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Abstract: The chapter examines recent changes in participation rates in Computing and Information Technology (CIT) subjects at the senior secondary level in New South Wales (NSW). It develops Downes' model for analysing curriculum from three alternative perspectives or standpoints – the curriculum as intended, as enacted, and as imagined. The curriculum framework from NSW is analysed, drawing upon the US-based ACM Model Curriculum for K-12 Computer Science. This reveals a shift in the current intended curriculum from an instrumental purpose in the early Stages (K-Year 10), to a discipline-based purpose in Stage 6 (Years 11-12). Discussion draws on these analyses, current literature, and data collected by the Gender and Information Technology (GaIT) research project to provide some insights into the basis for the confusions and complexities of the enacted and imagined CIT curriculum, as experienced by schools, teachers and students. The relationship of the intended curriculum to participation rates is questioned.

CONTENTS

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CHAPTER 1

Introduction: Exploring the gender and IT problem and possible ways forward

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THIS BOOK HAS GROWN OUT OF A RESEARCH PROJECT that focuses on gender and the study of Computing and Information Technology (CIT) at the senior secondary school level. It contributes to a longstanding tradition of inquiry regarding gender differences in participation within what have historically been considered the male-dominated disciplinary areas of science, engineering, mathematics and (more recently) Computing and Information Technology. What are popularly referred to as the 'Girls *and* …' problems (Girls *and* Science, Girls *and* Engineering, Girls *and* Maths …) have attracted the attention of many educational and feminist theorists and researchers. Over the past three decades, these researchers have explored the question of why fewer girls than boys participate in such areas, why this is considered to be a 'problem' and how this problem might be rectified. Despite advances made, these discipline areas continue to be seen as problematic by those who seek to promote females' equal and full participation in education and employment.

Participation rates for girls in CIT education, both at school and at university, continue to be significantly lower than those of boys, despite over 20 years of research attention, numerous waves of *intervention* and the vastly increased integration of computing technologies into our daily lives. Much of the research in this area has been stimulated by the CIT industry's need to attract more graduates, and its desire to include more women and a more diverse range of graduates suited to the new roles now available in this industry. Much of the existing research has therefore focused on reducing female attrition at the university level. This book builds on research at the school level that has begun to document complex gender differences in the nature and level of computer use by boys and girls, as well as the relations between computing as a field of practice and the gendering of identities within this field. We have sought to identify how the CIT curriculum is socially constructed as an area of study and how this influences the decisions boys and girls

make to pursue, or to avoid, CIT education pathways. Thus, we hope to develop a better understanding of the processes that occur during secondary school that lead to gender-based disparities in rates of entry to university CIT courses.

This introductory chapter is in three parts. First, I provide a description of the field of practice with which the book is concerned: CIT education. An explanation of the terminology used in the book is provided and the *gender and IT* problem is discussed. In the second part, I provide a description of the research project that is the basis of each of the subsequent chapters. Finally, the contribution of each chapter is introduced and discussed, and some preliminary recommendations stemming from this ongoing research project are outlined.

Part I: Computing and Information Technology (CIT) and the gender problem

What do we mean by CIT?

In this book, we are concerned with a diverse field of study and practice that we refer to as *Computing and Information Technology* (CIT). We use this term in three main ways: to refer to a school curriculum area, a major university discipline, and a group of industry sectors, all of which concern themselves with a particular category of technology. Artefacts — such as computers, computer software, computing accessories, handheld digital computing and communications devices, computer networking, and digital communication infrastructure — and the knowledge, processes and techniques that inform the development, implementation and servicing of these technologies, fall within the definition of Computing and Information Technology (CIT) used throughout this book.

In Australian schools, CIT education is manifested at the senior secondary level in subjects such as *Information Technology*, *Information Systems* and *Information Processing and Management*, offered at the Victorian Certificate of Education (VCE) level in Victoria;[1] *Information Processes and Technology* and *Software Design and Development*, offered at the Higher School Certificate (HSC) level in New South Wales; and *Information Technology Studies* and *Information Processing and Publishing*, offered in South Australia (SA). Similarly titled subjects are offered in Years 11 and 12 in other Australian states and territories. Content areas commonly included in these subjects include programming, software development processes, ethical issues involved in software development, project work and project management, information systems, systems development, computer hardware, communications technology and multimedia.[2]

1. Since the collection of data reported in this book, these (and other) CIT subjects in Victoria have been renamed. The pre-2006 names are retained here and throughout this book to reflect the names used by students and teachers in our school data.
2. Among the subjects listed above, *Information Processing and Publishing* is an exception in its inclusion of units focused on skills development in the use of business and publication applications (Kleydish & Downes 2007).

In response to the rapid growth of the CIT industry, university education in CIT has developed over the past 20 years from a specialty area located in Science and Engineering faculties to a number of sub-disciplines, many now forming the focus of independent university departments and faculties. University studies in CIT include areas such as electronics (as applied in the development of computing technology), computer science and software engineering, communications technology, information management, information systems, and (more recently) multimedia and computer game design. Most of the senior secondary school subjects currently offered in Australia, such as those named earlier, have been designed as pathways into university CIT courses — however, they are not prerequisites for entry into such courses. Most university courses in CIT require prerequisite study scores in English and mathematics. The Vocational Education and Training (VET) sector also provides opportunities for senior secondary school students to study CIT. VET certificates are offered in areas such as multimedia, software applications and network administration. These certificates do not usually provide a pathway into university education.

As an industry, CIT includes technology-focused sectors, such as Telecommunications and Consulting and Software Services, as well as personnel employed in non-technology focused businesses, for example in Finance and Administration and Government Administration and Defence (Multimedia Victoria 2005). Occupations within this industry include professional roles in areas such as Business and Systems Analysis, Database and Systems Administration, and Networking and Support (Australian Bureau of Statistics [ABS] 2006), which usually require at least a bachelor level qualification. The work of CIT professionals is often supported by technicians who hold diploma level qualifications. CIT technicians are also found in non-technology focused businesses, where they provide support for the maintenance of computer infrastructure and telecommunications networks (ABS 2006).[3]

A note on terminology

The terminology used to describe the field of practice discussed in this book is fraught with potential confusion. We have chosen to use a somewhat clumsy and unfamiliar term (Computing and Information Technology) to refer to the formal curriculum areas that explicitly focus on the domains of knowledge and skill outlined earlier. We chose not to use the more popular term *ICT* (Information and Communication Technology) because its common usage has led to a lot of slippage in meaning. In relation to school education, the term *ICT* is used in a number of

3. Although these areas are subject to similar gendered patterns as other CIT occupations, technical roles and the types of education and training pathways that lead to them are generally seen as outside of the scope of the research project, because these employment outcomes are not recognised as part of the CIT undersupply problem. That said, gendered patterns of employment in such technical roles are likely manifestations of some of the same issues that we explore in this volume.

different ways. In most Australian states, *ICT* is now used to refer to the computing hardware and software available in schools, the integration of this technology across the school curriculum, the development of students' skills in the use of these tools (which is currently promoted as a cross-curricular or interdisciplinary enterprise in all Australian states and territories), and sometimes to the elective or mandatory specialist CIT subjects offered in Years 7–10. To add to the confusion, junior-level CIT subjects are often referred to as *IT* (Information Technology). Among educators, the term *ICT* is often used interchangeably with *IT* as evident in references to *ICT teachers* and *IT teachers*. It is also sometimes used by senior CIT teachers when referring to the formal curriculum area that we call CIT. Despite CIT teachers' own usage of these other terms, in this volume we will consistently use terms such as *CIT education*, *CIT subjects* and *CIT teachers*, to avoid potential confusion. As a term, *Computing and Information Technology* appropriately reflects the current focus of many of the state senior CIT curricula in relation to the disciplines of computer science and information technology.

Importantly, we wish to distinguish between CIT as a formal curriculum area or discipline and initiatives which seek to increase students' general ICT literacy. This distinction is somewhat artificial and potentially deceptive in a number of ways. First, one might expect to see a developmental path in students' learning as they move from encountering computing technologies in their other curriculum areas towards studies in senior CIT subjects. However, as discussed in Chapter 4 by Downes, such pathways are rather haphazard and are rarely formalised (if they can be said to exist at all) at the school level. There are, in fact, distinct differences in the focus and aim of K–10 ICT initiatives and senior CIT subjects, such that their relationship is more often characterised by discontinuities and tensions,[4] rather than a developmental pathway. However, despite discontinuities in the formal curriculum, specialist CIT subjects and cross-curricular ICT initiatives are both sources of students' CIT learning, as are their out-of-school experiences with computing technology. In the eyes of our participants, particularly Year 10 students who have no direct experience of senior CIT subjects, the distinction may not be particularly meaningful. Further, the relationship between performances of gender and the construction of technology can be assumed to cross over the line we are drawing between specialist senior CIT subjects and other sites of technology use, both in and out of schools. The distinction is artificial; however, it serves a pragmatic purpose in defining the scope of our research and clarifying the distinction between the generic uses of computing and IT tools, and CIT as a specialist subject. It is also a useful device for focusing our attentions on the processes and constructions that pertain specifically to the problem we seek to illuminate — the persistent low numbers of girls enrolling in senior CIT subjects — and how aspects of this problem interact with, and are influenced by, performances of gender and technology at other sites.

4. This point is taken up in detail by Toni Downes in Chapter 4 and by Catherine Harris in Chapter 5.

In my opening paragraph, I referred to the 'girls and …' problems; however, limited participation of females in historically male-dominated fields is no longer seen merely as a *girls' problem*. Inquiry and intervention in such areas have moved beyond feminist movements of the 1970s and 1980s where it was believed that changing girls' attitudes and behaviours could lead to equal participation (Dillabough 2001). Instead, we frame the different attitudes and behaviours of girls and boys as a *gender* issue: children learn to perform particular versions of femininity and masculinity, influenced by the multiple and sometimes conflicting messages about what it means to be a girl or boy which emanate from a range of sources within their cultural context (see chapters by Robinson & Davies and by Rowan in this volume for more detailed discussions of contemporary perspectives on gender). Such performances can be self-limiting in terms of orientation to educational and career choices and they are notoriously difficult to *interrupt*. This understanding of gender underlies the research project upon which this volume is based.

Gender and CIT: What is the problem?

The low level of participation of girls and women in CIT education, training and careers is an enduring problem. Despite the considerable improvements made over the past three decades in terms of gender equity in other areas of education, enrolments in CIT subjects and courses continue to be low in schools and universities, with women making up less than 30% of CIT university enrolments (James, Baldwin, Coutes, Krawse & McInnis 2004). This is seen as an equity issue and also as a problem for the CIT industry, which anticipates worsening current shortages in specialist skill areas if more school students (both boys and girls) cannot be recruited into university courses (Department of Communications, Information Technology and the Arts 2006; Multimedia Victoria 2004).

Problems do not exist independently of the perceptions of stakeholders, and a problem for one group is not necessarily constructed as a problem (or the same problem) for another. The key stakeholders in the gender and IT problem include:

- Employers and industries who have economic interests in the status, sustainability and outcomes of school education in this area.
- Managers and educators in university CIT departments whose work and careers are invested in attracting school leavers to university CIT courses.
- Curriculum developers and teachers who work with the CIT curriculum.
- Students (and their parents and guardians) who hope to gain a range of returns (e.g. social, cognitive, emotional and economic) from their formal schooling experience and qualifications.

The interests of each of these stakeholder groups are outlined briefly in the following pages.

Employers, industry and the nation: A problem of skill supply and failed public relations

A commonly told story of the CIT industry, in Australia and internationally, is one of 'boom and bust'. This perception was established during the mid- to late-1990s when reports in the popular media were dominated by developments in the United States stock market, which became known as the 'dotcom' phenomenon. During the height of this period of rapid growth, the Internet and related businesses were seen as a limitless source of employment. However, by 2000, the 'dotcom bubble', as it became known, was beginning to burst and this was also widely reported in the popular media, as was the resulting 'glut' of CIT workers. University enrolments then decreased as the opportunities for employment declined (Frauenheim 2004; Lea 2006). Apart from a few notable exceptions (e.g. multimedia and computer game design, and double degrees in business and CIT), the numbers of students enrolling in Australian university CIT courses has declined steadily since the 'bubble' burst (Dobson 2007).

Seven years later, the CIT industry no longer commands the attention it did during that period of dramatic change, and the general public are not as well versed in the subsequent developments in the industry, or with the trends anticipated for the future (State Government of Victoria 2006). In fact, as is supported by the findings of our research, the dotcom story is still at the forefront of our imaginings about this industry. The students and teachers we interviewed still perceived the field as one that is in decline or, at most, lukewarm in terms of exciting employment opportunities. Consistent with this image of the CIT industry are the continued sluggish enrolments in university CIT courses. However, despite these popular perceptions, government and professional bodies report that the need for CIT graduates in Australia is not being met and that the industry, as well as other businesses that employ CIT professionals, face a potentially serious shortage of skills in the next few years (Department of Communications, Information Technology and the Arts 2006; Multimedia Victoria 2004). Even before the dotcom collapse and related declines in interest in CIT careers, women were seen as an untapped pool of potential graduates. In Australia, women make up only 15% of the Australian CIT industry and this 15% is over-represented in computing support roles and under-represented in computing professional roles (Department of Communications, Information Technology and the Arts 2006).

As well as misconceptions around employment and career opportunities, the CIT industry struggles against stereotypical but inaccurate images of the nature of work within the industry. The traditional stereotype is one of a male, socially inept, computer programmer, working 'twenty-four/seven' in isolation and in intense connection with his computer terminal. Contrasting images that circulated during the dotcom period of moneyed male youth, with flashy cars and online empires, do not seem to have dented the more traditional stereotype. A Victorian study of attitudes of 17–19-year-olds found 59% agreed that a career in CIT meant sitting in

front of a computer all day, with a similar proportion agreeing that a career in CIT would be boring (Multimedia Victoria 2004). This study also found that young women, in particular, emphasised the importance of creativity, human interaction and job security as important aspects of a career — characteristics they did not associate with careers in CIT (this finding is discussed in the chapters by Gannon, Robinson & Davies, and by Vickers & Ha).

The CIT industry, professional organisations and state governments have put considerable effort into countering these beliefs through campaigns that target school-age and university students, seeking to emphasise the new types of roles and ways of working that have emerged. These campaigns promote the collaborative, project-based nature of much of the work of a CIT professional, emphasise the importance of interpersonal and communication skills and highlight management opportunities. Recent examples of campaigns promoting the industry more generally include The Australian Computer Society's (ACS) *About ICT Industry* video (ACS n.d.) and the Victorian Government's *Upload your future* student career sessions (State Government of Victoria 2007). Examples of initiatives specifically targeting girls and women include *Go Girls, Go for IT* (Victorian ICT for Women n.d.; Women are IT WA n.d.) — a series of events run by different professional networks in a number of states, providing career advice to school-age girls, and *Elev@te* (YWCA 2007) — a three-day camp that aims to increase school-age girls' confidence and exposure to technology.

CIT employers and industry bodies generally recognise that a range of public relations exercises, particularly those targeting girls and young women, are important both in terms of recruiting greater numbers into the industry, as well as increasing the diversity of recruits. Women are sought after, as they are seen as a source of much needed communication, networking and lateral thinking skills (Roan & Whitehouse 2007). The CIT industry research literature also recognises that, despite the illegality of formal barriers to women's participation, women continue to encounter subtle forms of discrimination in what is a predominantly male dominated workforce (Anderson, Timms & Courtney 2006; Webster 2005). Although roles and work practices in the CIT industry are increasingly being promoted as women-friendly in their focus on projects, collaboration and interpersonal communication — as pointed out by Gannon in Chapter 8 of this volume — it is also an industry dominated by contract work and salary bonuses. Gannon suggests that the flexibility and mobility of this industry can be read in ambivalent ways by women.

University departments: Death or rebirth of an academic discipline?

The number of students pursuing university studies in CIT has been decreasing in Australia since 2000 (Dobson 2007). This is part of an international trend which has very few exceptions among western countries. In Australia, there are a few courses which are exceptions to this trend. Courses that have not suffered a decline

in numbers include those that emphasise computing application, focus on multimedia and games development, and that are offered as double degrees with business courses. Overall numbers of university CIT students have dropped; however, the fall in female enrolments has been greater than the fall in male enrolments, and it started from a much lower base. In 2002, only 24% of Australia's university enrolments in ICT courses were women (James, Baldwin, Coutes, Krawse & McInnis 2004).

There is ongoing debate among university academics and CIT professional organisations about the sustainability of disciplines such as computer science, given the continuing decline in enrolments. Some argue that the traditional computer science curriculum (with a primary focus on programming) is no longer suitable for the preparation of today's (and future) CIT professionals (Timson 2007). More interdisciplinary studies with a focus on the application of technologies may ultimately prove to be more attractive and more suitable (e.g. McBride 2007). Such beliefs are increasingly evident in the strategies used by universities to attract more students. Courses and promotional materials are beginning to emphasise connections between computing and the creative arts, between computing and other sciences, and between computing and business studies. New courses in multimedia and gaming and other aspects of computing perceived as being 'more fun' are being developed and promoted. Partnerships between university departments and high profile commercial groups such as Microsoft® and Cisco® are also seen as a means of attracting students who might otherwise be nervous about pursing more traditionally focused computer science and software engineering courses.

Curriculum workers: Navigating competing agendas

It is widely recognised by secondary CIT teachers and educational authorities that senior CIT subjects have experienced dramatic decreases in enrolments over the past several years. A review of participation rates in Year 11 and 12 CIT subjects over the past five years in the three states participating in our research revealed significant drops in participation in most CIT subjects (Kleydish & Downes 2007). This was particularly the case for subjects that focus on the disciplinary knowledge of computer science, with subjects focusing on applications faring less badly. Exceptions to the general decrease in enrolments were the *Information Processing and Publishing* subject in South Australia, which has a significant emphasis on skill development in applications, and VET studies in Multimedia in both NSW and Victoria (Kleydish & Downes 2007).

The general decline in senior CIT enrolments is a problem for curriculum workers, particularly teachers, who have emotional and material investments in the sustainability and status of CIT as a school subject. For teachers who have invested time, energy and status in the development and delivery of CIT education as a specialist area in which they are the experts, the decline in enrolments represents

a threat to the future viability of such subjects. To such teachers, the decline of this subject area would require them to recast and reposition themselves and their expertise within the context of their workplaces. The positioning of CIT teachers as members of staff is complex. They often play multiple roles as computing experts in the school who, further to their specialist teaching role, promote and support computing across the curriculum, as well as playing managerial and support roles in relation to their schools' computing infrastructure and related resources. As Harris points out in Chapter 5, cross-curricular ICT initiatives and specialist CIT subjects often have conflicting agendas, as well as being in competition for resources, which adds to the complexity of the micropolitics of being a CIT teacher.

Some teachers and schools have taken steps to attract more students to post-compulsory CIT subjects by attempting to increase general interest, or to interest girls specifically. Some CIT curriculum documents make explicit reference to the suitability of this area of study for girls. For example, the syllabus for the NSW Stage 6 subject, *Software Design and Development*, states that this subject is intended for both girls and boys, pointing to an emphasis in the content on creativity, problem-solving and collaboration. State education departments have also undertaken initiatives to increase girls' enrolments in CIT studies; for example, the Queensland Department of Education, Training and the Arts (2006) has developed a *Girls and ICT Strategy*, along with a range of multimedia and other resources, that is intended to help schools in that state increase girls' interest in CIT studies.

Students and parents: Why CIT is not a problem

With the convergence of computing and communication technologies, their use in the home for work, education and leisure has increased dramatically over the past two decades (OECD 2001). Young people in Australia are high users of new technological gadgets, particularly mobile phones, music (MP3) players and social applications of the Internet (ABS 2007). However, while this growing fascination with network and communication technologies might be thought to correlate with an increase in interest in CIT education, there are other cultural forces that possibly mitigate against this outcome. The increased interest in, and usage of, such technologies does not necessarily lead to an interest in learning about the disciplinary knowledge that underpins the engineering logic embedded in these devices. Today's university students have grown up with these technologies and largely take them for granted. They are generally not privy to the history behind their development and the initial excitement that surrounded the invention of the first microcomputers and the use of computer chips in household equipment. The science that is behind the development of such technologies is extremely remote to the vast majority of a generation who are considered by some to be 'digital natives' (Prensky 2001). This point was brought home in a recent *Sydney Morning Herald* (Timson 2007) article, where Justin Zobel of RMIT University pointed out that current first year university students were only six years old when

Windows® 95 appeared on our desktops. It is possible that the increased integration of technologies into the social environment in which young people inhabit actually reduces interest in CIT as a disciplinary study.

Other potentially mitigating factors include narrow, outdated understandings of what a career in CIT might entail, and potentially contradictory messages about CIT jobs and employment opportunities. Our student interview data suggest that not only do a large proportion of students (particularly girls) find school CIT education boring and irrelevant to their aspirations, but they also see it as a bad strategic choice in terms of immediate returns in their final school certificate scores and in terms of long-term career prospects.

Part II: The GaIT Project

Each chapter of this book reports preliminary findings from our research project, funded by the Australian Research Council's (ARC) national competitive grants program, titled *From High School to Higher Education: Gendered pathways in information, communication and computer technology education*. This project was funded as a Linkage Project by the ARC in the 2005 round of competitive grants for a three-year period ending in 2007. It is supported by the following industry partners: Robert Stevens and Ruth Habgood from the New South Wales Department of Education and Training, Viv White from the Australian National Schools Network, Ken Lountain and Dianne Mellowship from the South Australian Department of Education and Children's Services, and Alexandra Shehadie from the Office for Women in the New South Wales Department of Premier and Cabinet.[5] The project has become known (and in this book will be referred to) as the *Gender and Information Technology* (GaIT) project.

The GaIT research team draws on expertise from three Australian universities: Charles Sturt University, Deakin University and the University of Western Sydney. It comprises a range of skills and knowledges spanning both quantitative and qualitative research methodologies, and expertise in such diverse content areas as youth studies, technology and education, educational diversity and disadvantage, school curriculum and subject culture, teachers' work and teacher identity. This diversity is reflected in the authorship and flavour of the chapters included in this book and is one of the strengths of the volume.

In the section that follows, I outline the aims and methodology of the research project and briefly describe the range of approaches to data analysis taken by the authors of subsequent chapters. In terms of the project design and data collection, this chapter serves as a reference for other chapters, all of which draw on the data described here. However, the foci and analytical approaches taken by individual authors will be expounded in detail within individual chapters as appropriate.

5. The views expressed in this book are those of the respective authors only, and may not reflect the views of the Industry Partners or their respective organisations.

Project aims and scope

The broad aims of the GaIT project are (1) to ascertain why the proportion of girls who enter education pathways leading to CIT careers continues to be so small and (2) to identify strategies that might lead to increases in the numbers of girls who qualify for, choose, and enter CIT courses at the higher education level. With a view to meeting these aims, the following research questions were framed as drivers for the design of the project:

- How do girls and boys decide what to study at Years 11 and 12?
- What are girls' and boys' understandings and opinions of secondary school CIT subjects, CIT career-related courses and CIT-based careers, and what informs these understandings?
- Why do girls and boys choose or reject post-compulsory CIT educational pathways, including senior secondary CIT subjects?
- How do post-compulsory curriculum structures, school contexts and pedagogical practices affect boys' and girls' interests in pursuing studies in CIT-related areas?
- What changes need to be made at the school level to better and more accurately promote CIT industries, and the educational pathways that lead to them, to girls and boys?

To answer these questions, a multi-staged project was designed that included teacher and student interviews and a student survey. The school-based data were complemented by an analysis of student participation in post-compulsory CIT subjects, based on data from state boards of study, and by an analysis of state CIT curriculum documents and interviews with selected curriculum designers. The states included in the study were New South Wales (NSW), South Australia (SA) and Victoria. The study confined its school-based data collection to teachers involved in the delivery of CIT education and students undertaking the latter part of their secondary schooling: those in Year 10 in 2005 about to embark on their post-compulsory secondary school studies (who may or may not have elected to pursue future post-compulsory studies in CIT), and those in Years 11 and 12 in 2006 and 2007 respectively who had had varying degrees of opportunity to reflect on their senior secondary subject choices.

Most of the chapters in this volume were written early in 2007. At this point, data collection was completed but a year of project analysis and reporting remained. Thus, most of the chapters focus on responding to the first of our aims — to ascertain why so few girls pursue CIT education. This is undoubtedly the easier of the two aims to meet, for it involves an analysis of the situation at hand. Devising strategies that might lead to change is a much more ambitious aim, particularly when broader social forces and issues of identity are involved. That said, a number of the chapters make implicit and/or explicit recommendations in terms of pedagogy, curriculum, teacher education and professional development, and other aspects of the gender and IT problem. These, along with the key finding reported in each chapter, are summarised at the end of this introductory chapter.

Data collection

A mixed methods approach was taken to exploring how CIT is socially constructed as an area of study, how CIT educational pathways become gendered, and how this influences the decisions of boys and girls, to pursue or reject post-compulsory CIT education. The data collection methods employed included semi-structured teacher interviews, a (largely quantitative) student survey, and semi-structured interviews with groups of students. The selection of participants for these parts of the study was driven by the selection of schools. In the recruitment of schools to the project, we sought to vary the level of female CIT enrolment, the socioeconomic profile of the schools, and the location (urban, rural and metropolitan) of the schools.

In total, 26 schools participated in the study (12 from NSW, seven from SA and seven from Victoria). Only 22 of these schools participated in all data collection phases (teacher interviews, student interviews and student surveys). School pseudonyms and summary profile information (female participation, socioeconomic status, and location) are tabulated in Appendix A, by state. Teachers were also given pseudonyms. Pseudonyms are used consistently throughout this book where it has been appropriate to refer to particular schools and particular individuals. Of the 26 schools, 10 were metropolitan, six were located in regional centres, and 10 were rural. In terms of female participation in post-compulsory CIT subjects, nine had a high level of participation, three had a moderate level of participation and 14 had a low level of participation. Because of the low overall percentage of girls enrolled in senior CIT subjects in Australia, a Year 12 participation rate above 40% was described as *high*, while a rate between 20% and 40% was considered *moderate*, and a rate below 20% was considered *low*. In terms of socioeconomic status (SES), four schools were classified as high SES, 10 were medium SES and 12 were low SES. These classifications were based on information from respective state authorities.

Each mode of school-based data collection is outlined here.

Teacher interviews

CIT coordinators and other teachers of senior CIT subjects were interviewed in each school. Through these interviews we sought three main types of information:

- school demographic information;
- information about the school's CIT education, including subjects offered, resourcing and support, level of participation by boys and girls, student performance and student destinations, and any special programs or initiatives; and
- teachers' perceptions of CIT education and the IT and gender problem, including their perception of the value of senior CIT subjects, their views on the advantages and disadvantages of specific Year 11 and 12 CIT subjects, their understanding of students' subject choices and their explanations for the gender gap.

The teacher interviews were conducted either via telephone or in person, depending on the proximity of schools to the researchers, and were audio-recorded and subsequently transcribed.

Student survey

A quantitative survey was developed to explore how students decide what subjects they would study in Years 11 and 12 and what factors might influence their decisions to pursue, or to avoid, CIT subjects. Through a 35-item survey we sought to attain individual demographic information, perceptions of schooling, reported computing skills and behaviours, plans for future study, reported motivators for subject choice, career aspirations, and perceptions of CIT careers. The survey was administered to students who were either at the end of Year 10 or in the early stages of Year 11 in each school. The numbers of students surveyed in each school varied, based on practicalities within each school. In total, 1430 completed student surveys were returned.

Student interviews

Students were interviewed in small groups ranging from three to seven students, with most comprising four or five students. Sixty-six groups of students were interviewed. In most cases, students were grouped according to gender and level of interest in CIT (as indicated by their survey responses), such that, where practicable, groups could be categorised as *high interest girls*, *low interest girls*, *high interest boys*, and *low interest boys*. In some cases, due to practicalities in particular schools, student groups included both boys and girls. Through these interviews we sought to gain insight into students' perceptions of CIT and their CIT behaviours, their ideas about the CIT subjects offered in their school and of the teachers who teach them, their views of the CIT industry and careers, and their explanations of the gender gap in CIT education and careers. Student interviews were audio-recorded and subsequently transcribed.

Curriculum review

Alfred Kleydish was commissioned by the GaIT project to conduct a review of Year 11 and 12 CIT curriculum documents in each participating state, as well as a summary of female and male enrolment trends.

Limitations

An important data source that was not included in this study was the direct observation of CIT classroom. We have relied upon the reports of students and teachers to provide insight into what goes on when current CIT curricula are implemented in classrooms. Our view of this important site of gender and CIT politics is, therefore, limited, and is presented as such in the chapters that follow.

Analysis

A range of analytical methods have been employed in order to make sense of the large body of data collected via the methods outlined earlier. Chapter 2 by Vickers and Ha reports findings from an exploratory factor analysis of the quantitative student survey data. Chapter 4 by Downes uses a model-driven content analysis to examine curriculum documents, as well as providing a comparison of student participation rates in a range of subjects, comparing male and female participation rates over time in NSW. In Chapter 8, Gannon uses summary statistics to describe characteristics of the CIT job market, as well as providing a discussion of a particular CIT syllabus. Chapters by Rowan, Harris, Robinson and Davies, Reid and van den Akker, and Gannon, all use various forms of thematic content analysis to support their reporting of the qualitative teacher and student interview data. Where appropriate, specific data analysis methods have been elaborated in particular chapters.

The final part of this chapter examines the contributions of the book, discussing the main conclusions and implications of each chapter.

Part III: Contribution of this book

In the seven chapters that follow, drawing on parts of a common data set, the authors bring a range of perspectives and their diverse expertise to bear on the question of why overall participation in senior secondary CIT subjects is decreasing, why the participation of girls continues to be so low and indeed continues to decrease, and what avenues might be explored as a response to these problems. The chapters have different but overlapping foci: three of them explore issues in relation to the CIT curriculum (Downes; Vickers & Ha; Harris[6]), two pursue issues of pedagogy (Gannon; Reid & van den Akker[7]), four examine issues related to CIT teachers (Harris; Reid & van den Akker; Rowan; Robinson & Davies[8]), and four address issues relating to students (Vickers & Ha; Rowan; Robinson & Davies; Gannon[9]). The contribution of each chapter is discussed here in relation to these four aspects of the gender and IT problem — curriculum, pedagogy, teachers and students.

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6. While the primary focus of chapters by Vickers and Ha and by Harris are 'students' and 'teachers' respectively, each contributes to our understanding of the CIT curriculum: how it is perceived and the micropolitics that surround it.
7. While the primary focus of Reid and van den Akker's chapter is CIT teachers, their analysis extends to different pedagogical approaches and how they feature in the broader context of teachers' work and lives.
8. The chapters by Rowan and by Robinson and Davies focus on students' gendered constructions of CIT and of themselves as CIT students and users of technology; however, in their attention to the contribution of teachers' beliefs and behaviours to such constructions, they both provide insight into how teachers conceive of CIT and the 'girls and CIT' problem.
9. Although the primary focus of Gannon's chapter is CIT pedagogies, a key contribution is her analysis of students' reported experiences of such pedagogies, thus adding to the picture we have of students' beliefs about CIT subjects.

CIT curricula

Curriculum is an important aspect of the gender and IT problem. Central questions include:

- What is included and what is not included in the formal curriculum?
- What do manifestations of curriculum frameworks and syllabuses look like in classrooms?
- How are CIT curricula (as intended and as enacted) perceived by teachers and students?
- What impact do each of these have on participation generally and on the participation of girls specifically?

The answers to each of these questions have the potential to illuminate the processes behind boys' and girls' subject choices, the reasons behind the decline of CIT enrolments and the persistent and worsening gender gap.

In Chapter 4, Toni Downes provides a detailed analysis of enrolment patterns and the *intended* curriculum (i.e., syllabus documents) in New South Wales. She uses the ACM Model Curriculum for K–12 Computer Science (Tucker, Deek, Jones, McCowan, Stephenson & Verno 2003) to analyse the foci and purpose of intended CIT curricula in this state from Kindergarten to Year 12. Her analysis draws attention to gaps and discontinuities in the scope and sequence of CIT school education. Specifically, she describes the shift in focus from curricula which, in the K–10 years, focus almost exclusively on applications and computer literacy, to senior years' curricula wherein a *discipline-based* approach sees students focusing on substantive concepts from the disciplines of software engineering and information technology. Downes suggests that this discontinuity may have a deleterious effect on senior CIT enrolments because of the ill-informed beliefs that students form about CIT subjects, based on their K–10 experience.

This analysis is supported by the findings reported by Margaret Vickers and My Trinh Ha (Chapter 2), where the authors demonstrate that students expect Year 11 and 12 CIT subjects to have a similar focus on skills development and common software applications as those computing studies subjects encountered in the more junior year levels. Downes develops the concept of the *imagined curriculum* to describe the constructions of students who have no direct experience of Year 11 and 12 CIT subjects, yet need to choose whether to enrol in these subjects based on their perceptions of what they might entail and what purposes they might serve. As other chapters point out (e.g. Chapter 7 by Reid & van den Akker), sources of alternate messages about senior CIT subjects vary between schools, with many providing very little encouragement in terms of career advice relating to these particular subjects. Students' prior experience of school-based CIT education dominates in its influence on the *imagined* CIT curriculum. Taken together, these analyses demonstrate how both K–10 CIT subjects, and computer use as it is framed by other non-CIT syllabuses, support misconceptions of senior school CIT curricula and potentially narrow understandings of what higher education or careers in CIT

might look like. Downes' analysis of the instances of CIT education found in non-CIT syllabuses is also supported by arguments put by Catherine Harris in Chapter 5, who describes how CIT subjects and ICT cross-curricular initiatives are often 'at loggerheads' in terms of purpose and resources. A theme common in most of the chapters is students' narrow understandings of what senior CIT education and related higher education and careers might entail.

As well as providing some insight into how the nature of current school curricula might contribute to low senior enrolments, Downes also illuminates the recent downturn in enrolments and examines the impact of recent curriculum changes. Downes presents an historical analysis of participation rates and curriculum changes in NSW CIT subjects, revealing that previous (1995–2000) growth in student numbers (including significant growth in the proportion of girls) correlated with the instrumental focus of CIT subjects during that period. She speculates that this instrumental focus might have contributed to the relatively high pre-2001 proportion of female students participating in NSW senior school CIT education. She also suggests that the significant change in orientation of the senior CIT subjects (away from a focus on applications and computer literacy towards a focus on disciplinary knowledge), which occurred as part of the 2001 curriculum redevelopment, may have contributed to the decline in female participation which followed.

Together, these chapters help us to define and understand some of the ways in which curriculum issues contribute to low and declining overall enrolments in CIT subjects. What 'studying CIT' might mean is confounded by the lack of clear distinctions between CIT itself, and the use of technology in cross-curricular ICT initiatives. For many students, their extensive use of sophisticated computers at home, combined with the 'computer literacy' focus of the junior curriculum, leads them to conclude that they have little to gain from continuing their formal study of CIT into Years 11 and 12. Part of the problem lies in the imaginings Year 9 and 10 students construct, but these imaginings in turn build on and magnify problems that are inherent in the intended and enacted curriculum. Taken together, the Downes, Vickers and Ha, and Harris chapters raise important questions about the gendering of curriculum and provide a critical lens for future curriculum enquiry in this area.

CIT pedagogies

The gender and IT problem, and declining numbers more generally in CIT education, is increasingly framed as one of student disinterest. Pedagogy has the potential to influence students' enjoyment of school subjects and thereby to increase their motivation towards further study in this subject area. Pedagogies also have the potential to provide students with insights into the nature of work within particular fields and careers so are an important, but often overlooked, vehicle for raising students' awareness of CIT careers.

In Chapter 8, Susanne Gannon explores girls' experience of the new NSW *Information and Software Technology elective (IST)* (NSW Board of Studies 2003) by examining the pedagogical assumptions of the syllabus documents supporting the new curriculum, as well as teachers' and girls' reported experiences and opinions of it. As with a number of the chapters in this volume (Robinson & Davies and Vickers & Ha), Gannon focuses on the reported experiences and opinions of the 'high interest' girls, that is, those identified through their earlier survey responses as having a high level of interest in computing and information technologies.

In her analysis of the pedagogical assumptions behind the IST curriculum, Gannon identifies a strong emphasis on collaborative project-based project work and links with the community. This analysis is contextualised within a discussion of academic literature on innovative practices in the pedagogical use of ICT, and industry recommendations that CIT school education should reflect dominant CIT work practices, both which support the use of project-based pedagogies. She finds that the IST curriculum documents incorporate pedagogical directives informed by those recommendations emanating from research and from the CIT industry. However, both student and teacher interview data suggest that the types of project-based collaborations and links with community enterprises advocated in the formal syllabus documents are rarely seen in schools' implementation of the new IST curriculum. More often, students reported a dominance of individual book work and individual computer skills work. Gannon discusses the many forces that can mitigate against teachers' adoption of recommended pedagogical approaches and how the very nature of teachers' work as professional educators necessitates a transformation of intended curricula into local contexts. She provides an example of how the same CIT syllabus documents can be implemented in significantly different ways in different teaching contexts.

Gannon examines teacher and student interviews from five NSW schools. Her findings suggest that girls tend to lose interest as they progress in this subject due to a dominance of learning activities that they find uninteresting. The girls' perceptions of CIT pedagogies were constructed around a *creative* versus *theoretical* binary, where the adjective *creative* was used to describe design-based activities that make use of software applications (particularly multimedia and web-authoring software) and *theory* referred to book work and essay writing. The girls expressed a preference for activities that they characterised as *creative* and a strong dislike for what they termed *theory*. Within such a binary, there is no room for imagining creative approaches to theory or more generative views of the relationship between theory and practice. Nor is there — returning to the work by Downes and by Vickers and Ha on students' imagining of the senior CIT curriculum — room within the framework of these girls' perceptions for the possibility of a creative approach to fundamental computing science theory and processes. In Chapter 6, Kerry Robinson and Cristyn Davies point out that interest, or lack of interest, in particular CIT activities is often gendered, influenced by hegemonic discourses of gender that

position boys and girls differently. Similarly, these girls' desire for the *creative* and rejection of *theory* can be read as consistent with dominant constructions of femininity. Leonie Rowan, in Chapter 3, also takes up the issue of gendered interest and constructions of femininity, demonstrating how, when students explain gender differences in participation in CIT education, they describe 'natural differences' between boys and girls. Rowan also points out that, in terms of interest in CIT subjects, individualised computer-centred pedagogies are off-putting for both girls and boys.

