioned earlier, namely the VELS instrument introduced by the Department. Consistent observations and data collection over a 3 year period demonstrates a positive outcome with graphics and multimedia for the actor in Z. Long term memory clearly assisted in the acquisition of good ICT skills as demonstrated in further study at TAFE by Z. (The reader should refer to the generative learning model) ICT actively engages the brain and the students acquire essential information from the task on hand. For example, Office Skills, Personal Development at Concord in VCAL Studies and Graphics and Multimedia studies at TAFE for actor in Z.

***How does ICT help with the acquisition of skills and application of the various software packages like Photoshop, 3D Studio Max, Adobe Premier, Sound, and Video production, for LD students**?*

This question can be answered in an affirmative manner. Evidence from the Portfolio shows that learning difficulties were overcome significantly through skills attainment from the complex software packages and tools.

***How can pathways assist students with learning difficulties to succeed with job opportunities?* (Jobs West and relevant organisations in North Western suburbs – for example, for students at Concord)**

In order for LD students to succeed with job opportunities, there needs to be a strong and transparent School and Departmental policy. The policy must provide for adequate funding that would support the links and engagement of LD students with local jobs agencies and employers. This policy should involve agents and their networks, for example organisations such as Jobs West in the case of Z, the Life Skills program at La Trobe University, Pathways to NMIT and VU as well as job agencies which were identified in the study at Concord (such as North Star, Work Education, Adult Training Services, VATMI , VISY and CERES).

9.4 HOW CAN ICT FACILITATE THE ROAD AND TRANSITION FROM SCHOOL TO WORK FOR LD SUDENTS?

In seeking an answer to this question, the literature from Australia, Europe and the USA was examined. In addition, evidence from the research data was used to draw a conclusion and make recommendations.

The present study found that ICT equips LD students with adequate skills which should allow them to continue with further study through pathways. For example, at Concord the students were able to link with NMIT and La Trobe University Life Skills. Further, LD students can increase their Job Opportunities as the ICT skills may minimise the impact of the disability or learning difficulty and thus enable the students to enjoy the normal work environment like Seymour (2005).

In this way, one expects that the likelihood of being employed should increase to a significant level. The OECD (2000) review takes several factors into consideration, such as the time horizon, that may impact the transition policy given the individual differences and developmental delay in LD students. It is very challenging to build an initial skillset or base knowledge that encourages and results in greater participation in education and training later on life. Different countries have experimented with various strategies, but all are still at the stage of trial and error (OECD 2000).

It is essential to consider flexible pathways policy that establishes strong links between schools and institutions and employers. This ensures that learning continues during and after the transition process and is recognized for employment and educational purposes. It would also provide a safety net for school leavers as schools have a major role to play, but so do many other agencies and organizations. Clearly it is significant to argue that schools must build effective partnerships at the local level and to take greater responsibility for tracing their exit students. IDEA (2004) provides recommendations in regards to the assessment of standards of LD students in the preparation and continuity beyond the college. A recent memo from the Australian federal government provides further guidelines for transition for all students in Australia. (Chapter 4 mentioned a study by Bedini (1993) regarding the quality of life and skills for LD students)

The practical and pragmatic approach adopted by Concord, is that its Transition Students are provided with a curriculum with a strong focus on ICT. And this subsequently, can be seen as a vehicle that allows the students to build lifelong skills. The evidence from this study shows that the school recognises the importance of setting up and maintaining strong links with other local institutions, and employment agencies that would provide an avenue or pathway for either employment or further study at TAFE. The National Guidelines and Goods for Schooling are implemented, and the data from VCAL and transition that were presented in Chapter 7, clearly provide an example of best practice of the way in which the school contributes to the continuation of skills for its students beyond school. This was evidenced by ex-students who visited the school and displayed loyalty and respect.

In another way, recent visits to both schools showed that curriculum and ICT deployment in one school has made an impact on the other. In terms of ANT a translation has occurred and the networks (actors) have grown stronger and better aligned. Staff in the senior section problematised the issue of transition. The key actors who are aware of the significance of this issue are strongly aligned. There is a clear vision and acceptance of the role that ICT, as well as their e-learning plan, play as this has been designed to build and enhance lifelong skills (Concord 2008 Conference).

Further study is needed in this area to follow the actors and their networks for an extended time frame. This would provide data to review policy and make recommendations in respect to pathways that are compatible for LD Students on a National scale.

9.5 SUMMARY OF DATA ANALYSIS AND RECENT OBSERVATIONS

One of the most important questions that I proposed earlier in the study was: How does the study help with the case of actor in field Z? Undoubtedly, the answer to this question is that the study provides real insights from the two special schools – Macedon Ranges and Concord that can be applied to the actor Z. I have summarized the main activities from my observations and investigations at field Concord. I am including these in my discussion since these were taken over a significant and continuous time period, in comparison to those from Macedon Ranges. As discussed earlier, Macedon Ranges provided the gate for my research and allowed me to investigate the infrastructure for ICT. The results were very significant as I was able to identify the level of support, both at the local School level, as well as the Departmental level. Macedon Ranges was also instrumental in identifying Concord, where I conducted a significant part of the study, and in addition, identified other relevant actors for the study. Figure 9-1 below gives a summary of my involvement at Concord.

Activities in ICT VCAL Subject (2007)	Concord Experience in 121 ICT (2005)
• File management • Image properties • Social properties • Sharing of resources-share point • Social networking (blogs) • Email- concepts/ethics • Word processing skills • Logic skills (research) (MIT program attributes of different people) • Motor skills-use plain paper to create characters and the important information image applications • VCAL. ICT – Cert 1 I • Object attributes • Sprites • Live Gallery • Pixels • Animations • Games • Frogs • Scatter • Acid music • Mosaic	• Computers for learning • Integrated curriculum • Technology skills • Teacher observations • Link task to life experience • Experience learning • Awareness of world news e.g.: Tsunami survivors • Planting trees • Recycling program-Personal dev. skills • Adult choices • Environment-CERES • Collingwood farm • Clean up • Eurovision • Composing • Voice over recording • Record and play show • Research skills-Internet, library (books, tapes, DVDs) • Creativity • Individuality • Album • Slide shows

Figure 9-1: Summary of Activities at Concord, 2005-2007

The Concord School platform can be used to prepare lifelong learners and socially competent citizens. The points in Figure 9-3 below reflect the developments at Concord in recent years following the study period, 2005 – 2007. Figure 9-2 illustrates the E^5 Instructional Model adopted at Concord in 2008.

Domain	Capabilities	Performance Indicators
ENGAGE The teacher develops shared expectations for learning and interacting. They stimulate interest and curiosity, promote questioning and connect learning to real world experiences. Through the activities the teacher elicits students' prior knowledge and supports them to make connections to past learning experiences. The teacher presents a purpose for learning, determines challenging learning goals and makes assessment and performance requirements clear. They assist students to consider and identify processes that will support the achievement of the learning goals.	Develops shared norms	1. Models expected behaviours 2. Establishes protocols for interactions 3. Sets expectations for learning
	Determines readiness for learning	1. Assesses prior knowledge 2. Identifies a purpose for learning 3. Connects to students' lives
	Establishes learning goals	1. Uses evidence to inform learning goals 2. Communicates assessment requirements
	Develops metacognitive capacity	1. Models thinking processes 2. Provides strategies for students to monitor learning
EXPLORE The teacher presents challenging activities to support students to generate and investigate questions, gather relevant information and develop ideas. Tools and strategies are provided by the teacher for students to organise information and ideas. The teacher identifies students' conceptions and challenges misconceptions. They assist students to expand their perspectives and reflect on their learning. Attentive to the nature of the activities and student responses, the teacher intervenes accordingly.	Prompts inquiry	1. Generates questions 2. Challenges misconceptions 3. Broadens experiences
	Structures inquiry	1. Provides resources to support inquiry 2. Develops processes to select information 3. Presents tools and strategies to organise information
	Maintains lesson momentum	1. Manages time 2. Provides a structure for the lesson 3. Responds to student behaviours
EXPLAIN The teacher provides opportunities for students to explain their current understanding. They explicitly teach relevant knowledge, concepts and skills. This content is represented in multiple ways. The teacher provides strategies to enable students to connect and organise new and existing knowledge. To assist students in representing their ideas, the teacher uses language and images to engage them in reading, writing, speaking, listening and viewing. The teacher explicitly teaches the language of the discipline. They structure opportunities for students to practise and progressively assess students' understanding.	Presents new content	1. Selects content 2. Makes content accessible
	Develops language and literacy	1. Develops the language of the discipline 2. Teaches the conventions of English language 3. Employs the modes of language
	Strengthens connections	1. Connects new and existing content 2. Utilises student explanation 3. Structures opportunities to practise
ELABORATE The teacher engages students in dialogue to continually extend and refine their understanding. They support students to identify and define relationships between concepts and to generate principles or rules. The teacher selects contexts from familiar to unfamiliar, which progressively build the students' ability to transfer and generalise their learning. In applying their understanding, students are supported to create and test hypotheses and to make and justify decisions. The teacher monitors student understanding, provides explicit feedback, and adjusts instruction accordingly.	Facilitates substantive conversation	1. Promotes thinking 2. Maintains the flow of conversation 3. Builds on participants' ideas
	Cultivates higher order thinking	1. Structures learning tasks 2. Extends learning to new contexts
	Monitors progress	1. Provides feedback 2. Adjusts instruction
EVALUATE The teacher supports students to refine and improve their performance using assessment criteria in preparation for a culminating performance of understanding. Integrating evidence from each phase the teacher formally records students' progress against learning goals. The teacher provides feedback and assists students to evaluate their progress and achievements and reflect on their learning processes. They support students to identify future learning goals.	Assesses performance against standards	1. Makes judgements based on evidence 2. Communicates progress
	Facilitates student self assessment	1. Supports reflection 2. Facilitates identification of future learning

Figure 9-2: The E5 Learning Model at Concord

Participants' comments from the Concord Conference 2008

- Special school for mild-moderate students. About 300-400 students
- Participated in national Survey in 2000
- Key actors: Principal and ICT Co coordinator, previous ICT Co coordinator
- 121 ICT Pilot extended
- More applying Web 2.0 tools
- Focus on collaborative learning
- Staff becoming aware of "*Classroom without walls*"
- Students becoming social and collaborative learners
- This pilot could become lighthouse for other challenge to construct of Education as we knew it
- Students are showing the way forward
- Transformation: leadership, digital landscape, staff need to see research
- Risks involved: innovation, investigation, exploration, challenges
- Impediments: reserve costs, ICT expertise, Staff knowledge, DEET policy
- New Approach: Global learners-socially communicated

Figure 9-3: Recent developments in ICT at Concord

A summary that shows the principal elements of this thesis, including major studies in LD, its definition, ICT platforms, factors for ICT adoption, countries in which relevant studies were conducted and the relevant researchers in the respective areas is shown in Figure 9-4 below.

9.5.1 Key Researchers in this Research Study

Education and ICT	Factors affecting the adoption of ICT	Mainstream Vs. Special	ILS and MLS	LD definition
Somekh CERI OECD (EU) Jung (JP) Pillay (AUS) Florian (UK) Handal (AUS) Calnin (AUS) Caldwell (AUS) Meiers (AUS) Becta (UK) Baskin (AUS)	Mumtaz (UK) Afshari (Malaysia) White (AUS) Newhouse (AUS) Deakin ACER (AUS) Cuttance (AUS) Elliott AUS/USA) Elkins (AUS) Moyle (AUS) Shaddock (AUS) OECD/PISA (EU)	Shaw & Grimes (USA) Mercer (USA) Piaget (USA) Gardner (USA) Kavale (USA) Forness (USA) Clark (CA) Lloyd (USA) Bulgren (USA) MacMillan (USA) UNESCO	Underwood(UK) Hedley (UK) Baturo (AUS Jervis (UK)) Mlitwa (SA)	Elkins(AUS) Warnock (UK) Becta (UK) NJCLD (USA) Kirk (USA) Seymour (AUS)

Figure 9-4: Key Data for the Thesis

9.6 FUTURE DIRECTIONS

This is a very large and important topic and my thesis inevitably cannot cover everything. What follows are some other areas I have identified that should be investigated further.

1. Further research must investigate the teaching and learning, and professional development and its effect on the learning outcomes with ICT, as for example, the e-Potential program in Victorian Government Schools.

2. We need to carry out research on the analysis of the impact of equipment used, for example whiteboards, mobile technology and PDAs on the learning outcomes. The study identified (Moyle 2007, Lopez 2006, 2010) that whiteboards and other digital equipment can make a significant contribution to the learning outcomes for LD students.

3. This was a socio-technical study and it's the most appropriate analytical tool – Actor-network theory. Actor-network theory allowed me to set up and investigate the ICT infrastructure in the research fields and it also allowed me to follow the networks and the associations of all relevant actors through a process of enrollment. Actor-network theory breaks down the boundaries between technology, education and psychology, since the study involves people and their interactions with students, teachers and policymakers. It should be observed that a significant actor was the Principal who was referred to as the heterogeneous engineer by Callon (1986).

4. The main elements of the key learning model as were determined by Actor-network theory: key actors to investigate policy, actors to implement policy, - network that allows for the enrollment of actors, immutable mobiles, software and hardware, effective network infrastructure, for example wireless LAN and providers of ICT, LMSs, ILSs and suitable platforms, for LD education. Furthermore, it is essential to carry out skills assessments, (similar to the Skills Matrix which was employed in this study) of all actors – including students, teachers, parents and policymakers. The e-learning model is an integral part of the curriculum and School Policy. And technology must be viewed as a tool for learning as well as an assistant or facilitator to learning. This would have implications on the pedagogical model as well as policy.