It is conceivable that project-based pedagogies, should they be implemented, might hold some potential in terms of deconstructing the *creative* versus *theoretical* binary, challenging girls' (and boys') beliefs about school-based CIT education and attracting more students to enrol in senior CIT subjects. In Chapter 7, Carol Reid and Jose van den Akker describe the case of one school (Yellow Robin High School), where a female CIT teacher has bolstered female CIT enrolments by exploiting links with the local community and the informal networks that support the social relationships of the school — suggesting that as a response to declining female enrolments in CIT education such approaches warrant further attention.

Gannon's chapter sheds light on how students' experiences of different pedagogical environments can serve to further reinforce their narrow constructions of CIT as a field of study and practice. Gannon's analysis focuses on the constructions of 'high interest' girls; however, it is conceivable that the impressions these girls have of different pedagogical approaches, and their limited/limiting conceptions of the relationship between theory and practice as manifest in CIT education, could be shared by girls more generally and by boys as well. In fact, data excerpts quoted by Gannon suggest that some teachers have quite narrow conceptions of how the theory and practice of CIT might be incorporated into their classes. Similar *theory* versus *practice* constructions are identified in Harris's chapter on teachers and CIT subject subculture. However, Gannon warns that, although negative evaluations of CIT pedagogies may be disincentives for future interest in this subject area, positive experiences do not necessarily translate into future enrolments in CIT subjects. Some of the other factors that might contribute to girls' (and boys') decisions to discontinue CIT studies are discussed under 'Students and CIT' beginning on page 21.

CIT teachers

The beliefs and attitudes of teachers, as well as their behaviours and pedagogical practices, have the potential to affect powerfully the beliefs, attitudes and behaviours of students. Two chapters of this volume take CIT teachers as their primary focus. In Chapter 5, Harris uses a case study of one Victorian school (Otter College) to examine CIT teachers' self-perceptions, their perceptions of CIT as a school subject and how these contribute to CIT *subject subculture*. In Chapter 7, Reid and van den Akker explore the diversity of knowledge, practices and attitudes found

amongst CIT teachers from 12 NSW schools and examine how power and agency feature in these teachers' work and the differential effects of different power strategies on participation in CIT education.

Harris explains that, compared with other subject areas, very little work has been done towards understanding CIT as a school subject subculture, with much of the research into technologies in schools focusing on cross-curricular initiatives and the responses of non-computing specialist teachers. Harris focuses on what she terms the 'middle ground' of curriculum; that is, how teachers, through their beliefs and their talk, begin to enact curriculum before they enter the classroom. She cites research that suggests teachers' constructions of CIT subjects influence students' beliefs about these subjects. She also demonstrates how, within the same school, teachers' different career histories, as well as their CIT education and training and roles within the school, can lead to different perceptions of CIT subjects and different understandings about their roles as CIT teachers. Her observations resonate with those of Gannon and of Reid and van den Akker on how different teachers working in different contexts can implement the same curriculum documents in very different ways.

As part of the context to this chapter, Harris provides an overview of the positioning of CIT in Victorian school curricula. She describes the shift from a cross-curricular and interdisciplinary focus in the K–10 years to more differentiated, subject-based curricula in the post-compulsory years. However, she points out that many Victorian schools continue to offer both mandatory and elective CIT subjects during the compulsory years of schooling, despite state curriculum frameworks that focus on interdisciplinary approaches. Her analysis provides insights into the complex and contested nature of CIT in schools and leads her to conclude that the CIT subculture at Otter College is 'diffuse and is not based on shared understandings of CIT knowledge and pedagogy' (p. 93). In terms of teachers' gendered constructions of CIT subjects, teacher talk at this school contrasts two senior CIT subjects, where girls are reported to be more attracted to the subject that is constructed to be more 'practical' in that it focuses on software applications, and where boys are reported to be more attracted to the subject that is constructed as being more 'academic', with a focus on programming. Similarly, teachers in this school assert (as if it were 'natural') that their junior school elective CIT subject focused on design and software applications is 'more suited to girls' interests', while one focusing on computer-controlled machines and engines is 'more suited to boys' interests'. The contribution of such teacher talk to the social construction of CIT as a subject area, and to the production of limited/limiting conceptions of femininity and masculinity, is taken up in chapters by Rowan (Chapter 3) and by Robinson and Davies (Chapter 6).

Through her detailed analysis of the context of CIT education in this school and her analysis of the ways that two teachers in this school talk about CIT education and their roles in the school, Harris identifies a number of issues that

potentially mitigate against a sense of a well-established CIT subject subculture. These include the following: the lack of a designated departmental space in the school's staffrooms (with one teacher having a desk in the school administration office); the multifaceted nature of this teacher's role wherein, further to her teaching duties, she also provides technical support to the school's administrative staff; tensions between CIT subjects and cross-curricular ICT initiatives in terms of purpose and resources, with teachers fearing that increased emphasis on interdisciplinary approaches to CIT education will threaten the viability of dedicated CIT subjects in the junior years; and individualised and insular work practices, such that the two CIT teachers in this school have very little knowledge of each other's quite distinct approaches to the content and pedagogies of the CIT subjects that they teach.

The perspective provided by Harris's chapter reminds us that CIT is a nascent discipline that holds a complex position in relation to other curriculum areas and cross-curricular initiatives. Unlike more longstanding subject areas, like English and Mathematics, CIT school education is not supported by strong professional organisations (those that exist often serve multiple and conflicting agendas around CIT-specific curricula and the integration of ICT for learning across the school curriculum more generally), nor is CIT school education defined by well recognised and popularly valued content areas or pedagogies. Different teachers, even within the same school, have different ideas about what is valuable within the CIT curriculum and how it ought to be taught. As pointed out by Downes in Chapter 4, the scope and sequence of CIT content as it exists in current secondary school curricula in Australia is yet to reach maturity. Harris reports that CIT subjects are often constructed in functional and vocational terms. Such terms fail to recognise the disciplinary content outlined by Downes. In terms of pedagogy, as highlighted by Gannon in Chapter 8, even where syllabus documents recommend particular pedagogical approaches, such approaches are yet to be understood and/or supported by the majority of CIT teachers. These issues raise questions about the future of CIT education in schools. As a discrete subject area, as I pointed out earlier, it can be seen as nascent, yet to take its place or find its voice as a well-established and well-recognised school discipline. However, at the university level, disciplines such as computing science and software engineering and information technology appear to have already passed their prime and to be in decline (Timson 2007) or at least to be in a period of transformation and repositioning.

Chapter 7 by Reid and van den Akker is the second chapter in this volume to focus primarily on CIT teachers. The chapters by Harris and by Reid and van den Akker are complementary in terms of the light they shed on the gender and IT problem. While Harris's chapter serves to highlight some of the complexities, tensions and potential deficits of CIT as a school subject area, Reid and van den Akker look beyond the disciplinary lens, taking a sociological view of the lives and work of CIT teachers and the effects these have on pedagogical relationships and

potentially on the attractiveness of CIT subjects to girls. Reid and van den Akker report the findings of their analysis of CIT teacher interview transcripts from 12 NSW schools. They focus on how CIT teachers relate to governing systems and structures, to other teachers, to students, and to the local community. Because of the diverse backgrounds of CIT teachers, Reid and van den Akker argue that informal knowledge networks are central to understanding their identities and work practices. They describe how the teacher interviews they examined reveal a range of very different pathways to becoming involved in CIT education. Their analysis is embedded within an understanding of how the social relationships of schooling are framed by globalisation, particularly by the neo-liberal politics of individualism and the economic prerogatives of economic rationalism. In an examination of the interplay between teacher agency and trends towards centralised power structures in schools, they identify a range of sources of teacher agency which reflect the diversity found among CIT teachers.

In their discussion of teacher interview excerpts, Reid and van den Akker highlight the complexity of teachers' lives and the tensions felt by CIT teachers, whose interests in the sustainability of their own subject area, and in the overall morale and fiscal viability of the school as a whole, are often at odds with each other. They cite examples of CIT teachers who restrain their urges to actively recruit students to senior CIT subjects out of consideration for the micropolitics of the school and the desire not to be seen to be 'empire building'. Reid and van den Akker argue that such tensions arise from economic prerogatives that put timetables and budgets (manifesting in, for example, prescribed minimum enrolments for subjects) before relationships and community needs. This chapter provides an example of a teacher who has successfully increased the numbers of girls enrolling in CIT subjects. The teacher at Yellow Robin High School uses what Reid and van den Akker describe as *relational strategies* to create interest in CIT. She draws on relationships with students and parents, and on community networks, to provide subject and career advice that is consistent with community development agendas. This teacher's approach is consistent with the ethos of the school, which is described as resonating with the character of the local community. Reid and van den Akker contrast the example of the teacher at Yellow Robin with other teachers who used more *oppositional strategies*, such as providing non-traditional role models, which the authors explain are problematic and ineffective.

These chapters suggest that teachers and their communities need to be at the centre of any reforms or interventions which hope to reinvigorate senior CIT enrolments.

Students and CIT

Understanding students' beliefs about and attitudes towards CIT education and careers, and the relationships between such beliefs and attitudes and their behaviours and self-concepts, is critical if we are to understand and respond to the declining

numbers of students enrolling in senior secondary CIT subjects. Chapters by Gannon, Robinson and Davies, Rowan and by Vickers and Ha, all shed light on students' constructions of CIT as a curriculum area. The chapters by Gannon, Robinson and Davies, and Rowan, have a more sociological and post-structural flavour, as they draw on discursive analyses of student and teacher interviews and engage specifically with discursive constructions of gender and identity and gendered constructions of CIT.[10] The contribution of the Vickers and Ha chapter is distinctive in that it draws on analyses of the GaIT project's quantitative data sets (the survey results) and employs psychological constructs to explore the relationship between students' reported beliefs and their subject choices, focusing more on differences between boys' and girls' beliefs and choices, rather than on discursive constructions of gender.[11]

Vickers and Ha examine the complexity of subject choice and the role of factors such as student interest, student enjoyment and students' perceived utility of senior CIT subjects. They draw on aspects of Expectancy–Value theory (Wigfield & Eccles 2000) in their discussion of the quantitative survey results, focusing specifically on students' reported beliefs about their ability with computing and information technologies and how this might relate to the selection of senior CIT subjects. To do this, the authors constructed a variable which they term *perceived IT ability* (pITA), where students with a high pITA score rated their own abilities highly on a combination of low level (e.g. e-mailing friends) and high level (e.g. fixing the computer) computing skills. They then examined the reported beliefs, experiences and subject choices of students with *high* and *low* pITA scores, that is, high or low self-assessments of their own ability with computers. The findings of this analysis are telling, both in terms of general CIT enrolment trends and in terms of the gender gap in enrolments.

Drawing on Expectancy–Value theory, Vickers and Ha hypothesise that students with high pITA scores will be more likely than other students to enrol in senior CIT subjects. However, they find that this group of students is no more likely than others to pursue senior CIT studies. In seeking an explanation for this surprising (and potentially worrying) finding, Vickers and Ha report that 70% of the high pITA group consider that they learn more about computers at home than at school. This suggests that, although this group of students might have a high level of expectancy to succeed in senior CIT subjects, the *value* side of the Expectancy–Value equation is not satisfied in their imaginings of what such subjects entail. This is supported by qualitative analyses reported in other chapters. For example, Robinson and Davies report that 'many of the high interest boys were not engaged by the [K–10] CIT curriculum and were often bored and frustrated' (p. 106). It is also consistent

10. While these chapters share a broad research paradigm, they draw on different theoretical constructs and make quite distinct contributions, as discussed elsewhere in this chapter.
11. This is a distinction in research paradigm; there is an overlap in the issues raised by each of these chapters and the perspectives are complementary in terms of illuminating the 'gender and IT problem' and *troubling* our understandings of it.

with what might be expected, given Downes's analysis (Chapter 4) of the literacy focus in CIT education from K–10, and how this might influence students' imaginings of what is offered in the senior years.

For girls, the pITA picture is even more worrying. Of the high pITA group, fewer were female and there were more girls than boys in the lower pITA group. Girls who did rate their own abilities with computers highly were less likely than boys with similar self-assessments to enrol in senior CIT subjects. This suggests that, for girls, lower expectations for success as well as a lower perceived value of the activity have negative effects on their likelihood of choosing to pursue senior CIT subjects.

In Chapter 6, Robinson and Davies provide insights into the interaction between student subscription to CIT subjects and the identity politics that is played out in schools. Drawing on Judith Butler's concepts of the performativity of gender (Butler 1994), they analyse student interest in CIT in terms of hegemonic discourses of gender that position girls and boys differently in relation to their competence in, and their desire to undertake, certain kinds of CIT tasks and not others. They found that students' accounts of their experience with technology were highly gendered. Girls were far more invested than boys in technologies that could be used to communicate with friends, yet the use of these technologies was constructed as social in nature and unrelated to school CIT learning. Girls with a low interest in CIT education constructed CIT subjects in stereotypical terms (stuck in font of a computer; void of human interaction) and as diametrically opposed to their interests and desires.

Robinson and Davies examine the reported behaviour of those boys and girls who self-identified as 'nerds' and 'geeks', conceptualising these positionings as ones that challenge dominant understandings of masculinity and femininity. They found that the behaviours of students who take up the position of nerd or geek are often challenged and policed by their peer groups, who were highly invested in maintaining hegemonic oppositional readings of gender.

In Chapter 3, Rowan examines the explanations that students and teachers provide for the gender gap in CIT enrolments, both those explicitly stated and those implicit in their talk about girls and boys and CIT education and careers. To frame her analysis, Rowan outlines the dominant understandings of gender that have underpinned the various waves of gender-related educational reform that arose in the 1970s, 1980s, 1990s and onwards. She discusses three main perspectives on gender, as identified in the gender and education literature: that focusing on access and equity, wherein the removal of structural barriers is seen to provide equal educational opportunities to boys and girls; that focusing on the recognition and valuing of girls' difference through the provision of 'girl friendly' approaches and environments; and that seeing gender as performance, whereby performances are influenced by the diverse messages females and males receive from multiple sources about what it means to be a 'girl' and what it means to be a 'boy' — a perspective influenced by contemporary post-structural understandings.

In her analysis of the GaIT interview data, Rowan highlights the extent to which teachers' and students' explanations of the CIT-gender gap align with, or depart from, these perspectives on gender and related explanations of educational differences between girls and boys. She discusses two main explanations, the first being the belief that gender has no effect on subject and career choice; that is, both girls' and boys' decisions not to pursue senior studies in CIT are based on an analysis of CIT subjects, and the CIT industry and careers, that are independent of gender. Associated with this understanding is the view that the gender gap in CIT education and careers is not a problem: previous structural barriers have been removed and the gender difference that remains results from individual students' gender-neutral choices. The second type of explanation she discusses is that which reinforces more traditional perspectives. She found that many of the opinions and explanations in the student and teacher interview data were based on understandings of gender as a manifestation of 'natural', biologically-determined differences; that is, girls were naturally less inclined to be interested in, and to have abilities in, CIT and related educational and career pathways. Associated with this understanding of gender was the view that, for girls who expressed no interest in pursuing senior CIT education, earlier CIT learnings acquired during their junior secondary schooling would be adequate for their needs.

One of the key contributions of Rowan's chapter is her discussion of the significance of the persistence of seemingly (from contemporary feminist viewpoints) outdated understandings of gender, and of how educators and educational researchers might respond to this. Drawing on Michael Goldhaber's concept of the *attention economy* (Goldhaber 1997), she explains that the low number of girls in CIT educational pathways is not seen as a genuine educational problem by schools, teachers, students and parents, and that in recent times the gender and IT problem has struggled to draw attention to itself. It has received less attention than have other gender-based debates, particularly those issues that have been declared to be 'scandals' in the media, such as boys' literacy levels. Rowan frames the gender and IT problem as one of gaining, sustaining and managing attention, and doing so in ways that do not risk the reinforcement of limiting understandings of gender.

Conclusions: Why is CIT so hard to sell?

The chapters that comprise this book report a number of findings that add to our understanding of why enrolments in senior secondary school CIT subjects are suffering a decline and why girls' interest in particular, which has been historically fragile, is so hard to attract and is waning. In the figure opposite, I provide a summary of the main points emerging from the work reported in this book. I then go on to outline some of the main ways forward that are suggested by the authors.

Why is CIT so hard to sell?

- *The focus of K–10 CIT curriculum, together with cross-curricular ICT initiatives, lead to misconceptions about the focus of post-compulsory CIT studies.*
- *Students with an interest in CIT find both the content of school CIT subjects (those they have had exposure to — in our study, compulsory years CIT) and the pedagogical practices associated with them to be uninteresting and irrelevant. These perceptions tend to colour their expectations of senior CIT subjects.*
- *Senior CIT subjects are not constructed as a pathway to university studies in CIT. Messages from multiple sources suggest to students who are interested in computing technologies that other subjects would be a more strategic choice.*
- *Interest in CIT education is associated with marginalised performances of masculinity and is not constructed as appropriate for girls or for most boys. Both students and teachers tend to reproduce outdated understandings of gender, which mitigate against interventions aiming to interrupt limiting notions of what CIT is and who it is suitable for.*
- *Where teachers and schools have implemented strategies to attract more girls to CIT education, these strategies sometimes further reinforce stereotyped notions.*
- *As a subject area that bids for a share of post-compulsory student enrolment, CIT does not appear to have a unified group of teachers, at the school or state levels, who might promote the interests of the discipline. At all levels, specific studies in CIT compete with ICT initiatives for 'air time'. In fact, CIT teachers' time is often divided between these two competing agendas.*

Central to the discussions provided by each chapter in this volume is the importance of attitudinal changes. In the figure on the following page, I summarise the recommendations offered by the authors (often offered independently by multiple authors).

The literature on gender and CIT, and the data and analysis reported in this volume, suggest that limiting beliefs about gender and CIT can be found at all levels of schooling, both where CIT is explicitly being taught, but also in contexts of incidental and informal learning. Reiterating an important point made by Rowan in Chapter 3, no single 'solution' can work in isolation. The gender and IT problem requires ongoing attention on multiple fronts. What we have provided here is a basis for developing strategies, programs and interventions which do not fall into the trap of reinscribing old stories about what CIT education is, what CIT careers entail, and

Ways forward

- *Promote information about the content of senior-level CIT to K–10 students, by incorporating some of the fundamental concepts and processes of the CIT disciplines into the K–10 curricula, so that distinctions between the focus and aim of cross-curricular computer literacy initiatives and specialised CIT disciplinary education can be better understood by students. Or better still, so that the literacy and disciplinary agendas are mutually supporting.*
- *Provide accurate information about employment and career opportunities for CIT graduates.*
- *Recognise that many students will achieve high levels of computer literacy at home and will need a more challenging CIT program if their interest in the CIT field is to be sustained.*
- *Emphasise the alignment between senior CIT subject content and the content of university courses in software engineering and information technology.*
- *Employ and discuss pedagogies that align with work practices in the CIT industry (e.g. collaborative project work).*
- *Make links between school-based CIT education and activities, expertise and enterprises in the local community.*
- *Provide opportunities for students (and teachers) to position themselves in multiple ways in regards to computer use by employing a range of pedagogical practices and a wide range of technologies, including group work, project work and the use of new leisure and lifestyle technologies.*
- *Employ pedagogical practices that disrupt traditional stereotypes by affirming girls' interest and competence in difficult technical tasks, by affirming boys' interest and competence in communication and design activities, and by affirming the behaviours and attitudes of girls who express an interest in computing technology.*
- *Promote alternative images of girlhood and boyhood by continuing to document and to circulate performances that challenge normative understandings of gender and CIT.*

who they might be suitable for. That is not to say that such stories should be swept under the mat, rather, as a starting point for interventions that aim for attitudinal change, students' and teachers' own beliefs about gender and CIT ought to be examined within a supportive context in which alternative views and behaviours can be explored. ■

CHAPTER 2

The imagined curriculum: Who studies Computing and Information Technology subjects at the senior secondary level?

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IN AUSTRALIA, AS IN MANY WESTERN COUNTRIEs, survey data and research studies have persistently drawn attention to women's low rates of participation in tertiary-level Computing and Information Technology (CIT) courses. This has been of sufficient concern in Australia that the Department of Education, Science and Training has recommended that, in terms of participation in university, women should remain an equity target group in the field of information technology (James et al. 2004). While the focus over the past 20 years has been on participation and retention in university and other post-secondary institutions, attention has shifted towards the secondary years of schooling more recently, because this is where young people begin to establish their interests in particular subjects and careers (Jacobs & Simpkins 2005). In 2003–04, supported by initiatives from the New South Wales (NSW) Department for Women, a project aiming to examine the gender gap in participation in senior secondary CIT subjects in NSW, Victoria and South Australia was proposed. As indicated in Chapter 1, the *Gender and IT* (GaIT) project gained support from industry partners in these states in 2004, and was funded by the Australian Research Council (ARC) under the Linkage program in 2005.

The aim of this ARC project was to investigate the nature of the processes that contribute to the gender gap in participation in senior school-level CIT subjects in NSW, Victoria and South Australia. When the project began, we were aware that between 1994 and 1999, there had been a 30% increase in enrolments in university CIT courses. Data available for the 1990s suggested the while the enrolment share for women in university CIT courses was not increasing, the absolute numbers of women doing CIT courses was rising. Women's participation at these levels was part of the rapid overall increase in tertiary CIT enrolments. Initially, we assumed that

overall enrolments in CIT were generally on the rise at both the secondary and tertiary levels of the education system. What we were not aware of at the time was that total enrolments in senior secondary CIT subjects had started to fall in these three states towards the turn of the millennium. While the peak enrolment year prior to the initial downturn varied a little between the three states, it became apparent that by 2002 there was a steady downward trend in senior secondary CIT enrolments across the board. Statistics from the NSW Board of Studies, the Victorian Curriculum and Assessment Authority, and the Senior Secondary Assessment Board of South Australia all indicate that enrolments in senior CIT subjects have continued to decline since 2001. A detailed state-by-state analysis of these trends is not attempted in this chapter; however, the NSW case is discussed by Downes in some detail in Chapter 4. It serves to illustrate a general pattern of enrolment decline in senior secondary Computing and Information Technology studies that must now be defined as a cause for concern.

This chapter explores two issues, the first being the general decline in the numbers of students choosing to study CIT subjects at the senior secondary level, and the second being the persistent gender gap in enrolments in these subjects. This exploration is informed by results from student surveys that were conducted as a part of the ARC-funded *Gender and IT* study. Students were surveyed late in Year 10 (in 2005) or early in Year 11 (in 2006), and many of the students who completed the surveys were subsequently interviewed in focus groups, as part of the larger project.

When these data were collected, none of the students surveyed had studied CIT subjects at the senior secondary level. As a result, their ideas about these subjects were necessarily based on what they *imagined* senior level CIT subjects might be like. It is important, therefore, to explore how they constructed what Downes calls, in Chapter 4, the *imagined* curriculum. Theoretically, students may be able to access the official documents available from the boards of studies or state assessment authorities, that is, the syllabus documents that define the *intended* curriculum. A second possible source of knowledge about what it might be like to study particular subjects comes from observing how a subject is *enacted* in a particular school: who teaches it, what the equipment is like, how the subject is located in the school timetable, how the history of the subject within that school conditions the way the subject is viewed, and whether students who take it say they enjoy it.

The distinction between the *intended* and *enacted* curriculum referred to here is based on the work of Grundy (1998), and Marsh and Willis (2003). These authors point out that the written syllabus documents generated by subject matter experts and curriculum committees can never become 'the curriculum' on their own. What is eventually delivered to students (the enacted curriculum) is substantially shaped by the particular circumstances facing the teachers in each school. Effective teaching practice, in fact, demands significant on-site modifications whenever teachers use prescribed syllabus documents (see also Berman & McLaughlin 1975 cited in Marsh

& Willis 2003, p. 243; Fullan & Pomfret 1977). Hence, while the enacted curriculum is based on formal syllabus documents, in each school setting it will diverge from what was intended to a greater or lesser extent, depending on the teacher and the local circumstances in that particular school. Since our focus in this chapter is on the dynamics of subject choice, it is useful to propose that alongside these two perspectives — the curriculum as intended and the curriculum as enacted — there is a third, and that is the curriculum as *imagined*. This perspective refers to the cognitive constructions created by students who have not yet studied a particular subject, but who are attempting to decide whether this is something they would like, something useful, and something they would be good at.

It is possible, of course, that the overall decline in the numbers of students studying senior secondary CIT subjects is strongly influenced by broader contextual factors, such as the dotcom bust that followed the boom of the late 1990s, or the current ubiquity of computers in students' homes. Nevertheless, any assessment of changing enrolment patterns must include a focus on the curriculum and, in this analysis, each of the three perspectives on the curriculum identified here needs to be considered. In Chapter 4 these three perspectives are used to explore the dynamics of students' subject choices in relation to senior-level CIT subjects in NSW. Downes explains that, during the primary and junior-secondary years, computer studies as a subject is almost entirely dedicated to computer literacy and the development of skills in the use of application packages. Since students are not introduced to the theoretical principles of computer science during the early years, and since they know nothing of algorithmic thinking and the principles of software design, they are unable to imagine what computer science as a discipline might be all about. As the analyses presented later in this chapter suggest, students' *imaginings* about senior-level CIT subjects are almost entirely conditioned by their experience of the scope and sequence of computing education during the junior years.[1]

The next part of this chapter offers a brief review of three bodies of literature, in an effort to identify factors that have been found to be associated with (a) student subject choices at the beginning of the senior secondary stage, (b) the persistent *gender gap* in enrolments in Computing and Information Technology subjects, and (c) fluctuations in enrolments in these subjects. Before embarking on this literature review, it is important to define the three clusters of Year 11 subjects that are the focus of this study. Table 1 (on the following page) lists the subjects by cluster, and indicates the broad purposes served by the curriculum for each group of subjects. Since the survey results reported here relate to choices made by Year 10 students who are entering Year 11, this table only identifies the Year 11 subjects belonging to each cluster.

1. In New South Wales, there is a mandatory junior level computing education subject called Technology, which is a prerequisite subject for any technology subject taken in subsequent years. This subject is said to be a foundation course that increases student understanding of design, design processes, and the technology that can be employed to solve identified needs in a creative and innovative manner.

Table 1. Computing and information technology subjects offered at Year 11 level in NSW, South Australia and Victoria: grouped into three clusters

Cluster 1: Software development and the use of software tools to solve problems	NSW SA Vic	Software Design and Development Information Technology Systems Information Technology: Software Development
Cluster 2: Information technology applications focusing on their uses in a variety of contexts	NSW SA Vic	Information Processes and Technology Information Processing and Publishing* Technology: IT applications
Cluster 3: Vocational Education and Training (VET) Curriculum frameworks that aim to develop practical technical skills for the CIT workforce	NSW SA Vic	VET: Information Technology Information Technology (VET) VET: Information Technology

* In South Australia, a group of subjects is offered under the heading of *Information Processing and Publishing*. These include Business Documents, Personal Documents, and the popular unit Desktop Publishing.

Student subject choices, the gender gap and enrolment fluctuations

(a) Student subject choices at the beginning of the senior secondary stage

In both the Australian and the international literature, a number of explanatory constructs have been invoked to account for students' subject choices during the transition from the junior to the senior secondary stages (Adey & Biddulph 2001; Elsworth, Harvey-Beavis, Ainley & Fabris 1999; Nagy, Trautwein, Baumert, Koller & Garrett 2006; Watt 2006). Among these, four that emerge with great frequency are (a) liking the subject and being interested in it; (b) finding it useful and valuing the kinds of knowledge involved; (c) considering it important as preparation for future careers, or as constituting necessary background for future study; and (d) having a high self-esteem or high perceived ability in relation to a subject. Of course, these constructs are not mutually exclusive and, depending on the theoretical framework a researcher is using, two or more constructs may be melded together, or positioned in particular relationships to each other. An important generalisation that emerges from studies in this field is that students are inclined to take account of several factors at once. For example, as Adey and Biddulph's (2001) research indicated, most students do not simply choose subjects they *enjoy* unless they also consider these subjects to be useful.

Further explorations into the distinctions students make between 'finding a subject interesting' and 'liking it or enjoying it' suggest that student 'interest' might relate to the content of the subject, while 'enjoyment' might reflect the pedagogical processes employed in delivering the subject. For example, in Stables and Wikeley's

(1997) investigation into the reasons students gave for liking subjects, they found that statements about enjoyment were dominated by references to pedagogical process and activities. In their survey of 144 students studying history at Key Stage 3 in the United Kingdom, Adey and Biddulph (2001) also found that while most respondents thought modern history was interesting, they did not enjoy it because the pedagogical processes were boring: there was too much emphasis on 'repetitive questions sheets'. Unanimously, the least popular activity was answering questions from a set book or worksheet. The Adey and Biddulph study also found that students' perceptions as to whether they might enjoy studying history at Key Stage 4 were influenced by their experiences of studying the subject at Key Stage 3. Research by Boaler (1997) also supported this notion, indicating that process-based approaches to teaching and learning can increase student enjoyment and hence student achievement and motivation to continue with subjects such as mathematics.

It is impractical here to attempt an overview of the enormous literature on the relationships between the subject choices students make, what they believe themselves to be good at, the value they place on succeeding in particular domains, their sense of the intrinsic value of an activity, and what they consider to be important to study in terms of their future careers. Rather than reviewing the entire body of literature, we have chosen to address this set of components by operating within the framework of Expectancy–Value theory (Eccles et al. 1983).

Over the last decade, achievement and motivational theorists have developed a number of models to increase understandings of student engagement and participation in tasks, achievement and performance, and performance expectancy (see Eccles & Wigfield 2002 for an overview). The Expectancy–Value theory is one such theory which was developed to explain student motivation and its influence on choice, persistence and achievement in achievement related tasks (Wigfield & Eccles 2000). Since its development, the theory has received strong support, and has been successfully applied to explore the gender gap in choices and achievements in relation to mathematics (e.g. Watt 2006; Wigfield & Eccles 1992, 2000).

In its complete form, the Expectancy–Value model proposes that factors such as sociocultural beliefs and attitudes towards specific tasks, an individual's evaluations of these socially-bound beliefs and attitudes, previous experiences and affective memories of participating in a related task, goals (both short-term and long-term), expectations of success and failure, actual abilities and aptitude, and perceived abilities in the task, all have an effect (direct or indirect) on choice. In its simplest form, the Expectancy–Value model suggests that expectancies of success and task value are directly influenced by beliefs about ability and task difficulty. That is, an individual's choice to participate in a task, their persistence with the task, and their achievement and performance, can be explained in terms of their beliefs regarding how good they are at the task, how well they think that they will do on the task, and the extent to which they *value* the task (Wigfield & Eccles 2000). According to Wigfield and Eccles (2000), individuals' beliefs related to specific tasks

can be defined as their evaluation and perception of their competence at that specific activity (see also Eccles & Wigfield 2002). This is distinct from an individual's beliefs and expectations regarding their success and performance in a task. Although both are separate constructs, research has indicated that they are highly related and are both play pivotal roles in the prediction of task choice and participation (Eccles & Wigfield 2002).

Given the complexity of the model and each of the constructs proposed to predict participation, to examine this Expectancy–Value theory in its complete and comprehensive form is beyond the scope of this chapter. Hence for the present purposes, we will only focus on beliefs of ability (i.e. how good an individual perceives themselves to be at Computing and Information Technology) and how this might relate to task participation (i.e. whether or not to study CIT subjects in the senior years of secondary school). Other aspects of this complex model will be examined in more detail in later publications.

(b) The persistent gender gap in CIT enrolments

Disparities in the participation rates of women and girls in the physical science, mathematics, engineering and technology (SMET) career fields have existed for many decades (Congressional Commission on the Advancement of Women and Minorities in Science and Technology Development 2000; Fullarton, Walker, Ainley & Hillman 2003; National Research Council 1991; Stewart 1994). These gendered disparities have been the subject of much analysis, focusing on a range of issues — including the broader social milieu, the nature and perceptions of the SMET career field, the curriculum and pedagogies in schools and universities, and the gendered, racial and class identities of secondary school students (Ambrose 1998; McNees 2003; Siann & Callaghan 2001; Tam & Bassett 2006; Walkington 1998). Importantly, this literature indicates that the gender gap in these fields is an enduring issue for which few sustainable and scalable improvements have been achieved, and that changes in curriculum and pedagogy are not necessarily able to disrupt the gendered outcomes in terms of further study and careers in SMET (Goode, Estrella & Margolis 2006; Murphy & Whitelegg 2006; Sanders 2005; Wasburn & Miller 2005).

Recent research based on Expectancy–Value theory has shown that intrinsic value, and beliefs regarding ability and the expectation of success, can substantially explain subject choices made by male and female students. For example, within the Expectancy–Value framework, Watt (2006) investigated the disparities in male and female enrolments in senior mathematics and found that although there were no significant differences between males and females in terms of actual achievement in mathematics (i.e. results indicated that male and female achievement/ability in mathematics was equivalent), male students had more positive perceptions of their ability than female students and higher success expectancy (see also Eccles 1987). Moreover Watt's (2006) results indicated that self-perceptions of ability were the second best predictor of enrolments for both girls and boys (after intrinsic value).

Hence, it seems that it is an individual's interpretation of his or her abilities that explains non-participation, rather than the actual grades that students attain. Furthermore, Watt's (2006) results indicated that the predictive power of self-perceptions of ability was stronger for girls than for boys. These results highlight the need for further research into self-perceptions of abilities to fully understand the gender discrepancies in traditionally male subjects such as science, mathematics and more recently Computing and Information Technology.

(c) Fluctuating enrolments in senior CIT subjects

As indicated earlier, statistics from the NSW Board of Studies, the Victorian Curriculum and Assessment Authority, and the Senior Secondary Assessment Board of South Australia indicate that while enrolments in senior CIT subjects rose in all three states during the 1990s, total enrolments in this group of subjects began to decline after year 2000. The only exception to the general pattern of decline relates to an applications subject, *Desktop Publishing* that is offered as part of the South Australian Certificate of Education (SACE). A detailed analysis of the fluctuations in enrolments in Computing and Information Technology subjects in NSW between 1995 and 2005 is provided in Chapter 4. As this analysis shows, in NSW, total enrolments in senior CIT subjects increased by 35% between 1995 and 2000. However, between 2000 and 2005, the rate of decline more than eliminated the initial gains. During this five-year period, there was a 40% decline in total numbers enrolled in this group of subjects, as well as a substantial reduction in the proportion of female students in each subject. The data for the other two states shows similar patterns, with declining enrolments in most senior CIT subjects during the past five or six years.

As our brief overview of the literature on subject choice indicates, there are many possible reasons for this overall enrolment decline. It is possible that cohorts who reached the end of the compulsory phase after the year 2000 differed from the cohorts of the 1990s, and placed a lower value on succeeding in the CIT domain at school. Over the 20 years that have elapsed since computer awareness subjects were first introduced into secondary schools, computer facilities have become available in the homes of almost all secondary age children. Our interviews with students indicate that the computers students use at home are mostly superior to those available at school. It is possible, then, that students of the new millennium take competence in using computers for granted, so that success in computing as a *school subject* has a lower intrinsic value for them than for students in earlier cohorts. It is also possible that they consider the formal study of computing to be less important in preparing themselves for future careers. In part, this may be a result of the diffusion of CIT skills across the entire curriculum: it is now embedded in mathematics, science, business studies, and the creative arts. Our surveys indicate that young people make extensive use of a wide range of technologies for communication (two-thirds reported using e-mails and SMS to message their

friends). Simultaneously, the production of homework assignments routinely involves downloading information, and using word processing and publishing applications (nine out of ten students reported using computers to do homework assignments.)

The decline in participation in the advanced study of CIT in senior secondary years is neither unique to Australia, nor to the secondary education level. It is also occurring at the tertiary level across many English-speaking western countries including the United Kingdom, United States and Canada (Lewis, Mckay & Lang 2006; Patterson 2005). Nevertheless, the current decline in overall enrolments in CIT subjects raises serious questions about the role and purposes of the formal study of computers and related technologies in senior secondary schooling.

Analysis of data from student surveys

This section of the chapter presents preliminary findings from the student surveys carried out through the ARC-funded study. Twenty-two urban, regional and rural schools in New South Wales, South Australia and Victoria participated in the survey. They were selected as demographically matched pairs with contrasting participation rates (high and low) of girls in senior computing courses. Only public schools were invited to participate. In each state, the sampling of schools was designed to reflect a demographic spectrum from economically disadvantaged to advantaged urban areas, and also included rural areas. Surveys were undertaken in late 2005 and in 2006. Small groups of boys and girls whose survey results indicated either a 'high interest' or a 'low interest' in CIT were then invited to participate in a group interview. A total of 1340 surveys were included in the analysis, after excluding a small number of cases that were incomplete. These surveys and interviews aimed, among other things, to explore how young people decided what they would study in Year 11 and 12, and whether or not they would take one or more Computing and Information Technology subjects. Survey items asked students to indicate which subjects they enjoyed and what they thought they were good at, how they used computers at home and at school, whether they saw themselves as 'good at IT' and in what ways, and why they had chosen or had avoided choosing particular subjects from the Computing and Information Technology group. The students surveyed were boys and girls in Year 10 who had recently made decisions to study or not to study CIT subjects in Year 11, or Year 11 boys and girls who had just begun these studies and were beginning to formulate their plans for Year 12. In this study, we define *takers* as students who were (late in Year 10) planning to study, or students who (early in Year 11) were already studying, a CIT subject.

Of the 1340 students included in the sample, 398 students or 29.7% of the sample were CIT *takers*. Table 2 uses the clustering of CIT subjects presented in Table 1, and shows, for each cluster, the proportion of overall CIT enrolments accounted for by that cluster. As the table indicates, the most popular cluster of subjects was the information technology applications cluster, which accounts for

Table 2. Total proportions of females planning to enrol or enrolling in the three Computing and Information Technology subject clusters*

	Number of enrolments (total)	Cluster share — % of total enrolments	Number of female enrolments	Percentage of female IT enrolments	Females as percentage of of enrolments
Cluster 1: Software development and the use of software tools to solve problems	127	31.9	26	22.0	20.5
Cluster 2: Information technology applications focusing on uses in various contexts	175	44.0	66	55.9	37.7
Cluster 3: VET Curriculum frameworks that develop skills for the IT workforce	96	24.1	26	22.0	27.1
Totals	398	100.0	118	100.0	29.6

* These are aggregate data representing enrolments by cluster across NSW, South Australia and Victoria.

44.0% of all CIT *takers* in this sample. This cluster of subjects was particularly favoured by girls: 55.9% of girls who took a CIT subject chose an information technology applications subject, while 22.0% of female CIT *takers* chose a software development subject. Overall, among the 398 students who were CIT *takers*, 118 students or 29.6% of the total were female.

These results conform to overall patterns evident in data provided by the boards of studies and assessment authorities. Specifically, the information technology applications cluster attracts the largest numbers of students overall. Girls are under-represented in all CIT subjects; they are particularly under-represented in the software development cluster of subjects, where they represent 20.5% of *takers*. These data also accord with the persistent findings cited in the literature review regarding the gender gap in enrolments in Computing and Information Technology subjects.

As explained previously, the substantial body of research conducted over the past 20 years within the Expectancy–Value framework has provided cogent explanations for the persistence of low levels of participation by girls in mathematics. The preliminary analysis presented in this chapter draws on some particular aspects of Expectancy–Value theory, and focuses specifically on the students' perceived IT abilities and their participation in Computing and Information Technology subjects. As discussed earlier, recent research based on this

framework indicates that students' *perceptions* of their abilities has a powerful effect on their subject choices (over and above their *actual* abilities). Given the potential power of these perceptions, we considered it worthwhile to construct a variable that would provide a measure of perceived IT Ability (pITA). This scale was derived using student responses to a set of 13 items in which students were asked about their perceptions of their abilities on various Computing and Information Technology tasks. These items included tasks that involved lower level skills (common, everyday activities such as looking up information, downloading information, and e-mailing) as well as activities that required a higher level of knowledge and skills about computers and systems (installing programs, fixing the computer, building and creating web pages).

To determine the underlying factors within this scale (given that there has been limited research in this area) an exploratory factor analysis was conducted. This analysis aimed to summarise the 13 items into a smaller number of more descriptive and meaningful underlying factors. Essentially, exploratory factor analysis groups together those items within a scale that are related to each other. The goal is to then examine these factors and determine how they might be related to other constructs.

The factor analysis of the perceived IT ability data indicated that there were two underlying factors, one that incorporated the lower level and more common everyday skills and one that included higher level skills. However, the analysis indicated that there were some items within the scale that needed to be deleted as they either did not have a lot of explanatory value or because they did not definitively lie within the two factors that had been specified in the analysis. The remaining items that created the two factors in pITA were as follows:

A. Low level skills

- Downloading music, videos, and images
- Installing games and programs
- E-mailing friends and family
- Connecting to the Internet and looking up information
- Buying products online

B. High level skills

- Building web pages using templates or other tools
- Creating web pages using programmes
- Fixing the computer, printers, cameras and scanners etc
- Writing songs, lyrics or music

For each item, students rated their perceptions of their ability on a 5-point Likert scale (1 = *no good at all*, 5 = *very good*). Hence, pITA can be defined as students' perceived competence in high and low level Computing and Information Technology skills. Students' pITA scores were calculated as a mean score, based on their responses to the these items. Data indicated that, overall, students had a mean

pITA of 3.14 (*SD* = 0.84) out of 5. Students were then separated into three groups: low pITA (equal to or less than the mean minus one standard deviation); midrange pITA; and high pITA (greater than or equal to one standard deviation above the mean). Given the importance the Expectancy–Value model places on perceived ability in relation to participation and subject choice, data from high and low pITA students were explored to find out more about students who choose to take Computing and Information Technology subjects in the senior years of school.

Results from our preliminary analyses indicated that there were a total of 287 students in the high pITA group, of which 92 (32%) were female and 195 (68%) were male. This result suggests that a higher proportion of males than females had positive evaluations of their CIT skills. The average perceived IT ability score for girls in the high pITA group was shown to be 4.37 (*SD* = 0.32), whilst males scored an average of 4.44 (*SD* = 0.33). Furthermore, the data showed that girls far outnumbered boys in the low pITA group (60.9% were female and 39.1% were male). These data reflect previous results gained from investigations into gender differences in ability beliefs, suggesting that regardless of actual ability and performance, males have higher and more positive self-evaluations or perceptions of their performance.

According to the Expectancy–Value model, students who have higher perceived ability should be more inclined to pursue and participate in a specific task. In this case, students with high pITA scores might be more inclined than those with average or low scores to be *takers*. However, our data indicated that that approximately 30% of students with high pITA scores planned to study a senior CIT subject (85 of the 287 high pITA students). This level of participation is no different from the average level of participation in CIT for the survey sample as a whole. As expected, a very small proportion of students with low pITA scores (6.3%) stated that they were going to study a CIT subject, indicating that pITA scores do have an effect on subject choice. Nevertheless, the fact that high pITA students were no more likely than 'average' students to study CIT demands further consideration. A partial explanation for this is offered in the discussion which follows, where we discuss the responses of high pITA students to survey questions that explore the relative importance of the school (versus the home) as a site for learning about computers and information technology.

Throughout this chapter we have highlighted the gender discrepancy in student enrolments in CIT subjects. Our findings are consistent with this known gender discrepancy. Overall, less than one in three *takers* in our sample were female, and just over two thirds were male. This might be partly explained by the fact that only one-third of all females gained high pITA scores. Yet the responses of high pITA females reveal an additional problem. When male and female subject choices are examined, it becomes clear that girls with high perceived IT ability are somewhat *less* likely than boys with high pITA scores to be IT *takers*. While 33% of high pITA males chose to study an IT subject, only 23% of high pITA females

did so. This preliminary analysis suggests that the ultimate decision to take a Computing and Information Technology subject may involve more than just perceived ability (although there does appear to be a relationship between taking a CIT subject and having a high pITA score). More research on 'who chooses senior Computing and Information Technology and why' is clearly required.

Discussion

Throughout this chapter we have been discussing the subject choices made, during Year 10, by students who at that stage have had no direct experience with any of the CIT subjects offered at the senior secondary level. What we are dealing with here is a curriculum as they *imagine* it to be. Based on their experiences in the primary and junior secondary years, students create their own constructions about each particular subject — be it a software design subject, or information processing, or a VET information technology subject. Given their youth and lack of experience, this can be a difficult task in any subject area, but it is made especially difficult in the CIT area, because of the sharp disjunction between the focus and content of the junior and the senior curricula.

The argument outlined here is more fully developed in Chapter 4. In brief, the problem seems to be that during the primary and junior secondary years, most computing education classes focus on computer literacy and the use of basic software applications. This approach to the junior computing curriculum derives from the historical legacy of Computing and Information Technology as a school subject, reflecting an era when most students only gained access to computers when they came to school. Data obtained in our survey suggested that access to computers at home is now almost universal, and that most families have at least two working computers. When asked during interviews whether the computers they used at home were better than those at school, most students replied in the affirmative, and described school computers as 'incredibly slow'. What is lacking in most of the junior syllabus documents is any kind of an introduction to the inspiring ideas that drive computer science as a discipline. In some schools, the curriculum as *enacted* compensates for this, and some students gain an insight into what makes computing an exciting field to study.

As already noted, only 30% of students with high pITA scores planned to study a CIT subject at the senior secondary level. Given their perceived competence in IT, it would be reasonable to expect that a higher proportion of this group might enrol in senior IT subjects. However, our survey data indicates that 70% of high pITA students consider that they learn more about computers at home than at school, while less than one in five say they 'mostly learn about computers at school'. An interview conducted a part of the larger study, involving Year 10 students in a South Australian secondary school, provides an apt illustration of the problem. When asked what he thought it would be like to study CIT in Year 11, one boy answered:

> Well, between Year 8 and 10 we just did Excel from worksheets, and the main difference was it was harder, but more of the same thing. Still Excel, and more of it. So probably Year 11 will be more of the same.

Comments like this suggest that the computer literacy focus of the junior years creates a situation in which CIT subjects are not seen as adding much value to what students already know. Unfortunately, it would appear that many students are not gaining an adequate introduction to the more challenging concepts underlying the computer science field until after they have started studying at the Year 11 level.

This chapter also considered aspects of the continuing gender gap within CIT enrolments at the senior secondary level. Expectancy–Value theory leads one to argue that one of the drivers of girls' low levels of participation is that fewer girls than boys perceive themselves to have high IT ability. In the data reported here, the proportion of boys with high pITA scores was substantially greater than that for girls. However, student choice also seems to be influenced by factors other than perceived IT ability. We noted that boys with high pITA scores are no more likely to choose CIT subjects than students whose pITA score are only 'average'. Furthermore, girls with high perceived IT ability are even *less* likely than boys with high IT ability to be IT takers. It seems probable that factors other than perceived IT ability are influencing girls' choices in relation to studying CIT subjects at the senior secondary level. This accords with the more elaborate version of Expectancy–Value theory, where issues such as subjective value of participation, and affective evaluations of previous experiences can also explain students' subject choices. Although we have not yet conducted more complex causal analyses, our data seems to indicate that students' perceptions about the value of what they might learn when they study a CIT subject can have a marked influence on their decision to take or reject that subject. ■

CHAPTER 3

A question of attention: Challenges for researching the under-representation of girls in CIT subjects

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THE PERCENTAGE OF GIRLS UNDERTAKING university study in the broad fields of Computing and Information Technology (CIT) has barely changed in the past 20 years, hovering consistently around (and often below) 25% (James et al. 2004). Over this period, general interest has waxed and waned such that this particular 'girls' problem' has received less overt attention recently from teachers, parents and educational commentators than have other gender-based debates (such as those focused on boys and literacy, or girls and body image, or boys and their final school certificate results for example).

This chapter investigates some of the key contemporary issues for researchers interested in exploring the reasons for, and implications of, low numbers of girls in CIT study (at post compulsory levels). Specifically, it focuses on the ways in which students and teachers now make sense of this statistical reality and the extent to which their explanations relate to previous work in the area of girls' education. The chapter highlights the ways in which contemporary rationales relating to the under-representation of girls are connected to the history of gender-based educational reforms. It also emphasises some of the implications for researchers since debates about girls' education in the 21st century are now clearly competing for the attention of schools, teachers and students.

The chapter comprises three sections. The first provides an introduction to the key theme — the difficulty, in 2007, of drawing schools' attention to the problematic nature of the current situation regarding girls and CIT. The second links this question of attention to the history of gender reform in schooling over the past 30 years. The final section draws upon a current Australian Research Council (ARC) Linkage project focused on understanding the factors influencing girls' decisions to study (or to *not* study) CIT in the post compulsory years. In this section I will

identify the explanations put forward by students and teachers to account for the persistently low numbers of girls in CIT and relate these to rationales that have been previously used to account for girls' educational choices. A key aim in this section is to highlight that, despite 30 years of gender-based educational reform and the persistence of a robust literature focused explicitly on the implications of girls' participation in CIT-related areas, understandings of why girls do or do not study CIT have not changed dramatically over this time.

Emphasis throughout the chapter is on the difference between the ways in which various groups make sense of the same widespread phenomenon — low numbers of girls in CIT classrooms and professions — and the extent to which the explanations most commonly circulated work to reinscribe or interrupt traditional understandings concerning the interests, abilities and preferred career paths of contemporary Australian school students.

Part One: The question of attention

In common with the other chapters in this book, the data explored in this chapter is drawn from a current ARC Linkage project titled *From High School to Higher Education: Gendered pathways in information, communication and computer technology education* (hereafter known as the GaIT project). Allocations of ARC funding are generally connected to perceptions regarding the significance of a project — its importance to the national good, its significance for the future of the country and so on. Thus it seems reasonable to suggest that projects receiving ARC funding are generally regarded, at least by some people, as projects worthy of some ongoing attention.

Certainly there are many reasons why a project focused on better understanding factors influencing girls' decisions to study (or to not study) in the fields associated with CIT might be considered significant. Researchers working in the fields of gender and education, gender and CIT, or gender and computers, consistently draw attention to the persistent under-representation of women as students and employees within the broad field of Computing and Information Technology. Whitehouse (2005, p. 1), for example, makes the point that:

> … women's share of professional computing occupations has fluctuated somewhat since the mid-1980s, but on average has remained around 20%. In contrast the proportion of all employees who are female has increased steadily, if slowly, over this time period, from a little over 40% to close to 50%.

This point is echoed by Wentling and Thomas who write that:

> Despite impressive gains in employment, women are still under-represented in the IT field. The world of IT is still dominated by men, and the imbalance becomes more striking at the higher rungs of the corporate ladder … Obstacles and gender differences have created a gender gap that is responsible for the narrowing pipeline of women in IT careers. The

> shortage of women in IT fields has made it more difficult for them to obtain management positions … Women [h]old (sic) only 8.1% of executive positions (VP and higher) at major technology companies. One of the reasons for the scarcity of women executives at technology firms is simply that there are fewer women in the technology-management pipeline … (2004, p. 90)

This situation has long been understood as a problem (Jenson, de Castell & Bryson 2003, Miller & Hayward 2006). First, from an economic point of view, the low percentages of women moving into CIT fields — an area already struggling to fill vacancies — is at the very least, a practical matter. Any industry having difficulties finding employees cannot easily afford to ignore the disinterest in the profession displayed by such a large proportion of the available/potential workforce. Second, the rapid growth of employment in areas associated with CIT — according to Wentling and Thomas (2004, p. 90), the past 10 years has seen a tripling of employment in the United States computer and software industries — is a problem not only for industry but also for people wanting to join or remain in the workforce. Wentling and Thomas make the point that as the 'economy becomes more digitised, most of our jobs will involve the manufacture, operation, or use of equipment containing a computer chip; hence, all jobs will be IT jobs' (Cooke 2000 as cited in Wentling & Thomas 2004, p. 90). In this context, a persistent disinterest in the pursuit of CIT-related employment has the clear potential to impact severely upon the nature, stability and remuneration of women's employment into the future.

Thirdly, and in a similar vein, the point is often made that specialist positions associated with CIT (e.g. computer scientists, computer engineers, systems analysts and programmers) are generally very well paid and it is therefore important from both economic and equity standpoints to not restrict women's access to these potentially lucrative career paths (e.g. Wentling & Thomas 2004, Whitehouse 2005).

Feminist arguments also emphasise the fact that the under-representation of women in CIT fields means that they have reduced opportunities to shape the design, management and implementation of the kinds of technologies that are increasingly dominating contemporary life. A commonly raised question relates to the extent to which 'technology' and technological processes would look/be quite different if more women were involved in technological invention and design (American Association of University Women [AAUW] 2000). As Wacjman writes, 'Getting women into IT is not only an equal employment opportunity issue but also an issue of how the world we live in is designed and for whom' (Wacjman 2005, p. 7).

In summary, there appears to be no shortage of educational, economic, and equity-based arguments regarding the reasons why girls' low rates of participation in CIT is a problem in the short- and long-term: a problem not only for the industry

and the economy, but also for the girls themselves. As mentioned at the start of this section, the power of these arguments — at least within an educational research community — is illustrated, in some way, by the fact that the project on which this chapter is based was funded by a range of industry partners (across three states) and by the ARC.[1]

However, the attention that the project, or its topic, has received across various sectors of industry and research has not been matched by teachers, schools or students. Indeed, quite the opposite has been the case. From the start of 2005, researchers working on the project began the process of identifying schools and teachers who would be willing to participate. The initial project design was premised on the belief that in each of three states — Victoria, New South Wales and South Australia — between 30 and 50 schools would be invited to take part in an initial teacher interview and, from this set, 24 case study schools would be selected to participate in student questionnaires and interviews. These selected schools would be a mix of high female CIT enrolments and low female CIT enrolments, and would be selected from a range of urban, rural and metropolitan locations and have different socioeconomic characteristics. To this end, researchers obtained data relating to the percentages of girls enrolled in post compulsory CIT subjects at diverse schools, established a short list of schools to target (with the range of enrolments and demographic features identified above) and then set about approaching the schools to see if they would be willing to participate.

Some weeks into this process it became obvious that recruiting schools to participate in the project was not going to be a straightforward task and the target number of schools was significantly reduced. In Victoria, none of the original 'short list' of schools responded to the first or second invitation to participate. This was despite the concerted efforts of three members of the research team, including one having sole responsibility to make contact with participant schools. Contact with individuals in the Victorian Department of Education (some months into the project) eventually saw the identification of two schools who agreed to take part. Four other schools were subsequently enrolled in the project thanks largely to pre-existing relationships between the schools and members of the research team. Schools continued to be added to the project in a very slow manner over a 19-month period. In this time, only two schools — out of more than 30 that were approached — responded to a standard invitation to participate (i.e. an invitation made by letter or e-mail that was not based upon some existing network or personal contact).

Over time, ongoing participation of the schools became more difficult to maintain. This was signalled not only by slow response times to phone calls and e-mails, but also through poor response rates by students who, when a school *did*

1. Interestingly, this is not the only project on Girls and IT to be funded by the ARC during the past 10 years.

agree to participate, were ultimately given responsibility for returning signed parental consent forms. By the end of the first 20 months of the project, time lines had been rewritten so many times that it was quite obvious the researchers were *not* in charge of when data would be collected!

The most important point to emphasise here is that the students, the teachers or the schools more generally are not in anyway at fault, nor are they to be criticised for their reluctance to participate. Rather, overt and covert messages coming through to the Victorian research team suggested that in the crowded, busy and demanding world of teachers and students, a project focused on girls and CIT was unable to command their close attention.

This is where a key concern of this chapter emerges: if, as outlined earlier, there is so much evidence to support the claims that, firstly, girls *are* under-represented in CIT and secondly, that this under-representation has a number of significant effects for the girls, the profession, the economy *and* the nation then why does this 'problem' struggle to draw attention to itself in contemporary Australian schools?

This leads me to the concept of attention itself. In this chapter I am using the term to reflect the work of Michael Goldhaber who makes the claim that the specific character of the 21st century is not so much that of an information economy, but rather an *attention* economy. Goldhaber writes:

> The attention economy that is emerging is radically different from any prior economy, and certainly from the industrial market economy. In its pure form, it doesn't involve any sort of money, nor a market or anything closely resembling one. It involves a quite different pattern of life than the routine-based, industrial one with its work/home, work/play and production/consumption dichotomies. What matters is seeking, obtaining and paying attention. (Goldhaber 1997, p. 2)

Drawing on this work, Chapman makes the related point that:

> Because the basic needs of the middle and upper classes of the United States were by and large satisfied a generation ago, transfers of wealth today are now based on capturing the attention — and thus the income — of the people in these classes. (Chapman 1998, n.p.)

Reflecting upon the kinds of attention drawn, through the late 1990s to various public 'scandals' Chapman goes on to make the important point that:

> The "attention economy" opens the door to two pernicious and corollary effects: a "race to the bottom" in the kind of information that guarantees attention — the O.J. Simpson trial, the murder of Gianni Versace, the Monica Lewinsky case — and accelerating speed in the circulation of such information.
>
> Technology greatly enhances the latter effect, speed, and speed itself exacerbates the first effect by making attention more fleeting and difficult to maintain. (Chapman 1998, p. 1)

Chapman's point may be partly illustrated by the different degrees of attention received by two different strands of media focused on girls and computing. On the one hand, news stories reporting on projects such as GaIT have gained minimal coverage over the past few years. On the other hand, the media coverage associated with the launch of a Girls and IT calendar (a la *Calendar Girls* complete with recreations of famous movie scenes featuring scantily clad or overtly sexualised women) was tremendous. This coverage was able to take the longstanding issue of girls' under-representation in the computing industry and link it to a 'scandal' of established popularity: the exploitation of sexuality to 'sell' a product, a career, a brand of 'femininity'.

There are two immediate implications of the attention economy's association with speed and scandal for the GaIT project. The first is a general point: in an attention economy researchers located in universities must compete with many other imperatives — including those associated with media declared public scandals — for schools' attention. This means that academics are effectively in competition with people and things as diverse as new government agendas (including radical changes to curriculum structures via initiatives such as Essential Learnings in Victoria), media-based interrogations of school practices (focusing on everything from school canteens, bullying, through to literacy levels), changing workforce demands (including mixed messages about where employment now lies for the majority of children), and parents' and students' ever-increasing anxiety about all these issues. Schools, of course, are also staffed by real people who also have a range of personal and employment situations to address and may not always be well-positioned to play the role of eager research participant, no matter how worthy the problem.

In addition, when a school *does* turn its attention to research issues, there is little evidence to suggest that questions associated with the education of girls are likely to be at the top of a school's list. For a wide range of reasons, which I will explore in more detail in the pages that follow, it seems possible to argue that that portion of schools' attention which has historically focused on girls' education has increasingly shifted — firstly, towards the broader field of gender education and then subsequently to the related, but distinct, issue of boys' education. The important point is that in an attention economy the legitimacy of a research question is not the most important factor in recruiting and sustaining school interest. Rather, it is the ability to attach the research 'problem' to other factors that schools *are* interested in — or scandalised by — that may be the most significant influence on the implementation of current school-based research projects.

As the struggle for the attention of teachers and students became more apparent within the GaIT research project, members of the Victorian research team began to offer increasingly specific forms of support to the participants. Initially, schools were offered 'inducements' such as professional development sessions run by the research team on the girls and CIT topic, and some Casual Relief Teacher (CRT) support to

cover the organisation of the project. When this failed to generate much response, more dramatic measures were implemented. The time commitment required of participants was reduced significantly, from two sessions to one; all sessions were scheduled to coincide with, or run into, lunch breaks; a free lunch (funded by the researchers) was provided to all who took part (and often to their friends as well); participant teachers were offered not only CRT relief but also funding towards their own professional development funds. Staffrooms were provided with cakes and chocolates. Teacher participants received formal thank you letters, Christmas cards and, in some cases, movie tickets and lollies … the list went on. Few of these scenarios featured in the project's early planning; however, it is reasonable to suggest that it was only through these measures that we were able to capture the attention of some students and some teachers. Certainly it was not the topic of our discussion, nor any data we put forward to demonstrate the low numbers of girls in CIT that drew attention to our project. It was rather our ability to link the project to other products that attract attention — time, money, pizza — that eventually produced some level of participation. Of course, making these available to participants can be read in many way as simple markers of courtesy — or some small instances of reciprocity — towards students and teachers willing to participate in a university study. When read together with the data ultimately collected within the Victorian dimension of the study, however, they help to emphasise a widespread sense that the low numbers of girls (and indeed boys) in CIT pathways is not an issue of concern — that is, not a genuine educational problem.

This is an urgent area of concern and raises important issues when considered alongside the multiple contexts within which the low numbers of girls' in CIT classrooms is considered legitimate. This chapter seeks to explore this phenomenon of girls under-representation in CIT education in more detail, and to highlight some of the reasons why this is not seen as a priority area of concern for teachers and students within a number of the schools included in the GaIT project. Many of the explanations relate to longstanding debates about the 'nature' of girls and boys, and their varying/different/competing educational needs and abilities. For this reason it is useful to begin the next section of this chapter with a brief overview of dominant explanations for gender-based educational differences over the past 20 years.

Part Two: Shifts in attention: a brief history of gender-based educational reform

The history of gender-based educational reform is long, with debates about the purposes, strengths and limitations of girls' and boys' education dating back several centuries. Clearly it is beyond the scope of this chapter to review this literature in its entirety. What is important to acknowledge is that from the 1970s onwards there emerged a particular and relatively high profile focus on the differential educational achievements and experiences of girls and boys in western society. As McLeod notes:

> From at least the mid-1970s in Australia, teachers' organisations and government and education department reports began documenting and comparing the access, participation, retention and educational experiences and outcomes of girls and boys and found that to be a girl was an educational disadvantage: importantly, it was noted that the degree of disadvantage was also linked to girls' socio-economic status. (McLeod 2004, p. 168)

From this data, attempts were made to explain and account for widespread and persistent differences regarding the nature and outcomes of girls' and boys' education. The different explanations for the problem produced, naturally enough, a range of solutions that can be generally characterised in three ways. First, there were projects designed to improve girls' *access* to various experiences and to guarantee them *equal opportunities* in the literal sense of the terms. In this framework, attention was focused on removing formal barriers to girls' participation in various educational activities. Emphasis was placed upon ensuring that there were no structural barriers (including timetable issues) impacting on girls' participation in diverse curriculum areas; that they had opportunity for equal time in various school spaces (such as playgrounds and, later, computer labs) and that there was a stated school commitment to reminding students that 'girls can do anything' (including things to do with computers into and beyond the 1980s). This slogan is found both within general literature focused on the achievements of girls, and in school and government policies (see for instance the Women's Info Link site of the Queensland government at http://www.women.qld.gov.au/?id=3).

Alongside this access/equity approach to girls' education (which basically left contexts unaltered but just added girls into the mix) there were other projects designed to 'value the difference' of girls. In these initiatives girls were seen as having particular and (in some cases biologically-determined and thus unique) interests, abilities and capacities (for a summary of these arguments see Allard et al. 1995). In many schools, then, the argument was made (by teachers, parents, and to some extent official government policies) that to ensure girls got the most out of their educational opportunities they needed to be educated in 'girl friendly' ways (see, for instance, The Alliance of Girls' Schools 2005). This kind of logic supported initiatives as diverse as those designed to ensure that girls' prior and 'real life' experiences (including domestic and 'feminine' activities) were included and valued within curriculum. Such experiences extended to designing 'girl friendly' projects allowing girls to display their 'feminine' side by providing space for girls to demonstrate creativity, collegiality and intuition or to work on projects aligned with their 'natural' interests (in such things as relationships, fashion, dolls and so on). This kind of thinking has given rise to such phenomena as pink computers and Barbie® laptops, which are based on the premise that girls will be more interested in 'technology' if it is presented in traditionally feminine packages.

As the 1970s moved into the 1980s, there was an increasing recognition within girls' education, that working to improve educational experiences was not just a matter of removing barriers, or catering for some particular (and stereotypical) notion of what it might mean to be a 'girl'. During this time, emphasis was placed upon the diverse ways in which girls were socialised into performing particular versions of 'femininity' (for discussion see Allard et al. 1995; MCEETYA Gender Equity Taskforce 1997; Rowan et al. 2002). These discussions — in research documents, at conferences and in school staff rooms — generally attempted to downplay claims that girls' were 'naturally' interested in, or motivated by, traditionally feminine pursuits, and focused instead on the social processes through which girls and boys came to see certain interests, behaviours and educational activities as naturally suited to males and females.

Research into the socialisation of girls drew close attention to the multiple ways in which girls receive messages about what it meant to be a female, and a female student. Through this research schools became increasingly conscious of the role that diverse texts — curriculum materials, text books, teacher talk, student talk — worked to naturalise particular and limiting images of the 'good girl' and the 'good girl student' (for an overview see MCEETYA Gender Equity Taskforce 1997). At this point, the notion of role models and positive socialisation experiences became hot topics. Pictures of women engineers, scientists and computer programmers began to increasingly appear in schools and girls were again reminded that there was outside proof of the fact that girls could study/do anything they chose. Each of these strategies are reflected in the key policy document on gender in Australia through the late 1990s (MCEETYA Gender Equity Taskforce 1997).

By the end of the 1990s, therefore, three different explanations for girls' and boys' differing educational experiences had been put forward: the first emphasised equity of access and suggested modifications to access and the removal of structural barriers to equal participation. The second emphasised the natural differences between boys' and girls' and argued that this could only be addressed by modifying school systems to respect and value these differences. The third argued that to move beyond limited understandings of gender, students need access to a diverse range of images of femininity and opportunities to be rewarded for alternative subject choices. Alongside these explanations, of course, were counter claims often found in the popular press or on talk back radio that argued the differences were not, in fact, of any significance, and that there was no need to be meddling in the 'natural' order of things.

Into the 1990s, there were a number of important moves within girls' education debates. First, feminist analysis of the category 'girls' increasingly drew attention to the fact that just as there were differences in the life experiences of girls and boys, so, too, were their differences *within* the category of girls. Factors such as cultural background, socioeconomic status, physical ability and so on, were increasingly recognised as combining with gender to produce diverse and competing

understandings of what being a girl involved. Similarly, it was increasingly acknowledged within gender literature and policy documents that the category 'boys' was also characterised by significant diversity, and that just as gender norms could limit educational experiences and outcomes for girls, boys could also be disadvantaged by particular understandings of masculinity, and what it means to be a boy in education.

Parallel to the pro-feminist strand of this research there was, of course, the high profile 'backlash' literature which raised the question 'what about the boys?' Such literature simultaneously suggested that the problems facing boys in education were often the fault of over-zealous feminist educational reformers who went 'too far' to produce girls as the new dominant group and boys as the new victims within a feminised educational environment (for an overview of this literature see Rowan et al. 2002 and McLeod 2004).

At the same time as the categories of *girls* and *boys* were being problematised, attention was also focusing on the need for any debate about girls' education to recognise that the notion of 'gender' itself was not a fixed and unproblematic category. Gender identity was increasingly regarded as something negotiated at the intersection of multiple and competing discourses, so that 'girls' was a category that was defined not only by differences in regards to 'boys', or to differences amongst 'girls' but also differences *within* each individual girl (for some discussion see Braidotti 1994a; Butler 1990; Jeffries 1991; Rowan & Bartlett 1997; Yates 1994). This movement was based largely on the influence of poststructural writings, which argued the importance of gender-based educational reform focusing not only on the apparent structural influences on the formation of a gendered sense of self, but also on the multiple ways in which 'self' is understood, and performed, by different girls and boys, at different historical moments, in different physical environments.

This poststructural analysis of gender drew closer attention to the complex interplay of factors that shape the performance of gendered identities (in and beyond school), and helped to explain why standalone school-based 'reforms' did not always produce the kinds of transformation in student practice that schools might have anticipated. A key move within this literature is the identification of the ongoing nature of projects with a transformative agenda, and a parallel recognition that patterns of gender reform can not simply 'wish away' the consequences of sexist, patriarchal, or gendered ideologies (Braidotti 1994a, 1994b).

To summarise, each of the phases of gender reform explored earlier — including some of the more recent anti-feminist or backlash literature — have put forward different explanations to account for the differences in the educational interests and achievements of boys and girls. From access/equity literature we have the suggestion that it is mostly a question of equality of opportunity — that if structural barriers are removed then girls will be free to choose, or not, to study anything at all. From the literature on valuing difference came the suggestion that girls will generally choose to study or work in areas which respect their essential femininity,

and that subjects seeking to recruit girls therefore need to change to accommodate this fact or, alternatively, simply accept that there are some areas that will not be attractive to girls. The related essentialist perspective often explored by anti-feminist literature also emphasises the fundamental, 'natural' differences between boys and girls, and argues that schools need to respect these differences by treating boys and girls in different ways — by employing different pedagogies, using different texts, encouraging different career paths and so on.

Socialisation perspectives, by contrast, often suggest that boys and girls simply need to be shown that it *is* possible to step outside gender norms (Rowan et al. 2002). Girls can be encouraged through initiatives such as role models, critical thinking programs (helping them identify sexist or stereotypical images of women) and other pro-feminist initiatives into non-traditional areas which will, in turn, change the culture of these professions and make for more equitable futures.

Beside these initiatives is the poststructural awareness that no single agenda, and its associated 'solutions', can work in isolation. Any attempt to denaturalise long-standing gendered patterns of behaviour and employment requires ongoing attention to the multiple ways in which gendered identities are constructed, and the similarly multiple — but always fragile — processes through which new images of female (and male) subjectivity are brought into circulation. On this issue, it is worth acknowledging the work of theorists such as Braidotti, who argue that gender transformation depends upon the introduction of new subjectivities, or 'figurations' and the continual reference back to — and through — old identities. She argues:

> Figurations are not pretty metaphors: They are politically informed maps, which play a crucial role at this point in the cartography of feminist corporeal materialism in that they aim at redesigning female subjectivity … In this respect, the more figurations that are disclosed in this phase of feminist practice, the better. (Braidotti 1994b, p. 181)

Braidotti acknowledges that new figurations cannot be called into existence independent of the processes of denaturalising existing subject positions. In Braidotti's (1994b, p. 169) terms, 'the new is created by revisiting and burning up the old':

> Like the gradual peeling off of old skins … it is the metabolic consumption of the old that can engender the new. Difference is not the effect of willpower, but the result of many, of endless repetitions. (Braidotti 1994b, p. 182)

Theorists such as Braidotti, therefore, capture the poststructural emphasis about the ongoing nature of any transformative agenda, also highlighting the multiple fronts on which transformative work must operate. When read in conjunction with Goldhaber's comments on the nature of the attention economy, Braidotti reminds us that 'endless repetitions' of new gender figurations require ongoing attention: attention from those producing, or showcasing them, *and* the attention of those 'seeing' them.

Whilst changes in theoretical understandings of the construction and contestation of gender norms has a certain developmental or progressive character, it is important to recognise that this most recent wave of thought — that is, the broadly poststructural perspective — is neither the most fashionable or the most influential in regards to the ways schools today approach the analysis of scenarios such as girls' under-representation in CIT. Indeed, quite the opposite is the case with less complex, more easily circulated arguments to explain the different interests and abilities of girls increasingly dominating gender debates.

This brings me to the central point of this section: I have argued that the emergence of an attention economy has significant consequences for educational researchers who compete with multiple other actors for the attention — and thus the time — of schools, students and teachers. I have also suggested that these consequences are particularly severe for those wishing to pursue research in areas that have either faded from public attention, or had so much attention that they are understood as being already solved (as much as they ever will be) and which, as a consequence, now gain attention only when linked to something palpably different or scandalous. If we read this understanding of the attention economy alongside the history of gender reform and, most specifically, the emergence of complex poststructural perspectives on the performance of gendered identity it is possible to identify a clear tension between Braidotti's emphasis on the need for 'endless repetitions' of alternative subjectivities, and the pressure produced by an attention economy for the 'new' or at least the controversial.

This tension creates real challenges for those wishing to research 'old' topics in these new times. These questions concern how, in the first instance, to attract and sustain attention; how to go about managing attention when one has it; and how to move beyond creating forums within which old and, perhaps, limiting understandings of gender will receive another airing thereby reinscribing the very patterns with which the project may be concerned.

I will explore some of the theoretical and methodological issues associated with these challenges in a range of forthcoming papers. In the remainder of this chapter, however, I have two goals. First, to acknowledge that within the current GaIT project, data collected from students and teachers has routinely reinforced the traditional explanations for gender-based educational differences: explanations that pre-date the poststructural work of the 1990s — except in their general acceptance that 'gender problems' of the 1970s and 1980s have largely been solved and that boys maybe the new disadvantaged. Second, I want to position this data, not as evidence that there is actually no way to disrupt mainstream and popular understandings of gender, nor as proof that the feminist agendas of the 1990s have failed. Rather, I want to read this data as evidence that competing for attention means drawing attention *away* from well-established and powerful explanations; that this competition necessitates the provision of spaces for these normative explanations to be aired. It is only through this process — and endless repetitions

of this process — that disruptions to longstanding gendered-based behaviours (and their constitutive explanations) can hope to be displaced. There is clear evidence to suggest that in the broad area of girls and information technology this work has only just begun.

In the third and final section of this chapter I will look at the data collected from teachers and students who have participated in the GaIT project. The focus of this analysis will be on identifying the explanations put forward by teachers and students to account for girls' under-representation, and highlighting the extent to which these explanations depart from, or articulate with, previous explanations for the educational differences between boys and girls.

Part Three: So what IS the problem? Teachers' and students' explanations for girls' under-representation in CIT education

The voices recorded in this next section of the chapter are drawn from a range of public secondary schools located primarily in Victoria. In addition, some of this data is drawn from schools located in New South Wales and South Australia. As indicated below, the schools are from a range of locations, vary in terms of socioeconomic status (SES) and cultural diversity, and have generally mid-range to low rates of female participation in senior secondary school CIT education. All students have been anonymised, referred to only as boy or girl, and differentiated only from other speakers in their group.

- Crocodile Secondary College: Rural, low SES, low diversity, moderate female participation
- Otter College: Rural, low SES, low diversity, moderate female participation
- Bandicoot Secondary College: Regional, high SES, low diversity, low female participation
- Dragon Secondary College: Metropolitan, low SES, high diversity, moderate female participation
- Angelfish Secondary College: Metropolitan, low SES, high diversity, low female participation
- Black Mare College: Regional, medium SES, low diversity, low female participation
- Sheepdog Secondary College: Rural, low SES, low diversity, low female participation
- Dolomite High School: Rural, low-medium SES, low diversity, moderate female participation
- Fairy Wren High School: Rural, high SES, low female participation

All interviews were conducted between 2005 and 2006. The themes identified in this chapter emerged consistently in interviews with teachers and students: each of these themes connect to explanations for gender-based differences aired from the 1970s to the 1980s (and pre-dating the advent of poststructuralism). An important dimension of these explanations is, of course, a certain gender blindness, or a denial

that gender is the key determinant in any of the decision-making. This leads to the first theme identified in the GaIT data: that decisions are not motivated by gender, but connected to a 'neutral' analysis of the CIT industry and its career paths.

Why would ANYONE study CIT?