5. The study revealed that working with voice recognition software, like Dragon naturally speaking, proved to be very exhaustive and difficult for LD students. In particular, the concentration span of these students is limited and causes problems and could lead to a negative attitude towards the environment as a whole. At NMIT, a group of teachers worked on special programs to provide special fonts, catalogues and menus for students with learning difficulties (see Chapter 3). Given the enormous range of learning difficulties, this presents an enormous problem for the designers and implementers of special needs or adaptive technologies.

9.7 RECOMMENDATIONS FOR FURTHER WORK

The present work of the thesis can be extended to the following main areas:

- Investigate relationships of special schools – network and impact to curriculum for LD students.
- Investigate the significance and provision of adaptive technologies in both special and mainstream classroom schools.
- Investigate the local and national policy beyond the "digital divide" debate of the early 2000s and its impact on e-inclusion.
- Investigate networks of parents and friends
- Carry out a longitudinal study to follow the actors in order to track how technology would affect their life and work after school.
- Explore the support mechanisms and the infrastructure for actors from this research field.
- Carry out an analysis of the designers of adaptive technologies or web content to see how these may impact on the learning of students with LD.
- Conduct further research into brain models and their relationship to graphic objects, maps and so on.
- Investigate the teacher training and PD for the actors in the field and find how this impacts on the learning with ICT.
- Establish a national framework for assessing the teachers' skills for special education and ICT (skills matrix).

- Carry out an analysis of the effect of digital equipment, such as interactive whiteboards, on the learning outcomes.
- Establish a focus and a clear understanding of the role of ICT in educating students with LD.
- Give further consideration for the linkage between ANT and Petri Net concepts as a tool to describe actors and their interactions.
- Carry out further work on the Petri Net model for LD so that it can become a standard for evaluating the learning outcomes through ICT innovation.

9.8 LIMITATIONS ON THIS RESEARCH PROJECT

As described earlier, I had a personal involvement that could be considered as influencing my research, but made a considerable effort to avoid this from happening. Any vested interest has been ignored as I have aimed to be completely impartial in my endeavour to collect data for this study from the schools and the individual study. I believe that I was objective about my aims and objectives, and whilst I acknowledge that my association with the LD field could be misconstrued and regarded as a problem, I have made every possible effort through the application of an ethical approach to maintain objectivity and clarity of focus and scope in the research study for this thesis. It should be noted that my background, and any perceived bias, has been accounted for and discussed very early in the dissertation.

An interesting finding is the lack of relationships amongst the special schools and their networks, especially during my investigations of the infrastructure for the adoption of ICT. The networks were not very strong as the video conferencing project had to be abandoned due to boundary issues. This I felt was a limitation to my research as I could not finish the early part of my project and was not able to go as far as I would have liked to.

Another limitation is that the detailed descriptions of changes to technology are absent from any considerations. Technology was considered as an actor in the fields of research- Macedon Ranges, Concord and Z. I have dealt with technology in a general way for this purpose. The nature and issues that are always present with software and hardware have been omitted from my considerations due to the limits of a PhD dissertation and thus the story is incomplete. The research was not able to accompany transition Students to pathway visits to observe, from a close distance, what the students experienced. Clearly there was a limitation on the number of visits outside the school overall, as it was not possible to participate in dual activities concurrently (I was accommodated with several visits to NMIT).

Future work should make this a priority, namely follow the actors beyond the school classroom to gather further data that could be employed in policy recommendations.

9.9 CONCLUSION

The thesis identified early and recent e-learning models that were used as part of the final design of the e-learning model that has been proposed for LD. It applied the ANT framework to determine the attributes and interactions of various actors and their significance for teaching and learning with LD students, and with ICT as a tool. Actors and their networks were observed and analysed to determine the impact of ICT on learning outcomes. This analysis revealed that the e-learning models form and stabilise through enrolment of actors and translation of teaching paradigms and curricula.

The thesis captured important and relevant aspects of teaching and learning for LD students. I believe it has made a significant contribution to an understanding of the factors that contribute to the learning outcomes of LD students, and how ICT can be used to facilitate their skills and achievement. It identified key elements and actors for a successful ICT platform through close collaboration and participation in a pilot project; the 121 ICT Project at Concord School. The aims of the project and its success were demonstrated by the wide acceptance and application at the national mainstream classroom level. The uniqueness of the research setting, I believe, has contributed to the knowledge of special education and the role that organisations, both government and business, play in determining or shaping the future of LD students. This study has found evidence that the life and future of such students can be influenced in a positive manner via the engagement and acquisition of ICT skills. The case studies have demonstrated that ICT does have a positive impact as it enhances the learning outcomes for LD students and their self-esteem. This was supported by primary data and the benchmarking performed by Concord School. In addition, this study presented evidence that ICT is an enabler for pathways for further study, and last, but not least, is a facilitator for lifelong learning. This was reinforced by the long term examination of the individual study.

Therefore, the study has proposed the design of a suitable e-learning model for LD students that can be tested and revised as a standard for LD. The model has culminated from previous work and involvement in the secondary schools sector and from my previous research studies; therefore, I present this model as a conceptual e-learning framework for future LD students. Given the limited number of reported studies on the impact of ICT in special school education, over a significant time span, I conclude that this thesis and the publications arising from it over the past 8 years, has made a significant contribution both to the research, and the community of LD students. I am confident that it has contributed to the education and life skills for my son, and therefore, I look forward to his future- a future that looks hopeful, and much brighter, now that he has acquired a multitude of ICT skills. These skills are now in his portfolio and should stand him in good stead.

In closing, I would like to express my gratitude to the two special schools which provided me with the opportunity to observe, and apply, teaching and learning methods with a focus on ICT. This thesis has contributed to the body of knowledge by extending the application of ANT to ICT and LD. The thesis has presented a number of recommendations for further work and I look forward to seeing further studies being performed in this field. In particular, national studies would develop greater awareness and support for this significant universal community of learners, the LD students.

EPILOGUE

The reader was made aware of my background and motivation in the early part of the dissertation. From a researcher's perspective, I have explored teaching and learning paradigms and how these were applied to ICT. Given that in the past I had 20 or so years' experience working in the secondary sector, I wish to emphasise the following:

- ***The literature review was carried out over a consolidated period (10 years) and allowed me to observe changes to policy and trends in education in the secondary sector.***
- ***I have carried the knowledge and experience to my own classes in designing assignments and applying the skills and knowledge gained from the research to curriculum design for research, namely the Honours course for the school of MIS.***
- ***Gained an insight in special needs schools and their relationships.***
- ***Applied the knowledge and experience to assist my own child in his post-secondary education.***

The methods of teaching which I had observed, along with the knowledge of the various software tools and packages, enabled me to identify ICT as a strong alternative in Z's education. Furthermore, one of the research questions to be pursued was to address the issue of school to work transition. This was a high motivating factor for me personally as I was able to learn more about the special needs students and their requirements. The research allowed me to see from a close distance how 'Transition Students' at one of the special schools worked and prepared themselves as they finally reached the exit points of their schooling life. The links and associations with local and government organisations proved to be a vital link that can play a significant part in their lives. Institutions like TAFE allow such students to gain success and demonstrate their potential in one or more specific areas. The research findings overwhelmingly supported the alternative hypothesis, H_1, namely, that ICT does have a significant impact on the learning outcomes for LD students. Furthermore, it provides a vehicle or pathway for them to become lifelong

learners so that they can work and contribute to society. Wendy Seymour (a special needs person) quite strongly endorsed the positive aspects of ICT in her paper (Seymour 2005), whilst at the same time she also had some reservations about the negative aspects or challenges from ICT for people with special needs. My work and research have expanded my horizon and I can see how some of these dimensions, directly relate to my personal circumstances. I hope that ICT will carry the skills and hopes of these young learners into their future so that they can have a positive and rewarding lifestyle.

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APPENDICES

APPENDICES

APPENDIX	CONTENTS
A : B-E	Macedon Ranges curriculum/Implementation plan e-Learning Plan for Macedon Ranges Principal's endorsement of research study.
B: F-QQ	Concord curriculum 121 ICT Project data Summary of meetings for 121ICT Project e-Learning Plan for Concord ICT software at Concord VCAL curriculum and ICT at Concord
C: RR-XX	Portfolio data for individual student in Z
D: YY-EEE	Interviews schedule, School questionnaires and surveys
E: FFF-LLL	List of visits to Schools, SSP and questionnaire for principal from Macedon Ranges
F: MMM-OOO	ANT Terminology
G: PPP-PPP	Victorian Education Learning Standards –VELS

Appendix A: Research Field X- Macedon Ranges

eLearning Vision

Mission Statement

To empower students towards their optimum individual potential in achieving higher learning outcomes, through the use of information and communications technology.

Vision Statement

Sunbury Macedon Ranges Specialist School provides a comprehensive educational program for students with special learning needs between the ages of 5 and 18 years in a safe, supportive and caring learning environment. The school has a current enrolment of 64 students and continued growth is indicated over the next few years.

The use of information and communications technology (ICT) is an integral part of everyday practices and administration management. eLearning enhances student centred learning through the integrated and negotiated curriculum whilst maintaining continuity across all Key Learning Areas.

Through the integrated use of information and communications technology Sunbury Macedon Ranges provides a learning environment that facilitates and enhances student learning outcomes and opportunities by providing a diverse, challenging and innovative curriculum that maximises individual student's eLearning together with best practice in teaching and learning.

The school community is committed to the ongoing development of facilities and resources to ensure delivery of an innovative and engaging curriculum by providing staff with support and assistance to undertake relevant professional development and training for eLearning. At Sunbury Macedon Ranges lifelong learning is valued and nurtured by dedicated staff. We strive to prepare our students to embark and embrace the digital age in a rapidly changing and challenging world.

Sunbury Macedon Ranges Specialist School strives to:

- Expand network and infrastructure to meet current needs and to plan for and anticipate future needs
- Commit to investing funds for maintenance and upgrading of ICT infrastructure
- Provide a reliable, accessible and fast network for students and staff with minimal downtime
- Provide equal and widespread network access for all students and staff
- Ensure security meets requirements but does not impede student and staff usage.
- Provide ongoing high level technical support
- Provide staff professional development and documentation on the use of ICT equipment to ensure its utilisation is maximised.

Learning and Teaching

At SMRSS class programs integrate eLearning to ensure that all students are challenged and supported by appropriate teaching and learning programs within the Early, Middle and Later years. eLearning will also support the VCAL and certificate 1 courses undertaken by Transition students.

Classroom and teacher requirements for hardware and software resources continue to be met on a needs basis with staff having opportunities to upgrade their skills and knowledge through professional development and support.

Computer skills amongst staff and students vary greatly. The challenge for the school is to keep abreast with changes in technology, maintain on going PD for staff to enhance student opportunities to further develop and raise their skill levels.

Goals

The curriculum goals aim to promote engaged learning by all students and assist teachers in developing individual learning plans based on a student's entry skills.

1. Improve student learning outcomes through the use of eLearning
2. Consolidate and develop skills in literacy and numeracy and other KLA's
3. Create authentic learning tasks - Digital Portfolios
4. Develop confidence and independence in using technology
5. Collaborative learning
6. Integrated learning
7. Promote safe and responsible use of computers
8. Appropriate use of the internet to access information
9. Use email appropriately
10. Teachers as facilitators and guides
11. Develop student knowledge of computers: specific parts, mouse functions and desktop start menu

SPECIALIST SCHOOL

Sunbury & Macedon Ranges Specialist School

No. 5218
CIRCULAR DRIVE, JACKSONS HILL
P.O. BOX 304, SUNBURY 3429
TEL: 9744 4879 / 9744 7734 FAX: 9740 8581
Email: sunbury.macedon.ranges.ss@edumail.vic.gov.au

4 May 2001

The Doctoral program
Ethics Committee
Victoria University of Technology
Ethics Committee.

Re: Principal's endorsement and consent for the research study.

I have given permission to Mr. Tas Adam to carry out his research study at the Sunbury Macedon Ranges Special School. I have discussed the ethics issues that may arise from his participation as classroom observer, interviews with staff and parents, meetings with staff and curriculum committee, and other involvement with school activities.

Mr. Adam has my consent to carry out special projects that involve the use of Web-based technologies with of our classes. He has the support and assistance of another special school, Concord, to plan and carry out a project linking both schools through the Internet.

I am confident that the research presents no risks to students and will seek the permission of the parents of children involved in such research to participate.

Tas has already made some observations in our school and is becoming known to staff and students. He is very keen to learn about the school and its policy directions and especially the role that technology plays with the education of students with special needs.

The only further departmental requirement I will ask of Mr. Adam is to furnish the school with evidence of a current police records check

Subject to presentation of this report, I fully support this project and I will indicate my approval to the Department of Education by recommending that it officially grants access to the school for the present research study.

Yours Sincerely

Peter Redenbach
Principal

Appendix B: Research Field Y - Concord

eLearning Plan

eLearning Vision

Mission Statement

To empower students to achieve higher learning outcomes, through the use of information and communications technology.

Vision Statement

Concord is focussed on student achievement and learning. The school is recognised as a world leader in the provision of education for students with additional learning needs and, as a specialist school, is highly regarded for its curriculum, learning technology programs and educational leadership.