As indicated earlier, it was common for students *and* teachers interviewed through the GaIT project to remark that there was not a problem in girls (or boys) choosing not to study CIT because the industry as a whole was not a good employment option. This opinion was clearly expressed by girls and boys in a range of schools. For example:

> There [are] ways to influence more people to get on computers but there's … no point cause there's already a lot of people on computers. (Boy, Bandicoot Secondary College, Focus group)

> In Year 10 I did like certificate 2 and I was going to continue on with IT but then a lot of people are saying that there would be actually a shortage of positions in IT because its so popular so then I just had a different career change and I just decided to do something else. (Boy, Angelfish Secondary College, Focus group)

> A lot of our parents and that say' oh there's no jobs out in the IT word cause there's a big boom last time' and yeah that's what they tell us so we just don't need to do it. I just find the boys are more better at it than the girls cause they're more creative in that way and their brains work differently. (Girl, Crocodile Secondary College, Focus group)

This kind of perception may be associated with the fact that numbers of boys enrolling in CIT subjects has also declined over the past 10 years. A related line of argument emphasised the fact that CIT subjects were not ranked highly in the Victorian Certificate of Education (VCE)[2] calculations and that students wishing to maximise their final ENTER[3] score were likely to study other subjects.

> I think that people choose the subject that they do because of the pressure put on them by teachers and mixed teachers and parents as well but from like Year 10 you're pressured into choosing subjects that will get you into a uni course you want to do and from Year 10 you have to choose what you uni course you want to do and they're always going on about pre-reqs and what you need so you don't really have the chance to sort of explore other subjects. Its sort of if you want to do that then you have to do these subjects and then that's it. (Girl, Bandicoot Secondary College, Focus group)

2. Students and teachers in New South Wales and South Australia also indicated a belief that studying CIT was not going to improve their tertiary entrance scores.
3. The Equivalent National Tertiary Entrance Rank (ENTER) — is the university entrance score each student receives at the completion of the Victorian Certificate of Education. The ENTER is used as a selection tool for entry into university courses. The higher the ENTER score the better.

This means that CIT was an area that was generally chosen only by those students who were *seriously* interested in it or who saw it as an easy option. For example, the question, 'why did you choose IT?' produced the following kinds of responses:

Boy 1: … Sounds easy.

Boy 2: … 'cause I was dropping one subject so I had to pick up another. This is the easiest.

Interviewer: Why does everyone say that … [that] it was a bludge and it's easy.

Boy 3: … Because it is kind of a bludge and it is easy. (Students, Bandicoot Secondary College, Focus group)

It's just not interesting …

A second, similarly 'gender neutral' theme concerns the extent to which CIT as a broad area of study just isn't that interesting to most students. This 'interest' factor was also seen as separate to issues of gender and tied more closely to factors such as pedagogy and content, with the implication being that both girls and boys would be alienated by similar kinds of things. For example, on the question of the impact of the teacher, or the teaching style, students at Dragon Secondary College made the following points:

Girl: I think it would be better if an IT teacher was more fun. Cause they … not generalising but like IT for me its not the funniest, staring at a computer, clicking on things, is not my idea of … so if I enjoy it and so maybe the teachers a bit more vibrant. (Bandicoot Secondary College, Student focus group)

A different group suggested that being a good teacher would involve being interesting:

Boy 3: To be interesting.

Interviewer: And does that happen at the moment?

Boy 1: Not really.

Boy 2: No, not at all.

Boy 3: It's the same old stuff over and over again. (Students, Dragon Secondary College, Focus group)

Other students at a different school were similarly critical of the pedagogy of their classroom:

Interviewer: Does the teacher make a difference? Some students before said it didn't make a difference

Girl: Yeah it does; if they're like boring or strict or whatever no one wants to do it. (Crocodile Secondary College, Student focus group)

Within this strand of argument, the possibility that there are specific problems facing girls is downplayed. They are seen only as a subset of broader 'problems'

associated with CIT generally. These problems concern the subject content, the dominant pedagogies and the overall image that the profession isn't likely to be a good career choice.

Similar to some other studies (e.g. Thomas & Allen 2006), in at least some portion of the GaIT research, students and teachers proffered explanations that made no reference to issues of gender. Indeed, within the focus groups conducted by the author of this chapter, questions of gender were almost never raised by the students themselves: it was up to me, as the researcher, to ask the explicit questions about whether or not masculinity and femininity had any impact upon subject selection or enjoyment.

Responses to these specific questions drew two contradictory, but consistently articulated, responses. The first explicitly downplayed the role of gender in subject selection, ability or enjoyment — referring back to the issue of 'natural interest'; whilst the second used sex — or biology — as a rationale for the observed differences. These themes will now be explored further.

Natural interests or sexed brains?

On the one hand, when the question of gender was explicitly raised by the researchers, most students denied that it had any direct impact on subject choice, citing the more general phenomenon of 'interest' and 'ability'.

> Boy: I don't think it's the sex of the person. I think it's based on the interest and what they like doing.
>
> Girl: And their intellectual abilities. (Students, Angelfish Secondary College, Focus group)

A similar sentiment is expressed by a teacher at Fairy Wren who argues that:

> I guess it probably or maybe gets down to interests. Like we try to encourage the kids to take the courses that they're interested in. I guess, I don't know, it probably comes down to the girls probably aren't interested in it, I guess, the programming as well as computing. I don't know why but it's not something we promote, we try to promote everyone does it equally but it's probably that they're interested in other subjects you know. (Teacher, Fairy Wren High School, Interview)

On the other hand, it was equally common for students and teachers to make the point that girls' interests were routinely different to boys, and that this difference was a natural, biologically determined event.

> Girl 1: I think guys … it's probably the way guys' brains work more than anything. Cause you know how they do physics well a larger portion, maybe that's how they … [think] …
>
> Girl 2: I think its more the way … it's just what guys get into. Like guys won't get into hair and makeup as much as girls do so it's just the same computers and … (Students, Otter College, Focus group)

Girl: I reckon girls are more into fashion and social wise than boys. Like into computer games and … (Bandicoot Secondary College, Student focus group)

Boy 1: They're more interested in fashion and stuff.

Boy 2: Don't want to break their nails.

Boy 1: Like they just think fashion and stuff.

Girl: It's probably cause they are not interested, I think they choose another subject that they're more likely to become … and clear … probably won't get more together. Have like to create a multimedia industry. As you said probably go to hairdressing or fashion or something else. I think that is more suitable for a girl. (Students, Dragon Secondary College, Focus group)

Girl: I just think boys tend to play the games and things on the computer. Do you know what I mean. Kind of like a PlayStation, they'll go on and play the games together. Like PlayStation stuff aren't really … it's kind of like you've got girl and boy things. (Bandicoot Secondary College, Student focus group)

Similar sentiments were expressed by several teachers. For example:

Teacher: … I found most of the girls have problems in logic, in mathematics, they just can't understand the procedure. They cannot … I don't know why. They have to follow teacher's instruction step by step. I can't skipped some steps [sic]. It's quite hard for them. But in Microsoft Excel it's very hard for girls because they need to know how to create a formula. I mean that's very hard for them. (Dragon Secondary College, Teacher interview)

Teacher: Probably one of the difficult areas I have, certainly even in 12, is that the boys tend to look at the hardware and revolve around you know what sort of CPU have you got in the machine. Whereas the girls tend to not have that perspective. They've had no interest in hardware, and that's why I really don't want see us trying teach the systems which really revolves around the hardware. So the boys have more interest in that technical side, the girls don't. (Sheepdog Secondary College, Teacher interview)

The 'natural' dimension assigned to disinterest and ability was also reflected in comments by students regarding the relationship between CIT study and their future careers. It was common for girls and their teachers to argue that they had acquired all they would need in terms of CIT competency in the early years of their

schooling and that there was no need for further study. These career paths — particularly in schools located in rural areas, and in low-socio economic suburbs, were generally associated with traditionally feminine occupations including administration work, hairdressing and other service industries.

Rather surprisingly — given the more than 20 years that has elapsed since the emergence of the socialisation literature within gender reform (for a complete overview see Kenway 1997) — there were relatively few places within the data where either students or teachers suggested that girls' attitudes might be the result of their upbringing or socialisation. Where this possibility was raised, it was generally in regard to the ways girls could be encouraged into the area: through more female teachers:

Interviewer: … If you had a really good female IT teacher would that make any difference?

Girl 1: I think a difference because we've never had a female IT teacher.

Girl 2: Yeah, a couple of girls might be afraid to go up to a male and ask them.

Boy: Didn't know you felt that way.

Girl 2: I thought you would have known. (Students, Crocodile Secondary College, Focus group)

Teacher: I do wonder whether having some better role models of girls in the school teaching IT, helps. I know that a College down the road from us have got a whiz bang female IT teacher and I do wonder what their statistic[s] would be like. (Sheepdog Secondary College, Teacher interview)

Through peer support:

Boy: Have a few friends like so little women there, like they only do it because their friends are or something. Maybe. (Bandicoot Secondary College, Student focus group)

Teacher: If the groups going through is supportive particularly if they're a group of girls … girls do love to share. They love to talk. So if you get a group of them or a group of girls and boys who are cooperative in the class, if the chemistry works really well, then they'll support each other and they'll follow it through. If you don't have that then that's when you'll suddenly find that you've ended up with these boys who are tending to be really competitive about it and they're following it through but it's in a different sort of way I suppose. (Sheepdog Secondary College, Teacher interview)

Through appealing to existing gender stereotypes:

Interviewer: Any theories why girls mightn't be interested? What we could do to make them more interested?

Boy: Maybe you should paint the computers pink. Make computers a fashion accessory and it might work. (Bandicoot Secondary College, Student focus group)

And perhaps even through more visible media role models:

Girl 1: They make it look cool on TV and people will do it.

Boy: Does the same thing happen with legal studies? Is that sort of influenced by a lot of legal shows, cop shows, and stuff.

Girl 2: I use to want to be a lawyer because of all the law shows and stuff but like I thought it would be too hard so I gave up on that. (Students, Crocodile Secondary College, Focus group)

To summarise, the data collected from students and teachers throughout the GaIT project has generally argued on the one hand, that although there are low numbers of girls studying CIT, this is not necessarily a problem and that if it *is* a problem, attempts to correct the situation will need to appeal to the 'natural' interests and abilities of girls, which will involve investigations of curriculum, pedagogy and assessment to ensure that they are able to meet these 'natural interests'.

If we relate these explanations back to the history of gender reform explored in section two of the chapter, it is easy to see that the understandings of factors shaping girls' access to, and participation in CIT study and employment are most closely aligned with the earliest waves of debates about gender and education. There is recognition of the importance of access, there is an emphasis on the natural differences between girls and boys, and there is some acknowledgment that these differences can be the result of socialisation. Because of this, there is very little recognition, in the majority of the interviews and focus groups, of the value or even the possibility of attracting more girls into the CIT subjects in schools.

Nevertheless, it is important to acknowledge that at key moments through the study interviews and focus groups, the students *did* articulate ideas relating to gender and CIT which seemed to run counter to traditional representations of both terms. For instance, in opposition to the longstanding representation of boys as more technologically competent than girls, both boys and girls routinely argued that girls could and generally were as good 'with computers' as their male counterparts. For example:

Interviewer: So do you think that they are as competent as — you know, are boys and girls as competent as each other on computing, like they can use the computers as equally as good and they get marks as good as each other?

Boy 1: Yeah.

Interviewer: So would you actually ask a girl how to do something if you didn't know how to do it?

Boy 1: Yeah, probably.

Interviewer: Yeah. What about you?

Boy 2: Yeah. If they knew how to do it and then I would ask them. (Students, Dolomite High School, Focus group)

There were also moments within the interviews when students explicitly acknowledged the impact of social processes and stereotyping on identity formation. The following illustrative comment shows this awareness:

Boy: People think of computer nerds because they've seen the movies and they start their pants underneath their armpits …

Girl 1: … Work in the dark.

Boy: Backpack on their bag and they talk like this.

Interviewer: And 24 hours a day in a dark room.

Boy: And that's why people get the impression of nerds and this is just TV. It's not real.

Girl 1: TV generally always has a stereotypical point of view. Like with the gay person they always walking around with their hands bent and …

Girl 2: … Going Barbra Streisand

Girl 1: Yeah. Things like that. They do things that a stereotypical gay person does and that's what high school and generally everywhere else is turning out to be.

Girl 2: Stereotype. (Students, Angelfish Secondary College, Focus group)

These moments within the interviews provide some evidence that the kinds of poststructural awareness which sustains gender transformation is present within the normative context of Australian schooling. But read in conjunction with the data explored in the rest of this chapter, it is clear that this kind of awareness is not yet disrupting the powerful, longstanding representations of gender and CIT.

Conclusions and implications for educational research

I have argued throughout this chapter that over the past decade the portion of public attention which might once have been given to girls' education has generally been redirected to boys' education, and that where girls' experiences remain the subject of public or educational attention, emphasis is routinely placed upon how much they have gained (not what they still lack) or on some controversial dimension of their current achievements. In this context, focusing on an area where girls remain under-represented, such as the CIT area, can easily be read as a waste of effort (at best) and churlish (at worst).

In addition, when researchers *do* manage to draw attention to the problem of girls' low levels of participation, and where this generates forums for the rearticulation of longstanding explanations for differences in the educational interests of girls and boys, it is possible for this work to be regarded as complicit in the circulation, and continued legitimation, of narrowing and limiting understandings of both gender and CIT.

From a different point of view, however, projects which identify the persistence of longstanding explanations have much to offer those of us continuing to research in the fields of girls and IT, or girls and education more generally. They remind us of the need to recruit the attention of people across generations and that gender reforms are not easy to stabilise or naturalise. They highlight the ongoing competition between essentialist and anti-essentialist explanations for observable patterns in girls' and boys' school behaviour. They also remind us of the necessity of continuing to document and circulate performances of 'girl' and 'boy' in contemporary schooling which transgress normative understandings of gender and, in regards to this project, CIT.

A key challenge for future work in gender and education, then, is continuing to interrupt simplistic, limiting understandings of gender, and providing ongoing opportunities for teachers and students to position themselves in multiple ways in regards to gendered identities and computer use. As outlined in Part Two, there is no shortage of contemporary theory available to inform this work. The greatest difficulty comes from continuing to generate interest in, and draw attention to, both the persistence of gendered pathways into and beyond schooling and the significance, or consequences, of these pathways.

In future papers I will be exploring some of the ways in which a small number of schools have been able to take this step. Here I would like to conclude by emphasising the point that in an attention economy any form of gender work requires ongoing attention. It is this attention which may ultimately make a difference to the image, content, and appeal of CIT programs for girls and for boys. Bruno Latour makes the powerful point that:

> … anything can become more or less real, depending on the continuous chains of translation. It's essential to continue to generate interest, to seduce, to translate interests. You can't ever stop becoming more real. (Latour 1996, p. 85)

For researchers focusing on girls and CIT the persistence of narrow, limiting understandings of technology, technological career paths and the continuously problematic relationship between various forms of computing, communication and information technologies and diverse groups of girls makes it clear that there is much more work to be done in this broad field. This work, moreover, doesn't relate so much to finding new explanations for this longstanding problem, but rather continuing to generate interest in the existing explanations and working to link these explanations to new forms of feminine identity. ■

CHAPTER 4

The nature and purpose of Computing and Information Technology subjects in the senior secondary school curriculum in New South Wales

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GENDER GAPS IN STUDENT PARTICIPATION RATES in Computing and Information Technology (CIT) subjects in both schools and universities have been an abiding feature in Australia and other English-speaking western countries ever since these subjects were first introduced into the curriculum (Goode, Estrella & Margolis 2006; Margolis & Fisher 2002; Sanders 2005; Wasburn & Miller 2005). However, during the past decade there has been a decline in overall participation in most CIT subjects in Australia, at both the senior secondary and university levels (Lewis, McKay & Lang 2006; Patterson 2005). This chapter examines recent changes in participation rates in CIT at the senior-secondary level in New South Wales (NSW). It develops a model, initially proposed by Downes (2006), for analysing alternative perspectives on the curriculum. In the Downes model, it is argued that what students and teachers consider a curriculum to be about depends on their perspectives, or standpoints. The model proposes three perspectives — the curriculum as intended, as enacted, and as imagined. It analyses the formal curriculum framework (a key element of the intended curriculum) in NSW schools and raises questions about the possible contribution this framework might make to our understanding of recent fluctuations in the participation rates of both boys and girls in senior-secondary CIT subjects. The analysis also draws on the ACM Model Curriculum for K–12 Computer Science (Tucker, Deek, Jones, McCowan, Stephenson & Verno 2003) which proposes that 'the average citizen in the 21st century must understand at least the principles of computer science' (p. 5). In differentiating computer science as separate and distinct from 'management information systems (MIS), information technology (IT), mathematics and other sciences' (p. 5), and in distinguishing between computer

literacy and higher level computer *fluency*, and in viewing computer science education as a continuum, the report describes the staged and integrated elements of a K–12 computer science curriculum and hence provides a valuable framework for analysis.

The discussion draws on current literature and publicly available curriculum and other documents and information from the NSW Board of Studies, together with data collected by the *Gender and Information Technology* (GaIT) project[1] via a student survey and interviews with curriculum makers, teachers and students. Participation rates in the NSW senior secondary CIT subjects for the years 1995–2000 are compared with participation rates in the new CIT curriculum for the years 2001–2005. Analysis reveals a shift in the current intended curriculum from an instrumental purpose in the core CIT curriculum in Stages 1–5 (K–Year 10) to a discipline-based purpose in Stage 6 (Years 11–12). A content analysis using the ACM model curriculum found this shift in purpose is also accompanied by a shift in the nature of the curriculum from a focus on computer literacy/fluency to one on software engineering and information technology. The content analysis also revealed that no foundational concepts were developed in the early stages of schooling to prepare for the discipline studies in the NSW Software Design and Development (SDD) and Information Processes and Technology (IPT) subjects. The key concepts developed in the earlier years related to literacy and fluency and to the foundations of design and the design process. This latter outcome is a result of the placement of the CIT subjects in the Technology and Applied Studies Key Learning Area. The findings raise more questions than they answer about the relationship of intended curriculum to participation rates, but they do provide some insights into the basis for the confusions and complexities of the enacted and imagined curriculum.

The historical and social context of CIT subjects in secondary schooling

The family of Computing and Information Technology (CIT) subjects are recent arrivals in Australian secondary schools, with a history of just on 20 years. This period has been volatile with both rises and falls in enrolments and significant changes in the nature and purpose of these subjects as they have sought to establish and maintain their place in the secondary curriculum.

When microcomputers and CIT subjects were first introduced in the senior secondary schools in the late 1970s their focus was mainly on learning to programme in languages such as Fortran and Basic — the common languages on mini and micro computers. By the mid 1980s, their goals broadened somewhat to focus on familiarity with and use of computers, and understanding computing

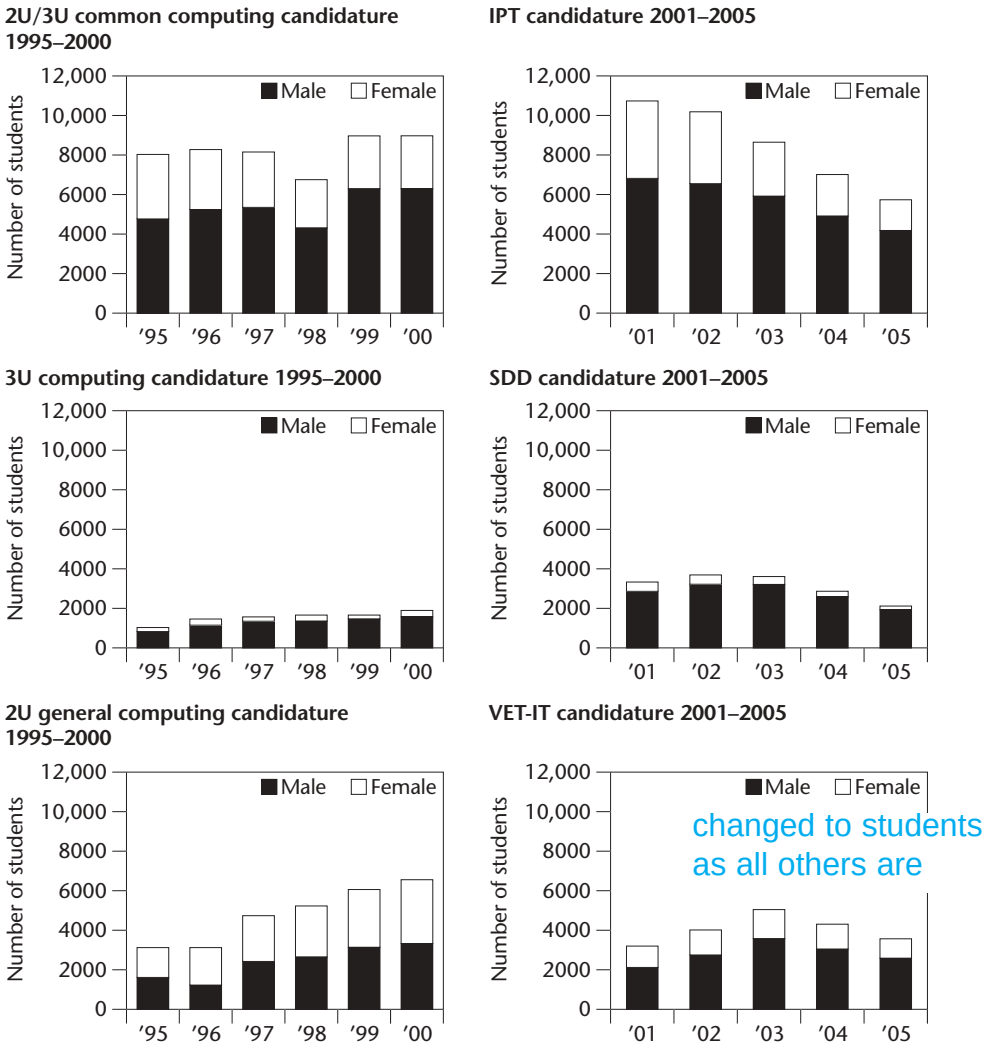
1. Please refer to Chapter 1 by Julianne Lynch for further details about this ARC Linkage project.

processes. Their novelty in the school setting, and indeed in the domestic and work environments, made them inherently attractive to a wide range of students. Furthermore, teachers, parents and students alike saw them as vehicles for the development of the new skills that would be needed in future workplaces and further studies. Often these subjects were the only place where students could learn about and use computers. In the 1980s, very few students had access to computers at home, most schools had a limited number of computers, and these mostly resided in the computer laboratory and were reserved for use in computer studies classes (Bigum, Evans, Groundwater-Smith, Grundy, Kemmis, Straton & Willis 1987).

Over the last 20 years computer facilities have become available in the homes of almost all secondary-aged children; often, these computers are more sophisticated and accessible than those generally available in schools. The integration and permeation of CIT in commerce and industry is universal, and daily experience with a range of converging digital technologies such as mobile phones, cameras, web-browsers and music devices is commonplace for most teenagers. Furthermore, secondary students now use computers across a range of subjects, with many students regularly using them for homework from the earliest stages of their schooling (Meredyth, Russell, Blackwood, Thomas & Wise 1999). In a number of Australian school systems, students are expected to develop computer literacy skills across the curriculum and have their levels of literacy assessed at different stages in their schooling (ACT Education and Training 2002; NSW Board of Studies 2006). Indeed, some commentators have argued that the cognitive capacities of today's students have been so significantly affected by the ubiquitous presence of computers and information technologies that these young people are best described as 'digital natives' (Prensky 2001).

Today's students are avid users of a wide range of technologies. Results obtained through the GaIT student survey indicated that two thirds of the Year 10–11 students said they 'send lots of e-mail and SMS messages to friends' and nine out of ten said they 'regularly use computers for homework'. Given young people's extensive use of digital technologies it might be reasonable to expect the current patterns of participation in CIT subjects in schools to reflect this interest and use. As the data in Figure 1 on the following page demonstrates, there has been a significant rise and fall in participation rates in NSW over the last decade, which coincide with curriculum changes. The total enrolment between 1995 and 2000 increased from 12,277 students to 17,496 (43% increase). However, after the introduction of a new CIT curriculum in 2001, enrolments decreased from 17,294 in 2001 to 11,463 (34% decrease) in 2005. The overall participation rates of female candidates declined from 41% to 36% between 1995 and 2000, with a further decrease between 2001 and 2005 from 32% to 24%, with the most dramatic decrease occurring in the last three years of this period (2003–2005) in each of the subjects.

Figure 1. Participation rates in Higher School Certificate CIT subjects, 1995 to 2005



Source: Data extracted from the CSV files of the HSC Student Entries by Sex for each of the years 1995 to 2005 < http://www.boardofstudies.nsw.edu.au/ebos/static/ebos_stats.htm> (downloaded on 1/9/2005).

It is worthy of note that each CIT subject shows a particular pattern of overall change and rate of gendered participation. One subject, the 2Unit (2U) General Computing subject,[2] did maintain a 50% female participation rate from 1995 to 2000. This subject along with the 2Unit/3Unit (2U/3U) Common Computing and the 3Unit (3U) Computing subjects were discontinued at the Higher School Certificate (HSC) level in 2000 as a result of the introduction of a significantly restructured HSC in 2001. This restructuring provided the opportunity for a

2. Prior to the changes to the NSW HSC in 2000, a number of areas of study had multiple versions of the subjects to allow for differentiation through levels of difficulty or depth. The labels 2U General, 2U Related (or 2U/3U Common), and 3U and 4U were used to denote the level of difficulty or depth.

comprehensive review and redevelopment of all Stage 6 (Years 11–12) curricula including CIT. The post-2001 suite contained Information Processes and Technology (IPT), Software Design and Development (SDD) and the VET Information Technology Curriculum Framework (VET-IT) subjects. The nature and purpose of these subjects will be discussed in a later section of this chapter.

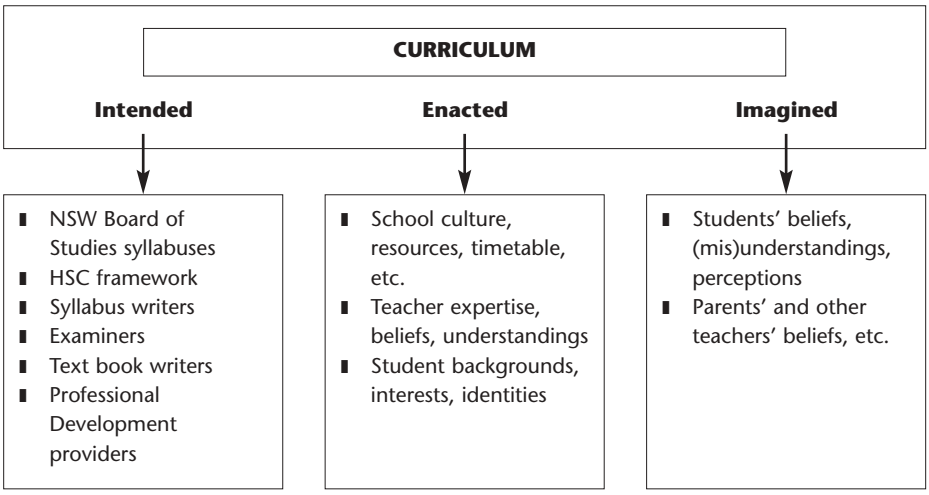
These fluctuations in participation rates raise questions about the role and purposes of the formal study of computing and related technologies in senior secondary schooling. While this chapter focuses on the NSW situation, it is important to note that the decline in participation in the advanced study of CIT in the senior secondary years is neither particular to NSW, nor to Australia, nor to the secondary education level. It is also occurring at the tertiary level across many English-speaking western countries including the United Kingdom, United States and Canada (Lewis, Mckay & Lang 2006; Patterson 2005). There have also been significant rises and falls in participation in other senior secondary subjects since the year 2001, when a series of reforms to the NSW Higher School Certificate, based on the McGraw Report (1997), were implemented. Such volatility is not unexpected given the changing political, economic, educational and social contexts, the changing purposes of senior secondary schooling, and the changing nature and functions of senior secondary curricula, assessment and credentialing. However, decreasing CIT enrolments in a context of increasing use of digital technologies by young people raises questions about the nature and purpose of these subjects.

It is important to recognise this broader context and be wary of any simplistic interpretations which pose a direct relationship between the falling participation rates in formal CIT study at the secondary level in NSW, and the nature of the NSW senior secondary curriculum. During the decade under examination (1995–2005), there were also fluctuations in demand for CIT professionals (The Information Industries Taskforce 1997; Meredyth et al. 1999; Whitehouse 2005), the dotcom crash (Multimedia Victoria 2004), and significant work at the national level around issues of skill shortages in the CIT industry (Department of Communications, Information, Technology and the Arts 2006). Any study of student participation in senior CIT subjects needs to be understood within the context of a rapidly changing CIT industry, perceptions and realities regarding CIT careers, the broader educational and social contexts of schooling, and the gendered identities and cultures within schools. For it is within these contexts and cultures that educational authorities such as the NSW Board of Studies develop their curriculum frameworks and subjects, that schools offer them, teachers teach them, and boys and girls choose whether to participate in them.

Frameworks for analysing the CIT curriculum

For the purposes of the GaIT study, Downes (2006) developed a framework using the concepts of the *intended* curriculum, the *enacted* curriculum and the *imagined* curriculum to help foreground curriculum as a co-construction of multiple

Figure 2. A curriculum analysis framework for CIT curriculum



Source: Downes (2006).

stakeholders at a particular moment in time within particular socio-political contexts. The Downes Framework (Figure 2) demonstrates how the *intended* curriculum stands in contrast to the curriculum that is *enacted* within school sites, and that as *imagined* by students and others who have not directly experienced that curriculum.

This Framework is consistent with Grundy's *pedagogical view* of curriculum — the curriculum as action (Grundy 1998). It also encompasses Schwab's four commonplaces of schooling — teachers, students, subject-matter and milieu (Schwab 1978); and it extends and yet differs in emphasis from the framework of Marsh and Willis (1999) which also distinguishes four types of curriculum — the planned curriculum, the enacted curriculum, the experienced curriculum and the hidden curriculum. While embodying all the Marsh and Willis concepts, the Downes Framework emphasises and groups the concepts in different ways, combining the Marsh and Willis's enacted and experienced, and adding a new element, the imagined curriculum. The imagined curriculum under discussion in this chapter is the curriculum as perceived by students in Stage 5 (Years 9–10) who are choosing whether to participate in formal CIT studies in Stage 6 (Years 11–12). This concept is essential for this study, as much of the broader GaIT project explored the curriculum at the point where students are making a decision about future study. The development and use of the Framework is an ongoing project. In Chapter 2, Vickers and Ha draw on the concept of the *imagined* curriculum in their speculations about why students, whose perceived ability with computing technology is high, might choose not to pursue senior studies in CIT subjects. This current chapter focuses on one element of the *intended* curriculum — the Formal NSW Board of Studies K–12 Technology Framework and its related syllabuses.

The intended curriculum analysed in this chapter includes the formal curriculum frameworks, syllabuses and outcomes that give direction regarding purpose, outcomes and content for teaching CIT subjects in NSW schools. These are the written materials that record the intentions of the curriculum makers who were charged with the responsibility of developing the syllabuses. Curriculum construction is a complex act which is both pragmatic and political, yet at the same time embedded in long-standing intellectual traditions which are themselves highly contested (Vickers 2007). According to Vickers these traditions rest on a number of fundamentally different philosophical stances about what a curriculum should try to do. "Reduced to their bare essentials, these stances relate to centuries-old arguments about the nature of reality, what schools are for, what it is possible to know and what is worth knowing" (Vickers 2007, p. 4). One way to categorise these approaches is to divide them under four broad headings: progressive, instrumental, discipline-based and sociocultural (Vickers 2007). Vickers describes *Progressivism* as emphasising the active engagement of the learner, focusing on learning by doing rather than by listening; and *Socioculturalism* as emphasising knowledge construction, proposing that knowledge only has meaning in specific cultural contexts. While these two positions may be quite influential in terms of teachers' pedagogical strategies, an examination of official CIT documents from the NSW Board of Studies suggests that both the current and previous curriculum frameworks favour a mixture of instrumental and discipline-based knowledge.

Instrumentalists, according to Vickers (2007) justify what is in the curriculum in terms of the necessary skills for success in future studies or in order to gain a good job in the future. Throughout our history Australians have mostly thought about education in instrumental ways; for most students and families, getting a job has always been the major aim of schooling (Collins 2002 in Vickers 2007). An instrumental curriculum is a tool-kit curriculum: its focus is on acquiring the skills and knowledges needed for further study, employment, citizenship or life opportunities (Vickers 2007). If we adopt this stance we might argue that students should learn how to use computers and software applications, how to trouble-shoot errors and how to get back on task when things go wrong. According to this view, a deep and coherent understanding of the underlying principles of computer science is not required. On the other hand, for those who argue that the essential purpose of education is to introduce young people to systematic bodies of knowledge that are organised in terms of *subject-matter disciplines*, the instrumentalist approach falls well short of what is desirable. It fails, because it does not lead students to acquire the foundational knowledges and ways of thinking inherent in particular disciplines (Hirst 1973). In the field of computer science, examples of such disciplinary knowledge might include the ability to use algorithmic thinking to solve problems, and an understanding of the principles and application of computer programming.

An examination of the CIT curriculum documents produced by the NSW Board of Studies across Stages 1–6 (K–Year 12) suggests the dominance of an instrumental perspective. The instrumentalist orientation of these documents is evident in the extent to which they advocate these subjects as important because the skills and knowledge they promote enhance students' current and future participation in personal, social, educational and economic activities. Importantly, there is a shift between Stages 1–5 and Stage 6. This shift, which will be discussed later, is best described as a significant narrowing of the utility from the broader focus described previously to one limited to further study and potential careers in the specific field of Computing or Information Technology.

Arguably, by Stage 6, students should have gone beyond this instrumentalist approach: they should have been introduced to some of the big ideas and ways of thinking that are essential to computer science as a discipline. These include algorithmic thinking, programming, digital representation of information, modelling and abstraction, computer organisation, information systems, networks, and information organisation (Tucker et al. 2003).

However, designing the scope and sequence of a curriculum for CIT studies across the 12 years of schooling is a complex undertaking. One issue relates to how the emphasis of the curriculum might change at various points between Kindergarten (Stage 1) and the final Higher School Certificate (HSC) (Stage 6) examination. At what stage should the inspiring ideas that drive the computer science discipline be introduced? There are dangers in introducing these ideas at a very early stage, since teachers at the primary and early secondary levels may not have adequate backgrounds in computing and may have a poor grasp of the conceptual issues. Nevertheless, one must ask how students can be expected to *imagine* what Stage 6 (Years 11–12) CIT subjects offer if these inspiring ideas are totally absent from the core curriculum they encounter through to the end of Stage 5, or are only available through elective subjects.

The *ACM 2003 Model Curriculum for K–12 Computer Science*, developed by the Association of Computing Machinery, provides a useful tool for analysing the nature of CIT curriculum documents (Tucker et al. 2003). The commentary within which the model curriculum is embedded identifies several content areas that form a coherent scope and sequence for this field of study. To summarise (Tucker et al. 2003, pp. 6–10), these content areas are:

1. *Computer literacy* — the capability to independently use today's technologies.
2. *Computer fluency* — adds to computer literacy the capability to independently learn and use new technologies as they evolve through one's lifetime. This includes the active use of algorithmic thinking (including programming) to solve problems and thinking abstractly about computers, computing and IT.
3. *Information Technology* (IT) — an applied field of study that involves the effective use of technologies (processes, systems and tools) by which people manipulate and share information in its various forms — text, graphics, sound and video.

4. *Software engineering* — the practice of designing and implementing large software systems (programs).
5. *Computer science* — the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications and their impact on society — how tools are designed and deployed — exposing students to the scientific and mathematical theory that underlies the practice of computing. It is a continuum that has some overlap with IT and software engineering but extends well beyond either of these other fields.

It is illuminating to use these different descriptors from the ACM model curriculum as a lens for examining the formal framework for CIT in NSW schools, since it indicates the possible scope of the curriculum. The accompanying commentary, and the curriculum model itself, recommends that, from the early years, students should be exposed to experiences that lead to fluency and to some of the foundational concepts and ways of thinking that underpin the more advanced disciplinary studies and that this exposure should become more sophisticated as they progress through the stages towards the senior years.

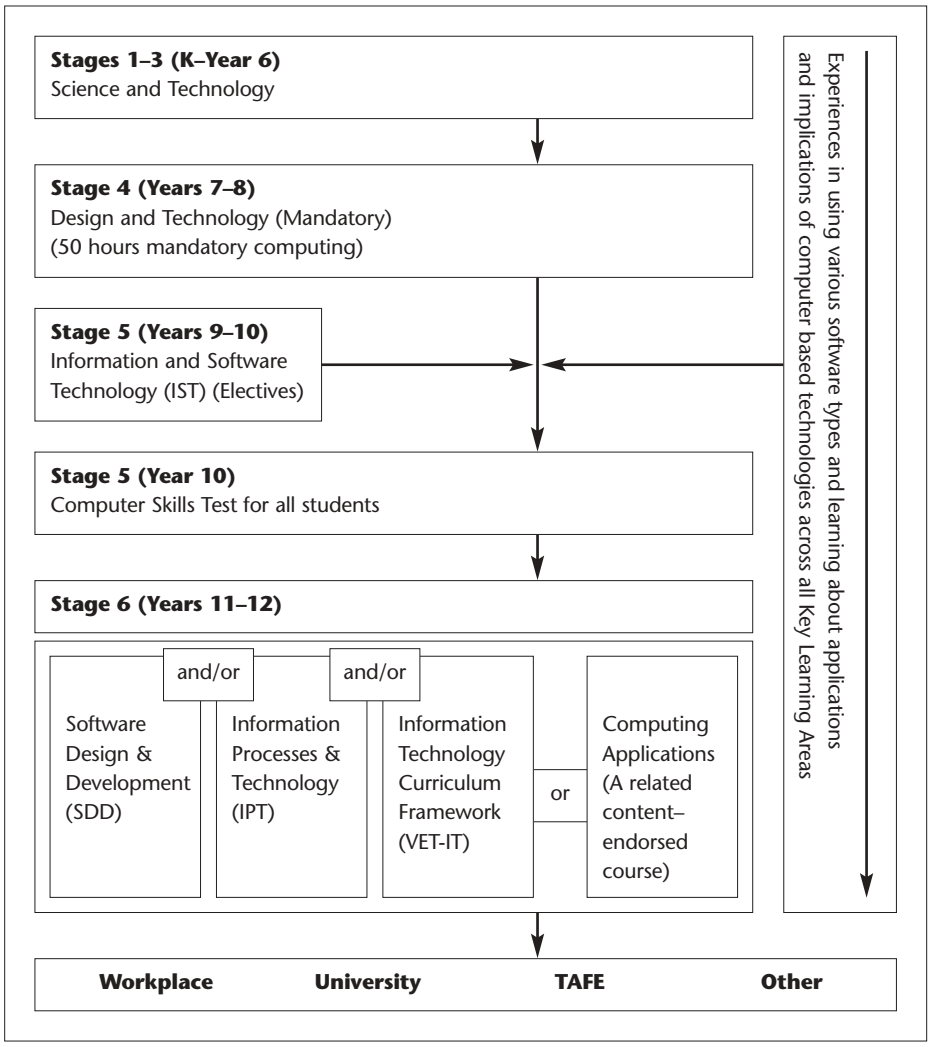
The NSW computing and IT curriculum (K–Year 12)

In NSW, CIT syllabuses are part of the *Technology Key Learning Area* (KLA). The *K–12 (Stages 1–6) Technology Statement* clearly situates CIT as serving 'instrumental purposes', stating that these technologies are 'to be *used* for researching, designing, manipulating and producing products, systems and environments' (NSW Board of Studies 2002, p. 7). This statement, and others like it in the document, emphasise the development of thinking 'skills' and 'tools to solve problems' to meet identified needs.

The CIT curriculum forms a subset of the full range of technologies addressed in the *Technology KLA*. The pathway for the study of CIT from Stages 1–6 (K–Year 12) is summarised in Figure 3 (on the following page). The pathway presents an amended version of that found in the introductory pages of the three CIT Stage 6 (Years 11–12) syllabuses (NSW Board of Studies 1999a, 1999b, 1999c), with the additional elements of the new mandatory requirement (i.e. the Computer Skills Test, which was introduced in 2006) and the Stage 6 content-endorsed subject Computer Applications. These additional elements have been added because some of the schools in the study had piloted the Computer Skills Test in 2004 and 2005 and/or offered the Computer Applications subject in Stage 6.

As part of the broader *Technology KLA* students in Stages 1–3 (K–Year 6) are expected to learn about CIT across a range of curriculum areas, but particularly within the *Science and Technology Syllabus*. In the *Science and Technology Syllabus*, one of the six content strands is 'Information and Communication … in which students learn about communication technology and the ways people make, store, organise and transfer images and information' (NSW Board of Studies 1993, p. 4). In other curriculum areas — such as English, Mathematics, and the Creative Arts — the focus

Figure 3. Curriculum continuum for the use and study of Computers and Information Technologies in NSW schools by 2005 Year 10 students in GaIT schools



Source: Adapted from the Continuum of Learning diagrams found in the Introductions to the NSW Board of Studies Stage 6 SDD and IPT Syllabuses (NSW Board of Studies 1999a, p. 7; 1999c, p. 7).

is on competence and confidence with using current technologies and applying them to tasks relevant to the student. Comparing these outcomes with the definitions supplied in the ACM model curriculum (Tucker et al. 2003), it is evident that the NSW outcomes contribute to building literacy only, rather than fluency, and that the curriculum focuses on information technologies rather than computing science. What is absent from the NSW documents is any reference to the importance of learning to learn to use new technologies as they evolve through one's lifetime, or making active use of algorithmic thinking (including programming) to solve problems beyond teaching students the basic steps of arithmetic.

Given that the Stage 1–3 (K–Year 6) curriculum provides the foundations which lead to the discipline-based Stage 6 (Years 11–12) subjects, it would be reasonable to ask how and when students in NSW schools might gain experience with certain simple antecedent concepts that underpin the study of computing science, software engineering and information technology. In particular, the ACM model curriculum highlights the failure of the curriculum to introduce concepts such as algorithmic thinking and the digital representation of information, during Stages 1–3 (K–Year 6). Yet there are simple approaches to algorithmic thinking and the digital representation of information that could easily be explored in Stage 1–3 Mathematics, and Science and Technology syllabuses (Tucker et al. 2003, pp. 12, 28–29). The only discipline-based concepts that are introduced in the Technology area during Stages 1–3 are those relating to *design*.

In the early years of secondary schooling in NSW (Stage 4), the instrumentalist focus on computer literacy is continued. This occurs in three different ways. The first is through the Technology (Mandatory) Years 7–8 syllabus. This syllabus uses the concepts and processes from the field of design as the basis for their CIT work. Within this syllabus students will 'utilise ICT within each design project and have the opportunity to study ICT in depth in the Information and Communications area of study' (NSW Board of Studies 2003b, p. 18).

The second is through a formal expectation that in Stages 4 and 5 (Years 7–10) all students should use and learn about computers and information technologies in a variety of ways within the context of other curriculum areas. These experiences are framed by explicit statements in all syllabuses about forms of information and computing technology (ICT) that are to be incorporated into teaching and learning. As the Board of Studies states, the basic aim of this 'across the curriculum' policy is to ensure that all students become 'better able to achieve syllabus outcomes through effective use of ICT for enhanced learning' (NSW Board of Studies 2006). The outcomes of these experiences form the basis of what is now tested through a mandatory component of the 2006 NSW School Certificate — the Computer Skills exam. This test measures students' skills in five areas: computer operations, word-processing, spreadsheets and databases; graphics and multimedia; and Internet and e-mail. The implication embedded in this entire operation is that computers and related technologies are merely a toolkit to be used to manage information and to enhance one's performance in other subjects.

Thirdly, the instrumentalist focus is continued through a number of elective subjects that directly or indirectly address the use of computing and information technologies as relevant tools and technologies. These include the Industrial Technology syllabus (NSW Board of Studies 2003d) which explicitly addresses multimedia technologies, and the Graphics Technology syllabus (NSW Board of Studies 2003c) whose outcomes assume a significant competence in using computing and information technologies to generate and manipulate images.

The only subject that has the potential to provide a different perspective to the dominant instrumentalist/literacy perspective during Stage 5 (Years 9–10) is the *Information and Software Technology Syllabus (IST)*. An analysis of the core content and outcomes of this syllabus also suggests a continuation of the instrumentalist perspective. However, it places a much stronger focus on computer fluency, practical problem-solving and ethical practices. This is best evidenced in the learning outcomes (NSW Board of Studies 2003a) that refer to problem-solving, designing solutions, analysing decision-making processes, justifying practices, manipulating data, working collaboratively and communicating to target audiences.

The IST syllabus stresses that the core content needs to be taught through project work, with the selection and sequence of *options* planned in such a way to allow the entire core to be taught through the project options over the course of study.[3] It is within a number of these options that students are formally exposed to some of the fundamental ideas and concepts that underpin the three fields of study (or disciplines) that the ACM model curriculum identified as the foundational disciplines (i.e. *information technology, software engineering and computing science*).

In Stage 6 (Years 11–12), students are able to select one or more of three CIT subjects and other technology-related subjects. There is also an increased opportunity to use computing and information technologies and further develop CIT literacy in other Stage 6 subjects such as English Extension and Visual Arts. The CIT subjects are:

1. Software Design and Development (SDD)
2. Information Processes and Technology (IPT)
3. VET Information Technology Curriculum Framework (VET-IT)

Other technology-related subjects include:

4. Computer Applications Content Endorsed Course: this subject has been specifically designed for students with limited exposure to computers throughout their K–10 schooling (NSW Board of Studies 2001)
5. Photography, Video and Digital Imaging Content Endorsed Course: this is designed for students who have previous experience in these media, and provides opportunities to increase accomplishment and independence in their use.
6. Multimedia is also an 'Industry Focus' area within the Stage 6 *Industrial Technology Syllabus*: this subject offers students the opportunity to study the interrelationships of technologies, equipment and materials used by industry and to develop skills through the processes of design, planning and production.

The first three Stage 6 subjects listed above are intended, as indicated in their rationales, as subjects that may lead to further study or careers in CIT. Their descriptions which follow are based on quotations from each of the introductory pages of the three NSW Board of Study Syllabus documents (NSW Board of Studies 1999a, 1999b, 1999c).

3. See Chapter 8 by Susanne Gannon for a discussion of how these intentions are enacted.

Software Design and Development (SDD)

This subject 'is designed to develop in students the knowledge, understanding, skills and values to solve problems through the creation of software solutions' (NSW Board of Studies 1999a, p. 8). The rationale for this subject highlights 'creativity' as well as 'problem-solving, career prospects, and interesting content'. It also states that the focus of the subject is the 'development of computer-based solutions that require the design of computer software rather than the computer applications that are used'. The rationale goes on to point out that the subject has intrinsic value as a field of knowledge as well as value for further education and careers. It makes an explicit statement about being intended for both genders, reinforcing earlier emphases on 'creativity, problem-solving and collaborative work environments' (NSW Board of Studies 1999a, p. 6).

Information Processes and Technology (IPT)

This subject 'is designed to enable students to become confident, competent, discriminating and ethical users of information technologies, to possess an understanding of information processes and to appreciate the effect of information systems on society' (NSW Board of Studies 1999c, p. 8). The rationale highlights the social significance of information systems and technologies and future education and employment prospects (NSW Board of Studies 1999c).

VET Information Technology Curriculum Framework (VET-IT)

This subject 'is designed to provide students with appropriate learning opportunities that will enable them to acquire a range of technical, personal and interpersonal skills valued both within and beyond the workplace as well as underpinning skills and knowledge related to the support and management of IT'. Later in the introduction the additional statement is made: 'The focus of each of the courses in this industry curriculum framework is in the support and management of the use of IT' (NSW Board of Studies 1999b). The rationale makes explicit the relationship with the needs of industry and providing training and education opportunities for the full range of students. Clear advice is provided about suitable careers in IT and related sectors.

The nature and focus of the senior CIT curriculum

In terms of curriculum perspective and focus, while the first two syllabuses (SDD and IPT) have an instrumentalist rationale, their content and outcomes follow a discipline-based perspective, which focuses on the ACM-identified fields of *Software engineering* and *Information Technology* respectively. The third syllabus (VET-IT) is part of the suite of VET Curriculum Framework syllabuses that are explicitly designed from an instrumentalist perspective to provide students with appropriate levels of computer literacy for employment in IT support roles.

This suite of subjects represents a significant departure from the set of Stage 6 (Years 11–12) subjects that were offered in NSW between 1995 and 2000. These changes were made within the context of major changes to the whole NSW Higher School Certificate, and within the increased emphasis on the development and assessment of computing skills across the curriculum in Stages 4 and 5 (Years 7–10). The Evaluation Report (NSW Board of Studies 1998) clearly identifies the difference in focus between the pre and post-2000 syllabuses.

The pre-2001 set of Stage 6 (Years 11–12) CIT subjects were 2U General Computing, the 2U/3U Common Computing and, in addition, a 3U Computing subject. As stated in the Evaluation Report, the 2U General course was designed to meet the needs of students who 'wish to understand how computer applications can be used to solve problems relevant to them. It was intended for students with an interest in understanding how software and hardware work together, how computers carry out instructions and how to design solutions using computer applications' (NSW Board of Studies 1998, p. 4). In that sense, it had an instrumentalist perspective and a literacy/fluency focus. However, unlike the suite of subjects adopted in 2001, the 2U General course continued and extended the literacy/fluency focus while introducing basic computing science and information technology concepts and processes. As Figure 1 indicates, the increase in enrolments in this 2U subject drove the entire increase in CIT enrolments between 1995 and 2000, and it also accounted for the relatively high participation rates of girls.

In comparison, the Evaluation Report indicates that the 2U/3U Common course was intended for students who 'wish to understand how computer-based systems are designed, how the system carries out its task and how the computer can be instructed to carry out new or different tasks' (NSW Board of Studies 1998, p. 4). The 3U course was intended 'for high ability students to draw together their experiences in Computing Studies in order to produce complete, computer solutions' (NSW Board of Studies 1998, p. 5). These subjects contained a mixture of instrumentalist and discipline-based perspectives and included aspects of all five areas of focus identified in the ACM Model.

The changes to CIT curriculum frameworks in year 2000 were based on a systematic review and evaluation of the existing suite of subjects in the light of proposed overall changes to the structure of the NSW Higher School Certificate (McGraw 1997). The evaluation drew on a review of national and international literature about trends in the field of study, and syllabuses in other jurisdictions, plus two independent research studies, one by Frank Small and Associates and another referred to in NSW Board Studies documents as the KIP study (NSW Board of Studies 1998). It also involved extensive consultation with various stakeholders. The results of the evaluation fed directly into the development of the *Information Processes and Technology* (IPT) and the *Software Design and Development* (SDD) subjects. The emphasis and content of the new Information Technology Curriculum framework was drawn from the units of competency in the National

Information Technology Training Package ICA99 (NSW Board of Studies 1999b, p. 10). This approach was consistent with the wider restructure of VET courses in the Stage 6 curriculum.

Overall, the evaluation revealed that the pre-2001 set of subjects were identified as highly valued by teachers and students. Teachers valued the subjects for their 'relevance to the needs and interests of students and for [their] relevance to post-school experiences, whether vocational or academic' (NSW Board of Studies 1998, p. 7). Students valued these subjects 'because [they are] practical, relevant, potentially interesting and business related' (NSW Board of Studies 1998, p. 53). These teachers and students were supporting the instrumentalist perspective and the broad mix of topics across the five content areas described in the ACM Model.

The tertiary education key consultative group was less positive about the pre-2001 suite of subjects, expressing a view that the 'courses are not good preparation for students undertaking computer courses at university … They suggested that the learning was not adequate and that there was little difference between students who had studied and those who had not studied Computing Studies at school' (NSW Board of Studies 1998, p. 46). They advocated syllabuses designed with a disciplined-based perspective (as defined by current degree structures in NSW universities of the time). Interestingly, the report noted that the Frank Small and Associates research found that only 23% of surveyed teachers considered tertiary entrance a critical issue, while 46% considered vocational opportunities to be so. From the commentary in the report, it appears as if the discipline-based perspective was seen as more appropriate than the instrumentalist perspective given that '… well over half of the HSC intake into university computing courses have completed a Computing Studies course, this is significant' (NSW Board of Studies 1998, p. 46).

The major finding of the evaluation report was that the existing subjects neither reflected recent developments in the field of study, nor current views on the nature of computing from the perspective of tertiary institutions and the CIT industry, nor clear pathways to the two dominant forms of university study: computing science (which includes software engineering) and information technology. The two syllabuses, *Software Design and Development* and *Information Processes and Technology* represent a considered response to these issues. This shift, in effect, represented a change of emphasis from upwards continuity through Stages 1–6 to a downwards continuity from curriculum in tertiary institutions.

The evaluation report highlights both the pragmatic and political considerations and foregrounds questions about the purposes of senior secondary CIT curricula. Such questions are not unique to the field of CIT; though they might be more obvious in this case because of the short history of the field as an area of study in schooling, and the rapidly changing technological and employment contexts.

From one standpoint it could be argued that this shift in focus represents a maturing of the field of study in schools: a continuation of the transition away from the literacy/fluency focus of the mid-1980s; to the mixture of literacy,

studies of applications, and some computer science foundations in the mid-1990s; to the point where the post-2001 subjects are discipline-based mirroring the two dominant forms of university study (i.e. computing science and information technology). It could be argued that this transition makes much sense, given the increasing permeation of computer use across the curriculum, the literacy/fluency focus in the Stages 1–5 Technology syllabuses, the existence of a framework for systematic development of a range of computing skills across the Stages 4 and 5, and the mandatory requirement of a Computing Skills Test at the end of Stage 5. Within the framework of the overall changes to the Higher School Certificate this change was also consistent with the move to ensure that the bulk of subjects that count towards university admission were discipline-based and rigorous, and differentiated by field and focus. Creating two discipline-based subjects focused on two distinct fields of study — *Information Technology* with its strong emphasis on information and business processes and *Software engineering*, a part of a traditional computing science program, — allowed for their co-existence, and the possibility for interested students to take both of them, or even all three CIT subjects.

Notwithstanding the rationale behind the changes, it is important to appreciate the discontinuity created at the level of the *intended* curriculum and the ensuing confusions at the level of the *enacted* and *imagined* curriculum. In Chapter 5 of this volume, Harris also identifies issues at the level of the *enacted* curriculum created by the discontinuity. She discusses the highly contestable, and at times oppositional, relationships between the discipline-focused CIT subjects and the broader literacy/fluency focus within other subjects and across the curriculum more generally.

At the level of the *intended* curriculum, the post-2000 subjects create a major discontinuity since there is now a dramatic shift away from an instrumental perspective and literacy focus through Stages 1–5 (K–Year 10) core curriculum, to the challenging content of the new courses framed by a discipline-based rationale in the *Information Processes and Technology* and the *Software Design and Development* syllabuses. While a weak instrumental perspective does co-exist with this dominant discipline-based rationale in the Stage 6 CIT subjects, it does so in a very limited form. The general utility at the personal, social, educational and economic level has been limited to utility in terms of a CIT-focused career.

At the level of the *intended* curriculum, this discontinuity raises questions about the unintended consequences of the shift, the absence of some form of transitional pathway within the core curriculum, and the absence of foundational discipline-based concepts in early stages of the core curriculum. Unlike most other Stage 6 discipline-based subjects — such as Mathematics, Science, History, or Music — the subjects taught at earlier stages in the NSW CIT sequence fail to introduce any conceptual or discipline-based ways of thinking that might indicate what is entailed in Stage 6 studies. Positioning the CIT subjects within the *Technology and Applied Studies Key Learning Area* reinforces instead, in the earlier stages, the concepts, skills

and understandings of the design process. The ACM model curriculum particularly emphasises the importance of embedding simple experiences in the foundational concepts of computing science in the early years of schooling.

The absence of such foundational concepts and ways of thinking clearly influenced the *imagined* curriculum. When we asked, in focus group interviews, whether students thought ability in mathematics was important for studying CIT, most Stage 5 students were perplexed. They had little or no understanding of the mathematical and scientific foundations of computing science or software engineering (the basis of the Stage 6 *Software Design and Development* subject). They thought the most important indicator as to 'whether IT study is for me' was whether they enjoyed, or were good at using, computers and IT applications. In Chapter 2, Vickers and Ha present further confusions and complexities in the students' *imaginings* about the CIT subjects. Many of the interviewed students explained their decision to enrol (or not) in Year 11–12 computing subjects in terms of 'needing', or more commonly, 'not needing' to know, or 'already knowing' enough and being a competent user. If they could already use computers as tools, they thought it would be a waste of time to study more CIT subjects. It is not surprising that this is what they believe, given that they have been through 10 years of schooling where they constantly experienced computing with a literacy/fluency focus. It is also not surprising, given the increasing levels of literacy and fluency of both boys and girls through their almost ubiquitous use of a range of technologies, that most do not see further formal study of CIT as important. For this generation are, as we have noted, digital natives when it comes to the use of mobile technologies (phones, music players, cameras) and home computers, which nine out of ten students use regularly for their homework.

Conclusion

This exploration of one element of the CIT curriculum in secondary schooling — the intended curriculum as defined by the NSW Board of Studies K–12 Technology Framework and syllabuses — has raised a number of questions about the nature and purpose of the CIT curricula currently found in schools today. An analysis in terms of curriculum perspectives (Vickers 2007) revealed a clear discontinuity between the post-2001 discipline-focused senior syllabuses and the instrumental focus of both the earlier syllabuses and the current cross-curriculum emphasis on literacy/fluency. Given the increase in the participations rates between 1995–2000 in CIT senior syllabuses, particularly the 2U General Computing subject which extended the literacy/fluency focus at the same time as introducing some of the foundational discipline-based concepts, it seems plausible to suggest that the discontinuity caused by the post-2000 shift to a discipline-based approach may have contributed to the decline in numbers. Is also seems reasonable to speculate that the instrumental focus of the 2U General Computing subject contributed to the relatively high and stable proportion of female students participating in the subject.

An important question to ask of the GaIT data is what insights can we glean from teachers and students about the impact of a discipline-based approach to CIT syllabuses on overall and female participation rates. We know from research in Physics education that particular orientations to Physics curriculum are gendered (Murphy & Whitelegg 2006). Within the field of CIT curriculum an important question to ask is whether the actual orientation and selected subject matter is gendered or whether the gendering lies more at the level of the enacted and imagined curriculum. These questions form an ongoing agenda for the authors of this volume.

An analysis of the conceptual bases of the core Stage 1–5 curriculum and the Stage 6 CIT syllabuses against the ACM model elements, also demonstrated the lack of foundational CIT disciplinary studies in the earlier years of schooling. Thus, the question for curriculum writers in the next round of reforms is, if senior CIT subjects in secondary schools are to remain discipline-focused, whether curriculum in earlier stages need to progressively expose students to the scientific and mathematical theories that underlie the discipline of computing.

This curriculum analysis has obviously raised more questions than it has answered. It does however provide some important insights in the nature and purpose of CIT curriculum in NSW secondary schools. These insights about intended CIT curriculum are important in their own right, but are essential to better understanding the enacted and imagined CIT curriculum and their relationship to the steadily declining and gendered participation rates in CIT. ■

CHAPTER 5

The social construction of Computing and Information Technology subject subculture

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DESPITE THE RHETORIC ABOUT THE BENEFITS of learning to understand new technologies, the implementation of Computing and Information Technology (CIT) subjects across varied Australian school settings and the integration of ICT[1] initiatives across varied subjects have been both differential and problematic. A common explanation for the lack of curriculum and classroom infusion is the varying levels of resistance offered by teachers and the subject subcultures in which their practice is embedded (John 2005, p. 472). Whilst there are a growing number of studies addressing ICT adoption across varied subjects (see for example, Goodson & Mangan 1998; John 2005; Selwyn 1999), such research tends to focus on the levels of fit between ICT and established subject subcultures. These studies often focus on how non-CIT specialists implement cross-curricular ICT policies in their classrooms. This is an important area of research given that all Australian states and territories have mandated the implementation of ICT across the curriculum and it is often non-CIT specialists who assume responsibility for the integration of ICT in their specific subjects.

What is largely absent from the literature however, is an examination of CIT specialist subject teachers (subsequently referred to as CIT teachers) and CIT subject subculture, and how these act as critical contextual factors influencing both the teaching and learning of CIT subjects in schools, and students' subject choices in the senior school. This oversight is significant given that many Australian schools employ CIT teachers (in varied technical and academic roles) to teach school-endorsed mandatory and elective CIT subjects across the junior secondary school and elective CIT subjects at senior school levels. Further, an examination of CIT

1. For the purposes of this chapter the term Computer and Information Technology (CIT) subjects will be used to refer to discrete school subjects whilst the broader term Information and Communications Technology (ICT) will be used to refer to cross-curricular or whole-school initiatives aiming to integrate computing technology.

teachers and CIT subject subculture yields new insight into the complex and contested nature of CIT in schools, and may offer further insight into why student enrolment in elective CIT subjects is both gendered and in steady decline.

This chapter draws on data from an Australian Research Council Linkage Project — *From high school to higher education: Gendered pathways in information, communication and computer technology education (GaIT)*[2] to redress this oversight. As discussed in earlier chapters, the GaIT project aims to identify how CIT is socially constructed as an area of study and how this influences the decisions boys and girls make to pursue or avoid CIT education pathways. An important aspect of this investigation is developing an understanding of how CIT subjects and cross-curricular ICT initiatives are socially constructed in formal curriculum policy documents (at the high ground of curriculum) and how these constructions influence classroom practice (the ground level of curriculum). The high ground of CIT subjects is examined by Toni Downes in Chapter 4 while, in Chapter 8, Susanne Gannon focuses on classroom practice. This chapter explores the *middle ground* of curriculum. The middle ground of curriculum acknowledges that teachers enact curriculum long before they enter the classroom and that classroom practice is influenced by the ways in which teachers talk about, debate and socially construct their teaching 'subject' (Harris 2002, 2005). Accordingly, this chapter focuses on the ways in which CIT subject teachers shape and are shaped by constructions of CIT as a school subject before they enter the classroom. Specifically, this chapter draws on teacher interview data from one of the GaIT Victorian case study schools to examine CIT teachers' self-perceptions, their perceptions of CIT as a school subject, how these contribute to CIT subject subculture and the potential effects of these on the teaching and learning of CIT subjects in secondary schools. To provide context for this examination, I first provide a brief overview of the positioning of CIT in Victorian curricula and review relevant literature.

The positioning of CIT subjects and cross-curricular ICT initiatives in Victorian curriculum

CIT subjects first emerged as 'computer studies' in the late 1980s (Bigum 1990) and a plethora of discrete CIT subjects have since emerged. Simultaneously, government policies and curriculum documents in Australia, at both state and federal levels, began to encourage the integration of student computer use for learning across the curriculum. The need to have a cross-curricular ICT approach in Victorian schools was further endorsed in 1994 when the Directorate of School Education recommended that all teachers be trained to use computers and encouraged the integration of student computer use for learning across the curriculum (Directorate of School Education 1994). The focus of cross-curricular ICT implementation

2. The project is known by the acronym GaIT (Gender and Information Technology).

was on providing computer resources for schools across the state, rather than developing specific projects and/or providing professional development for teachers (Lynch 2003; Meredyth et al. 1999).

The emergence of CIT subjects and later cross-curricular ICT initiatives in Victoria has been fragmentary and at times ambiguous. This has much to do with different views of the nature and purpose of CIT subjects and ICT (as will be discussed later in this chapter) and the recency of these in schools. Importantly, CIT subjects and cross-curricular ICT initiatives have been introduced into a pre-existing framework of educational and social activity and, at times, policymakers have attempted to overlay the teaching and learning of CIT subjects and ICT initiatives on incongruous and/or highly resistant school curriculum practices (Tolmie 2001). Whilst such resistance has often been labelled technophobia, it has much to do with the ways in which CIT subjects and cross-curricular ICT initiatives have been positioned in the curriculum and how teachers perceive this will impact on their teaching and learning practices.

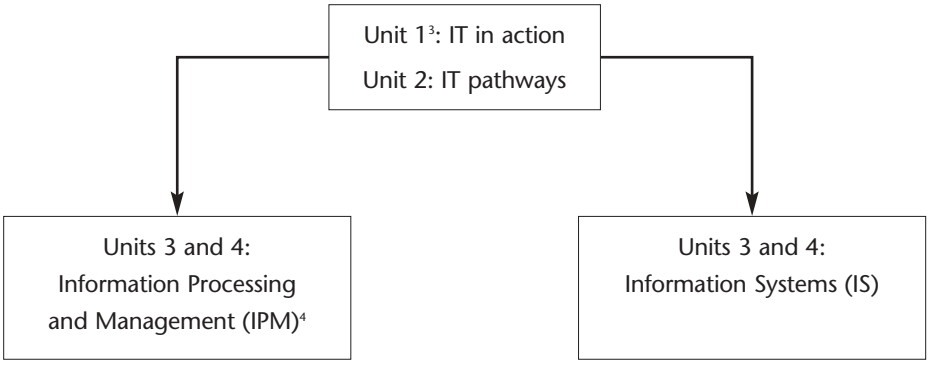
There have also been several curriculum restructures seen in Victoria since the emergence of CIT subjects and ICT initiatives in schools, and these have further blurred understanding of the role of both CIT subjects and ICT initiatives in teaching and learning. Between 1995 and 2005, the Victorian Curriculum Standards Framework (CSF) and the revised CSF-II endorsed a cross-curricular ICT focus in the compulsory years of schooling and one of the eight mandated Key Learning Areas (KLAs) was 'Technology', the focus of which was 'information, materials and systems' (Victorian Curriculum and Assessment Authority [VCAA] 1998). Interestingly, CSF-II explicitly addressed the role of computing technology in the Technology KLA, thus simultaneously endorsing ICT as a cross-curricular focus and providing space for CIT subjects within the Technology KLA. The newly introduced Victorian Essential Learning Standards (VELS) has eschewed KLAs and has instead organised the curriculum under three supra-strands: Physical, personal and social learning, Discipline-based learning and Interdisciplinary learning. Fourteen 'domains of learning' stem from these strands with ICT a domain attached to the Inter-disciplinary learning strand. This signals a clear intention for schools and teachers to focus on interdisciplinary (or cross-curricular) ICT initiatives, rather than relying on discrete CIT subjects in the compulsory years of schooling. Despite this, GaIT project data found many schools have retained mandatory CIT subjects across Years 7–8 and offer elective CIT subjects in Years 9–10, whilst also endorsing an interdisciplinary approach to implementing ICT. How the roll-out of VELS will impact on CIT subjects in the future is currently unclear.

The positioning of CIT subjects and ICT initiatives in Victorian Certificate of Education (VCE) curricula (Years 11–12) is more differentiated than in the compulsory years' curriculum (VELS). This is, in part, because the VCE remains structured along KLA lines and differentiation focuses on the depth and breadth of CIT subjects available. In Victoria, Year 11–12 students can elect to study VCE CIT

subjects, which can take the form of academic (school-based) subjects, or Vocational Education and Training (VET) courses; or they can elect to matriculate with a Victorian Certificate of Applied Learning (VCAL). VET and VCAL CIT subjects are offered as industry/TAFE-based courses. The structure of CIT as a 'school subject' is therefore varied. As the GaIT project focused on gender and CIT career pathways (with a specific focus on university pathways), we chose to focus primarily on VCE CIT subjects that were school-based and, as such, discussion of CIT subjects in this chapter will focus on VCE 'Information Technology' subjects. For the VCE, students complete 'units' rather than subjects. There are four units of information technology offered over Years 11–12. These are shown graphically below.

There are no prerequisites for Units 1–3 so students can complete Units 1 and 2 and then complete either one or two units of either Information Processing and Management (IPM) or Information Systems (IS). This means that the candidature for these subjects may include Year 12 students who have not completed elective CIT subjects in Years 9–10 nor have they completed Units 1–2 of Information Technology. For the purpose of this chapter both Information Processing and Management and Information Systems will be considered VCE CIT subjects as they are distinct areas of study both within the curriculum and within schools. It is within these curricular contexts that the GaIT project sought to examine how CIT subjects are socially constructed and it is within this frame that I shall now start to examine CIT subject subcultures.

Figure 1. VCE Information Technology structure



3. Units 1 and 2 are typically completed in Year 11 and Units 3 and 4 are completed in Year 12.
4. In 2007, the VCAA reaccredited these subjects and along with minor changes the names of these subjects have been altered slightly. Information Processing and Management is now referred to as IT Applications and Information Systems is now called Software Development. As the GaIT data referred to in this chapter was collected in 2005–2006 I will refer to these subjects by the titles above.

The nature and purpose of CIT in schools: Some relevant research

Contention exists about the nature and purpose of both CIT subjects and cross-curricular ICT initiatives in schools and it is important to recognise that these are both socially constructed concepts that have no stable meanings. Often CIT subjects and the cross-curricular integration of information and communication technologies are conflated under the term ICT (or similar) and/or reduced to a focus on computer use — this is problematic given that CIT and ICT encompass far more than computer use and that the relationship between CIT subjects and ICT initiatives is highly contestable and at times oppositional. To understand this relationship we must first consider the nature and purpose of school subjects. School subjects, particularly those with a long history (such as the humanities, mathematics, English and the sciences) are intimately tied to academic disciplines. Whilst it has been argued that school subjects are merely watered down versions of their parent academic discipline, Stengel (1997) argues that the relationship between academic disciplines and schools subjects is much more complex. Specifically, she argues that academic disciplines are not sacrosanct bodies of knowledge that exist unchallenged (Stengel 1997, p. 593). Musgrove describes academic disciplines and school subjects as 'social systems sustained by communication, networks, material endowments and ideologies' (as cited in Goodson 1981, p. 163). These social systems should be viewed as comprising a range of conflicting subgroups, segments or factions and these factions fluctuate considerably over time (Goodson, Anstead & Mangan 1998). Often such conflict focuses on epistemology (the nature of knowledge) and pedagogy (the nature of teaching and learning), both across different school subjects and within specific school subjects (Marsh & Harris 2005).

This is clearly evident in research in the CIT/ICT field where cross-curricular ICT initiatives are often defined in functionalist ways (the belief that ICT is about the 'insertion' of computers into the classroom, for example) that position ICT as a resource for students to utilise, and/or a set of skills that students need to acquire, rather than a distinct field of learning (critics of this perception include Selwyn 1999 and Waite, Wheeler & Bromfield 2007). CIT subjects have also been socially constructed in ways that limit their status and flexibility. For example, CIT subjects are often perceived to be technical/vocational subjects within schools. John believes this perception stems from the physical setting in which most CIT subjects are enacted — the computer lab. His study of non-CIT teachers' perceptions of ICT found that 'for many, the computer room represented the vocational curriculum made manifest; it was seen as the place where highly prescribed activities are introduced and practised in routinised situations' (2005, p. 478). Underlying this assumption is another, related assumption, that the pedagogies on which CIT subjects rely are functionalist and mundane. Gannon examines related perceptions of CIT pedagogies in Chapter 8 of this volume.

This may be because CIT subjects are not historically related to a recognised academic discipline and hence it may be more difficult to promote a particular CIT epistemology. What I am suggesting is that the absence of a broad public understanding of what CIT as a discipline might entail seems to limit the status of CIT subjects and compromise the status of those who teach them. A related limitation is that, unlike other more 'established' school subjects, there is no highly visible CIT subject subculture to support both its visibility and status. This may be partly due to the fact that CIT teachers are not typically 'housed' in a CIT subject department, as will be discussed later in this chapter. This is not to say that CIT subject subculture is not a powerful contextual force shaping the teaching and learning of CIT subjects and ICT initiatives in schools, but rather that it receives little attention in either the relevant research fields or in schools where the predominant focus is the 'deployment' of ICT across the curriculum.

Subject subcultures exert enormous influence over teachers and students. If we return to Musgrove's description of school subjects as social systems (in Goodson 1981) we can define subject subculture as a set or system of beliefs and practices that contain a group's (in this case those who engage with CIT subjects) pattern of meanings about the world, others and themselves (Henry 1993). Teachers and students are socialised into these subject subcultures and teacher self-identity, in particular, is intimately tied to the subject subculture into which they are socialised. This socialisation is most evident in secondary school subject departments as they 'collect teachers of like subject-area interests, expertise and professional language' (Grimmett & Neufeld 1994, p. 34). Goodson (1981), Bernstein (2000) and others have discussed the ways in which school subjects can be highly insular and work to protect their 'otherness' by constructing and maintaining strong epistemological and pedagogical boundaries. The introduction of ICT across the curriculum threatens these boundaries and Selwyn (1999) concludes that subject subcultures, most notably subject content, pedagogy and assessment, are having a significant effect on teachers' and students' use of ICT in schools.

Specifically, Selwyn (1999) and others (see for example, John 2005, Waite et al. 2007) have examined the ways in which established subject subcultures have responded to the introduction of cross-curricular ICT initiatives and have variously found that well-established high status subjects (such as English for example) view ICT in functionalist terms; that is, they view school ICT initiatives as serving the economy through the production of human capital, and that this is at the expense of the education of the 'whole person' (John 2005). Specifically, ICT has been socially constructed such that:

> … responsibility for practical capability rested with technology and for critical awareness with subjects such as social studies, history or religious education … this would tend to confirm technology as a ghetto for ingenious tinkerers, and the humanities as the natural home for anti-technologists. (Barton as cited in John 2005, p. 473)

John (2005) suggests therefore, that perceptions of CIT subjects and cross-curricular ICT initiatives vary according to the dominant subject subculture to which one belongs. This was evidenced in a study by Williams, Coles, Wilson, Richardson and Tuson (2000) who found that attitudes towards 'IT' differed according to subject affiliation: 'those teachers with lower attitudinal scores were maths, science and then languages [whilst] … teachers of business and management subjects tend to have a more positive attitude and make more use of ICT than other groups' (p. 312). Those subject subcultures displaying more positive attitudes towards CIT subjects had traditionally exerted 'ownership' over the CIT/ICT sphere and this is evidenced by the number of teachers of business and management subjects, such as commerce, who according to interview data went on to become CIT subject teachers.

Over the last decade, formal curriculum documents (the high ground of curriculum) have attempted to address differential 'ownership' of ICT by pushing a cross-curricular focus on ICT (as is evidenced in VELS). CIT has had to be redeveloped in schools in a context of various subject departments struggling to negotiate power and control within the overall school organisation. In this way the social construction of school subjects is a micropolitical process. Blasé (1998) explains that:

> … micropolitics refers to the use of formal and informal power by individuals and groups to achieve their goals in organizations. In large part political actions result from perceived differences between individuals and groups, coupled with the motivations to use power to influence and protect. (p. 545)

Micropolitical processes relate to issues of power, with these processes benefiting some and not others, and this influence shifting over time. The micropolitics of school subjects, then, reflect 'the strong advocacy of some and the strong opposition of others' (Mangham as quoted in Blasé 1998, p. 545). The micropolitical processes underlying the social construction of CIT subjects reflect uncertainty about the role and purpose of CIT education and ICT in schools as my analysis of project data will later address.