Concord is a day specialist school, which caters for students with mild to moderate intellectual disability between the ages of 5 and 18 years. Concord is located in Bundoora, a northern suburb of Melbourne, over two campuses.

The vision of the school community encompasses a commitment to achieving excellence in education for students with additional learning needs through a curriculum, which integrates learning technologies with best practice in teaching and learning.

The school has a high level of commitment to eLearning in order to enhance opportunities and outcomes for our students. The building of the new state of the art Technology Centre has enhanced opportunities for students and staff and now sees Concord at the forefront in the area of Technology.

Concord is committed to the use of appropriate, motivating and innovative technology and programs in both the Technology Centre and in classrooms. This technology supports literacy, numeracy and integrated units across the school, as well as TAFE and VCAL Vocational courses undertaken by Transition students.

eLearning in the Curriculum

Class programs integrate eLearning in Key Learning Areas (KLA's), in particular the charter priority areas of Literacy and Numeracy. eLearning will also support VCAL and Certificate 1 courses undertaken by Transition students. Library and Healthily Living and other specialist areas use eLearning for their programs.

Concord's Technology Centre is a flexible learning environment which can be divided into three areas, housing a total of 38 computers. All classes attend the Technology Centre, with their classroom teacher, once a week for a lesson with the ICT Coordinator. Students have access to computers on a one to one ratio when in the Technology Centre.

The other two areas are timetabled enabling teachers to bring their class to the Technology Centre to continue and further develop work done with the ICT Coordinator and in the classroom. It also allows teachers to introduce skills and programs they have identified as targets for their students.

Two of the three sections have large data screens, which allow teachers to demonstrate new skills and programs to the students as a group. This teaching method allows students to follow instructions on computers. Individual students are given assistance when necessary.

Staff routinely use the Technology Centre and the focus has shifted. The innovation of the Technology Centre is now a foundation. Staff rely on the Technology Centre and its use is integrated into their program. eLearning has become embedded as a meaningful, essential part of learning at Concord. Students have, on average, 2.25 hours of time in the Technology Centre per week.

Applications such as Word, PowerPoint and Excel are used in these lessons, as well as programs including WiggleWorks, Clicker 4, Inside Stories and Galaxy Kids. See "Appendix B" for a complete list.

All classrooms have three or more networked computers, allowing staff and students to access many resources via the network. These resources include email, internet, intranet, shared folders, colour laser printers and many programs.

The ability of the students and the program focus determines the use of specialist hardware including scanners, digital and video cameras and other devices.

Curriculum Goals

The curriculum goals assist teachers in creating individual learning plans, for all students, which set targets based on entry skills.

These targets aim to:

1. Improve student learning outcomes, through the use of eLearning
2. Reinforce and further develop skills in literacy and numeracy and other KLA's, through the use of eLearning
3. Develop confidence and risk-taking in using technology
4. Encourage students to work independently
5. Ensure safe and responsible use of computers
6. Assist students to follow verbal instructions
7. Use Internet to access appropriate information
8. Use email appropriately
9. To familiarise students with the computer
    a. Locate (and name) specific parts eg monitor, mouse, keyboard
    b. Develop basic keyboard and mouse skills
    c. Use the desktop and start menu

10. Develop basic word processing skills
    a. Change font, size, bold etc
    b. Insert clip art, word art
    c. Print work
    d. Save and retrieve work

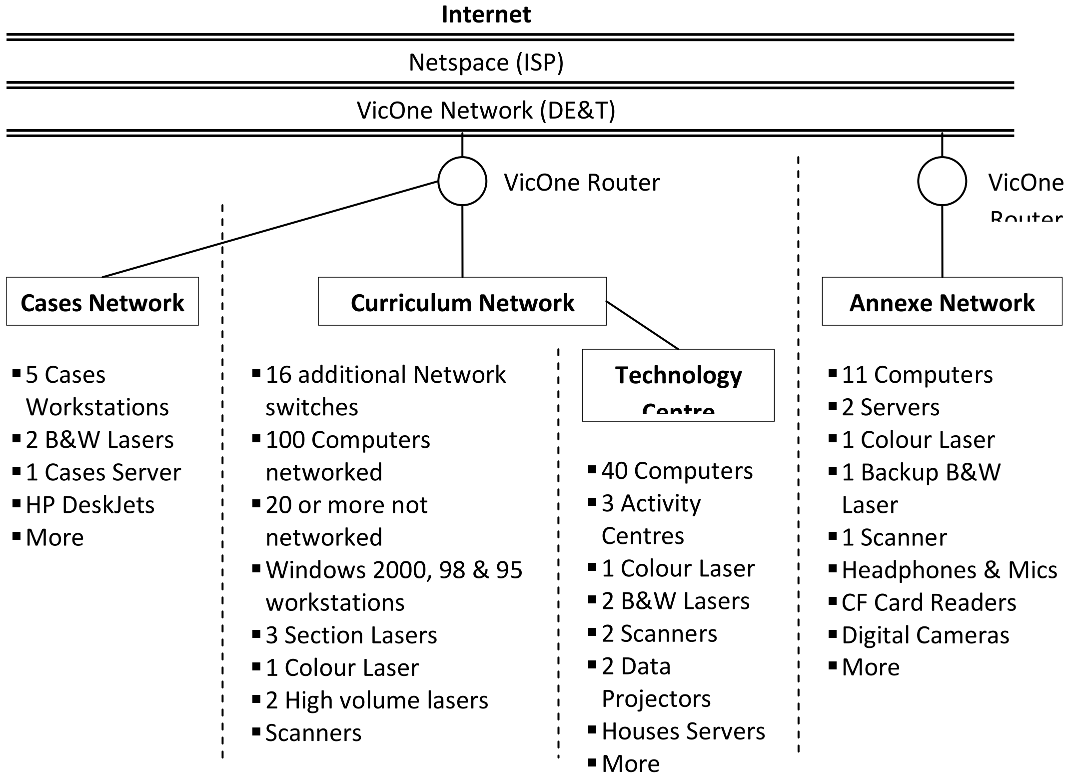
11. Internet Licence
    a. Gain an understanding of appropriate use of the internet
    b. Complete set tasks related to the internet
    c. Gain Concord School Internet Licence

eLearning Curriculum Support

Concord School relies on the support of selected staff, as needed, to further eLearning related Curriculum. These staff:

- Assist the ICT coordinator to build, develop and manage curriculum and goals for their sections
- Provide feedback, report and evaluate the curriculum
- Provide support for the curriculum, by communicating with the ICT Coordinator
- Provide assistance, with surveying staffs needs
- Help create, update, review the goals within the eLearning plan and other curriculum based documentation

Network Overview



Software Resources: Detailed Overview

Details in this document are subject to change. Software is added and upgrades are on-going.

Software Resources

Major

1. Windows 2000 Pro (Service Pack 3)
2. Internet Explorer 6.0
3. Office XP (Service Pack 2)
    a. Word 2002
    b. PowerPoint 2002
    c. Excel 2002
    d. Access 2002
    e. FrontPage 2002
    f. Outlook 2002
4. Greetings 2000
5. PhotoDraw 2000

Literary

1. Clicker 4
2. WiggleWorks
3. Galaxy Kids Reading 1
4. Galaxy Kids Reading 2
5. Galaxy Kids Reading 3
6. Galaxy Kids Reading 4
7. Blue’s Clues: ABC Time
8. Blue’s Clues: Reading Time Activies
9. SpinOut Stories- Red
10. SpinOut Stories- Blue
11. Literacy Box 2
12. Crossword Deluxe
13. Cloze Wizard
14. Inside Stories: Red Riding Hood
15. Inside Stories: Cinderella
16. Inside Stories: Goldilocks & the Three Bears
17. Inside Stories: Three Billy Goats Gruff
18. Inside Stories: Jack and the Beanstalk
19. Inside Stories: The Fisherman and His Wife
20. Inside Stories: The Ginger Bread Man
21. Inside Stories: The Three Little Pigs
22. Inside Stories: Red Riding Hood
23. Inside Stories: eBook- Cinderella
24. Inside Stories: eBook- Goldilocks & the Three Bears
25. Inside Stories: eBook- Three Billy Goats Gruff
26. Inside Stories: eBook Jack and the Beanstalk
27. Inside Stories: eBook- The Fisherman and His Wife
28. Inside Stories: eBook- The Ginger Bread Man
29. Inside Stories: eBook- The Three Little Pigs
30. Inside Stories: eBook- Red Riding Hood
31. My Personal Tutor, Sam’s Hide and Seek Adventure
32. My Personal Tutor, Sky Space Station
33. My Personal Tutor, Turru’s Daring Sea Quest
34. The Spelling Centre- The First 200 Words

Maths

1. Money & Shopping
2. Maths Made Easy Level 1
3. Let's Go Shopping
4. Maths Goes Mental
5. Aussie Maths Invaders
6. Galaxy Kids Maths 1 (Magenta Level)
7. Galaxy Kids Maths 2 (Red Level)
8. Galaxy Kids Maths 3 (Yellow Level)
9. Galaxy Kids Maths 4 (Blue Level)
10. Galaxy Kids Maths 5 (Orange Level)
11. Galaxy Kids Maths 6 (Light Blue Level)

Science

12. Thinkin Things Collection 1
13. Thinkin Things Collection 2
14. Thinkin Things Collection 3
15. Thinkin Science 1
16. Magic School Bus, Explores the Solar System
17. Magic School Bus, In Concert
18. Magic School Bus, Dinosaurs
19. Magic School Bus, Inside Bugs
20. Magic School Bus, Inside the Human Body
21. Magic School Bus, Mars
22. Magic School Bus, Rainforest

Further Software

1. Kid Pix Deluxe 3
2. Phonics Alive! 6- Typing
3. Microsoft Dangerous Creatures
4. Microsoft Musical Instruments
5. Australian Teacher's Workshops
6. Encarta Encyclopaedia Deluxe 2000
7. Encarta World Atlas 2000
8. Victorian Image Bank
9. Pathways
10. Certificates and Awards Creator
11. Films 2000- Library System
12. Stop Motion Animator Version 1.1
13. Life Online
14. Road Smart
15. MotorVation 2

Minor Applications

1. Acrobat Reader 5.1
2. PowerArchiver 2001 (freeware)
3. QuickTime 6.1
4. QuickTime 2.1.2
5. IrfanView 3.61

6. ChangeRez
7. Down
8. Macromedia Flash & Shockwave
9. Windows Media Player 9
1. Avery Wizard
2. Read Please 2003
3. Sony Memory Stick Adaptor
4. Bink And Smack
5. Macromedia Flash and Shockwave
6. RealOne Player Gold V2

Sound Reco

Meeting Schedule for 121 ICT Project

TRANSITION SCHOOL 121 ICT ACTION PLAN and IMPLEMENTATION REPORT 2005

ACTION	RESPONSIBILITY	TIMELINE	OUTCOME
Articulation of shared vision re 121 ICT. Goals: - Successful completion of VCAL Foundation award - Preparation of portfolios of evidence (multi-media) to meet the VCAL course requirements - Preparation for post-school, further study, TAFE and/or employment - Technology as a portal – to support learning and increase student engagement and autonomy - Moving toward a paradigm shift in teaching - 'Brain Compatible Learning' supported by Technology	Transition Team	March 20th	Planning day end of term 1
Proposal presented to school leadership	Anna Rigoni	April 12th	Approved
Proposal presented to School Council	Anna Rigoni, Marg McCrohan and Colin Schot	April 26th	Approved
Meet with Tas Adam from VUT – data from research to demonstrate program strengths	Anna Rigoni (with Andrew Donnison)	May 6th	Tas to work with TSA each Thursday
Change Technology Centre Access for	Anna Rigoni	Middle of	Anna liaised with other teachers to