Intersecting the epistemological and pedagogical construction of CIT subjects and ICT are issues of gender. Much research has focused on the gendered nature of the CIT workforce and how gendered perceptions of ICT influence girls' decisions about whether to enter the CIT workforce (see for example, Miller & Hayward 2006; Smith 2000; Volman & van Eck 2001). Interestingly, in a study of first year Bachelor of Business and Bachelor of Information systems (at a Victorian university) students' perceptions of CIT as a career, Thomas and Allen found that:

> Students are being turned away from IT during their middle school years rather than when choosing a university course. By Year 10, 69.3% of females and 53.1% of males had given up the study of IT. Males and females differ in their reasons for giving up IT, with females listing computer illiteracy and dislike of being called a nerd as their main reasons and males

> listing boredom, teachers not encouraging and little creativity as their main reasons for stopping … both groups felt that their perceptions came mainly from school, the media and friends. (2006, p. 176)

This speaks volumes about the power of subject subcultures in schools (and the broader ICT cultures at play at a societal level) to shape teachers' and students' perceptions and ultimate engagement with CIT subjects and ICT initiatives. What is perhaps most interesting is that the studies mentioned earlier primarily focus on cross-curricular ICT initiatives and generalist teacher practice. Little or no mention is made of CIT subject specialists and CIT subject subculture as distinct from ICT subject culture.

CIT subjects and cross-curricular ICT initiatives can be distinguished from one another in terms of teachers (specialists versus generalists) and students (voluntary enrolment versus mandatory completion). I argue that the subject subcultures that underlie these two phenomena are not only different, but at times oppositional. Of particular interest is the ways in which CIT subject subculture is constructed in opposition to ICT (i.e. that cross-curricular ICT initiatives are used as an oppositional frame of reference). To further examine the ways in which CIT subjects are socially constructed in schools, I draw on data from one of the GaIT project Victorian case study schools — that of Otter College[5] — and explore CIT subject subculture through teacher interview data and student focus group data.

CIT subjects and teachers at Otter College

Otter College is a P–12 state school situated in an agricultural belt of rural Victoria. On average, the school caters to 300 students and has a full-time staff of 26 teachers and 10 support staff. Students at the school have mid–low socioeconomic backgrounds and tend towards cultural homogeneity (Anglo-Celtic background). The secondary school staff are organised into subject/KLA areas and are physically located in subject departments. Two specific teachers — 'Rita' and 'Jack' — teach CIT subjects across Years 7–12. The school also endorses the integration of ICT across the P–12 curriculum.

At Otter College, all students must complete a mandatory CIT subject in Years 7 and 8 (simply called *Information Technology*) which covers basic computer applications such as PowerPoint, word processing, desktop publishing, and using databases and spreadsheets. Students can then choose to undertake one elective CIT subject in Years 9–10. Two electives are offered: *Information Technology* which focuses on web design, multimedia and digital technologies, and *Systems and Technology* which enables students to use modern technology to solve problems (students utilise computer-controlled models and machines, rockets and small engines to work in collaborative groups to address specific problems). Typically, these electives

5. To protect participant anonymity, pseudonyms are used when discussing the school, teachers and students.

are offered on a rotational basis (depending on enrolments and available staff) as running two simultaneous CIT elective subjects in Years 9–10 is not feasible given the small student and teacher numbers, and limited access to computers.

In Years 11–12, Otter College offer VCE Information Technology Units 1 and 2, and Information Processing and Management Units 3 and 4 (refer to Figure 1). A range of CIT subjects are therefore available to Otter College students and, like all other Victorian schools, the school endorses cross-curricular ICT; although, there are no clear ICT initiatives or projects at the school. Rather, each subject/KLA has to demonstrate how and where they have integrated ICT into their teaching programs. The school's size limits students' subject choice. Smaller staff numbers means that Otter students are only offered a restricted number of Year 9–10 electives and VCE units. Timetable clashes may also prevent students from undertaking the electives and units they desire across Years 9–12.

Whilst Rita's teaching load is entirely comprised of CIT subjects, Jack teaches only one CIT subject (Year 12 IPM). He also teaches VCE Chemistry and is an active Deputy Principal. Whilst these differing roles might be perceived as gendered, the differences in Rita and Jack's career histories, CIT education and training and their different status give rise to different perceptions of CIT subjects and different understandings about their role as CIT teachers, as is detailed in what follows.

Rita

In the 1960s, Rita accepted a Commonwealth Scholarship to attend Teachers College. At the time there was a shortage of commerce teachers whose role, among other things, was to teach touch-typing. As Rita could touch-type, she trained as a commerce teacher and worked in this role until the birth of her children. Whilst she was on family leave, computers 'came into schools' and upon her return to full-time teaching in the mid 1980s: 'they just told me that I had to teach computer studies [laughs] so I learnt the hard way, the kids [students] and I learnt together'. By her own admission Rita is a 'self-taught' CIT teacher and, although she has 'done a lot of professional development on IT', her construction of CIT as an area of specialist study centres on the application of software programs.

Interestingly, neither Rita nor Jack physically resides in a subject department. Rita has a desk in the school administration office whilst Jack has a private office as he is Deputy Principal. The physical location of CIT teachers within high schools is of interest given that it speaks to issues of status and also perceptions about the role of CIT teachers. Rita's location within the administration office positions her in the role of technician, a role which she has fallen into, given that she is the only teacher able (and willing) to perform the role of computer technician for administrative staff. The school employs two part-time computer technicians (one of whom is a recent Year 12 graduate) to maintain the computer labs and school network, but Rita explains they have little time for the everyday support administrative staff require. It may be that Rita perceives CIT in a technicist sense

and/or that she is personally rewarded in this role. The ways in which teachers construct themselves as CIT specialists is varied and importantly this has implications for the ways in which others (teachers and students) socially construct CIT subjects.

Interestingly, Rita knows little about cross-curricular ICT integration in the school:

> Interviewer: In terms of integrated ICT, what ICT is taught in other classrooms?
>
> Rita: I only know what is being taught if I am in the staffroom and hear what they are discussing otherwise there is no real ICT track through other subjects but I feel if you can teach the students the basics in their [compulsory] junior high school CIT classes, they are armed with the knowledge to work out which software they need to complete certain projects. So I believe that the only way to have ICT across the curriculum is to maintain ICT specialist classes also. I am not sure if this possible though.

Rita goes on to suggest that the integration of ICT across the curriculum is constrained by the fact that, other than private-use computers and library computers, all school computers are located in two computer labs. Undeniably, access to resources and the physical positioning of computing resources within a school not only enables or constrains cross-curricular integration, it also influences the pedagogies in which teachers and students engage. For example, the physical layout of computer labs is often such that computers line the walls for ease of power access and this may limit the teaching and learning strategies teachers feel are available to them. It may also force individualised learning which Volman and van Eck consider gendered as 'girls prefer authentic and realistic learning environments, cooperative learning and an emphasis on communication' (2001, p. 628). When asked about the gendered nature of CIT subjects, Rita explains that girls seem more attracted to Information Processing and Management in Year 12 as 'IPM is more about the practical use of software — like putting the information systems into an organisation and solving the problems it causes'. However, few girls elect to study Information Processing and Management (five of the 17 students in the Year 12 IPM class of 2005 were girls), and Rita attributes this to the masculinised nature of the Year 9/10 CIT elective Systems and Technology, which she feels focuses more on the programming side of CIT and perceives to be a male dominated area of interest.

Elective CIT subjects at Otter College regularly draw enough students for a CIT subject to run across each of Years 9, 10, 11 and 12. When you consider that the average number of students in any one year level is only 35, and that the average CIT class has approximately eight students, CIT subjects are attracting a 25% share of any cohort. This is, however, in large part due to the limited numbers of VCE units offered. In 2005, only four non-core VCE units were offered and IT/IPM was

one of these. Despite this enrolment share, only 30% of any CIT class is made up of girls and, Rita cannot think of any girls who have completed Information Processing and Management who have gone on to pursue careers in CIT. She gives several reasons for this; the first being that Otter is a rural school and whilst there is local access to both university and TAFE institutions, there are few CIT job opportunities in rural Victoria, with those available tending to be less well paid than there metropolitan equivalents. Rita also thinks that students see CIT subjects as an easier and less academically rigorous subject to study for their VCE:

> I don't think I get the real academic students because they tend to get channelled off to the Science area which is a real focus of the school [which is located in a agricultural community], it varies from year to year but I think I probably get very much the average student and maybe some of the poorer ones because this is one of the subjects they can cope with … no, I wouldn't call it a hard subject, it is actually scaled down[6] in the VCE.

Rita goes on to add that students like Year 12 Information Processing and Management 'because it is not so much theory-oriented … and kids love the practical aspects much more then the theory'. Rita's construction of Information Processing and Management is therefore founded on her perceptions of the subject being practical as opposed to theoretical. Students' perceptions of CIT subjects as 'easier' influence broader staff perceptions about the status of CIT subjects, and their relevance to student learning, and vice versa. Within this context Rita remains an optimistic CIT teacher. She is a passionate teacher and she feels that teaching CIT subjects allows her to 'continue to learn, I really like the new multimedia software and so do kids, it allows them to be very active learners … [and] often they will pick up and learn software operations that I don't even know exist and teach me'. She also believes that CIT as an area of teaching and learning is highly engaging ('we don't have so many classroom management issues because kids love all kinds of technology like mobile phones and palm pilots') and highly flexible ('all students can experience success … I think your average student does a little better in here than they do in their other subjects'). Rita's primary focus is her students and, as such, she doesn't seem to mind being housed in the general office or being perceived as the local computer technician ('I love the interaction with the admin staff and if they've got problems with their computers they'll just come up and ask'). Rather, Rita seems content to work in a highly individualised manner.

Jack

Like Rita, Jack has been a high school teacher for over 35 years. He initially trained as a Science/Maths teacher and it was not until the late 1990s that he decided to go to university:

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6. The VCE is a norm referenced assessment. If students do not perform well in particular subjects they are liable to be 'scaled down'.

> … and do a degree in ICT through the School of IT, [it was] a bit of re-skilling for myself, and I am now teaching Year 11 ICT for the first time which I am enjoying but finding a bit of a challenge with my Deputy Principal role.

When asked about how prepared he felt to teach school CIT subjects, Jack concedes that since completing his IT degree (only eight years prior to interview) CIT subjects have changed dramatically:

> I guess the biggest change is that it used to be all about software but these days you don't need to know so much about the software, you can just pick up the installation disks so it is more about the application of software and the young kids today love the multi-media and popular culture stuff.

Jack's initial construction of CIT focused 'on the programming side of things' and he both acknowledges and welcomes a greater focus on software application; although he points out that current VCE units tend to separate these two functions (programming and application):

> I think the fact that the Year 11 IT is more about the programming and the academic side of things might mean that students choose not to follow through with IT [in Years 11–12] … personally I would like to see the Year 11 course [IT Units 1 and 2] made much more practical. I think there needs to be a good link between the academic side of things and the practical.

Further, when asked about the gendered nature of CIT subjects he stated:

> My sense is that it still attracts boys. I think there is a bit of a perception that it is a boys' subjects, there was a show on the ABC once … a sort of revenge of the nerds documentary … and I think that perception still exists.

These comments uncover multiple, competing and gendered CIT subject constructions. CIT subjects seem to have competing and gendered interests — programming versus software application — that are differentially perceived to be either academic or practical. Students share these perceptions, as Jack's comments about enrolment patterns in Year 11 Information Technology units reveal: 'the course itself is fairly academic and some students do have trouble with the academic side of it and this turns them off it which is hard because they do like the practical hands on stuff'. This construction of CIT is markedly different to that of Rita who only teaches Year 12 Information Processing and Management, which Jack perceives to be 'more hands on'. Interestingly, Jack sees that both theory and practice are essential to effective CIT pedagogy and he would like to see this reflected in formal VCE curriculum as, at present, he feels constrained by the Year 11 Information Technology curriculum. Rita, on the other hand, has constructed CIT subjects in terms of the 'practical' and justifies this in terms of both her own ICT preferences and her perceptions of student interest and ability.

That Rita and Jack teach Year 11 Information Technology and Year 12 Information Processing and Management as separate 'subjects' (rather than

sequential units of the same subject) is obvious as neither seem informed about each other's areas of expertise or each other's units they are teaching. This may be because they do not cycle the teaching of VCE CIT subjects:

> Interviewer: So will you continue to teach Year 11 IT and Rita teach Year 12 IPM in the future?
>
> Jack: I imagine that is what will happen.

This means that both Jack and Rita are unsure of students' prior CIT learning and unclear of future CIT directions, given that they teach in highly individualised and insular ways. CIT subject subculture is therefore fragmented and is largely invisible to staff and students at Otter College. Typically, highly visible cohesive subject subcultures enjoy high status within schools. Both Rita and Jack believe that ICT (Jack uses this as a generic label to encompass CIT subjects and cross-curricular ICT) enjoys a high status in the school. Jack associates this status with students' perceptions of computing technology rather the positioning of CIT within the school (both physically and conceptually): '[it has] a fairly high status among students, right from the primary years kids understand it is important … kids don't see it as a career option, they see it as part of their everyday business'. Despite these perceptions of status Jack expressed concern about the future of CIT subjects under the newly introduced VELS:

> Jack: I don't know how it (integrating ICT across the curriculum) will work here but I do believe that we should have specialised IT teachers and specialised IT subjects, there is a need though for students to be able to connect what they are doing in IT with their other class work to contextualise it.
>
> Rita: Our current principal is very much into ICT but she wants to disperse it amongst other subject areas and I just don't know how that is going to work unless you get teachers who have good knowledge because the teachers don't have time to learn all the different software and they are still trying to teach their own material.

Williams et al. (2000) argue that teachers often focus on the technical aspects of 'teaching ICT' rather than the application of ICT within the learning process. It would seem that Rita sees practical knowledge of software systems as critical to the role of teaching CIT, whilst Jack acknowledges the role of ICT within the learning process but is constrained by the formal curriculum he feels forces a theoretical focus in the Year 11.

The CIT subject subculture at Otter College is consequently diffuse and is not based on shared understandings of CIT knowledge and pedagogy. Rather, Jack and Rita have constructed their perceptions of CIT subjects in view of the work environment, their individual career histories and CIT preferences (software applications versus programming) and their perceptions of student gender, interest and ability (theory versus practice).

The contexts that shape CIT subject subculture

My analysis of teacher interview data revealed a number of critical contextual factors influence the social construction of CIT subculture. These are summarised in what follows.

The physical context

The physical contexts that shape CIT subject subculture centre on the provision of resources, the organisation of resources and access to resources. The hardware and software that CIT teachers utilise influence the teaching and learning process (most notably through pedagogy and assessment) with students associating CIT subjects with particular physical spaces (such as computer labs). Similarly, the presence or absence of shared working space in the form of subject departments and/or a teacher lounge is significant as it visibly signifies membership to a particular subject group and provides opportunities for specialist subject teachers to develop shared goals. The absence of a shared space for CIT teachers at Otter College was not only divisive in terms of promoting individualism, it also has implications for the status of both CIT as a subject and CIT teachers.

The subject context

Subject subcultures are socially constructed phenomena that are constantly being reconstructed at a variety of levels. In this sense subject subcultures are nested within multiple and sometimes contradictory layers of construction. For example, CIT subject subculture is influenced by broad societal perceptions about the role and purpose of computing technology in current and future society, educational opinions about the pedagogical value and purpose of computing technology and its relationship to the market economy, and school-level views on the level of fit between CIT subjects and mandatory cross-curricular integration of ICT. Intersecting these layers of construction are issues of gender — how CIT careers are gendered, how schools gender CIT teachers and the teaching and learning of ICT, and how students' choices to study CIT subjects are shaped by perceptions of gender. These layers of construction position CIT subjects within a broader curriculum hierarchy and the status of any school subject is dependent on its ability to construct a visible and dominant subject subculture and its ability to mobilise human and material resources. In this sense, the subjects with the greatest status can command prime physical space within the school (subject department and specialist classrooms), they can attract and maintain high student enrolment and they can compete for scarce human and material resources (Siskin 1991). CIT teachers and students who elect to study CIT subjects construct their understanding of CIT as a subject through these varied perceptual lenses, and the ways in which they construct CIT subjects are filtered through the perceived status they attach to the subject and those that teach it. The introduction of VELS and mandatory cross-curricular implementation of ICT has implications for the status, and indeed the survival, of CIT subjects in secondary

schools. One response to this threat would be for CIT teachers to align themselves with cross-curricular ICT initiatives and to endorse a hybrid approach to the teaching and learning of CIT/ICT in schools, as both Rita and Jack suggest. This would acknowledge that a two-pronged approach (CIT subjects and ICT initiatives) offers an opportunity to develop skills and concepts in specialist CIT lessons and then where appropriate use these skills across the curriculum.

The teacher context

The ways in which teachers orient themselves in relation to CIT as a subject area not only shapes their practice, it shapes the prevailing CIT subject subculture evident within a particular school. Teachers' subject identity is shaped by their formal educational experiences, their career histories and their perceptions about learners (Harris 2002). The differential ways that teachers identify with their teaching subjects and the differential effects of this are evident in Rita and Jack's interview data. Teachers' orientations to CIT as a subject area are also shaped by the social construction of computing technology and the CIT professions as masculinised (Goodson & Mangan 1998). Whilst Rita's engagement with CIT subjects and her students provides her with job satisfaction, her positioning as a technician within the administrative office and her exclusion from cross-curricular integration of ICT at a school level, position in her in a low-status and highly gendered position.

The learner context

Learners' perceptions of CIT subjects are filtered through the varied social, educational and school constructions of CIT subjects. They are also influenced by students' perceptions of subject difficulty, their general level of interest in computing, their perceptions of and experiences of learning CIT/ICT in schools and their perceptions of the value of CIT/ICT to potential future careers.

Conclusion

In the current curricular climate, where most Australian schools are offering CIT subjects (mandatory and elective) and endorsing cross-curricular integration of ICT, it is important to understand the ways in which CIT subjects and indeed ICT initiatives are socially constructed and the ways in which these constructions shape the teaching and learning of CIT/ICT in schools. It would seem that CIT subjects and ICT initiatives are not only separate phenomena in schools, but that they are also often 'at loggerheads', and these inherent contradictions may contribute to low enrolment patterns in CIT subjects, poor 'deployment' of cross-curricular ICT and indeed decreasing numbers of women (and men) choosing to pursue a career in this field. Given the importance of computing technology to modern life, a concerted effort to understand CIT subject culture is needed so that educational policies and curricula can work towards the re-culturing of CIT practices at the high, middle and ground levels of curricular practice. ■

CHAPTER 6

Boy nerds, girl nerds: Constituting and negotiating Computing and Information Technologies and peer groups as gendered subjects in schooling

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THIS CHAPTER, BASED ON EMPIRICAL RESEARCH conducted across three Australian states with students and Computing and Information Technology (CIT) teachers, explores girls' and boys' perceptions of CIT and how they negotiate various landscapes of cyberspace. Girls' and boys' relationships with CIT are contextual and complex, but they are often read within stereotypical understandings of gendered subjectivity by students and teachers. Girls often have an ambivalent relationship with CIT; for example, they can see themselves as being competent with computers if they choose to be, but many indicate that they are 'just not interested'. This lack of interest is analysed through discourses that constitute perceptions of the CIT industry and girls' understandings of self and their futures. Our research demonstrates that girls' positive relationships with CIT tend to be associated with using technology as a communication tool, but this is often interpreted as wasting time socialising. This research also suggests that some teachers and some male students believe that girls are not being 'serious' about CIT business. Using students' narratives, we examine affective responses to the ways in which hegemonic discourses of identity — such as gender, ethnicity and class — play out in the classroom environment. In addition, we examine how identity intersects with discourses of the 'computer nerd', and the impact of the ways in which gendered identities are negotiated in peer groups.

This discussion draws on Judith Butler's concept of the performativity of gender to provide an explanation of the ways in which girls and boys have differentiated experiences and interests in taking up CIT. We also employ Silvan Tomkins' theory

of affect to provide an in-depth reading of how shame functions to modify student interest in CIT. In much of the data, we discovered that students regulate each other's behaviour through the use of shame which is frequently linked to stereotypical understandings of performances of gender. On some occasions, these shaming practices included stereotypes around ethnicity and class. In addition, we utilise Bourdieu's notion of habitus and cultural capital, which offers a useful framework for understanding how students' dispositions and success in relation to CIT are affected by home and school environments.

Overview of GaIT research project

The research on which this chapter is based was undertaken in South Australia as part of the *Gender and Information Technology* (GaIT) project as outlined in Chapter 1. This project was funded by the Australian Research Council (ARC) under the Linkage program in 2005. The aim of the study was to explore the serious gender-based disparities that exist in participation in the information communication and computing technologies field. This study sought to identify the causes of this gender gap through investigating Year 10 students' interest and subject choices in relation to CIT. Researchers on this project believed that this gender gap in the CIT field could be traced back to students' choices in their schooling. Students from a number of public secondary schools in New South Wales, Victoria and South Australia participated in this research project. The research involved surveying students regarding their interests and practices around CIT and their prospective subject choices. Focus groups were held with boys and girls who identified themselves as having a high or low interest in relation to CIT. The study also investigated the nature of CIT in the participating schools, as well as the experiences of CIT teachers and their perceptions of students' gendered interests and experiences within this discipline.

This chapter focuses on the experiences and interests of students and the quotes used throughout are from students who participated in this research, unless otherwise specified.

Theorising gender and interest

A theoretical framework that incorporates feminist poststructuralist and queer theory, where gender is understood as performative (Butler 1990, 1993, 1997, 2004), informs our discussion in this chapter. Within these perspectives individual subjects identify and make sense of themselves as men and women or boys and girls through discourses of gender made available to them. Gender is considered to be socially constituted in discourse and is a dynamic process referring to the cultural inscription of bodies into masculine and feminine characteristics. Gender is not fixed, but rather is an unstable, contested and relational social category whose meanings and representations are susceptible to change across and within different cultures over time. Despite the fact that there are multiple ways of 'doing'

masculinity and femininity, gender is strictly regulated through disciplinary discourses that not only manage individuals but also actively constitute them (Butler 1990, 1993, 1997, 2004).

Butler (1994, p. 33) defines performativity as 'that aspect of discourse that has the capacity to produce what it names … this production actually always happens through a certain kind of repetition and recitation'. Butler also suggests that performativity 'is the vehicle through which ontological effects are established' (1994, p. 33). This refers to the ways in which masculinity and femininity are played out, culturally and historically, and also how hegemonic forms of masculinity and femininity get established, instituted, circulated and confirmed (Butler 1994). According to Butler, it is the repetition of the performance of masculinity and femininity that constructs and reconstructs the masculine and feminine subject. Individuals perform their femininity and masculinity, in order to 'do it right' in front of their peers and others (Butler 1990) and it is through this repetitive process that the feminine and masculine subject become defined and constructed. The repetitiveness of the performance makes it seem natural and real. Individual subjects strive to have their gendered performances considered authentic or real through the judgments of others.

Dominant discourses of gender that prevail today have been constituted within dualistic oppositional thinking. That is, masculinity and femininity have been constituted within a cultural binary — signified as male/female — and primarily represented and defined in opposition to each other (for example, boys are technologically competent/girls are technologically incompetent). This cultural binary also constructs subjects in a hierarchical power relationship that is reflective of gendered social relationships operating more broadly in society. Within this binary, women and girls are always relationally constituted as the powerless 'other' to men and boys. The gendered division of labour that operates in the home and in the workplace is reflective of these gendered sociocultural relationships. In this research, students' readings and practices of CIT often reflect strong gendered oppositional understandings of competence in this area.

Within our research, young people often identified a process by which their interest in CIT was diminished and compromised through negative interactions with their peers, or with teachers and others. This was particularly the experience of girls, who were often already feeling anxious about their CIT skills and knowledge. The affect generated by these interactions was to further mobilise feelings of shame and an even greater sense of incompetence and inadequacy. As part of developing his theory of affect, American psychologist Silvan Tomkins attended to the relationship between interest and excitement. 'To think, as to engage in any other human activity, one must care, one must be excited, must be continually rewarded' Tomkins argues (cited in Sedgwick & Frank 1995, p. 77). When a subject is interested, that person shifts 'in attention from one stimulus to another by head and eye movements which track a moving stimulus' and in

combination with these involuntary reflexes, interest enables individuals to 'sustain attention to complex objects' (1995, p. 74). Tomkins places shame–interest at either end of a continuum of affective possibility, suggesting that shame operates 'only after interest or enjoyment has been activated, and inhibits one or the other, or both' (1995, p. 5). Although shame has been elegantly theorised as potentially transformative (see Davies 2007; McInnes 2004, 2007; McInnes & Davies 2007; Probyn 2005), there is also the risk that shame's reduction of the affects interest and joy, provides a barrier to further exploration. Unlike interest, shame is characterised by 'the lowering of the head and eyes' so as to reduce further exploration or self-exposure' (Tomkins cited in Sedgwick & Frank 1995, p. 5). Shame does not involve complete withdrawal of interest (which might be closer to disgust) but, as McInnes has argued about the shaming of 'sissy' boys, gender-related shaming 'operates to support a fictional autonomy, coherence and competence on the part of boys' (2004, 2007).[1] Shaming is frequently used by boys as a defensive mechanism and this behaviour is often read by others through essentialist discourses that align masculinity with the male body and, in this case, technological competency (Davies 2007; McInnes 2004, 2007; McInnes & Davies 2007). We contend that the use of hegemonic discourses of gender that position girls and boys as competent or incompetent, or desiring or lacking desire to undertake certain kinds of tasks and not others, negatively impact on student interest in CIT subjects. While it appears that students who are positioned as technologically incompetent (often girls and low interest boys) frequently take their interest elsewhere (to other subjects), some of these students could have their interest captivated if they were not positioned within traditionally gendered frameworks, and if pedagogical practice employed affect in positive ways. In addition, we suggest that these gendered discourses are also mediated by dominant discourses of class and ethnicity that position subjects as capable or incapable within the field of CIT.

As Butler (2004) argues, gender is a norm, producing and naturalising notions of masculine and feminine within everyday embodied social practices. This process of gender normalisation regulates performances of masculinity and femininity constituted within hegemonic discourses of gender that operate to exclude alternative ways of doing gender. In this research, boys and girls who challenged binarised understandings of masculinity and femininity — exemplified by some high interest students who self-identified as 'nerds' or 'geeks' — opened up possibilities for different gendered subjectivities and different relationships to the CIT field. However, peer groups — who were highly invested in maintaining hegemonic oppositional readings of gender — often challenged, policed and regulated the behaviour of the 'computer nerd'.

1. Thank you to David McInnes for his illuminating comments about affect, specifically the use of shame in the pedagogical environment.

Students with low interest in CIT

Throughout many of the focus groups with students in this project, perceptions of student interest in CIT were constituted through hegemonic discourses of gender. 'If gender is a kind of doing, an incessant activity performed, in part, without one's knowing and without one's willing, it is not', Butler argues 'automatic or mechanical' (2004, p. 1). Our research suggests that gendered understandings of technology are pervasive in students' accounts of CIT experiences. Hegemonic discourses of gender position boys and girls differently in terms of their desire to engage with CIT, a point that has been acknowledged in previous research in this field (for example, see Bryson & de Castell 1996; Littleton & Hoyles 2002; Wajcman 1991, 2002). However, this desire is also mediated through dominant discourses of class, ethnicity, sexuality, as well as affected by the geographical landscapes in which they live.

Students' locations within discourses of class and gender, in particular, constitute their perceptions of gendered relationships to CIT. Boys were often viewed as having an interest, ability and competency in CIT, and technology more generally, that was not shared by most girls, primarily because it was considered to be 'a boy thing'; and that unlike girls, 'guys just like technology type things'. Their perceptions of these relationships were based on essentialist understandings of gender in which boys were seen to have an innate interest and ability in CIT because they were male. This perspective reflects the binarised construction of gender into male and female outlined previously, rather than seeing gender as a complex matrix. These fictions about gender continue to reinscribe stereotypical assumptions about competency and ability.

Students, who tended to have a low interest in CIT, had minimal involvement with this field beyond using the Internet for study, or using computers as a communication tool or to download music. Some of these students (most often girls) did not have access to computers at home. Consequently, they did not have the cultural capital of basic CIT knowledge, language and skills gained from playing on computers at home to bring into the schooling context, where such capital is highly valued. As Bourdieu (1991) points out, habitus, such as that operating in the family home, is critical in contributing to individuals' ability to tap into the cultural, social and economic capital valued in other fields such as schooling. Habitus refers to the dispositions, perceptions, and attitudes generated throughout an individuals' cultural history that can enable or prohibit effective exchange or accumulation of one's capital (Robinson & Jones Diaz 2006). It is critical to point out that low interest in CIT did not equate to low academic performance. Many academically competent students had no interest in CIT because they perceived that these subjects were less relevant to their career choices that included the medical profession, law, and various professional trades. These students also indicated their lack of interest in pursuing CIT subjects beyond their interaction with the curriculum in junior years, or beyond their use of technology at home.

Some students commented that they 'just don't like computers' and, as one boy remarked, 'I'd rather do the dishes!' Both boys and girls, who were disinterested in CIT, found computers 'boring', and school CIT subjects did little to ignite these students' interests or passions in the area, a point also raised in other research in this field (State Government of Victoria 2001). Students also found computers 'frustrating' and 'difficult to understand', especially if their computers crashed. Our research indicated that boys were more likely to attempt to fix a computer problem, despite any perceived consequences, whereas girls would often fear making the problem worse and 'blowing it up' further. This remark reflects the different ways in which boys and girls are positioned in relation to CIT, and highlights how boys (particularly those positioned in hegemonic masculinity) are constituted as mechanically and technically competent. Based on student comments, boys were more likely to have everyday experiences of 'tinkering' with machines and technology (i.e. pulling machines apart and reconstructing them) that constituted a confidence in attempting to fix objects, even with minimal specific knowledge in the processes involved. Consequently, if boys do not fix the problem or make it worse, there is a perception that 'having a go' outweighs anything else. In order to take up a hegemonic masculine position, boys are expected to be competent trouble-shooters of mechanical and technical problems. Jenson, de Castell and Bryson (2003, p. 562) reinforce this point by suggesting that masculinity can 'be seen to be constructed, at least partially, through assumptions related to technological skills and competence: technological competence … has less to do with actual skills and more to do with construction of gendered identity'. Dominant discourses of femininity, on the other hand, constitute girls as being incompetent in relation to mechanical and technical processes. Consequently, many girls lack the confidence and tinkering experience exemplified by many boys and these girls are often shamed through a lack of knowledge, or their previous failed attempts to fix the problem, into 'keeping well enough alone'.

Girls, who had limited interest, if any, in spending their time in what they considered to be an isolating environment, 'stuck' in front of an aesthetically displeasing 'boring grey square box' — an image that reflects how they perceived the IT industry more generally (see also Stieler 2003) — were far more invested in participating in outdoor activities and socialising and communicating with their friends face-to-face. Part of this investment is linked to a performance of femininity that adheres to dominant cultural scripts that constitute the feminine subject as socially competent. Boys with low interest were also more invested in enacting their masculine subjectivities by being outdoors playing sports or doing practical things, such as fixing cars or something similar. Girls' investments in talking, engaging and relating to others is often read as problematic, particularly in schooling contexts, rather than being viewed as developing their critical communication skills. Many of these girls used mobile phones with a dexterity that was hard to match, but this extension of communication skills was not considered appropriate or useful, but

rather, was viewed by some teachers and male students as wasting time. It has been argued by some that the perception of what counts as 'technology' often excludes the technologies that girls and women tend to utilise (Bryson & de Castell 1996; Cockburn 1992; Jenson, de Castell & Bryson 2003; Wajcman 1991), and we argue that this includes their proficient usage of mobile phones.

Developing CIT skills, beyond basic word processing, Internet usage, or creative design (for example web design and graphic design), was viewed as peripheral to girls' potential career choices. Many young women were interested in entering traditional apprenticeships or professions considered appropriate for their gender — such as beauty therapy, hairdressing, childcare, teaching, veterinary nursing, and so on. Similarly, boys with low interest in CIT subjects considered technical and computer skills as marginal to their future careers in areas such as law, physical education teaching, and apprenticeships, such as plumbing, building and other trades. One boy commented that 'You get a secretary to do that stuff!' This last comment is reflective of strong gender and class stereotyped perceptions that many young people have of the workforce, as well as the gendered nature of CIT education and of the industry itself. Alsop, Fitzsimons and Lennon (2002, p. 3) point out that this gendered division of labour 'is dependent upon our cultural understandings of men and women being different and thus more suited to different types of work'.

The vast amounts of time that many boys invest in playing computer games contribute to an interest, ease and competency around negotiating CIT that most girls do not share. As one young woman commented: 'I think because they get into video games and stuff on computers, they get into computers more. So they start off playing their games and then they start doing other stuff. They get to know more about computers'. Boys and men are generally the main market for designers and manufacturers of computer games. Consequently, computer games tend to mobilise hegemonic discourses of masculinity, taking up and constituting boys' fantasies around war, violence, fast cars and sexual prowess. One boy, who perceived that girls hated computer games, made the following comments about gendered relationships to these games: 'They hate them, well they don't hate them, but they only play the really crap games like SMS, and stuff like that because they are more into making houses and stuff like that, and boys like shooting people and killing people and stabbing people'. We continued to ask what it was about games that involved shooting and killing that seemed to interest him: 'It is just fun … run around a city killing people and shooting cars … I don't know it is just cool … It is just like you can do stuff you can't normally do'. Duncum suggests that only a small number of boys and men find violence the principle attraction, but rather, 'the attraction is not violence per se but violence as a means to an end — an acceptable device for making dramatic points where violence is valued for what it does rather than what it is' (2006, p. 23). Violence in computer games is usually represented through a linear narrative that frequently offers users the opportunity to play the role of the protagonist — a protagonist who employs violence to achieve narrative success.

Much of the thrill and excitement experienced through violent narratives in computer games is a result of manufacturers packaging suspenseful scenarios, action-packed movement, high energy, novelty, fantasy, sophisticated graphics and the sensation of speed and heightened audio effects (see Duncum 2006).

Computer games that incorporate violent narratives become a site in which some boys are able to perform hegemonic masculinity so as to cement gendered cultural bonds. However, not all boys found computer games interesting or exciting, indicating that they 'have better things to look at' and that they only played games at school because 'everyone else is'. Not all boys take up hegemonic masculinity, or take it up to the same degree as others; some shift in and out of different performances of other forms of masculinity available to them, depending on their contextual reading of the space, situation at hand and the power relations operating. However, as Robinson (2005a, 2005b) argues, utilising Butler's work, the 'realness' of gender performance is primarily about the ability to compel belief in others. The perception that one is doing hegemonic masculinity correctly is largely based on the critical judgments made by one's male peers. Therefore, the hegemonic masculine collective, represented in male peer groups is critical in regulating performances of gender. As Butler points out, one is always 'doing' one's gender 'with or for another, even if the other is only imaginary' (2004, p. 1).

Many of the girls we spoke to found computer games alienating, boring and often distasteful. It was hard for them to comprehend the interest and time that they perceived boys investing in CIT, and computer games in particular. One young woman, amazed about the amount of time her two brothers spent at home playing computer games, considered their behaviour to be 'obsessive' and 'kind of scary'. Not really understanding what they did in all that time, she shook her head and concluded that it was 'just crazy what they do'. Some girls, aware of how gender is regulated by peers, considered peer pressure from other boys was a critical factor in boys' involvement in games, especially having the latest and the best games:

> I think my brothers play it because all their friends are always talking about it, like oh have you got the new PlayStation or the Xbox yet? And have you played this new game on Xbox and have you got the latest technology and stuff. And so they get heaps excited and then ask mum every Christmas. I swear they get like the updated version of like a game thing. Like when they get home from school boys are just on it … Like car games and all the war games and stuff and I think it is a big interest that guys have.

Some girls did enjoy playing computer games that boys found interesting, but they acknowledged that the reactions of boys with whom they played were often intimidating and potentially shaming. This is consistent with findings of studies of girls who do actively engage with computer games, but are often viewed as less competent and as impostors in the male dominated gaming world (Beavis & Charles, in press). One young woman in our study commented about the impact of the boys' intimidating behaviour on her interest in playing computer games:

> No, I'm not really interested in computer games or anything like that, I don't know, I'm not good at them so I just don't like them … Like the only time I've got to play with them would be usually when I am with a guy mostly; [they can be] intimidating, like they would know everything, it was just like, what ever, I can't be bothered.

When the girls were asked if they thought they would be just as good as the boys if they tried and practised, another young woman commented: 'Yeah. If we learnt all the stuff. Yeah, just so long as you knew how to work it, because they do and we don't'. Some girls commented that they believed that boys really liked to prove that they knew more about computers than girls, as acknowledged by this student: 'I reckon they like to prove that they are better than us … Girls don't do it because it is not girly in a way … But they are like yeah, I can do this and this, like a geek'. This competitive and public performance of masculine confidence and ability, especially in relation to CIT, was alienating and intimidating for many girls, resulting in limited interest in using computers. This behaviour was particularly associated with boys who were considered 'geeks', whose knowledge, interest and behaviour in relation to computers far exceeded the socially accepted norm. Perceptions of the ways in which male 'geeks' or 'nerds' embodied masculine subjectivity were contradictory. Boys were viewed as confident and competent with technology and were not afraid to demonstrate this publicly, but other aspects of their performance of masculinity more generally was read as highly problematic. This point will be discussed further in the section on computer nerds later in this chapter.

The shaming that some girls experienced went beyond their involvement in computer games and into classroom experiences. As pointed out previously, low interest in computers was often associated with feeling incompetent. Many girls expressed concern that they fell behind more competent students in class and that competent students tended to drive the pace of learning. One young woman commented that she found it difficult to ask for help when using computers: 'You don't want to ask because you feel like a big idiot'. Some girls indicated that they were less intimated to ask another girl for help than asking a boy. Another girl commented: 'I hate it when like teachers just like expect you to know everything first off … you don't want one that just plays little guessing games and the like, "no, you should know that, I gave you a clue" … I don't know what the answer is!' This comment raises a critical issue around the use of this type of pedagogical practice and the shaming effect it can have on students, regardless of the discipline. It intensifies an already existing shame of incompetence and humiliation through failure to second-guess and recognise the supposedly obvious clues provided by the teacher. The shame–pride axis in particular, is seen by Tomkins as the measure against which'we evaluate all of our actions and along which is strung our precarious and fragile sense of self' (Tomkins cited in Sedgwick & Frank 1993, p. 20). In order to recuperate girls' interest in CIT, pedagogical practice needs to employ positive affects. Gannon and Davies point out that pedagogical practice that

embodies and utilises positive affects: interest–excitement and enjoyment–joy has a transformative effect on student interest and desire to learn (2007; see also Watkins 2007).

Highly interested students: The computer nerds

Boys constituted the majority of that small proportion of students who identified as highly interested in CIT. Their competency was demonstrated by practical application of their CIT knowledge that often exceeded that of their teachers. These boys were highly proficient and interested in programming, building computers, playing strategic and action-packed computer games (considered 'exciting' and 'thrilling') and participating in technical problem-solving tasks. Their perceptions of the interest of other students in CIT also reflected gendered stereotyping. They perceived that girls use computers mainly for homework and talking to their friends and that they do not like engaging with computers to undertake more technical tasks. When discussing girls' interest in computers, a highly computer literate boy remarked: '… no offence or anything — yeah they just like talking, they can't stop constantly talking … they just love to talk'; he went on to point out that 'boys just don't like talking like girls do'. These boys' stereotyping of girls' relationships to CIT were contradictory. Unlike many other students, they did not generally believe that boys were innately better than girls in this area and they indicated that girls could be equally competent if they were keen and interested. However, girls' ability to be equally proficient was based on the perception that they were able to concentrate more effectively: 'Yes because they can concentrate, they concentrate better than boys, because boys tend to muck around, well I do … yeah, but there is nothing really stopping them from being better than anyone, any boy, it is just that they don't, well don't like doing it'. Many high interest boys were not engaged by the CIT curriculum and were often bored and frustrated; some admitted to 'mucking around' on occasions due to boredom. This student's comment suggests that high interest boys could 'muck around' and still be competent, but comparatively, these boys perceived that highly interested girls had to concentrate and apply themselves in order to be successful. However, some teachers were aware that the curriculum often did not extend the knowledge and skills of these boys and organised for their skills to be used more profitably. In one school, these boys' CIT skills were a highly valued commodity that was exchanged for privileges; they were involved in organising, running and maintaining the school's administrative computer system in exchange for free access to the Internet. This privilege was accompanied by a status in the school that was not generally experienced by other highly interest students in the other schools we visited.

Highly interested girls were much rarer than highly interested boys amongst the students in our focus groups. Like highly interested boys, they had an enthusiasm for CIT and a highly developed technical knowledge of computer software and hardware. They tended to spend long hours playing and working on

computers, could generally solve problems when they arose, could dismantle and rebuild computers and could talk computing language. According to other students, highly interested students could talk about computers incessantly; though this was a trait that was considered to be a characteristic of boys. Both highly interested girls and boys preferred to spend their free time engaging with computers than socialising with others; though when they did socialise, they tended to choose the company of other students who had similar interests in computers.

Other students viewed these highly interested students as computer nerds or geeks. Students' perceptions of computer nerds were often coloured by stereotypes that they had seen in the media and were often visualised by students as male and/or of Asian descent. Students displaying extreme interest were identified as 'geeks', and were viewed as spending 'most of their life on a computer'. When asked to define a computer nerd, students gave a range of characteristics, such as, 'they live and breathe computers 24/7'; are technically knowledgeable about computers and how they work; wear 'rainbow suspenders and things like that'; have 'no friends and talk weird … like really sophisticated and use big words'; but as one student pointed out, 'the emphasis is they don't go out! … they don't have a social life!'. One high interest boy, who was labelled a nerd by other boys in his focus group, defined nerds in the following manner and raised how an interest in computers was often associated with being considered 'weird':

> They don't leave the computer … They spend all the time on the computer, lunch time, recess, when they get home, before school, after school … They can get weird but anyone can be weird. Simply using computers and working with them a lot doesn't make you weird instantly, although a lot of people seem to think it does.

Some students' perceptions of computer nerds reflected stereotypes about Asian students — believing that 'Asians are the real smart ones'. Such racialised stereotypes operate not just in schools, but circulate through popular culture. As Matthews (2002, p. 194) argues:

> The 'ethnic success' theory is premised on the idea of a fortuitous alignment between Asian cultural values, such as respect for elders, high regard for teachers and education, capacity for hard work, self-discipline, high motivation, ambition, good behaviour, politeness, deference and the tendency not to argue with or question teachers, and the values sanctified by Western education systems.

Without a critical review of such stereotypes, there will be limited understandings about how schooling may operate to constitute and reinforce these racialised perceptions (Matthews 2002).

As indicated in the comments above, being perceived as a computer nerd was often not associated with a positive reputation, though some students, who identified as nerds and were willing to publicly acknowledge that in front of their peers, wore the label with pride. One of these boys defined being a nerd as

'[knowing] as much stuff as I can on the computer. I just put myself into that category'. A self-proclaimed female 'computer geek' commented, 'I would go on MSN for like hours and yeah go on the Internet a lot and just use Word'. However, some highly interested boys did feel anxious about being viewed as computer nerds and were quick to disassociate their CIT interests from any connection to this reputation: 'like I wouldn't talk about it!' This comment brings us back to an interesting point about the contradictory ways that boy 'computer nerds' are perceived to embody masculinity, which was flagged previously. Students identified incessant talking as a characteristic constituting the computer nerd. This perceived overindulgence in talking, as pointed out previously, is considered a female trait, which is not highly valued by masculine subjects. Within oppositional readings of masculine and feminine, boy nerds are recognised as doing their masculinity incorrectly, because they talk incessantly about computers, which is viewed as feminising their performance of gender. This perceived failure to get their masculine performance correct is intensified through the way they often isolate themselves from peers, which is often read by other students as being asexual. That is, they are not actively engaged in what is generally considered to be critical to the performance of hegemonic masculinity, a healthy sexual interest in girls. One girl commented that boy computer nerds talk 'like they haven't hit puberty!' This last remark reflects how boy computer nerds are also often perceived as sexually immature, as doing their gender does not incorporate a public performance of hypersexuality, critical to one's location in hegemonic masculinity. This makes these boys even more vulnerable to the regulating harassment of others, especially other boys, who operate in peer groups to police the normalisation of gender (Robinson 2005a, 2005b).

Most students, when asked if girls could be nerds, took a bit more time to think about their answers, though many concluded that they could be. However, some girls found it very difficult to consider a girl as a nerd: 'I've never really known girls that are into it that much; it's like all these guys … I suppose girls are more interested in talking to each other so they don't really know everything about the computers'. Some high interest boys believed that those girls who did actually get into computers could be more excessive than they were. Students had very different readings of girl and boy nerds. Girls who were considered nerds were seen far more favourably than boys and were perceived to be more 'normal' and less 'geeky' than boy nerds. Other girls in particular, viewed them as 'smart' and 'cool', as indicated in the following comment from a female student:

> I don't think it is as geeky if they are. Like that's what I have sort of found. They are not as geeky … because guys are meant to be all buff and cool and sporty and stuff … If girls know computers then they are sort of cool. Yeah, they are sort of smart.

The girls who identified as computer nerds or geeks in our research performed an alternative femininity; one that often took up a modulated masculinity. Their off-beat appearance, often reminiscent of that fostered in skateboard cultures —

baggy jeans, baggy shirt, sneakers, cap; or some readjustment of their school uniform — suggested an alternative femininity. This performance of femininity was accompanied by social and communicative competence that reflected a quiet assertiveness and sense of control in these young women. Their manner was often relaxed and, unlike other girls in the focus groups, they frequently took up space with their bodily slouching, a practice more typical of boy behaviour. Kelly, Pomerantz and Currie (2006) in their research on the shifting nature of girls' performances of gender in cyberspace and the impact this has on their everyday lives, also acknowledged that girls who identified as computer geeks or nerds in their research performed a different femininity — one similar to those girls in this study. This distancing of themselves from dominant forms of femininity gave these girls a power that was not shared by girls who took up dominant femininities, or some high interest boys who transgressed dominant forms of masculinity. Opposing stereotypical or normalised feminine subject positions allows these girls to reject the inherent disempowerment that is discursively constituted in heteronormative male and female power relationships. On the other hand, their performance of 'female masculinity' (Halberstam 1998) allows them to claim some of the power inherent in hegemonic masculinity. Their tomboy behaviour, accompanied by exceptional knowledge and skills in CIT, was often read as 'cool'. In one focus group, boys with low interest in CIT commented that girl 'computer nerds' could be sexually 'hot'. Unlike boy 'computer nerds', whose sexuality, as discussed previously, was often read as immature or nonexistent because of their transgression from dominant forms of masculinity, high interest girls were still read as having sexual power and were the focus of the male gaze.

Conclusion

This chapter has argued that stereotypical understandings of identity, particularly those discourses that concern gender, ethnicity and class, have a direct impact on the construction of student interest within the CIT discipline. Students often employ understandings of gender that depend on binary opposition, rather than conceiving of gender as a fluid and complex matrix, and understand subjectivity as shifting and contextual. Instead, boys and girls are frequently positioned and position each other, as technologically competent according to whether they are either male or female, and their ethnic and class identities. Further, this perceived competency is based on how effectively their performance of gender conforms to a social script in which boys are expected to be hegemonic masculine subjects competent with technical tasks and girls are expected to be socially competent and enjoy design and aesthetics. In addition, technical skills and difficult technical tasks are more highly valued and are largely perceived to be the domain in which boys are competent, while girls are positioned to enjoy tasks that involve communication and design, tasks and skills that are frequently less valued. As demonstrated in this chapter, some students and teachers use shaming practices

that impact on students' sense of self, their sense of competency and interest in CIT. We argue that pedagogical practices that incorporate positive affect are required to tap into the interest that does exist for students, however minimal, in order to foster further interest and skills development for these students. Through their different performances of masculinity and femininity, high interest students challenge dominant discourses of gender, opening up new possibilities for doing their gender differently. In addition, what this does is provide a different reading of the relationship between gender and CIT. This is particularly significant for girls' participation in CIT education because high interest girls provide an alternative reading of the relationship between gender and CIT, breaking down essentialist understandings of gendered competency within the context of CIT.

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CHAPTER 7

CIT teachers' cultures in a globalising world

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IN THIS CHAPTER WE EXPLORE TEACHERS' CULTURES in relation to Computing and Information Technology (CIT) curricula. Specifically, we consider the changing private and public dimensions of teacher culture and CIT curricula in the context of globalisation. To do so, we draw on data from an ARC-funded project known as *Gender and Information Technology* (GaIT).[1] In particular, interviews with New South Wales (NSW) secondary school teachers working in the field of CIT are analysed to gain insights into how they came to teach CIT, their qualifications and experiences. We argue that because teachers who become involved in CIT education do so via multiple pathways as private individuals, they respond in different ways to the CIT teaching contexts and social relationships that constitute organisations such as schools (Monahan 2005, p. 82). We consider how the social relationships framed in and through globalisation impact on CIT teachers in schools. We draw heavily on Monahan in this regard, who writes about the effects of globalisation on an entire educational district in Los Angeles through a detailed empirical study of daily school life. He suggests, 'the current trend in social relations, in spite of the democratic promise of informational networks, is toward increased discipline, control and centralised power' (ibid p. 182). While the rhetoric of globalisation is new markets, new practices, new ideas and seamless communication, we in fact find that globalisation comes with a particular kind of political order — neo-liberalism — which, with a focus on individualism and the organisation of social life based on economic prerogatives, blocks innovation. So we find in this study that, while informal communities of knowledge and labour exchange provide space for the agency of teachers, teachers simultaneously over-determine the scope, and therefore limit the potential, of knowledge developed through informal communities because of the effects of economic rationalist

1. Please refer to Chapter 1 by Julianne Lynch for further details about this ARC Linkage project.

policies. Drawing on these key ideas we consider the agency of the individual CIT teacher, the dynamics of globalisation that produce specific pedagogical practices and the changing dimensions of the field of CIT.

First, we outline a theoretical framework that helps us to understand the potential for, and constraints on, teacher agency by drawing on understandings from the sociology of teachers' work. Second, we discuss 12 transcripts of interviews with CIT teachers working in New South Wales, analysing them in terms of agency and power. Third, we examine *glocal* pedagogies and the paradoxes confronting the changing field of secondary education in the face of globalisation. Finally, we conclude with some policy implications for teacher professional development.

The sociology of teachers' work

This chapter focuses primarily on teacher culture; however, the term *culture* is not unproblematic. Culture can be understood on the one hand as static or a *product*, or on the other hand as a *dynamic process* (Green 2002, p. 223). Static conceptions of culture, which describe cultures in terms of sets of characteristics or traits, tend to obscure teacher subjectivity and the ways that individual teachers negotiate the contexts and the relationships of their work. Abdallah-Pretceille (2006) introduced the term *culturality* to distinguish the dynamic from the static. In this chapter, we prefer to use the term culturality because we focus on the dynamic processes through and in which CIT teachers participate as they construct pedagogies and selves while they weave in and out of their working lives. These processes not only include visible forces, but also those invisible to 'the eye' that serve the 'master-plan' of globalisation and related 'innovative' or 'transformational powers' (Pearson & Somekh 2006). These constructions of teachers' work and teacher cultures as dynamic and negotiated frame the analysis in this chapter.

Any analysis of the uptake of CIT subjects in schools, in particular the ways in which teachers are implicated, requires an understanding of the nature of the multiple factors shaping teachers' work. Relationships between 'teacher cultures' and disciplines tend to dominate literature on secondary school teachers' work and identity (Carrington 2006). While useful for acting at the level of the school such an approach has limitations, largely because it can obscure wider social dynamics, as well as individual factors that shape teachers' work. Carrington explains that, 'secondary school teachers are defined as discipline specialists and positioned in terms of the rigid organisational structures understood to be characteristic of secondary schools' (2006, p. 85). She argues that secondary teachers are never considered in familial terms, rather they are considered to be less connected to students than primary teachers and 'stereotypically' less concerned with pedagogy and pedagogical knowledge than they are with discipline knowledge. Te Riele (2006) offers a critique of such homogenising views of teachers, arguing that, by focusing on professionalism and the concomitant concern with ethical standards and 'duty of care', and thereby putting an emphasis on responsive pedagogies in

terms of emotions and wellbeing, we can bring the 'private' more sharply into focus, rather than the disassociation that occurs when we construct teachers as workers only. This public/private dichotomy permeates discourses around teachers and is scaffolded, according to Vick (2004), by the dominant tendency to pay attention to the greater detailed regulation of work — meaning that we ignore the relationship between work and other spheres of social life. In a sense, we miss the important contribution that informal knowledge networks make to the construction of teaching practice. Such informal knowledge networks are particularly pertinent when we consider the work and identities of CIT teachers.

In his discussion of the Los Angeles school district and the effect of globalisation on teachers' working lives, Monahan (2005) draws on the concept of *built pedagogies*, where this term refers to the embodied space created in the architectural design of computing instruction spaces, as well as the technological and social systems that govern the use of technology (ibid, pp. 9–10). Monahan (2005, p. 75) contends that 'the actual production of technological worlds [is an] expressions of globalisation'. This means that we need to understand the *built pedagogy* to understand the social relations that are produced, in addition to questioning the content and larger context of pedagogy. When attending to the production of technological worlds it is possible to reveal the mechanistic, patriarchal network that influences education. It is also easier to illuminate the hidden curriculum that regulates and hollows out teachers' *connoisseurship* (Eisner 1979, p. 34). In many of the student and teacher transcripts we examined it was easy to see *how* the mechanistic stifling of creativity, imagination and communication operated in the school networks and how it shaped the teacher–student relationship.

To a certain extent, technology has destabilised relations between teachers and students by removing the locus of control from the teacher. However, both students and teachers are increasingly governed by bureaucratic mechanisms such as testing, regimes of management and processes of standardisation created through discourses of competition and neo-liberal economic imperatives. However, these broader forces are not the whole story: We also need to understand the relationship between teachers' lives (personal) and work (professional) as forms of globalisation on the ground, and attend to the relationship between individual people and the various global and local forces and conditions and related forms of agency (Monahan 2005). For example, when research carried out in the area of CIT points to gender-based differences in how technology is used at home and school (Downes 2002; Mumtaz 2001), we may ask the question how these relate to personal experiences that are gendered both at school and at home. While professional processes and practices may *be constructed* as non-gendered to serve educational management purposes, leaving out personal experiences alienates the collective nature of social activities and therefore obscures broader social patterns (Monahan 2005, p. 59).

In the next section, teacher interview transcripts are discussed in terms of the insights that can be gained into the ways in which globalisation shapes local CIT teacher cultures. The discussion draws on an analysis of interview transcripts from 12 secondary schools in New South Wales (NSW) across metropolitan, regional and rural areas, which vary in terms of socioeconomic status (SES) and level of female participation. The following list gives school pseudonyms, their location, an indication of the socioeconomic status of their student population, and the level of participation of girls in senior CIT subjects.

- Rock Dove High School[2]: Metropolitan, low SES, high female participation[3]
- Galah High School: Metropolitan, high SES, high female participation
- Honeyeater High School: Metropolitan, medium SES, low female participation
- Lorikeet High School: Metropolitan, low SES, high female participation
- Magpielarks High School: Metropolitan, high SES, low female participation
- Plover High School: Metropolitan, low SES, high female participation
- Bowerbird High School: Rural, low SES, high female participation
- Budgerigar High School: Regional, medium SES, high female participation
- Currawong High School: Regional, medium SES, low female participation
- Fairy Wren High School: Regional, high SES, low female participation
- Frogmouth High School: Rural, medium SES, low female participation
- Yellow Robin High School: Rural, low SES, high female participation.

The dataset was initially analysed by open coding procedures, followed by axial coding, and concluded with evidentiary-unit commentary interpretations (Ezzy 2002). This content analysis is deductive and works 'down' from theory to test it against empirical data. The focus of the axial coding was on identities articulated by teachers in terms of pathways and qualifications, and school culture in terms of local communities, staff mobility and organisational processes and practices.

Agency and power

Teacher cultures are powerful mediating forces that reveal much about issues of agency and power and their manifestations in classroom and broader school relationships. We contend that the relationship between various forms of power and the uptake of CIT subjects in schools is linked to work practices and the globalisation of technological change shaping everyday practice in schools. If we assume CIT teachers are public service workers who, according to Lipsky (1980, p. 3) 'interact directly with citizens in the course of their jobs and have a substantial discretion in the execution of their work in the frontline of public service' and, as Bruining (2006, p. 168) has argued, see discretion as 'a form of power available to every individual', then how does the CIT-teacher facilitate power?

2. To protect participant anonymity, pseudonyms are used when discussing individual schools.
3. Because of the low overall percentage of girls enrolled in senior CIT subjects in Australia, a Year 12 participation rate above 40% was described as *high*, while a rate between 20% and 40% was considered moderate, and a rate below 20% was considered *low*.

Waters-Adams, writing about science teachers, points out that, regardless of the subject they teach, teachers interpret a subject as they see fit for their world.

> There are potentially contradictory elements at work within the teachers' practice: their espoused and tacit understanding of the nature of science; their understanding of what makes good science teaching; their beliefs about the aims of education, the curriculum, and appropriate pedagogy; and the pressure of external demands from school and curriculum. The tensions between these elements created a fertile dialectical situation for change. (2006, p. 12)

While the above quote refers to science teaching it is also useful for understanding teaching in CIT, since at the senior level both are often constructed as bounded disciplines inside schools and by curriculum bodies such as the NSW Board of Studies. However, as 'public servants', teachers have been subjected to a centralising philosophy that avoids dialogue and the notion of collective thought, thus leaving fundamental viewpoints unquestioned. The result is that '(a)ll our energy is taken up with our response to the immediate issues, and we don't get into contact with the whole problem' (Bohm & Edwards 1991, pp. 15–16). Another perspective suggests peoples' belief systems are negotiated culturally and enacted in the milieu in which they work (Connell 1985, 1993; Grundy 1994). For example, when a teacher from Budgerigar High School was asked about the advantages of doing subjects like Information Processes and Technology (IPT)[4] and Software Design and Development (SDD),[5] he responded:

> Well from my contacts in the industry, it does give them a leg up when they come to study at higher levels or it does give them a real advantage when they're trying for a cadetship or an apprenticeship in the computing industry.

This teacher draws on the power of knowledge gained through industry 'contacts' that lends authority to his support for the only 'really useful' pathway to take and, in this case, it is towards the requirements of the CIT industry.

In other contexts, additional forces shaping the agency of CIT staff in schools impact on their desire to encourage students to take CIT subjects at all levels. For example, a respondent from Bowerbird, a rural secondary school, made this comment when asked if students were encouraged to take CIT subjects in Years 11 and 12:

> [I don't want to give] … the wrong impression … but I'd certainly say [we are] under selling it … and a lot of other faculties I think [also] find it easier to either express or to demonstrate to students the sorts of things they'll be doing when they get to Year 11 and 12. I've found that very difficult and I just give them a rundown of the difference between the two. But then again I was in the position of being the year advisor too. I tried to be very impartial with that one, but …

4. This subject is oriented towards application and everyday processes and is the most commonly taken CIT subject in the senior years.
5. This subject requires a high level of mathematics to gain entry and is more theoretical in orientation.

As year advisor, this teacher was concerned that his power should not be used to profit his own subject area. Agency, in this case, is revealed in the teacher deciding to remain impartial and to provide students with only a brief outline of the subjects, rather than explicitly encouraging students to enrol in the senior CIT subjects. A teacher from Frogmouth, another rural secondary school, was quite explicit about how power operates in the teacher cultures of schools when neo-liberal imperatives associated with globalisation impact on the agency available to teachers on the ground.

> … I think we have to be careful when students are selecting courses — I guess in every school people are very wary that you are not empire building as I guess the same would go in trying to recruit kids for the sake of numbers rather than recruiting kids for their needs …

The limitations to agency are clearly articulated in this example. Teacher cultures are based on professional collective interest as well as personal interest, and these interests are further complicated by tensions between specialist CIT curricula and cross-curricular ICT initiatives.[6] For example, in this school there was strong support for directives from the NSW Teachers Federation that had placed a ban on a generic Computing Skills Test, which aimed to test all Year 8 students' computing skills. It was highly contentious in schools, not least because it used a paper and pencil format; although, an online version has since been added. Yet despite teacher support for this ban, *all* the high schools in the study in NSW had responded to the new testing regime through increased studies in computing, either across a range of disciplines or in the form of special subjects, designed to teach to the test. These neo-liberal dynamics shape teacher cultures in fundamental ways and lead to a refashioning of 'what matters' in terms of curriculum decisions.

Top-down pressure from the national level to become globally competitive[7] through constant demands to innovate — particularly in the area of technology — can have the opposite effect. The following comment from the Head Teacher of CIT at Plover High School typifies the stress teachers experience when the purpose of pushing through a curriculum is not clear to them:

> Teachers feel nervous around technology. They feel they're not capable of teaching technology or even assessing outcomes of students based on technology [and] not sure of the politics of [technology] …

Similar sentiments are expressed by a CIT teacher of Magpielarks High who suggested that such attitudes rub off on the students and that this may produce particular outcomes for girls taking up CIT subjects:

> Staffing first, staff really are very, very scared, in my opinion, of CIT. That is they're afraid to display it to students and to other teachers, even though

6. See Chapter 5 by Catherine Harris for a discussion of these tensions.
7. As evidenced in government publications such as *Learning for the knowledge society: An education and training action plan for the information economy* (DETYA 2000).

> back in the home, I think most of them are quite confident and capable of doing CIT, but they do not want to show it … and that sort of harks back to the girls.

The effects of top-down pressure to integrate technology across the curriculum elicited another reaction from a CIT teacher at Magpielarks. When asked if a concerted effort is made to sell or market the CIT subjects, she commented:

> Well, there is from above and I think there should be [though] the teachers are very nervous about teaching and bringing more technology into their classroom. And because they're unsure themselves and you know now we're expected to go into further curriculum areas, there's a few teachers getting into a panic mode … and 'oh my goodness we're going to get inspected and fail because we're not doing technology'.

These concerns reflect the direct and indirect effects of a neo-liberal climate in which policies and curricula are designed centrally, so that teachers feel directed by way of 'carrot and stick' (Scott & Dinham 2002, p. 16) to respond in a particular direction, regardless of the realities of local contexts and factors that may be specific to their professional and private lives. There is an inherent reduction in the rights and powers of teachers to design their work so as to make a difference in their own classrooms. Therefore, teacher practice is not validated as a dialectical and dynamic process that is co-constructed with the needs of the students and the local community. What the 'carrot and stick' approach produces is a 'technical and mechanistic view of teaching' (Dallmayer 1998, p. 39).

In the preceding sections we have focused on the ways in which power shapes teachers' work — including knowledge of the CIT industry, the gendered nature of the school/home link to CIT perceived competence, the pressure on teachers to attend to demands of a centralised hierarchy, and the fear this produces, and the power of collective tactics such as maintaining solidarity with other teachers to resist regimes of testing. In the next section, the factors of time, space, timetables and budgets are explored to reveal further aspects of the built pedagogy that were raised by teachers in this study.

Time, space, timetables and budgets

Teaching cultures are complex and interwoven systems in which people tend to assume a similar space with similar principles in order to sustain a community fabric. An example of this was revealed earlier in this chapter at Bowerbird and Frogmouth when key CIT staff discussed how they were conscious of the effect that 'recruiting' students to CIT subjects might have on the overall morale of the school staff and the future options of students. While assumptions about space and time often prove incorrect among interacting individuals, people negotiate their assumptions in a way that reflects and sustains the natural spaces in which communities live. We focus here on one school to illuminate these processes.

Yellow Robin High School is in a region known for its natural and nurturing space. Many teachers at this school, including the current CIT teachers, moved into this geographic area with a view to eventually retiring there. One teacher told us that 'some teachers have been here since 1974'. Others come from a tourist area some 150 kilometres away and 'don't want to go … They're very happy to keep up-skilling and have a range of … creative attributes.' He explained that the school:

> provides a fair reflection of the character of the local community [and] draws from a fairly broad section of the community. [And though] all of its feeder schools are priority schools … this school has not been assisted in a fixed funding … and so we are, you know, minimally resourced … But because of the age being the oldest high school in this district it has a fairly strong P&C which helped to support it [and] we tend to do a lot of self-resourcing. So that reflects a little bit upon the quality of the resources we are able to use at all times.

The nurturing quality of this space was evident in the approach taken by one highly regarded female teacher who had increased the participation of girls in Yellow Robin High. She provided 'road maps' for students and said: 'I would direct them to where I saw that they would be best suited and told them what was needed to get to particular courses and jobs'. This career advice was sadly lacking in most schools in this study. In addition, she thought that stories of women in CIT were thin on the ground and said:

> I also use to put up lots of stuff in particular with women in CIT. My classroom would always have lots and lots of … I found all these case studies at one time of women who went into IT careers and you know what? Their initial training was you know at school and what they trained in and what they're doing. And you know I'd happen to encourage the girls that way.

Her colleague commented she was 'a very modest person … but very, very organised and enthusiastic'. She was known to:

> get through all the course work … very comfortably but [making] sure that she's got some fun things to do as the easy bits [and] the kids see 'oh, well, that's how you can use this' [and] not only for analysis [or] the quality of a person's rating or whatever it happens to be but you can actually use it to communicate with someone.

When asked what she thought drew the children and especially girls into the CIT subjects, she commented:

> we actually encourage the kids and parents … you know, parent and teacher nights and subject selection nights. [And] taking computing … even if you don't intend to go into computing as a career. If you're gonna do any university courses you still need a level of computer literacy.

When asked how and why she came to teach at this school, she turned the attention to the surrounding space and said she'd lived here now for 20 years. She said:

> First … I was a casual and it took me 18 years to get on to permanent staff … you know living in [this] high demand area [and] [this job] gave the opportunity to move across … when there was a position … which is great … I just love it.

Her male colleague said that mainly 'self-resources' — because of lack of funding — come from a commitment to the people in their community. He suggested that:

> Whilst teachers put in extra time to build a good community school … I know for a fact that the Government preys upon that process, in all negotiations. They know that teachers will complete their work because they won't leave the kids in the lurch.

In contrast to the relational strategies employed by this Yellow Robin teacher, less productive, more oppositional strategies were employed at other schools. One female teacher from Honeyeater High made pointed references to the gender boundaries that tend to be policed and reproduced in particular curriculum areas, including CIT.

> I think that we have good role models … especially in the subject. I think that I'm the only woman here but they see, the kids see me doing other things — wood, metal, you know the typical tradition, very typical man's role and there is, I think there's probably some transference from them seeing me do that then thinking well I can do anything. And that's, that's the thing that pushes it in the school at all levels is that you're not bound by those things you can do whatever you want. You have to do what you enjoy, you have to maybe have a little bit of think about where you want to continue at the end of year, if that is going to help you. I would like to see more female teachers involved in it.

This valorisation of a woman who 'does non-traditional things' serves to maintain the gendered boundaries of curriculum practice. It is an 'oppositional strategy' which emerges from an outmoded approach to role model theory. Oppositional strategies promote the idea of becoming more successful at traditionally 'male' subjects or developing what might be seen as stereotypically masculine qualities, such as competitiveness and assertiveness. So, rather than questioning the value of these qualities per se *and* the attention given to them, the approach reinforces the hegemony of such qualities and narrows the imaginative and productive capacities of students and staff. Connell (1996) has critiqued this approach as being overly simplistic and socially deterministic. If we narrow our gaze to school practice in ways that reinforce gendered binaries then we miss some of the substantive issues impacting on the work of teachers in schools today.

In contrast to the relational strategies used at Yellow Robin to create spaces for interest in CIT, interviews with CIT teachers from other schools highlighted how budgets, timetables and resources dominate discussions about what teachers want to and can teach. One teacher from Galah High School, for example,

suggested all teachers at that school are trying to teach some computing in their courses, which leads to competition for resources. Another teacher from Honeyeater High suggested teachers might want to offer a Software Design and Development course, but it is considered by most students as 'pretty tough, pretty rigorous'. As a result:

> We don't get enough numbers to form a class; we need at least 14 students to elect the course and we particularly might get nine or ten … we can't run it with those numbers.

These examples are quite distinct from that of Yellow Robin High School. While teachers at Yellow Robin employed relational strategies, making use of community networks to create space for interest in CIT, interviews at Galah and Honeyeater highlight a mechanistic attention to timetables and budgets in discussions of their CIT offerings. The case of Yellow Robin demonstrates how social relations based on the complex interplay of place and community networks can be used to increase the uptake of CIT. Such strategies may be more effective and less problematic than attempts to provide space for 'girl focused' strategies, such as providing non-traditional role models.

Glocalising expressions in the built pedagogy

Some of the tensions that are created by the neo-liberal imperatives of global competitiveness and economic rationalism can be responded to at the local level. The Yellow Robin teacher discussed earlier was able to work with local knowledge networks and local community to mitigate some of the effects of the built pedagogy. This intersection of the local and global has been called 'glocalisation'. Robertson (1995) coined this term to express the ongoing tensions, and at times symbolic violence, that occur when two countervailing tendencies — homogeneity and heterogeneity — are part of social life.

Carrington (2006) suggests that teachers and students can become active citizens in a *glocal* community, where the school functions 'as a key and central site for the intersection of global and local issues and forces' (p. 171). In the first instance, Carrington's vision may seem compelling, but from a sociological perspective, it must be considered functionalist. For example, when teachers completely identify with their teaching roles the danger is that their behaviours are shaped according to preformatted models and then individual creativity is denied. Parsons (1961, p. 43–44) described this as the 'normatively regulated, participating of a person in a concrete process of social interaction with specific, concrete role-partners'. Carrington's argument for 'project-based work' that is linked to student experiences of the glocal sees collaboration as a pedagogical regime in which the lives of teachers themselves are absent. Thus, Carrington risks portraying teachers' practices as independent of the creative, active role of the individuals that are engaged in the interactive process of teaching and learning. Her emphasis on techniques not only limits an understanding of the connection

between method and purpose, but also takes away the focus from the person and emphasises people's roles. This emphasis on techniques is consistent with a functionalist viewpoint that sees people as contributors to the functioning of the whole of society who ought to be socialised into roles and behaviours that fulfil the needs of society. Here the limitations of progressivist[8] pedagogical cultural change needs reworking by CIT teachers to manage the competing demands of globalisation, imposed curricula and their own values, beliefs and experiences.

A Parsonian perspective on social life suggests that people have expectations of other peoples' actions which cohere with the accepted norms and values of the society which they inhabit. If this viewpoint propels education reform then it seriously counter-effects the ideal of glocal collaboration. After all, collaboration cannot occur when people have become stifled in their creativity and adhere safely to roles rather than negotiated and situated dispositions. An interview with a CIT teacher at Lorikeet High School demonstrates some of the consequences of a functionalist approach. This CIT teacher first clarified that she had worked as a salesperson and as a training manager in a big computer company, and when that company experienced financial difficulties she 'got out' and got the job at Lorikeet High. She explained:

> I got a Science Degree. I knew that that was a big asset as a Science Teacher because you've got more depth than the kids. And a lot of teachers don't have more depth than the kids when it comes to computers so I wanted to get that yeah.

From this perspective, she assumed the position of expert who not only saw her students as amateurs but also negotiated her power towards her colleagues in a top-down kind of way.

> I have felt … the reluctance on the part of a lot of teachers to adopt the new technology [and] literally had to drag teachers kicking and screaming into a classroom to show them what you could do. And they were intimidated and then keen … I remember interviewing the Principal and showing what you could do to the Network in terms of educational outcomes and stuff and he just didn't want to know …

In this teacher's narrative, we are alerted to her positioning of herself as an expert in a hierarchy that requires no feedback or input from the 'other', which is in essence a relation of power over others according to an ideology of competition that deflect the possibility of collaboration.

In contrast to the functionalist orientation of some CIT teachers, there were a few teachers completely committed to their students and the people in the wider

8. One of the contradictions of progressivism is that, although we were alerted to the static and decontextualised nature of centralised, traditional curriculums, progressivist curriculum reform often ignores relations of power, in this case, the reality of teachers' lives and work. For more discussion see Cope, B. and Kalantzis, M. 1999, 'Traditional versus 'Progressive' pedagogy: A philosophical reflection', *Pedagogical frameworks: from theory to classroom practice*, Athens: Aristotle University of Thessaloniki.

community. One CIT teacher at Plover High School said that, at a school where she was previously employed, she:

> … used to run classes in sports time for parents to come into the class because they were isolated from their children because they didn't know what was going on. So I used to run classes on a Tuesday afternoon … where parents would come into the lab and have lessons.

This teacher, like the female teacher at Yellow Robin discussed earlier, considered that local knowledge networks were important in sustaining a culture whereby CIT capacities were understood in relation to social networks and local and global histories, knowledge and politics. In doing so, CIT was demystified and the school opened up to transformative practices that maintained and supported capacity building of local communities.

Conclusion

In this chapter we have argued that, because teachers who become involved in CIT education do so via multiple pathways as private individuals, they do not relate in a uniform way to CIT as educational practice. This diversity of knowledge, practices and attitudes is also gendered, but not in any consistent manner. While there were few female CIT teachers, those that did teach in the area maintained diverse practices. Some worked within the framework of hierarchy, competition and assertiveness and others challenged this dominant narrative by working with social networks and explicitly encouraging girls with knowledge, rather than trying to change their behaviours. The irony, of course, is that this approach also encouraged the greater uptake of CIT subjects at all levels by boys, particularly at Yellow Robin High School.

We discussed our analyses of 12 interview transcripts, which revealed how power shapes teachers' work — including knowledge of the CIT industry, the impact on teachers of the necessity to attend to pressures from employers, and the power of social solidarity forged through collective tactics such as refusing to promote the area of CIT in competition with other subjects and support for union principles and directives. The relationship between these forms of power and the uptake of CIT subjects in schools was shown to be linked to broader work practices and the globalisation of technological change shaping everyday practice in schools.

Given the diversity of responses by teachers to the contexts of CIT subjects in schools and the various pathways that teachers take to develop knowledge in this curriculum area, what possible ways forward emerge? We would first point to the example of the teacher at Yellow Robin who recognised the local community and the informal networks that support the social relationships of the school — such as parents and local CIT networks. Using and working with these informal networks allowed her to adapt the curriculum to the needs of students and therefore enhance their understandings about CIT. In demystifying CIT the area was opened up to pedagogy built around a negotiated curriculum.

In terms of the gendered dimensions of teacher cultures we saw an overwhelming number of men teaching CIT and thus there is a tendency to see particular pedagogical practices in this field as masculine or feminine. However, this direction of inquiry might not be as valuable as understanding that gender matters in the sense of *caring*. As we argued, the public/private schism that conceals the practices that emerge from gendered social relations — particularly those of the family and community — but which are often left at the school gate, are revealed in the ways in which some female teachers open up their work to processes of caring that unsettle dominant ways of doing and knowing. It is useful, therefore, to consider ways in which the capacity to *care to make a difference* might be used to frame and motivate teacher professional development. ■

CHAPTER 8

Perceptions of changing pedagogies in Computing and Information Technology

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SECONDARY SCHOOL TEACHING AND LEARNING have conventionally taken place in highly regulated and often individualised classroom contexts. However, changing practices in Computing and Information Technology (CIT) education have the potential to challenge conventional classroom practice. In this chapter I trace the extent to which contemporary CIT curricula are influenced by the nature of the CIT industry, which is characterised by collaborative, client-focused project work. I consider the tension between collaborative project-based work and the individualised assessment regimes of schooling. The construction of CIT pedagogies within syllabus documents and directives are explored and I examine how such pedagogies are utilised in schools, in particular, how they are perceived by students and teachers.