TSA Infrastructure audit		May	swap IT access times. Organised 3 consecutive sessions on Thursdays
Permission to participate in project form to be written. Same form to be distributed to parents/carers for parental permission for students to participate in initiative.	Anna Rigoni	Week of May 27th	Permission form approved by Colin, sent home and returned by all parents/carers of student participants.
Meet with Andrew Donnison re equipment requirements. Andrew to investigate lap-top, projector and interactive whiteboard functionality and price.	Anna Rigoni, Tas Adam and Andrew Donnison	Ongoing Term 2	Participated in demonstrations by two interactive whiteboard companies. Discussed and explored tablet PC idea – too small and fragile. Tablet PC functionality also unsuitable – difficult to write on. Shadow from projector can be minimised by having projector at the correct angle. Tas provided Andrew and Anna with pocket PC's – how do these items support student learning?
Tas Adam to observe students and develop skills matrix (technology and learning skills).	Tas Adam and Anna Rigoni	Each Thursday from week 1 of June '05	Anna Rigoni provided Tas with curriculum and documentation as well as briefed Tas on Brain Compatible and Personalised Learning principles of learning and teaching being implemented from Year 7 to 12 at Concord School. Tas observed current teaching where technology is used to support learning.
Anna to confer with Transition team re students skills (technology and learning skills) Introduce 'Lane Clark' professional development opportunity. Negotiated with leadership as to how this would be funded. Asked for teacher commitment. Put in PD application on behalf of all staff.	Anna Rigoni	June 6th	Tas's Mind Manager version of Skills Matrix (to be used for measuring students' skills) presented to team. Team indicated preference to have document set out according to VCAL and CTE modules/units being delivered. Anna devised alternate document in a Word for Windows format. Anna and Tas agree that the scale used to measure skills (on student and teacher assessment charts) should be simple. Scale yet to be decided upon. Anna suggests we use scale from school SLPs.
Terms of Use document prepared.	Colin Schot	Week 9, Term 2	Completed.
Andrew to order lap-tops, projector and interactive whiteboard	Andrew Donnison	Week 10, Term 2	
Skills matrix assessment to be completed by students	Anna Rigoni and Tas Adam	Week 1, Term 3	
Student self -assessment re skills to be	Anna Rigoni	Week 2,	

completed – across 3 classes.		Term 3	
Terms of use document to be signed by students and their parents/carers at SLP meetings	Anna Rigoni	Week 2, Term 3	To be signed by parents/carers in SLP meetings
Learning environment to be assessed re position of new IT hardware. Furniture to be purchased (shelving, lockers). Carpets and wall to be installed. Tables and chairs/stools.	Anna Rigoni, Marg McCrohan, Colin Schot, Andrew Donnison	Term 3	Decision made to purchase all technology equipment first, implement the program and then assess other infrastructure needs.
Meeting to discuss project progress	Colin Schot, Tas Adam, Anna Rigoni and Andrew Donnison	Week 2, Term 3	
Notebooks arrived at school	Andrew Donnison	Week 3, Term 3	It took several weeks to configure the notebooks ready for distribution
Students completed skills matrix self assessment/evaluation of students' own technology skills – pre and post program Students completed learning outcome assessment matrix	Anna Rigoni	Week 3, Term 3	
Review of 121 ICT Action Plan Devise survey for parents re technology at home	Tas Adam and Anna Rigoni	Week 5, Term 3	
Notebooks distributed to students	Andrew Donnison	Week 6, Term 3	(Week 7 students on camp in Queensland). Students are to keep their notebooks locked in their lockers overnight.
Completed 'Lane Clark' PD applications, completed order form, confirmed which staff attending what days (from Transition and Pre-Transition), faxed order, asked staff to check CRT coverage with Jeannine. TSA timetable reworked to include on-line learning.	Anna Rigoni	Week 7	
Projector, speakers and trolley set up in TSA classroom. Distribution of 'Technology at Home' survey. Warren Gaff – IT teacher – agreed to teach the students in the TSA classroom rather than the IT Centre Invitation to staff across the school to come and observe classes Enquired about e-mail accounts for the	Andrew Donnison	Week 8, Term 3	

students			

Meeting with Tas Adam, Andrew Donnison and Anna Rigoni

Date: Friday May 6th, 2005

Tas's goal is to find out how technology can be used to establish and/or increase engagement (and thus improve student learning outcomes) for special needs students.

The desired outcome of Tas's research work is to develop a plausible model of technology implementation (hardware and software) to achieve the desired result of increased student engagement and improved learning outcomes.

This involves:

- The study of learning models and understanding how kids learn as well as the study of teacher paradigms.

- Establishing a technology skills matrix and developing an appropriate teaching/learning model that marries with the skills matrix. The matrix will be developed in two parts – thinking/learning skills and technology skills. The skills matrix will include such things as problem solving and communication skills (for example). Tas has requested I present him with some ideas about what skills might be included in the skills matrix – in reference to 'learning to learn' / 'thinking curriculum' pedagogy.

- The model with then be tested via its application in a learning environment and applying appropriate measures. This involves setting criteria for measurement. This part of his study will examine whether the application of technology leads to students meeting the expected learning outcomes.

1. Skills Matrix	2. Learning Objectives	3. Expected Outcomes

The overarching questions are to what extent can technology be integrated into the curriculum? How can we harness technology to enhance learning? How can technology support our VCAL and CTE module learning outcomes?

How can we increase student participation in 'the 'virtual community'? In the Transition Centre's 121 ICT initiative we referred to this as the 'global community'?

The role of the teacher will be as an 'action learner', to become skilled in the use and application of ITC and then to train other teachers.

Tas is available any day next semester – until the end of Term 2 either Thursday or Friday. He is also available for a day and another half day. Tas will come to work with us on Thursdays – this will require rescheduling of technology time.

Tas has various resources – how can they be utilised? These resources include a tablet PC, 3 Pocket PC's (with a stylus, phone, camera, personal organiser, internet access, palm pilot), web-cams and other items of hardware and software (including DragonFly 8 – voice dictation software, and Mind Master – concept mapping software).

We are purchasing lap-tops and smart boards for the final year students.

There may be security and home access issues. Concord is a reasonably controlled environment – and the students sign a technology agreement? Does this cover the work Tas will be doing with us?

We should plan a parent (and staff) information sessions to keep our community abreast of the changes and what our desired outcomes are.

When we meet with parents can we conduct a survey regarding students' access to technology at home?

Will we be able to use the technology to its ultimate access - to develop smart card technology thus harnessing the portability of technology?

See Tas's proposal – for his requirements re his action plan.

Use the web-cams to contact our link in England (iNet). A submission for next year OSP (outside studies program) release for 6 months to conduct study and research may be possible to extend the study into next year. This is certainly a possibility for us.

Our underlying philosophy is a commitment to an applied learning program, to personalising student learning programs and to assisting our Futures students attain their VCAL award. Technology should be there to support our student's learning and underpin our educational pedagogy.

I spent some time discussing our VCAL Learning Program with Tas. I gave him copies of this year's learning plan and a draft copy of the proposed learning plan for 2006. I also provided Tas with sample PowerPoint Presentations prepared by our VCAL students last year, as well as a copy of the learning outcomes for all our units of work, and a copy of the Certificate of Technology documentation (a course we hope to provide next year).

Initially Tas will come and observe some classes. His next scheduled day to come is next Thursday (May 12th).

121 ICT at Concord School

A Pilot Project for Students with Special Needs 2005/2006

Anna Rigoni, Concord School, Bundoora
Tas Adam, Victoria University of Technology

PROJECT SUMMARY

- Established a pilot 121 ICT learning environment.
- Provided each student and the teacher with a lap-top computer.
- Provided an interactive whiteboard, projector, digital still and video cameras and other accessories to the pilot class.
- Consulted with technology staff to purchase, install and train the teacher and students in the use of software and hardware.
- Tracked student progress via production of technology based work and showcased this work.
- Evaluated the program's success via data collection and analysis.

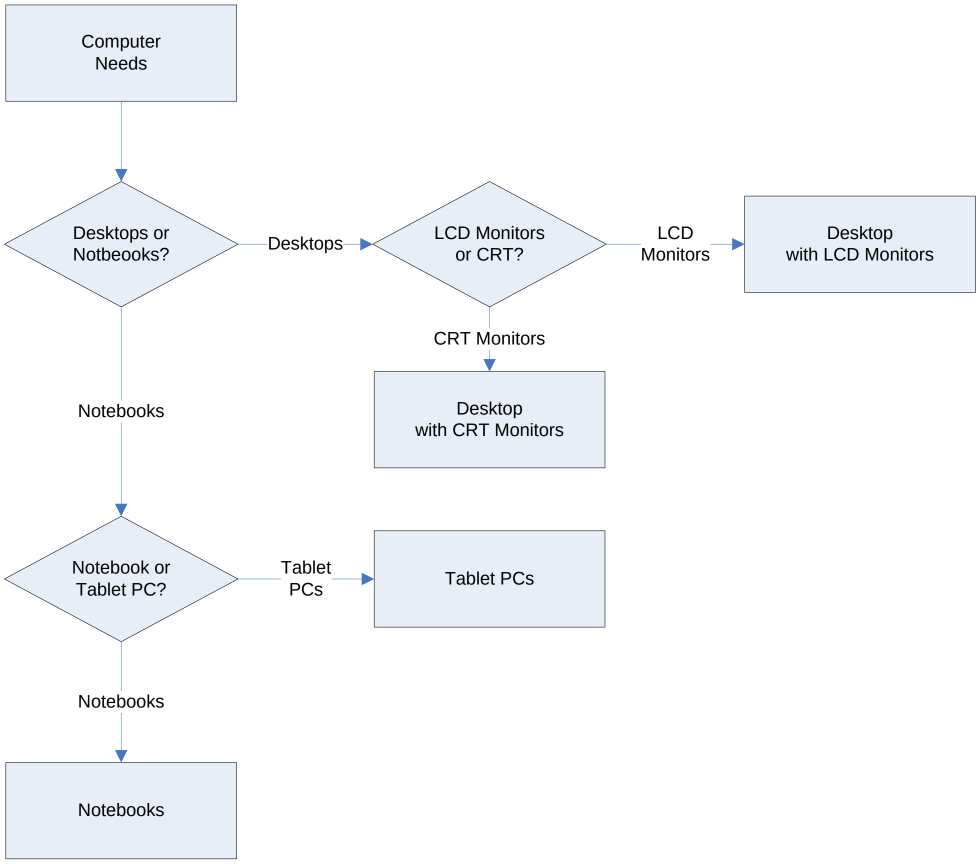
VISION

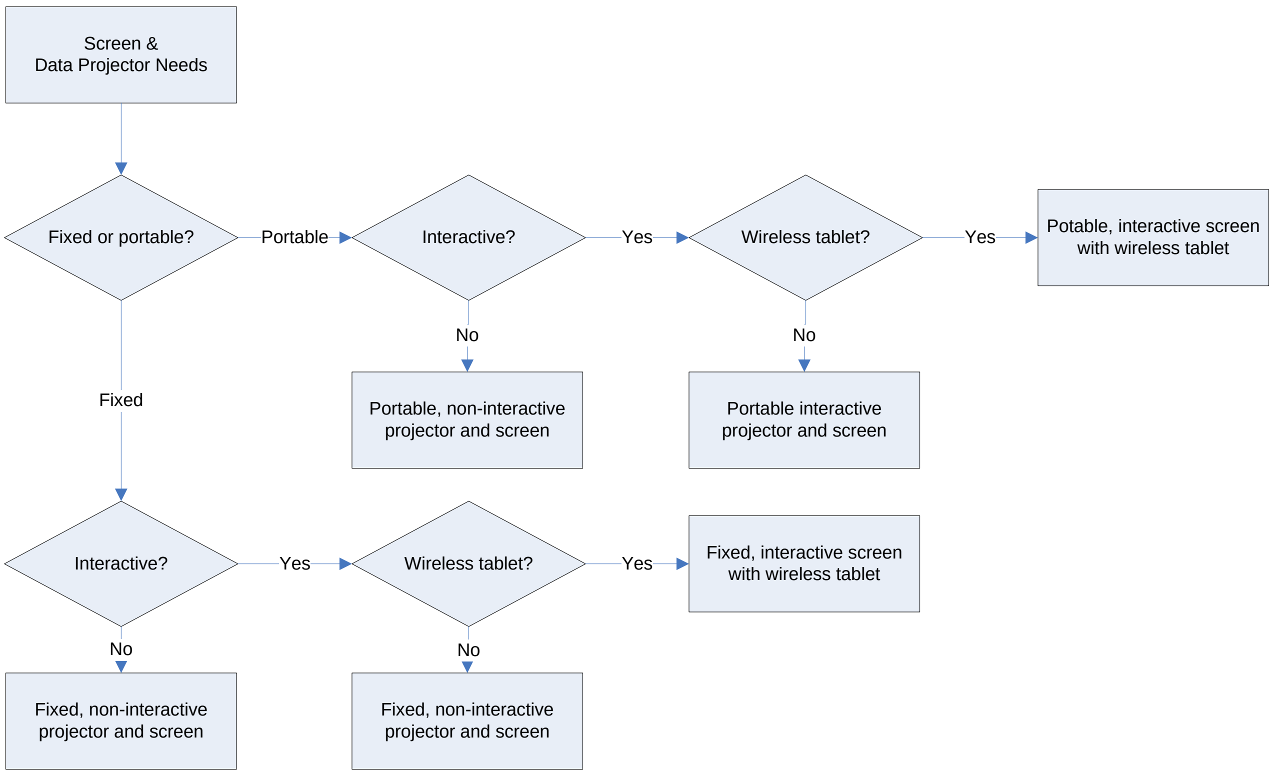
- Over four years (2006/2009) set up each of the three VCAL classes as 121 ICT learning environments.
- Continue building teacher capacity via creation of a professional learning team.
- Develop a new shared curriculum and pedagogy in the Transition Centre VCAL Pathway
- Promote and enhance students' capacity to pursue lifelong learning experiences via developing ICT skills and competencies..

- **STUDENT LEARNING OUTCOMES**
- Increased student engagement.
- Increased opportunities for students to participate in learning that contributes to competency based assessment (students demonstrating a skill in a variety of contexts over time).
- Increased opportunity for students to produce high quality work independently.
- Increased technology skills, including the completion of Certificate One in Technology.
- Increased student capacity to complete the required assessment tasks as defined by the Victorian Qualifications Authority in respect to VCAL Certification.
- Increased availability of learning tools to enhance personalised learning experiences including student capacity to source information and construct own learning experiences.

Q

121 ICT Project   Classroom Design





R

121 Learning Proposal

121 Learning

- 121 Learning describes a classroom where every student has access to ICT (Information and Computer Technology).
- A 121 Learning environment usually offers each student access to a lap top or desk top computer.
- 121 Learning involves fully integrating technology.

VISION: 121 Learning Environments for Futures' Students

- Transition Centre students have demonstrated technology skills.
- Our students live in a multimedia environment.
- Students can multi-task and each new cohort has superior ICT skills.
- Students are part of a global community – they regularly 'chat' and email via the internet.

Future's Student's Needs.

- Our final year or 'Future's Students' will live, study and work in a world where they are surrounded by technology. ICT offers a portal via which students access, make sense of and come to understand the world.
- VCAL Modules require preparation of portfolios of evidence – these are increasingly technology based.
- 121 Learning Technology is an age appropriate learning initiative for these students.

Why 121 and not a PC Lab?

- 121 is the next phase of ICT access: fully integrated ICT in all learning.
- Laptops – as opposed to desktop PC's, are affordable and portable.
- Where 121 Learning is adopted teachers can work with a Smartboard-or interactive whiteboard.

Staff Partnerships

- 121 Learning would require a partnership between teaching and technology staff.
- Technology staff helps ensure software purchased and employed suits our learning environment and our students' special needs.
- Technology staff will advise teachers and assist them with the integration of ICT into a 121 Learning environment.

Outcomes from 121

The anticipated outcomes would be:

- Increased student engagement.
- Increased opportunities for students to participate in learning that contributes to competency based assessment.
- Increased opportunities for students to produce high quality work – independently.
- Completion of core work on line.
- Capacity to complete required assessment tasks as defined by the Victorian Qualifications Authority in respect to VCAL Certification.

VCAL Learning Program and ICT

- From 2006 students may be enrolled in up to 10 VCAL units.
- Access to ICT is imperative for these purposes. Presently Transition Centre staff have concerns about limited availability of time in the Technology Centre for students to complete their course requirements.

Proposal

- Establish a pilot 121 Learning classroom.
- Provide each student and the teacher with a lap top computer.
- Provide a Smartboard to the pilot class.
- Consult with technology staff to purchase, install and train teacher/s and students in the use of such new technology.
- Track student progress via production of technology based work and Over four years set up each of the three VCAL classes as 121 Learning Environments.
- This would involve establishing teacher learning action teams. In such teams teachers would participate in internal discussion/support group meetings where the pilot program teacher and technology staff would also support staff in the move toward a 121 Learning pedagogy.
- This would involve the development of a new shared curriculum and pedagogy in the Transition Centre VCAL Pathway. It would tie in with the School's commitment to a 'Thinking' or 'Learning to Learn' pedagogy.

Review of Pilot and Data Collection

The following data would be tracked to demonstrate the investment in establishing121 Learning Environments has contributed to improved student learning outcomes:

- Number of students attaining VCAL Certificate, completing unit requirements
- Student self assessment – reporting on use of ICT in own learning
- Teacher assessment – running records of tasks completed by individuals and class, ICT employed by teacher and students
- Tracking internet sites accessed
- Parent and student opinion surveys – internal and external (benchmarks)
- Engagement – tracking incident reports, level of behavioural issues, absentee rates
- Development of student digital portfolios for demonstration night.
- Demonstration classes/open classroom for members of school community to see 121 in action.

Web Quests – internal and external student use

A Web Quest for each VCAL Unit at Foundation level

1. VCAL Numeracy
2. VCAL Literacy Reading and Writing
3. VCAL Oracy
4. VCAL Personal Development, Unit 1
5. VCAL Personal Development, Unit 2
6. VCAL Work Related Skills, Unit 1 (including links to ‘A Job Well Done’ training)
7. VCAL Work Related Skills, Unit 2
8. Certificate 1 in Information Technology
9. Certificate 1 in Horticulture
10. Links to Work Education at NMIT Preston

Activities in 121 Class

The Shrine

- We went to The Shrine to learn about all the soldiers who died.
- We looked at the medals and saw the light move across the Epitaph inside The Shrine.
- We ate lunch in the gardens around The Shrine.

What I learnt about…

- TEAMWORK
- Teamwork is working as a group.
- Sometimes you have to wait your turn.

- PROBLEM SOLVING
- You have to solve problems when you are having trouble.
- It's easier to solve problems in a group.

LOOKING AFTER THE GARDEN

- We have to water the garden.
- We look after the garden so it doesn't die.
- We look after the garden because we care about the garden.

VCAL Work Stations at Concord

- We do work stations 2 times a week
- We have 4 work stations

1. GROUNDS
2. CONTRACT
3. CANTEEN
4. OFFICE SKILLS

Work experience

- I learnt how to wash cars properly
- I learnt all about cars – about different models.
- I had fun working with the cars because I got rides in all of them.
- The people there were really nice and funny.
- Now I know everything about cleaning cars, getting scratches off and glossing up the wheels.
- I LOVED getting paid! That was my favourite bit.!

VCAL SKILLS/LEARNING OUTCOME ASSESSMENT

STUDENT NAME: ____ CLASS: ________________ YEAR:______________

Rank the student's ability in each skill area on the following scale.

Unit or Module	Learning Outcome/Skill. *The student can:*	Always	Sometimes	Beginnin
VCAL PERSONAL DEVELOPMENT UNIT 1	Plan activities			
	Solve problems			
	Show knowledge			
	Demonstrate skills			
	Demonstrate teamwork			
VCAL PERSONAL DEVELOPMENT UNIT 2	Plan activities			
	Respect rights of others			
	Communicate information			
	Work in team effectively			
	Resolve conflict			
	Self advocate			
VCAL WORK RELATED SKILLS UNIT 2	Collect and analyse information			
	Plan activities			
	Communicate ideas			
	Work in team effectively			
	Use maths			
	Solve problems			
SOCIAL SKILLS (CTE PERSONAL DEVELOPMENT)	Develop self awareness			
	Discuss self confidence			
	Demonstrate self confidence			
	Discuss responsible behaviour			
	Demonstrate responsible behaviour			
	Maintain good interpersonal skills			
	Show personal independence			
	Make decisions			
	Solve problems			
INDIVIDUAL LEARNING PLAN	Be organised and responsible			
	Use services and facilities			
	Identify preferred learning style			
	Contribute/revise ILP			
	Identify skills and interests			
	Evaluate Individual LP			
EXPLORING ADULT OPTIONS	Research adult options			
	Make and keep appointments			
	Work experience and observation			
	Form and discuss action plan			
	Prepare resume and portfolio/s			
	Develop application skills			
EVERYDAY CALCULATIONS	Use a calculator to solve problems			
FRACTIONS DECIMALS & PERCENTAGES	Outline concepts			
	Use fractions			
	Use decimals			
	Use percentages			
	Explain relationships between FD & P			

NUMERACY SKILLS	Manage time			
	Use measurement			
	Manage money/prepare budget			
FUNCTIONAL COMMUNICATION	Demonstrate listening skills			
	Communicate clearly and effectively			
	Obtain meaning from print			
	Write to meet needs			
	Give and follow instructions			
	Use private and public phones			
RECREATIONAL READING	Access reading material			
	Select own reading material			
	Discuss recently read material			
	Enjoy reading			
SPELLING IMPROVEMENT TECHNIQUES	Edit and correct spelling			
	Spell set of problem words			
	Use spelling rules and conventions			
COMPUTERS FOR LEARNING	Use computer equipment			
	Use operating system functions			
	Use programs to develop skills			
	Use programs to improve work			
INTRODUCTION TO THE INTERNET	Access the internet			
	Locate information on the net			
	Discuss information found on the net			
	Use the internet for research purposes			
	Be a responsible internet user			

121 ICT Pilot Program Update

Transition Centre, Concord School
Term 4, 2005

By Anna Rigoni

The Vision

Creating Life Long Learners

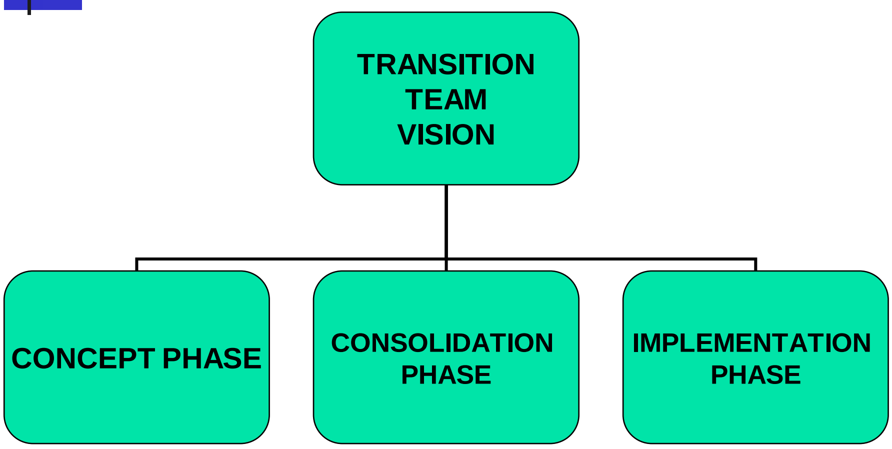
Technology as a tool:
Teaching ICT skills to students enables interaction with and utilisation of tools to meet their learning and personal needs. Examples of tools are computers, webcams, mobile phones, MP3 players, digital cameras and X-boxes.

Technology as the 'environment':
We live in a world where access to technology is ever increasing. Many of our interactions depend upon and/or are enhanced by technology. We need to equip our students with skills that enable them to navigate their way through this ever changing and challenging environment.

To meet the vision we need to ensure staff understand the role they play in facilitating ICT application in the classroom.

In addition, access to technology increases engagement and improves student learning outcomes.

121 ICT : 3 Phases of Implementation



2005 Pilot Program Team

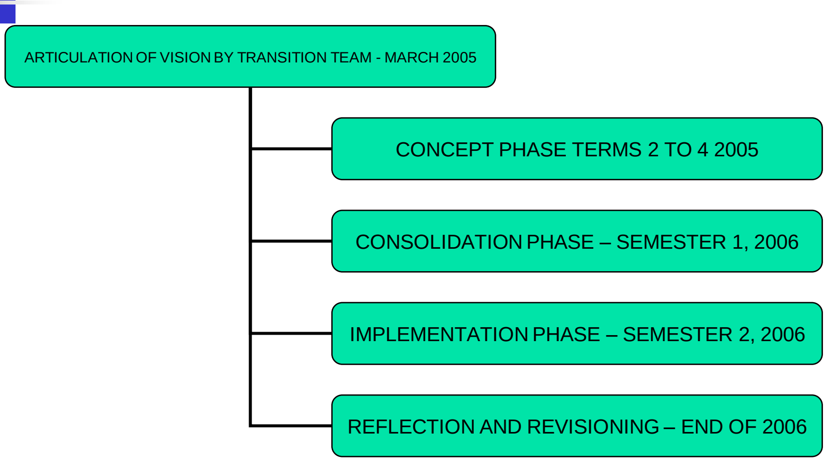
School Principal: Colin Schot

Project Coordinators: Anna Rigoni (Curriculum Leader Transition School and Tas Adam – Doctoral student from VU

Technical Coordinator: Andrew Donnison

Professional Learning Team: Transition Team

121 ICT Timeline



Outcomes Achieved

The anticipated outcomes proposed that have all been met were:

- Increased student engagement.
- Increased opportunities for students to participate in learning that contributes to competency based assessment (students demonstrating a skill in a variety of contexts over time).
- Increased opportunity for students to independently produce high quality work.
- Increased technology skills – the option of completing a the Certificate 1 in Technology in 2006.
- Completion of core work on-line.
- Capacity to complete required assessment tasks as defined by the Victorian qualifications authority in respect to VCAL certification.
- New shared pedagogy of 'personalised learning' undertaken – staff trained in 'Lane Clark' methodology.
- Permission forms and new policy drafted.

Technical Support

Various forms of support will be required for staff

- ACADEMIC – provision of knowledge about how ICT can be used to assist students meet learning objectives and improve student learning outcomes.
- TECHNICAL – assistance with hardware and software issues in their classrooms.
- OUTSIDE – training by hardware/software vendors and/or other experts.
- The ICT Leading Teacher will work with each teacher a session per week in the Technology Centre. This is a time where this teacher can role model new skills, clarify issues and assist teachers in their own skills development.
- Tas Adam will work in partnership with the ICT Leading Teacher, however Tas may be able to spend time assisting individual teacher's in their classrooms. Tas may be available for 6 months on a placement in 2007.

Proposed 2006 Team

- Principal: Colin Schot
- Project coordinators: ICT Leading Teacher and Tas Adam – Doctoral student from VU
- Technical support coordinator: new Technical Support staff member
- Pilot Classroom Teacher: Ann Park
- Professional Learning Team: whole of Concord Staff

TAFE Program

- The TAFE program is part of our post-school options program.
- Some of us went to Kangan Batman TAFE at Broadmeadows every Monday.
- We all had a TAFE orientation week at Preston NMIT in November.
- Emilia and Luke are also at TAFE a day a week but they are doing a different course.

2006… Our Future!

- Seljma – La Trobe Lifeskills
- Grad – TAFE
- Luke – TAFE
- Anthony – TAFE
- Brittany – La Trobe Lifeskills
- Nevena – La Trobe Lifeskills
- Emilia – TAFE/apprenticeship
- Sharon – La Trobe Lifeskills
- Chris DeOliveira – La Trobe Lifeskills

CONGRATULATIONS UPON YOUR GRADUATION & GOOD LUCK!

Learning with ICT

- Early models:
  - Computer assisted instruction (CAI), computer based learning (CBL), and computer based training (CBT) etc
  - Unsuccessful with most students
- In addition to this games can also be used to develop and consolidate reading/spelling skills
- Principles for the design of software programs for use by LD students
  - The principle of uniqueness – tasks or methods for motivation
  - The principle of educational necessity – focused on critical problems with LD students

Learning to Learn Pedagogy

- The 'thinking curriculum' or 'learning to learn' pedagogy requires students learning programs are personalised.
- This means students' learning is student driven. Studies demonstrate student engagement soars when students negotiate what they want or need to learn and how they are going to learn.
- Learning to learn and understanding how One learns is a critical part of personalised learning pedagogy.
- ICT offers students a capacity to source information and construct learning in an individual capacity never before experienced in education.

What are we doing?

- Developing a photo sharing community
- Investigated the use of blogs
- Aggregated blogs through a feed reader
- Investigated using social book marking of web pages for collaboration and community
- Made tentative steps towards developing an online community around free and appropriate music

Email Etiquette Guidelines

When sending mail:

- Send messages only to relevant people
- Be brief, but don't be too abrupt. This could be interpreted as rudeness
- Keep in mind expression: humour, sarcasm and alike, may not be expressed in you message or picked up by the reader. They may take offence
- Make sure you always have a relevant subject, in the subject field. Do not send messages with a subject
- Make it clear if a response is required, and by when
- Keep in mind your message can be easily forwarded to anyone and everyone
- Don't over-use capitals. All capitals is considered 'SHOUTING'!

When checking your email:

- Check your email frequently (daily)
- When a message is received, take action promptly and
  - Reply to messages
  - Forward messages to relevant people for action, their information or records
  - File, save, and/or print the message
  - Delete the message, if you don't need to keep it
- Don't reply to junk mail - just delete it
- Ensure your email box is not over the size limit. Delete old messages if needed

Digital Portfolios

- The outcomes that we (say we) are trying to achieve can be achieve easily and comprehensively through web based services.
  – Reflection
  – Demonstration of work
  – Evidence of wide range of experience

Software	**Computer Installed On**	**Licence Location**	**Owner**	**Description**
Writing with Symbols 2000 (1/5)	Speech	File	Speech	
Writing with Symbols 2000 (2/5)	MSM-T1: Maire Stamp	File	Speech	
Writing with Symbols 2000 (3/5)	JSW-T1: Lisa Weidermann	File	Speech	
Writing with Symbols 2000 (4/5)	Annexe: BK-OF1	File	Speech	
Writing with Symbols 2000 (5/5)		File	Speech	
Pinnacle Studio 9 (4/4)		File	DP Init Curr	Digital Video Editing

Pinnacle Studio 9 (4/4)		File	DP Init Curr	Digital Video Editing
Pinnacle Studio 9 (4/4)		File	DP Init Curr	Digital Video Editing
Pinnacle Studio 9 (4/4)		File	DP Init Curr	Digital Video Editing
Adobe Acrobat 5.0 (Creator)		File	Tech	Used to create PDF files

Challenges

- Professional Development
- Building the web services and plugins
- Monitoring and filtering
- Filtering
- Privacy
- Acceptable use

VCAL 2006 CONCORD SCHOOL

Certificate 1 in Information Technology

Student Name :... Teacher:

ICAU1128A Operate a personal computer **Element:** Elements describe the essential outcomes of a unit of competency	
1. Start the computer	
2. Access basic system information	
3. Navigate and manipulate desktop environment	
4. Organise basic directory folder structure and files	
5. Organise files for user and/or organisation requirements	
6. Print information	
7. Shut down computer	

ICAU1129A Operate a word processing application **Element:**	
1. Create documents	
2. Customise basic settings to meet page layout conventions	
3. Format document	
4. Create tables	

5. Add images	

ICAU1130A Operate a spreadsheet application **Element:**	
1. Create spreadsheets	
2. Customise basic settings	
3. Format spreadsheet	
4. Incorporate object and chart in spreadsheet	
5. Print spreadsheet	

ICAU1131A Operate a database application **Element:**	
1. Create database	
2. Customise basic settings	
3. Create reports	
4. Create forms	
5. Retrieve information	

ICAU1132A Operate a presentation package **Element:**	
1. Create presentations	
2. Customise basic settings	

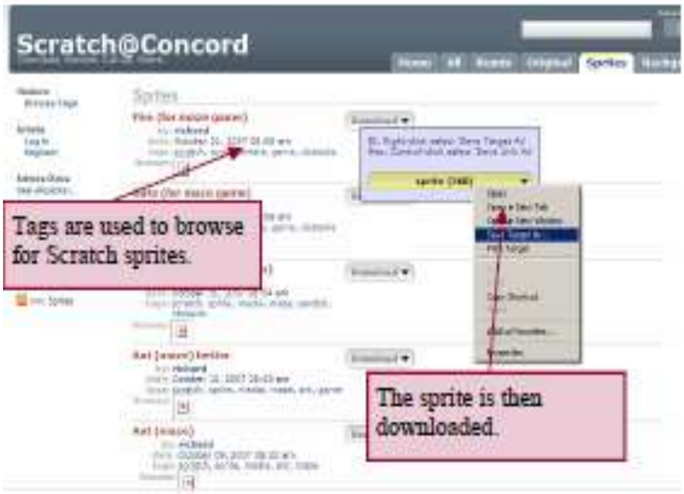
3. Format presentation	
4. Add slide show effects	
5. Print presentation and notes	
CAU1133A Send and retrieve information using web browsers and email **Element:**	
1. Access the Internet	
2. Search the Internet	
3. Research and apply 'netiquette principles'	

ICAU1213A Conduct on-line transactions **Element:**	
1. Determine how to undertake on-line instructions	
2. Undertake on-line transactions	
3. Complete on-line transactions	

Collaborative Game Making

When creating maze games using Scratch with our students, we used our Intranet to store the tagged components (sprites) needed to construct the game. Students used the tags to locate the resources they needed to construct the game.

Completed games were uploaded by the student to the Intranet or to the student's blog where others could play the game or download and remix it.



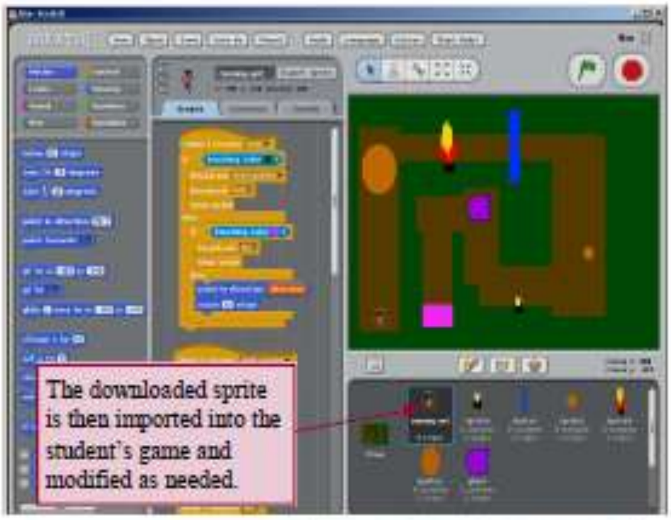
Tags are used to browse for Scratch sprites.

The sprite is then downloaded.

ccHost is open source software, created by Creative Commons, that allows resources to be uploaded, tagged, shared and remixed. ccHost is designed primarily for music samples but can be adapted to share any type of media. Concord School currently has two separate installs of ccHost, one for sharing music samples and songs, and one for sharing Scratch content.

Scratch is used to make games and to teach programming skills, techniques and mathematical concepts. Scratch is open source and allows exporting and importing of sprites (programming building blocks) and backgrounds.

Scratch has the added advantage that projects can be run as an embedded java applet on a web page, making it extremely useful for online community learning.



The downloaded sprite is then imported into the student's game and modified as needed.

The finished game can then be uploaded to the scratch site for others to enjoy, learn from or remix.

The finished project can also be uploaded to the students blog.

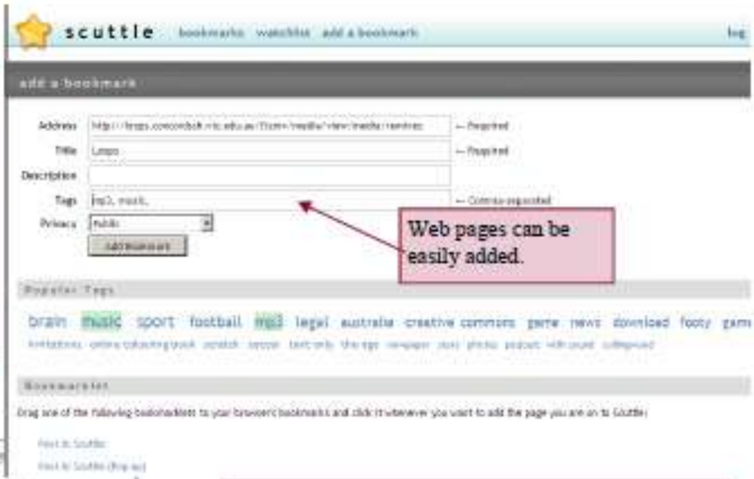
Social Bookmarking

Social bookmarking enables students and teachers to save web pages and tag them according to their content.

When a web page is publicly saved all users can see the tags and description associated with it.

Social Bookmarking allows different students to take different roles. Some students may only use social bookmaking to find resources that others have tagged.

Scuttle is an open source web-based social bookmarking website and service that can be run on a school's Intranet. Students and teachers can use tags to identify web pages and other Internet resources. Users can monitor and share resources with other Scuttle users.



Students and teachers can create an online identity and make connections to others with similar interests based on the web pages they choose to tag and the tags they used.

Students can include their bookmarks on the sidebar their blog, to let others see the latest sites they have found worth visiting.

STRAND	DOMAIN	DIMENSION	KEY ELEMENTS OF STANDARDS
Inter-disciplinary Learning	Communication	Listening, viewing and responding	• Practise being attentive listeners and viewers. • Use questions to clarify meaning and extend interaction.
		Presenting	**Students make regular short presentations to groups or the whole class communicating their ideas on a single topic or personal experience** • Present a talk on a given topic • Use strategies for improving presentations (e.g. varying volume and pace, and making eye contact with the audience) **Students make short presentations to the wider community** • Present information on a topic that has been researched in class using the given criteria
	Design, Creativity and Technology	Investigating and Designing	
		Producing	
		Analysing and evaluating	
	Information and Communication Technology (ICT)	ICT Skills	
		ICT for Creating	**Students create multimedia products** (a Power Point presentation)
		ICT for Communicating	**Students can use a search engine to locate information from websites** • With assistance, locate internet icon • Locate internet browser • Locate and identify address bar • Type in web address from given sample • Navigate to and use search engines
	Thinking Processes	Reasoning, Processing and Inquiry	• Questioning and wondering are encouraged, recorded and shared, and become the basis for further learning. • Develop skills in making accurate observations about animals and people. • Develop own explanation for observations, and question accuracy for others explanations.
		Creativity	• Use a variety of thinking tools. • Practice ordering and sequencing ideas, and use a variety of thinking tools to recognise patterns in surrounding events and objects.
		Reflection, Evaluation	• Test the effectiveness of creative solutions against given criteria. • Prompted by questions, begin to reflect on individual thinking.

Appendix C: Portfolio for Z

Kangan Batman TAFE

THIS IS TO CERTIFY THAT **GEORGE ADAM**

has received the following results in

ICP40205 CERTIFICATE IV IN PRINTING AND GRAPHIC ARTS (MULTIMEDIA)

Year	Subject		Mark	Grade
2008	CUFIMA01A	PRODUCE AND MANIPULATE DIGITAL IMAGES		CN
2008	CUFIMA03A	CREATE 2D DIGITAL ANIMATION		CN
2008	CUFIMA05A	CREATE 3D DIGITAL MODELS AND IMAGES		PN
2008	CUFIMA06A	DEVELOP AND IMPLEMENT VISUAL EFFECTS DESIGNS		DN
2008	CUFIMA07A	CREATE TITLES FOR SCREEN PRODUCTION		DN
2008	CUFMEM01A	USE AN AUTHORING TOOL TO CREATE AN INTERACTIVE SEQUENCE		CN
2008	CUFMEM04A	TEST A MULTIMEDIA PRODUCT		DN
2008	CUFMEM10A	DESIGN AND CREATE A MULTIMEDIA INTERFACE		CN
2008	CUFMEM11A	DESIGN THE NAVIGATION FOR A MULTIMEDIA PRODUCT		CN
2008	CUSSOU24A	EDIT SOUND USING COMPUTERIZED DIGITAL EQUIPMENT/SYSTEMS		DN
2008	ICAITB165A	CREATE DYNAMIC PAGES		CN
2008	ICPMM263A	ACCESS AND USE THE INTERNET		DN
2008	ICPMM492A	CREATE AN EXTENSIBLE STYLE SHEET		DN
2008	ICPMM65DA	CREATE WEB PAGES WITH MULTIMEDIA		DN
2008	ICPPP211A	DEVELOP A BASIC DESIGN CONCEPT		CN
2008	ICPPP221A	SELECT AND APPLY TYPE		DN
2008	ICPPP224A	PRODUCE PAGES USING A PAGE LAYOUT APPLICATION		DN
2008	ICPPP225A	PRODUCE GRAPHICS USING A GRAPHICS APPLICATION		CN
2008	ICPPP226A	PRODUCE INTERACTIVE PDF FILES		CN
2008	ICPPP328A	GENERATE HIGH-END PDF FILES		CN
2008	ICPPP333A	ELECTRONICALLY COMBINE COMPLEX IMAGES		DN
2008	ICPPP484A	SET UP AND OPERATE AUTOMATED WORKFLOW		CN
2008	ICPSU216A	INSPECT QUALITY AGAINST REQUIRED STANDARDS		DN
2008	ICPSU260A	MAINTAIN A SAFE WORK ENVIRONMENT		DN
2008	ICPSU262A	COMMUNICATE IN THE WORKPLACE		DN

******** Printed Results = 25 ********

GEORGE ADAM

ADA07275046

Kangan Batman TAFE

THIS IS TO CERTIFY THAT **GEORGE ADAM**

has received the following results in

ICP50205 DIPLOMA OF PRINTING AND GRAPHIC ARTS (MULTIMEDIA)

Year	Subject		Mark	Grade
2009	CUFEDT01A	MAKE CREATIVE AND TECHNICAL EDITING DECISIONS		PN
2009	CUFIMA04A	CREATE 3D DIGITAL ANIMATION		PN
2009	CUFMEM02A	AUTHOR A MULTIMEDIA PRODUCT		PN
2009	CUFMEM06A	DESIGN A MULTIMEDIA PRODUCT		PN
2009	CUFMEM07A	APPLY PRINCIPLES OF VISUAL DESIGN AND COMMUNICATION TO THE DEVELOPMENT OF A MULTIMEDIA PRODUCT		DN
2009	CUFMEM08A	APPLY PRINCIPLES OF INSTRUCTIONAL DESIGN TO A MULTIMEDIA PRODUCT		CN
2009	CUFMEM09A	APPLY PRINCIPLES OF GAME DESIGN TO A MULTIMEDIA PRODUCT		CN
2009	ICAITB137A	PRODUCE BASIC CLIENT SIDE SCRIPT FOR DYNAMIC WEB PAGES		DN
2009	ICAITB210A	ANALYSE INFORMATION AND ASSIGN META-TAGS		CN
2009	ICPKN315A	APPLY KNOWLEDGE AND REQUIREMENTS OF THE MULTIMEDIA SECTOR		PN
2009	ICPMM491A	CREATE AN EXTENSIBLE DOCUMENT		DN
2009	ICPMM581A	MANAGE MULTIMEDIA PRODUCTION		PN
2009	ICPMM582A	MANAGE MULTIMEDIA PROJECTS		PN
2009	ICPPP485A	DEVELOP A DIGITAL DATA TEMPLATE		DN
2009	ICPPP494A	DEVELOP DOCUMENT CONTENT AND STRUCTURE		CN
2009	ICPSU458A	MONITOR PRODUCTION WORKFLOW		PN
2009	ICPSU553A	PREPARE PRODUCTION COSTING ESTIMATES		PN

******** Printed Results = 17 ********

RESULT CODES

CN	CREDIT PASS.
DN	DISTINCTION.
PN	PASSED.

GEORGE ADAM

ADA07275046

Award of Qualification

This is to certify that

GEORGE MICHAEL ADAM

has fulfilled the requirements for

DIPLOMA OF PRINTING AND GRAPHIC ARTS (MULTIMEDIA)

ICP50205

Victorian Registration & Qualifications Authority

Nationally Recognised Training

President – Board of Directors

CEO

Date: April 30, 2010

Certificate Number: 800607

Summaries of employability skills developed through most qualifications can be downloaded from http://employabilityskills.training.com.au

The qualification certified herein is recognised within the Australian Qualifications Framework
Kangan Institute, Victoria, Australia
National Provider Number 0306

TT

PENLEIGH & ESSENDON GRAMMAR SCHOOL
A.C.N. 006 038 071

P.O. BOX 417
NIDDRIE, 3042
Telephone: (03) 9336 1855
Fax: (03) 9336 3421

22 February, 1999

CONFIDENTIAL

GEORGE ADAM

This assessment was conducted to provide information regarding George's intellectual development in relation to his current academic progress and to assist with establishing appropriate educational goals.

Tests administered :	Weschler Intelligence Scale for Children - 3rd Edition (WISC-III) Wide Range Achievement Test - Revised (WRAT-R) Neale Analysis of Reading Ability - Revised (Neale-R)
Date of Testing :	8.2.99 - 16.2.99
Age at Testing :	9 years, 3 months

George was enthusiastic about many of the activities, although it was necessary to keep testing sessions short in order to maintain a reasonable level of concentration.

Interview-Parent of Z

Responses to open-ended questions from parent of individual in field Z

1. Can you tell me your views about your son's education in regards to
   - Support
   - ICT
   - Work-transition?

Support Groups:

Support has grown over the years. As a young parent, I was unaware of the organisations/groups available to help. As he went to an independent school we were unable to access the government state programs.

There is a large gap: There appears to be no central group or place to guide parents for extra help/programs. To be identified and gain funding they now have to have a significant learning difficulty.(the benchmark is high).

Many students (treated as mild) miss out on funding and are placed in schools where they are expected to cope with limited facilities.

School to work transition:

- challenging
- opportunities to gain employment (limited)
- networks to help them (eg Jobs West) but again the success is low (even for a P/T job)
- wages→ out to work __> subsidized
- VCAL→
- School's-careers leader attempts to find them a job- hairdressing, cooking etc
- Further study- TAFE- get extra help

TAFE: learning outcomes

ICT impact:

- Gained success
- Learnt skills
- Grown in confidence
- Independent
- More mature environment
- Teacher welcomes him/helps him
- Made some allowance in their expectations of work requirements

2. I-learning: curriculum. How is it introduced? Administered?

The program is provided with ICT: portable laptops in classrooms-teaching philosophy-thinking curriculum

How is it measured? Indicators (effectiveness)

Parents views? (involved)

Level?

Pilot program: 4 years, personal goals-integrated in Years 7 8 9

2A. The initiative was to integrate students into mainstream schools and often some were not professionally diagnosed e.g. mild. Many mainstream teachers are already integrating them into their program. However, having said that, PD is essential to educate teachers of the students' special needs and to learn strategies to help them gain success.

2B. The idea is that teachers within the school are trained through PD (train the trainers) who then return to their school in an attempt to train the rest of the staff.

Initiative- government school initiative

Language support leader/ Coordinator to train staff and administer program.

Good Points	Bad Points
Internal	Never enough time allocated to pursue such PD in detail ie aides
Teacher knows personalities of staff and adapts the program to local needs	
There are aides allocated to identify and work with students with learning difficulties	

Government funds: originally there were 24 laptops provided which have been added to annually.

The school has a Wireless network which offers easy access (Individual and teacher assessment)

3. What is your view on ICT? (A) Ultranet? (B)Personal use of ICT? (C)What is your pedagogical approach in using ICT-? (D) Students with LD?

(A) Ultranet is good idea

.(B) My personal use includes: email, internet, banking, entertainment

.(C)Use ICT in classroom/supportive

Ultranet:

Effective

- Increased communication between parents, teachers, schools, community.
- Basic-WebSite at present but has potential
- → Greater access to information
- academic standards should improve with greater accessibility

Concerns

- technological issues
- cyber bullying- happens regardless
- staff competencies in using the network

Special Needs→ are part of the school community

“LD students may be good at computers skills”

There are two schools of thought shown: Special and Mainstream. In some private schools the idea is to integrate. Socially: attempts to include them and cater for them (some teachers are more effective than others) wide range of abilities in the classroom –can pose a challenge.

Integration coordinator-helps LD students and really caters for their individual needs.

4. . What is your philosophy re: teaching and students with LD?

. How do you apply this philosophy to your own child?

. Do you think qualifications are needed?

My philosophy is that teaching should be inclusive, tasks modified to help students gain success and self esteem.

Expectation plays a huge role in the outcome and the success. We expected that he would learn skills like other children would. We persevered and he gained success in reading, decoding, survival skills because we insisted on it. We reinforced it in everything we did.

Swimming lessons; initially this was very difficult for him to gain these skills almost are almost instinctively learnt them by others, but we persevered and eventually he gained success.

Gymnastics, tennis, squash, golf, expectations high, but not unrealistically high.

Special qualifications help in the understanding and delivery of the strategies appropriate to students with LD. Enthusiasm and an interest in the area can sometimes compensate for lack of qualifications.

Appendix D: Questionnaires & Surveys

Interviews schedule

Principal (Y) 23/04/07

Richard Y 3/5/07

Ann Park Y 25/6/07

Rhonda Y 25/6/07

Anna Y 5/6/07

Anna Y 20/6/07
Principal (X) 25/7/0

Individual students with software- Ben (several sessions)

Main Impressions from the interviews

- Students have a bond with the school
- Integrated curriculum
- Cooperative learning
- 2000 study reaffirmed the direct re school was taking
- identified as a leader in ICT adoption
- continued the vision or milestone
- external recognition eg; Australian National Skills Network
- School focused standards
- Community supportive council
- Leader in ICT use as a vehicle to produce good learning outcomes and self development
- Skills of teachers improved dramatically→ skills
- Learning becomes meaningful very active user of technology

SURVEY FOR PARENTS

Dear Parent

The purpose of this questionnaire is to gather information about how students with learning difficulties use Information Communications Technologies (ICT) in their learning. This involves computers and the Internet, and also information quality problems associated with their use of the Internet.

On behalf of the school, I would like to thank you for your time and assistance with this task. I am sure the results from the survey should provide further ideas on improving the teaching and learning for students with special needs.

Would you please complete the following questions and return to your child's classroom teacher by
Tas Adam

1 What is your age group?

A. 20-30 B. 30-40 C. 40-50 D. 50 and over

2 How do you rate your computer/technology skills?

A. Poor B. Fair C. Good D. Very Good E. Excellent

3 Does your child use a computer at home? Y N

4 What activities does your child do on the computer?

A. Homework B. Games C. Communicating with others (Email) D. Photo editing

E. Exploring subjects of interest F. Blogs

5 Do you have Internet access? Y N

6 Have you used the Internet regularly for more than 1 hour per week over the last 6 months?

Y N

7 What Internet services have you used?

A. Email B. Banking C. Exploring special topics of interest D. Photo Editing

8 Have you experienced any difficulties with the Internet information accessed? Y N

9 How serious were these difficulties?

A. Not Serious B. Serious C. Very Serious

10 Did you have difficulty in finding the information you required? Y N

11 Did you access any Internet sites (Web pages) where you had difficulty understanding the information? Y N

12 Did any Web sites have too much information? Y N

13 Did you have cause to question the reliability of the information accessed? Y N

14 Does your child use the Internet to communicate to other children or friends? Y N

15 Do you or your family use the Internet to find information or support for your child's disability?

A. Never B. sometimes C. Regularly

16 Does your child use the Internet to access information from the school website at home?

A. Never B. Sometimes C. Regularly

17 Does your child use any special support equipment, eg screen, mouse, voice, when using the computer?

A. Never B. Sometimes   C. Regularly

(Please specify equipment-……………………………………………………………..)

18 Does your child work frequently on the computer when at home?

A. Never   B. Sometimes   C. Regularly

19 Does your child use the computer for leisure?   Y   N

20 How do you rate your child's ICT skills?

A. Poor   B. Fair   C. Good   D. Very Good

21 What kind of skills would you like your child to have when he /she leaves school?

Please specify three or four skills …………………………………………………………………………..

22 What is your view of ICT in relation to job prospects for your child?

A. Poor   B. Fair   C. Good   D. Very Good

23 Any other comments?

Thank you for your participation and support in this questionnaire. This information will be treated strictly as confidential and the full anonymity will be preserved.

Main Questionnaire for School Principal

1. What got you into working with children with special needs?
   (relative, friend, university course, etc)

   What qualifications do you have in special Education?

   Have you thought of doing further related qualifications? Masters? If so why?

2. What use of ICT do you make personally (not directly related to teaching)?

3. What is your perception of how ICT is implemented/ used in the school? How effective do you think this is?

4. How is ICT Learning /Policy developed and implemented in the school? Where does the drive come from?

5. What do you think the community view of ICT is in the school (employers, council, parents Edn Dpt etc)

6. In which area is the school regarded as a leader in learning for students with special needs?

7. What type of connection exists amongst the special schools?

8. Does it make a difference to your school?

9. To educational matters? Exchange of educational ideas?

10. Where or what is the forum from which educational ideas and policies are exchanged or shared? Do you see this as an important aspect of the learning for students with special needs?

11. How do you see the international component or relationships of the virtual communities? E.g. UK? Is there a need for internationalization?

12. How do you see the importance of working with other virtual communities, eg special needs children (i.e. outside the school)?

13. How is Curriculum developed and implemented in general?

14. Is there anything else you would like to mention that you think I ought to know?

Questionnaire for teachers in 121 ICT project–Concord School

1. What got you in to working with children with special needs?
   (relative, friend, university course, etc)

   What qualifications do you have in special Education?

2. What is your own philosophy about educating students with special needs? How does your own philosophy compare with that of Concord? E.g. Thinking Curriculum, Digital Portfolios?

3. What is the pedagogical approach to teaching and learning that you have adopted for your students? What methods do you employ to enhance their engagement and learning outcomes?

4. What personal use of ICT do you make?

5. How do you think ICT helps your students in your office skills class? What skills do they need to pick up so as to prepare themselves for life and work? What can be done to improve the skills and hence enhance the opportunities for these students?

   Can you give me some examples of where some of the students have gone after Concord?

6. How is curriculum developed and implemented in the school? Do you see a role for yourself in this?

7. The school is regarded as a leader in teaching and learning for students with special needs. Can you comment on this please?

Thank you.

Main Questionnaire for ICT Leader –Concord School

1. What got you in to working with children with special needs?
   (relative, friend, university course, etc)

   What qualifications do you have in special Edn?

2. What innovations have you inherited? How do you see them working in the school (eg 121 project)? Where and how does ICT fit in the curriculum at the school?

3. What innovations have you proposed? How are you going with these at present?

4. What is your own philosophy about educating students with special needs? How does your own philosophy compare with that of Concord? Eg thinking curriculum, digital portfolios?

5. What is the pedagogical approach to teaching and learning that you have adopted for students with special needs? What methods do you employ to enhance the student engagement and learning outcomes?

6. How is ICT Learning /Policy developed and implemented in the school? Where does the drive come from? Do you make a distinction between teaching about ICT and using ICT in other curriculum areas?

7. What is your own vision about ICT in the school? How suitable are the tools for special needs students? What other tools would be useful?

8. What do you think is the community's view of ICT usage in the school (employers, council, parents Edn Dpt etc)?

9. The school is regarded as a leader in teaching and learning for students with special needs. Can you comment on this please?

10. What projects have you worked with that linked schools together? Do you have plans to extend these to Concord? Eg MMc2?

11. What support or policy do you get from Dept? Region? What is their vision/ agenda? Do you see this as an important aspect of the learning for students with special needs?

12. How do you see the international component or relationships of the virtual communities? Eg HK? Is there a need for internationalization? MC2?

13. How do you see the importance of working with other virtual communities, eg special needs children (ie outside the school)? Mainstream schools?

14. What is your view about cyberlaw, standards, relevant bodies on ICT etc? Any concerns?

15. Do you see students leaving Concord with adequate preparation for life and work with suitable ICT skills? Can you give me some examples of where some of the students have gone after Concord?

16. Trends for the future? Where do you see ICT in 5 years time? What issues do you see at present that need to be resolved? What is your view of the digital divide? Is this an issue for Concord's staff and students? Parents?

17. How do you keep up with the latest developments in ICT and curriculum?

Thank you.

Appendix E: SCHEDULE OF VISITS

MACEDON RANGES

31/10/2000 Visit to the school with supervisor to discuss research plan

18/12/2000 First meeting with Principal to discuss research proposal

28/02/01 Meeting with School Council Representative to discuss the plan for my research

09/03/01 First day observations

29/10/01 Ethics application approved

18/02/02 Commenced regular observations, introduced to different aged groups

11/05/02 Principal invited me to accompany him to a meeting to another school

20/02/03 20/12/03 Period of low activity due to a long wait for ethics approval from DEET

04/02/04 Commenced observations on a regular basis –assigned to a particular class and the IT coordinator

20/09/04 Letter to Principal of Concord School to find out what happened to the proposed link up project via video conferencing between the two schools

CONCORD SCHOOL

18/02/05 Letter to School Council re future research at Concord

06/03/05 Principal allocated me to the pilot project 121 ICT to work with Anna

13/03/05 20/12/05 worked on 121 ICT project and carried out participant observations

20/02/06 9/11/06 Visited the school on and observed classes on a weekly basis

9/11/06 Meeting with Transition Team teachers to join the team on a regular basis for 2007 (I was granted SSP from the University).

STUDY DURING MY SSP

TERM 1

07/02/07	Meeting – Richard, Ann, Principal
14/02/07	Class observation – ICT Richard
19/02/07	Class observation- Ann (Transition)
	Class observation/participation- Rhonda
26/02/07	Class observation- Ann (Transition)
	Class observation/participation- Rhonda
	ICT discussion with Richard
05/03/07	Class observation- Ann (Transition)
	Class observation- Rhonda
05/03/07	Class observation-Richard (ICT)
19/03/07	Class observation- Ann (Transition)
26/03/07	Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)

TERM 2

16/04/07	C Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)
23/04/07	Interview Principal
	Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)

30/04/07	Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)
02/05/07	Interview ICT Team Leader, Richard
	Discussed organisation of parental survey, skills matrix, and other resources (voice recognition)
07/05/07	Education Week- Class observations postponed
09/05/07	Class observation- Richard (ICT)
14/05/07	Class observation- Ann & Warren, careers activity
	Class observation/demonstration- Rhonda
21/05/07	Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)
28/05/07	Class observation/participation- Ann (Transition)
	Class observation/participation- Rhonda
	Interview- Rhonda– Transition Office Skills
	Class observation/participation- Richard (ICT)
30/05/07	Class observation/demonstration- Richard (ICT)
04/06/07	Planning Week
06/06/07	Class observation/demonstration- Richard (ICT)
13/06/07	Class observation/demonstration- Richard (ICT)
25/06/07	Class observation/participation- Ann (Transition)
	Interview Ann –Transition (Personal Development)
	Class observation/participation- Rhonda
	Class observation/participation- Richard (ICT)

27/06/07 Class observation/participation- Richard (ICT)

I continued with regular observations for the second half of the year with reduced frequency of visits to the school. (Returned to duty from SSP leave)

MACEDON RANGES

Original research started at Macedon Ranges in 2004, therefore it was necessary to return to this School and review the developments and changes that took place with respect to student numbers growth, and also Computing/ICT resources.

16/05 07 Meeting – Philipl, Tas, Arthur

30/05/07 Meeting- IT coordinator, Con , Tas

13/07/07 Meeting- APrincipal, Tas, Con

25/07/07 Meeting –APrincipal, Con, Tas

Data collected- School Implementation Plan, e-learning Education Technology Plan, Curriculum Development Plan, Software Catalog and Applications used in School, and Questionnaire to Principal completed.

3. Work relating to time spent at Concord, Bundoora

Observation and participation in class activities:

Classroom teacher- Ann

Activities included, interview of Ann, observation of students during normal class time and assistance with some of the technical aspects of the subject. This ranged from assisting students accessing special resources to designing special background and formatting of their powerpoint presentations, and folios of work.

Classroom teacher- Rhonda Office Skills

Activities included, interview (informal), class observations, and participation with certain demonstrations to assist with the design and implementation of the subject requirements. It was very important to observe the breakdown of skills into "getting ready to do the work", "doing the work", etc which showed the appropriate methodology and application of the manual, as well as the use of technology with laptops as an extension to the "121 Project" from 2005.

Classroom teacher – ICT - Richard

Activities included interview of Richard, (as he was one of the most important actors in this environment), participation in the delivery of some curriculum matter, for example, email. This was very challenging as it needed some sensitivity and the right level of approach to the topic. Refer to Appendix for summary of various software and recommendations.

Other- Work with individual students subject to parental permission. This involved the trialling of specific voice recognition software with a student in transition class or final year of School. The task revealed difficulties with the training in that the concentration span of the student was rather limiting. The training period was far too long to accomplish the voice pattern recognition for this student. The activity provided useful data for the research into adaptive technologies and their readiness.

4. Work relating to time spent at Macedon Ranges School, Sunbury

The purpose of the visit was to return to the School and complete the data collection from the previous phase in 2004. In addition, this gave the opportunity to see how the ICT program and computing resources have been upgraded from the earlier systems.

A parental questionnaire was also requested to be administered through the School Principal. The School has now set up a website where some of the official School data can be downloaded.

The visits have identified a significant change and development with respect to technology and ICT. The School has appointed an ICT administrator to provide assistance on a daily basis.

Questionnaire for School Principal

1. What got you into working with children with special needs?
   (relative, friend, university course, etc)

   What qualifications do you have in special Education?

   Have you thought of doing further related qualifications? Masters? If so why?

   Influence of Relative (Uncle) who held the position of Director of Special Education in Victoria during the late 70's and early 80's.

   Qualifications – Graduate Diploma In Special Education

   Graduate Diploma in Physical Education and Recreation for the Disabled.

   No thoughts to undertake a Masters Qualification.

2. What use of ICT do you make personally (not directly related to teaching)?

Personal use of ICT – Email, exploring areas of interest, net banking, photoshop,

3. What is your perception of how ICT is implemented/ used in the school? How effective do you think this is?

ICT implemented via e-learning plan based on learning and curriculum needs of students. ICT used to improve student learning outcomes. Network is expanded to meet present and future needs of both staff and students. Driven by ICT staff member and Technology Domain co-ordinator in collaboration with the consultative forum

4. How is ICT Learning /Policy developed and implemented in the school? Where does the drive come from?

As above.

5. What do you think the community view of ICT is in the school (employers, council, parents Edn Dpt etc)?

Parent community view is very positive. Learning programs (incorporating Literacy and Numeracy,as well as, life skills available to all students) DET actively pursues e-learning within the school.

6. In which area is the school regarded as a leader in learning for students with special needs?

Curriculum documentation, curriculum provision/resources, therapy services provision and student welfare.

7. What type of connection exists amongst the special schools?

Connected via special interest groups eg- PASS, Curriculum Co-ordinators, VCAL. Special Schools Annual Conference.

8. Does it make a difference to your school?

Yes. Resource sharing, not re-inventing the wheel collegiate/professional support.

9. To educational matters? Exchange of educational ideas?

Ad hoc sharing of educational ideas, but willingness to share if a request is made via email stream.

10. Where or what is the forum from which educational ideas and policies are exchanged or shared? Do you see this as an important aspect of the learning for students with special needs?

Principals Association for Special Schools (PASS) email stream.

11. How do you see the international component or relationships of the virtual communities? E.g. the UK? Is there a need for internationalization?

There is a need for internationalization. Present Dept infrastructure does not support it.

12. How do you see the importance of working with other virtual communities, e.g. special needs children (i.e. outside the school)?

This is important, particularly from a dissemination of information point of view for parents.

13. How is Curriculum developed and implemented in general?

Developed within a national framework – VELS and localized to suit individual student needs. Developed collaboratively at the local level via the Education Committee.

Appendix F: ANT Terminology

ANT orientation/ framework for initial report on each site

Site
Age of school
Number of students
Demographics
Number and nature of teaching positions
How long teaching personnel have worked there
How many researchers collaborated at this site

Actors
Students
Parents
Principal
Teachers
Teaching assistants
Central Office Consultants
Special Education Consultants
Policy Documents, Procedures and Protocols

The Actors and their Networks
(This section should examine the data with reference to key tenets of Actor Network Theory)
Beliefs
Attitudes, Interests and Motivation
Interests and Agendas
Networks and Stability
Alignment
Translation of Interests and Enrolment of Actors
Inscriptions and Precedence
Irreversibility
Black Boxes

Conclusion

Appendix F: Key ANT terms to guide the analysis (adapted from McBride 2005) **ANT elements**	**Relationship to study**
Actors are both human and non-human stakeholders who pursue…	Who are the actors? (Para-educators, teachers, adm staff, children, children with special needs, principals, parents, schools, policies, resource)
interests which may encourage or constrain…	What are the underlying, explicit or implicit, interests of the para-educators, teachers, children, children with special needs, principals, and parents?
network of interests which becomes	How do these networks of interests match/ clash with each other?
a stable as they are… ***Reach agreement or their interests are accommodated***.	How have networks become a stable over time?
aligned to the network. (Skills, practices, organisational arrangements and contracts may all be part of the process of alignment.) This alignment is achieved through the…	What skills, practices, organisational arrangements and contracts constituted the alignment of networks?
translation of interests (translating involves showing how an actor's non-aligned interests may become aligned) and the… ***Continual negotiation of actants to reach a compromise for allies in the network.***	What practices, attitudes, procedures or processes have ensured/ prevented the translation of interests into aligned networks?
enrolment of actors into the network. Alignment is established in… ***A set of roles identified and accepted and this leads to stable network***.	Who and what processes were responsible for the enrolment of actors?
inscriptions which give a particular viewpoint precedence. These become fixed and indeed may become ***Actant with certain properties, policies, viewpoints, etc***.	What policies, charters and verbal agreements constitute the inscriptions used to establish certain practices?
irreversible. That is, it may be impossible to go back to a point where there were alternative possibilities. They may in fact be so deeply embedded that they become… ***Association of elements cannot be undone***.	Are these inscriptions fixed and perhaps even irreversible? And if so, what makes them so?
black-boxes whose use is accepted without questioning how it works, or whether it represents the best way to do things.	Have the inscriptions become black boxes? And if so, what attitudes and practices

Network elements that become "frozen", it is a "given".	reinforce them?
Immutable mobile. Non-human actors, e.g. laptops, PDAs , Internet.	
Problematisation. Process in which an actor attempts to define the nature of the problem and the roles of other actors to fit the proposed solution.	The agenda for the 121 Project was problematised by key actors.
Interessement. Series of processes that attempt to impose identities and roles defined in the problematisation of other actors.	
Mobilisation. As the proposed solution gains wide acceptance and an even larger network of absent entities is created from spokespersons.	The 121 Project was mobilised to an implementation phase from the pilot in 2005.

Appendix G: Victorian Education Learning Standards – (VELS)

Strand	Domain	Dimension
Physical, Personal and Social Learning	Health and Physical Education	Movement and physical activity Health knowledge and promotion
	Interpersonal Development	Building social relationships Working in teams
	Personal Learning	The individual learner Managing personal learning
	Civics and Citizenship	Civics knowledge and understanding Community engagement
Discipline-based Learning	The Arts	Creating and making Exploring and responding
	English	Reading Writing Speaking and listening
	Humanities	Knowledge and Understanding Skills
	Mathematics	Number Space Measurement, chance and data
	Science	Science knowledge and understanding Science at work
Interdisciplinary Learning	Communication	Listening, viewing and responding Presenting
	Design, Creativity and Technology	Investigating and designing Producing Analysing and evaluating
	Information and Communications Technology (ICT)	ICT Skills ICT for creating ICT for communicating
	Thinking Processes	Reasoning, processing and inquiry Creativity

QQQ