This chapter draws on qualitative data collected as part of the GaIT Project.[1] It focuses on student and teacher interviews conducted in five New South Wales (NSW) secondary schools (Budgerigar High School, Currawong High School, Honeyeater High School, Lorikeet High School, Magpielarks High School and Plover High School).[2] Specifically, it draws on participants' self-reported experiences of CIT learning experiences up to the beginnings of their senior schooling; that is *prior* to Year 11 and 12. The assumption underpinning the arguments made here is that students' subject selections in the senior years of secondary school are informed, at least in part, by previous experiences. The data analysed in this chapter is from student and teacher commentary about the only dedicated CIT subject offered at this level in NSW schools: *Information and Software Technology* (IST). This is the subject identified by Downes in Chapter 4 as having 'the potential to provide a different perspective to the dominant instrumentalist/literacy perspective' that pervades CIT education in the junior years of secondary schooling (p. 74). I draw

1. Details about the GaIT Project's aims, methodologies and theoretical and conceptual frameworks can be found in Chapter 1 by Julianne Lynch.
2. To protect participant anonymity, pseudonyms are used when discussing particular schools.

specifically on the syllabus for this subject and on student focus group responses to the questions: 'What experiences have you had with CIT in secondary school? What did you enjoy/not enjoy?' Using the work of Honan on curriculum as 'assemblage' (2004a) and teacher as 'bricoleur' (2004b), I also outline the complex conditions within which pedagogy emerges in classrooms, and incorporate discussion of broader research into pedagogical change associated with technological innovation. The chapter begins, however, by framing this pedagogical focus within the broader 'real life' contexts of employment structures and modes of working in the CIT industry.

Project work and the CIT industry

In late 2003, the NSW Board of Studies published the new *Information and Software Technology Years 7–10 Syllabus* (NSW Board of Studies [BOS] 2003a). In NSW, this syllabus guides compulsory experiences with computing and information technologies for all Year 7 and 8 students *and* for the discrete elective course of study in the subject (IST) that is offered to Year 9 and 10 students. This section explores how the project-oriented pedagogies of the IST syllabus, detailed later in this chapter, relate to the nature of work in the CIT industry.[3] It also explores the extent to which our assumptions about unrealised opportunities for women in that industry are accurate.[4] As Von Hellens, Nielsen and Beekhuyzen note (2004), it is difficult to identify a clear sense of the nature of the CIT industry. There are many divisions and specialities, each with different prerequisite skills, and each requiring different education and training. However, a snapshot of current CIT job advertisements provides some insight into how careers in this industry are conceptualised and marketed. In this section I present a brief content analysis based on advertisements on www.seek.com.au, the largest job search platform in Australia, on a single day (3 February 2007). On this day there were a total of 157,005 jobs advertised. Of these positions, 23,042 were classified under the designated subsection 'IT jobs'. This is significantly more than the next largest category ('Accounting' 15,264). It seems there *are* jobs in the CIT industry. The next assumption underpinning this project is about the monetary rewards possible within the field. Only 286 (just over 1%) of these IT jobs were advertised in the $80,000+ 'executive' bracket. In comparison, the 'Account/Fin/Bank' category shows 950 positions (6%) at this salary level. At first glance, it seems like very high salaries are *not* representative of the industry. However, 1064 (4.6%) of the IT jobs offer salary bonuses as an incentive. Further peculiarities of the industry are apparent in the classification of 'Work type' — 6622, or more than 28% of these positions, are listed as 'Contract/Temp.' in comparison to 2507

3. In Chapter 1, Julianne Lynch provides a summary of the sectors of the Australian workforce which contribute to what we refer to here as the CIT industry.
4. The key premise upon which the GaIT project was established was that the CIT industry has many well-paid opportunities for employment, but women tend not to take up these options, and this disinterest is reflected in enrolments for CIT courses in tertiary and secondary education. See Chapter 2 by Margaret Vickers and My Trinh Ha for an analysis of female CIT enrolment figures.

(10.8%) for Accounting. In terms of the nature of the work, more than half (64.5%) of the advertised IT jobs (14,641) use the word 'team' in their advertisement and just under half (11,070 or 48%) name 'project' work in the job description.

The image of the industry that this snapshot of advertisements conjures up is of a higher incidence of contract and short-term work than in other industries. Work might be available but much of that work is of a particular nature — on the one hand flexible, with scope for financial bonuses, on the other hand, unstable and requiring a manic work ethic to achieve the salary bonuses that make it lucrative. These were amongst the elements of the industry noted by the European study *Widening Women's Work in Information and Communication Technologies* (Valenduc et al. 2004), that were seen to be disincentives for women. In Australia, researchers associated with the longitudinal study *WinIT: Women in Technology Project* (2007) have explored these issues in the local context. Von Hellens, Nielsen and Beekhuyzen (2004) identify the rapid rate of change and high staff turnover in the CIT industry as obstacles to research into the nature of that industry. In addition they say that '[d]efinitions produced by industry organisations (such as the Australian Bureau of Statistics) do not necessarily reflect the experience of people working in the industry' (2004, p. 110). The flexibility and mobility of the industry can be read in ambivalent ways by women, and by the girls in our interviews, some of whom claimed overt gendered disadvantages.

The prerequisite skills for the CIT industry are also difficult to discern and subject to rapid change. In their contribution to the *Real Time* report, Nielsen and Von Hellens cite research suggesting that increasingly 'employers rated analytical ability above any general or specific information technology skill … creativity, teamwork, problem solving and communication skills rated more highly or as highly as most technical skills' (1999, p. 257). They suggest that this creates a dilemma for schooling as it is unclear how to teach such skills in school or tertiary institutions. One essential approach is the integration 'of information technology into classrooms as social practices rather than as a technology' (1999, p. 257). This suggests that *both* broadly conceived and diffuse cross-curricular information and communication technologies (ICT) initiatives *and* dedicated CIT curriculum offerings are essential throughout secondary schooling.[5]

Syllabuses, pedagogies and complex assemblages

This chapter is concerned with the elective component of *Information and Software Technology* (IST), offered to students in Years 9 and 10 (Stage 5 in NSW). The new IST syllabus was implemented in 2005 with Year 7 and Year 9 students and in 2006 with Year 8 and Year 10 students. A number of schools trialled the syllabus before this, including several of the schools selected for participation in the GaIT project. The students we interviewed were among the first cohort to be exposed to this

5. See Chapter 1 by Julianne Lynch for elaboration of the distinction between what we term CIT education and what are commonly known as ICT cross-curricular initiatives.

new syllabus. The syllabus is explicit about 'project work' being at the centre of assessment procedures and practices. Although — like many syllabuses — this one does not use the word 'pedagogy' it details the types of learning activities with which students should engage: student learning should focus on solving 'problems in real life contexts', the subject is based on 'experiential and collaborative tasks' and students will develop skills through 'practical involvement in projects' (New South Wales Board of Studies [NSW BOS] 2003a, p. 8). Core content should be delivered via student-developed 'information and software technology solutions through project work, individually and collaboratively' (New South Wales BOS 2003a, p. 8). The accompanying document, subtitled *Advice on Programming and Assessment* (New South Wales BOS 2003e), outlines assessment requirements as entailing 'a minimum of two projects and a maximum of four projects' in the 100 hour course or 'a minimum of four projects and a maximum of eight projects' in the 200 hour course (New South Wales BOS 2003e, p. 6). In addition, when designing their school program, teachers are advised to make use of 'local businesses or community groups' to provide 'a focus for project work (e.g. development of a membership database for a local sporting club)' (New South Wales BOS 2003e, p. 6). These syllabus reforms appear to be driven by a strong orientation to 'project-based' and collaborative pedagogies.

In Chapter 4, Downes describes a useful conceptual framework for understanding the co-construction of curriculum by curriculum authorities, teachers, students and other stakeholders. She differentiates between the *intended*, the *enacted*, and the *imagined* curriculum, where the *imagined* senior CIT curriculum is that perceived by students in Stage 5 (Years 9–10) who are choosing whether to pursue senior CIT studies. The later sections of this chapter intersect with this work by examining how classroom pedagogies were perceived by our student respondents. Their responses to questions about their experiences of CIT provide a window into both the *enacted* and the *imagined* CIT curriculum in that students reported on their remembered (and reconstructed for the researcher and their peers) experience of CIT instruction. The quality and nature of these experiences, their perceptions of them, and their imaginings of the senior CIT curriculum, are critical for their futures as Year 10 is the moment of choice for continuing or dropping CIT as a subject area and future possibility for most students (Thomas & Allen 2006).

As Downes' work acknowledges, curriculum is not merely constructed around syllabus documents. Rather, any syllabus intersects with complex local contexts and broader agendas and directives (and the particular bodies of teachers and learners in real classrooms). In some Australian states, additional specific initiatives pertaining to girls and technology also provide part of the curriculum context for teaching and learning. These initiatives can be understood as part of a network or 'assemblage' (Honan 2004a, 2004b) of interdependent, and sometimes competing, factors. The pedagogy of any particular classroom teacher is impacted upon by all these variables, as well as that teacher's own career trajectory, pre-service training

and outside interest and expertise. The teacher will use texts such as her syllabus within 'a complex assemblage of meaningful practices' including other texts, making her pedagogy more like 'bricolage' than a linear plan, and enabling her to develop a sense of herself as both 'effective and professional' as a teacher (Honan 2004a, p. 277). The particular school site in which she works — in terms of policies, everyday practices, organisation of time and space — is also part of the local pedagogical assemblage. When talking about pedagogy in this chapter it is with an awareness that the contexts within which pedagogy is enacted are more complex than they may seem at first.

Whilst a teacher in NSW will recognise the need to implement her own syllabus, she operates within a network of other documents and local and systemic imperatives. As Honan describes, within a pedagogic 'bricolage', teachers' classroom practices:

> cannot be clearly identified as examples of governed practices adapted or adopted from the policy texts. The teachers use the policy texts as only one form of reference. As well, each teacher uses the policy texts in very different ways. (2004, p. 275)

This teacher will develop and practise her pedagogy within an assemblage that incorporates both her own *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a), and the current full suite of new and revised 7–10 syllabuses (NSW BOS 2007), each of which elaborates how the integration of information and communication technologies might be achieved in each subject to meet cross curricular imperatives. This may mean, for example, that the history teacher comes to her for assistance with 'accessing, collecting, retrieving and interpreting electronic information to the stage where they can use an image bank (such as Clip Art or Web Images) as a source for historical research' (New South Wales BOS 2003f, p. 17), or that the drama teacher comes to her for help with the 'graphics programs' that her syllabus tells her that her students should use 'to create, import and manipulate images to produce theatre posters, programs and flyers, costume, lighting and set designs' (New South Wales BOS 2003g, p. 15). Practically, this may also mean that the drama and the history teachers book their classes into available computer rooms more often than they did previously or that students come for assistance with the 'PowerPoint assignment' to the CIT teacher rather than the history teacher. It can also mean that, at some schools, CIT faculty are involved in designing and delivering application-oriented professional development to other teachers at their school.

Another critical feature of the curriculum assemblage in NSW schools is the *Computing Skills Test* for Year 10 that became mandatory in 2006. This consists of a 100-question multiple-choice test to be completed online or by paper and pencil. The skills assessed in the test — many of which are application-specific — are mapped

5. See Chapter 1 by Julianne Lynch for elaboration of the distinction between what we term CIT education and what are commonly known as ICT cross-curricular initiatives.

against new and revised syllabuses across all Key Learning Areas. In NSW, then, to talk about CIT pedagogy means recognising that computing skills must be increasingly embedded in all parts of the school curriculum, at least according to the Board of Studies and its assessment regimes. The earlier discussion also demonstrates how pedagogies for CIT subjects are often connected with details of hardware and software capacities, rather than modes of organising and sequencing teaching and learning. Any discussion of the pedagogic assemblage that the teacher as 'bricoleur' pulls together will also incorporate the NSW *Quality Teaching Program* (NSW Department of Education and Training [DET] 2003) which has driven professional development around pedagogy in recent years. The latest professional development offering, *Pedagogies in Practice 2007* (NSW DET 2007) focusing on Quality Teaching and Technology, features interactive whiteboards and collaborative forums with chat and other new technologies. In addition, the new NSW *Strategic Plan for Middle Schooling* aims to 'increase the innovative use of technology to support learning, increase learning choices and develop students' skill and confidence as technology users' (NSW DET 2006, p. 16) and identifies 'connecting through technology' as a strategic (and well funded) priority (NSW DET 2006, p. 12). Thus it can be seen that there is a wide range of documents and policy agendas that compete for teachers' attention and which will be taken up (or not) in different ways by different teachers.

Teacher views of information and software technology

In this section, two schools are used as examples of how the same syllabus documents can be recruited in different teaching contexts to quite different effects. The schools provide a stark contrast not only in terms of demographics and location, but also in the teachers' views on the effectiveness and appeal of the new subject to themselves and their students. Plover High is a large metropolitan school characterised by high enrolments in CIT subjects, low socioeconomic status and a diverse student population. The two CIT teachers interviewed here each named the project orientation of the new course as its most striking feature:

> Teacher 1: It's better than the old course. It's been updated now. The old course was written a long time ago and has been modified so it's a lot more project oriented and [therefore] leads a lot more logically into the *IPT [Information Processes and Technology*] course [in Year 11]. (Plover High School, Teacher interview)

The second teacher interviewed at this school also identified this as the salient feature of the curriculum reform; however, she identified the project orientation as a feature that would assist students in the different senior subject for which she was responsible:

> Teacher 2: It's all project driven. So, yes, in hindsight I think it's a good idea with *Software Design and Development* because if they're coming up from Year 9 [and 10] and they're used to doing the

projects then they'll be fine. They'll be better off but who knows whether the chicken should have come before the egg or the egg should have come before the chicken.

Interviewer: I guess when those kids hit Year 11 and you'll see whether those kids are better prepared?

Teacher 2: Exactly, yes, but Plover High School is quite innovative and they were doing lots of project work, even in the way they approached the old syllabus. Even in Year 9 and 10. So it was quite an eye-opener when I went there. (Plover High School, Teacher interview)

For these teachers, projections into the NSW Higher School Certificate syllabus and references to unique and innovative aspects of the school itself were also parts of their pedagogic assemblage. Although the school population of Plover was identified as having low socioeconomic status, the school itself was well equipped with a state-of-the-art network. The teachers reported that good enrolments meant that more than half of the eligible cohort had chosen to do the Year 10 IST elective: 'we still have three or four classes in Year 9 this year so that's 90–100 kids out of 160 or so' (Teacher interview 1, Plover High School). Idiosyncratic features, including the profile of the subject within the school, also contribute to local assemblages of pedagogic practice.

Providing a direct demographic contrast to Plover High, Currawong High School is a small rural school with low enrolments in the IST elective. The teachers at the two schools demonstrate opposing views on the effectiveness of the new syllabus. Curiously, teachers at both schools make use of everyday metaphors using chickens to explain the reception of the subject within the pedagogic assemblage of the school. The Plover High teacher used the 'chicken and egg' metaphor as she pondered the sequencing of syllabuses through the school, while the teacher at Currawong used 'live' chickens to explain low enrolments in the Year 9 and 10 elective. On subject selection night, she explained, they were competing for enrolments with the Agriculture elective where teachers 'brought sheep into the hall, you know, and two chooks and all that sort of stuff and they got very good numbers and that's what you're up against' (Teacher interview, Currawong High School). The teacher at Currawong, which used the identical new IST syllabus, reinforced the perceived unsuitability of her students for the subject:

Teacher: … the kids just like practical things like cooking, agriculture where they get to go outside, and sport where they get to run around and I think we only get the die hard kids who pick computers … they just don't like sitting down at a desk … any of those sorts of things where they're sitting at a desk, actually doing more theory than practical elements. And I don't think they understand that you're actually sitting at a computer most of the time. I don't think they've got that idea.

Interviewer: One of the other schools I interviewed talked about the students actually working on projects with other kids being an attracting feature of how it was delivered at their school.

Teacher: OK, I've tried that. Maybe their kids are different to our kids. That's actually the way I teach the junior classes. They do quite a lot of projects and work in groups. I just think the new course hasn't been focalised enough yet … (Currawong High School, Teacher interview)

When inadvertently given the words by the interviewer, this teacher did talk of 'projects' for a moment, but prior to this point the teacher had stressed that the new IST subject was 'more theory than practical', and entailed passively 'sitting at a computer most of the time'. The pedagogic assemblage includes the teacher's implicit and explicit perceptions of the capacities and interests of her students. These all have a significant effect on shaping the learning experiences that the teacher designs (or does not design) for her students. Although this teacher delivered the same syllabus that had excited the teachers and students at Plover High, and which underpinned the high enrolments at that school, the Currawong teacher explained her lower enrolments in terms of the nature of the subject and the students. While we do not have data on what shapes this teacher's beliefs, we do know that the school is rural and moderate in size and socioeconomic status. Competition for numbers occurs not only between faculties, but between this school and several private schools in the district. Although more girls than boys stay on to complete Year 11 and 12 at Currawong, there were no girls in the small CIT classes in Year 11 and 12. Nevertheless, she stressed a little further on in the interview that:

Teacher: … the ones that are in the [IST] class are thoroughly enjoying it.

Interviewer: Do they talk about which elements of it they like?

Teacher: Not particularly but probably because I started with digital and multimedia and all that. They enjoyed all those forms of computing. (Currawong High School, Teacher interview)

This teacher's representation of her pedagogy is expressed in terms of applications here, she did not elaborate the reasons, purpose and within what contexts the 'digital and multimedia and all that' are taken up by the students in her classes. That is, she did not give any detail about what a project orientation might mean to her use of these software applications in her classroom.

In this section of the chapter I have looked at syllabus and policy documents and how they contribute to the assemblages that surround teachers' classroom practice. The *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a) is very new and the conditions within which teachers take it up and make it part of their own curriculum assemblages varies enormously. In Plover High, an urban school which was well equipped and already noted for project-

oriented curricular innovation with CITs, the new syllabus was welcomed and the new subject had high enrolments. In Currawong High, marked by low enrolments and rurality, teacher-talk suggested that old binaries persist between theory and practice, passive and active learning, application-orientated pedagogy and problem-based pedagogy, despite the new syllabus. However, it is also evident that — perhaps driven partly by the mandatory Year 10 Computer Skills Test and partly by the embedding of information and communication technologies across the curriculum — computing technologies are no longer quarantined within specialist elective subjects. The following section of this chapter reviews some of the relevant international literature on the use of information and computing technologies in secondary schools, suggesting that classroom practice with regard to CITs is due for radical renewal.

Problems and projects in CIT pedagogies

Much of the current knowledge about the pedagogies appropriate for CIT education is based on empirical observation of innovative practices in broader, cross-curricular contexts. Although discussion of cross-curricular innovation in information and communications technologies might seem remote from the problems facing dedicated CIT syllabuses, insights can be gleaned from research into broader technology usage across schools. Additional insights emerge from research into the changing nature of work in CIT and other industries. Many of the pedagogical features identified by research into cross-curricular initiatives are explicitly promoted in the new *Information and Software Technology Years 7–10 Syllabu*s (New South Wales BOS 2003a), and a number of authors working in this area contextualise their claims in terms of the demands of the new work order outside of school.

A raft of research exists which investigates effective pedagogies incorporating the use of computing technologies across the school curriculum. Researchers consistently promote open-ended, collaborative enquiry that links to real world projects and which radically reframes the roles of students and teachers. Researchers in the Pedagogies for E-learning Resources (PELRS) project in Manchester, UK (Pearson & Naylor 2006; Pearson & Somekh 2006), for example, describe the powerful 'transformative learning' that ensues when institutional hierarchies are overturned and students become electronic media producers. Dede (2000) describes 'virtual communities of practice' in schools that enable asynchronous and collaborative learning and new modes of presentation/representation. Such pedagogies, he suggests, utilise tools 'similar to those in today's high-tech workplaces' (2000, p. 282) and thus are better able to prepare young people for the '21st century knowledge-based global marketplace' (2000, p. 301). In Australia, influenced by the pedagogies for multiliteracies work of the New London Group (2000) and the *Digital Rhetorics* project (Lankshear et al. 1997, 2000), Kimber and Wyatt-Smith (2006) stress a students-as-designers pedagogy. In this context, the teacher designs 'activities that effectively apply collaborative inquiry to electronic

learning tasks for deepening student knowledge … whatever the subject area, student age or software choices' (Kimber & Wyatt-Smith 2006, p. 25). Investigations of CIT-specific pedagogies also emphasise active and experiential learning, collaboration, and stress the use of real world issues or modes of working. For example, the pedagogies developed in robotics and digital media programs for children in Bremen, Germany,[6] promote collaboration, creativity and 'freedom', and emphasise students' capacities to be active agents and designers (Hartmann et al. 2007).

Explicit direction has also come from industry about how CIT education should be addressed in Australian schools. In the *Real Time* report, Taylor, Nielsen and Von Hellens explain that CIT education in schools needs to develop the qualities that the industry values: 'flexibility, the ability to be autonomous and the capacity to adapt to change' (Taylor, Nielsen & Von Hellens 1999, p. 263). These can be nurtured in particular types of learning environments, they suggest, where 'information technology skills should be conceptualised broadly and should emphasise learning how to learn, rather than the acquisition of specific technical skills that will need to be frequently unlearned' (1999, p. 253). Industry changes mean that software development teams are becoming larger and more geographically dispersed, requiring a broader range of skills including 'communication, documentation, project management, and peer review' (1999, p. 256). They also recommend learning environments enabled by technologies that require virtual collaboration across time and space.

Project-based pedagogies, however, can be problematic for secondary schools. The collapse of space and time that new pedagogies require are difficult to achieve in educational institutions characterised by traditional structures (e.g. timetables, classrooms, rigid hierarchies regulating interactions between people) and subject to increasing regulation.[7] The constraints of timetabling and the restrictions of filtering software were significant obstacles in the secondary schools with which Pearson and Somekh (2006) worked. They also noted 'intractable barriers' to pedagogical change emanating from the control of schooling via the centralised bureaucracies that manage national testing and 'inspection regimes', and school fears of 'media attention' and 'legal action' (Pearson & Somekh 2006, p. 533). They argued that current policy agendas continue to 'construct learning solely as an individual enterprise' and to silence debate about 'how the very act of learning may be changing as a result of new ICT tools' (Pearson & Somekh 2006, p. 531). Similarly, Crawford (1999) argued that government educational policies which promote audit cultures encourage 'teachers to adopt didactic, whole class teaching

6. While preparing this chapter I visited the Digital Media in Education (DiMeB) Centre, University of Bremen, where I observed work with school children and graduate students and engaged in conversation with researchers. In particular I would like to thank Professor Heidi Schelhowe, Ms Anja Kümmel and Mr Torsten Grüter. Conversations with Professor Bridget Somekh at Manchester Metropolitan University also added to my understanding of issues discussed in this chapter.
7. These issues are taken up in detail in relation to teachers' work in Chapter 7 by Reid and van den Akker.

methods focused on the achievement by pupils of tightly specified learning objectives assessed through immediately observable outcomes' (1999, p. 55). In NSW these contradictions are inherent in all syllabuses to some degree as they are currently designed — as sequences of explicit and measurable individualised outcomes.

The *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a) and the supporting document demonstrate attention to industry recommendations as well as research into best practice in CIT education. The syllabus explicitly advocates that projects be at the centre of teaching and learning in these subjects: 'The core content cannot be taught in isolation: it must be integrated with options in the form of projects.' The form these projects should take is detailed as follows:

> Projects include organised series of activities to design, produce and evaluate information and software technology solutions for an identified need or problem. The content for projects focuses on problem-solving, generating ideas, modelling, managing, communicating, collaborating and evaluating solutions. The project should be relevant to student needs and interests and address real-world problems … It is not required that all learning be independent based learning. (New South Wales BOS 2003a, p. 15)

The accompanying document, *Advice on programming and assessment* (New South Wales BOS 2003e), distributed alongside the IST syllabus, provides comprehensive advice and elaborate examples of how teachers might plan 'Integrated learning experiences, instruction and assessment' within a project-based pedagogy and according to 'principles of assessment for learning' which emphasise purposeful and responsive assessment practices. Despite the institutional and assessment restraints that frame all schooling, the recommendations for assessment instruments in the syllabus and supporting documentation provide considerable scope for collaborative and real-world oriented projects that meet many of the recommendations for innovative pedagogies outlined earlier.

Student experiences of CIT pedagogies

In the context of the apparent consensus that effective pedagogies emphasise active engagement, design processes, collaboration, flexibility and communication around real world problems and projects, and the pedagogical directives of the current IST syllabus, what did the students we interviewed tell us about their experiences of the IST elective? In this section I explore some of the themes identified in the NSW student focus group data, paying particular attention to female students' reported experiences of pedagogies in the IST elective. I contrast their reported experiences with the pedagogical orientation of the IST syllabus which frames their learning. I discuss the contradictions evident in the data in order to speculate on whether, and in what ways, pedagogy might influence girls' decisions to pursue (or not) senior studies in CIT.

Students' responses to questions about their experience and enjoyment of the IST subjects provide very little evidence of the implementation of pedagogies discussed in the literature cited previously, or of the project-oriented approach advocated by the *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a). The extracts discussed in the pages that follow are all from focus group interviews with female students at the end of Year 10 whom, based on their earlier survey results, we had identified as having 'high interest' in CIT. These students are the girls who we might expect to have had the most positive experiences of, and attitudes towards, the subject and discipline. Their brief recitations of what and how they learned in the subject is insufficient for generating a complete picture of what went on for them in class. In order to ascertain a full picture of the actualities of classroom pedagogy, ethnographic research in each classroom — supported by ongoing conversations with their teachers about planning, programming and institutional constraints — would be more reliable. However, the data does provide a window into these students' perceptions, perceptions which play a central role in their beliefs about the senior CIT curriculum.[8] Most of the students in the focus group interviews discussed in this section were completing the IST elective at the time we spoke to them and simultaneously selecting their subjects for Year 11 and 12. This important moment of choice underscores the significance of prior experiences in the subject area. Few of the students in these groups expressed interest in continuing with CIT studies in senior schooling. Their comments about their experiences in IST indicate discrepancies between what the Syllabus says and how it is experienced by them. The distinction between curriculum as 'intended' and as 'enacted' (Marsh & Willis 1999) is well known in the academic literature on curriculum processes. Students' comments in this section indicate that the learning environment they experience is very different to that advocated in the syllabus documents. When the teacher is envisaged as bricoleur and curriculum as part of a complex assemblage (Honan 2004a, 2004b), a one-to-one correspondence between 'intended' and 'enacted' curriculum is not expected. However, as will be discussed in the following pages, the gulf between the intention of formal syllabus documents and the reported experience of the students in our study suggests that very little progress has been made — in some locations at least — towards conveying the new pedagogical paradigm to teachers and assisting them to radically alter their practice.

Project pedagogies are characterised by collaboration and engagement with real world problems and solutions. Industry and research recommendations stress the importance of these qualities and the IST syllabus specifies them in its rationale. The extracts discussed in this section come from students at Budgerigar High School. Budgerigar is a rural high school of moderate size and socioeconomic status

8. See Chapter 2 by Margaret Vickers and My Trinh Ha for a discussion of the role of perception in subject choice and an analysis of related constructs from quantitative data gathered in the GaIT project.

in a regional centre with a growing population and diverse industries and services. The girls at Budgerigar mentioned how real world contexts were incorporated into their Year 9 program as follows:

Student: Everyone had to do a website and then everyone had to do an animation …

Student: You have to select a company and do a web page — we're trying to get investors in to buy into our company and we had to do all that stuff.

Interviewer: Did you have any interaction with outside of school on that? Like did you have business people come in?

Student: No.

Interviewer: Did you have any investors?

Student: No.

Student: Our teacher was our investor …

The 'everyone' that the student repeated at the beginning of this extract references the individualised nature of this learning activity. Each student completed their own separate website and animation. This extract also demonstrates how real world contexts are used to frame learning experiences. However, the real life problem and solution in this example are merely simulated and the multifunction teacher (pseudo-client and pseudo-investor) remains the pivot for planning, assessment and evaluation. This type of approach to project-based learning is unlikely to have the effects hoped for by syllabus writers who advise that teachers use local businesses and community groups as the focus for project work. At their best, such engagements can foster mutually beneficial and ongoing relationships between the local community and the school. For example, the senior high school in the NSW study, Lorikeet, matched individual students for some years with mentors from business and community, including sporting groups. Student projects in Years 11 and 12 CIT subjects were thus designed to meet the needs of real organisations in the real world; they were negotiated and refined in consultation with these mentors and each year culminated with a showcase of student work. Such an approach collapses the 'theory'/'practice' divide that perplexes many students and can provide real concrete benefits to local entities with limited resources. In the middle years of secondary school, where the IST elective is delivered, students' opportunities for similar engagement is rare and, rather than projects tailored to problems and solutions, students' experiences are more generic and often distanced from real world contexts.

The example described by students at Budgerigar High still operates with an individualist rather than a collaborative paradigm. Collaboration was scarce in students' accounts of their learning in Information Software Technologies in Years 9 and 10. Further into their explanation of what they disliked in IST, the girls at Budgerigar explained:

Student: … This year we've looked into Artificial Intelligence.

Student: And had to do a big copyright essay type thing.
Student: Yeah a copyright essay and we had to create a website on a topic of our own.
Student: Yeah, make it up.
Interviewer: Individually?
Student: All individual work.

A collaborative approach in a project-based pedagogy that mimics industry approaches would have students working together much of the time. However the syllabus itself displays some ambivalence around this. While the rationale mentions collaboration, and 'collaborative work practices' are listed amongst the outcomes (New South Wales BOS 2003a, p. 14), such references all but disappear later in the document. While specified as part of the content for *Core topic 1 'Design, produce, evaluate'*, collaboration and group work do not appear in the other seven core topics or the eight options. The centrality of collaborative team work to work in the CIT industry does not seem to be reflected in the syllabus. For example in *Core topic 6 'People'*, where students examine the roles and responsibilities of a range of different CIT personnel, there is no suggestion in the topic outline that these people work most often on projects with other people (New South Wales BOS 2003a, p. 24). These omissions partly explain the absence of collaboration in the students' reports of their learning in IST in NSW, but they also reflect the rarity of collaborative learning in secondary schools in general.

The problem of 'theory' (and the textbook solution)

The copyright essay mentioned by girls at Budgerigar was mobilised later in the focus group interview to demonstrate the tedium of some of the work — particularly what they call 'theory' — that they have completed in Year 10 IST. The following comments raise further issues about the nature of assessment as well as how the syllabus has been implemented in their classrooms.

Student: I don't like the theory.
Interviewer: What's the theory?
Student: Like we get a heap of work and we have to write full essays but.
Student: Having to do 700 word essays on copyright — I don't see the point. Not 700 words, it's like 20 pages worth of just stuff about copyright. Like I understand a little bit but …
Student: I think if we understand the basics of copyright then we should be right.
Student: Yeah but we had to go into like every little detail all about copyright. Stuff like that. I don't see the point.

Neither the IST syllabus nor its supporting document mention 'theory' as a discrete focus, yet students at this school and others use the term 'theory' in a familiar and normative way to refer to particular types of learning activities. The syllabus identifies core topics that must be covered, such as *Core topic 5 'Issues'* which includes

copyright. However the document is emphatic that 'core content cannot be taught in isolation: it must be integrated with options in the form of projects' (New South Wales BOS 2003a, p. 15). These 'projects' are defined as 'organised series of activities to design, produce and evaluate information and software technology solutions for an identified need or problem … [which] should be relevant to student needs and interests and address real-world problems' (New South Wales BOS 2003a, p. 15). According to student reports of their learning, the copyright essay seems not to fit this directive from the syllabus. However the syllabus does include 'essays' amongst a long list of assessment tools, including 'documentation, portfolios, log books, surveys, questionnaires, evaluation reports, documentation of solutions, plans, storyboards, documentation of experimental work, field trip reports, interviews and essays' (New South Wales BOS 2003a, p. 58). In relation to copyright and the ethical dimensions of technology, the syllabus guidelines suggest that students themselves 'use a variety of sources (e.g. computing magazines, the Internet and newspapers) to find articles and case studies that they 'discuss' and that they may then use to write 'a data policy document for a doctor's surgery' (New South Wales BOS 2003e, p. 23). This is a clear example of how 'theory' can be contextualised in a project paradigm with links to the wider world. However, students at Budgerigar High, who were united in their distaste of the copyright essay, did not seem to have acquired knowledge of the relevance of copyright law to the real world. They did not report their own processes of researching problems associated with copyright or of using a range of sources for their essays. Notably, although a medium-sized rural s chool subject to similar conditions to those of Currawong High, Budgerigar was one of the schools selected to participate in the GaIT project because of its relatively high enrolment of girls in CIT subjects at the time the project began. Yet none of the girls in this high interest focus group, all of whom had completed the elective successfully in Year 9 and 10, planned to go on to enrol in Year 11 and 12 CIT subjects at this school; though one student was moving interstate and was open to further CIT studies there. Other students did not elaborate on their decision — they stressed, however, that although they see computers as diffuse and relevant to working lives, for their own chosen professions (club/hotel management, chef, interior design, childcare) they would need to pursue different subjects in Year 11 and 12.

The next school that I turn to is Magpielarks High School where the girls also stressed their abhorrence of 'theory'. Magpielarks is an urban high school with a low non-English speaking background population and high socioeconomic status. The school is characterised by its low enrolments of girls in CIT subjects. The new IST syllabus has also been fully implemented at Magpielarks. The girls in this focus group had self-identified as relatively 'high' interest within their school, however an evident attrition of girls from the subject was clear here as well. Though each of them had done some CIT study from Years 9–11, they had all dropped out at various points along the way. They were explicit in their naming of theory as a direct cause

of them losing interest in the subject. They claimed that the subject might be made more appealing to students if the theory was reduced. In their talk they set up a binary between practice and theory which privileges theory as prerequisite to 'practical' work:

Student: And also not to make it very theory-based. Theory-based is boring because, what are you doing? You're just using a textbook and copying down notes and that's not really …

Student: But you understand you've got to have some theory …

Student: Yeah we understand that you need to have theory to progress on to the practical but …

Student: If it was more practical based I'm sure a lot of people, a lot of other people would join …

Here the students' elaboration of what 'theory' entails locates the textbook at the centre of this aspect of their learning.

Student: Copying …

Student: So there were computers in the textbook we use that are no longer in existence in today's society and who want to learn about the biggest units.

Student: We're talking about supercomputers … and none of us.

Interviewer: It needs to be updated?

Student: There needs to be more relevance to today's world. I mean if it was, I'm sure a lot of people would take it.

The syllabus does not mandate nor recommend the use of textbooks; however, the combination of designated and clearly separated 'theory' and 'practice' lessons has a long tradition in many more practically-oriented school subjects. Theory was also mobilised as a descriptor by teachers we interviewed; though, this was more often in the context of the senior CIT subjects.[9] The syllabus does recommend 'research' in a number of contexts, beginning with the *Core topic 1 'Design, produce, evaluate'* where students should 'use electronic communication to research data relevant to solutions' (New South Wales BOS 2003a, p. 18). In Stage 5 (Year 9 and 10), for example, students should 'analyse problems and initiate independent research. They ethically acquire and manipulate *a broad range of* data sources when solving problems' (2003a, p. 52, [italics added]). The wording of this outcome statement makes it unlikely that any singular source, such as a textbook, could enable such research. Textbook-based 'copying', as described by the girls we spoke to, will not meet the desired outcomes for the subject. The textbook industry is pervasive and persuasive, however, and textbooks have been designed and marketed explicitly to meet the new syllabus. For example, Grover et al.'s *Information and Software Technology: A Project Based Approach* (2004) was published in time for syllabus

9. See Chapter 5 by Catherine Harris for further discussion of binaries of theory/practice and academic/practical.

implementation in NSW with the claim that it 'isn't based on previous texts written for the old Computing Studies syllabus' and that it 'covers the varied content of the course in a straightforward and concise manner' (Pearson Education 2007a). The textbook is supported by a companion website (Pearson Education 2007b) which includes multiple choice 'quiz' questions and comprehension questions on each chapter of the textbook, and a companion Teacher's Guide which offers a range of ready-to-use assessment tools to generate results for individual students. Nowhere does the IST syllabus feature the sorts of assessment tools, tests, exams, multiple choice quizzes or other comprehension tasks that are provided with the textbook. These students did not tell us which textbook they used (though this is the most likely one), nor did they mention how they were assessed, nor can we be sure that 'copying' is an accurate representation of their engagement with the textbook content, but their comments draw attention to this important element of the pedagogic assemblage — the textbook — and to the commercial context of schooling and the textbook industry. Where schools have invested in textbooks (and a class set of 20 of these would cost the school just under $1000), they must be used in classrooms. Where parents have paid $46.95 for a copy of this new textbook, they will demand that it be used. Although the textbook may appear to be tailored to fit the outcomes of a particular syllabus, it may also mitigate against the appropriate pedagogy for that disciplinary area.

Boring/interesting

Beyond the designation of theory in particular as uninteresting, many of the girls we spoke to labelled the entire domain of CIT as 'boring'. Notably these were often girls who had enrolled by choice in the Information and Software Technology elective in Year 9 and 10. At Magpielarks High the girls in the focus group had been selected for interview because of their relatively high interest in CIT. However, they reported a falling off of their interest in the subject during the elective. Although they named theory and textbooks as contributing to the construction of the subject as boring, the girls also explained their disinterest in terms of gender:

Student: A lot of us were, when we were in Year 9 and 10, we actually wished in our class, actually wanted to be in the IT field but after a while the interest level just dropped …

Student: When I started doing [IST] … technically I was very interested in that sort of area but then …

Student: … my mum told me it's really hard for a woman because it's such a male dominated thing. That and the interest levels completely dropped in Year 9, after Year 9, 10. I was, so many girls were doing computing last year they said that if they had to do it again they would completely kill themselves because it's that boring.

Student: Completely.

Despite the hyperbole, the girls' elaborations of the sorts of learning experiences they had in the elective describe quite a different approach to the essays, copying and textbooks already mentioned. In the following exchange, the students constructed their enjoyment of the learning experience in terms of a set of binary oppositions between boring/interesting or boring/creative in terms of hardware/software, and 'pulling apart'/'out there doing it'. They expressed a very clear preference for the latter term in each pair, but they located their classroom experience of the elective at Magpielarks in terms of the first in each pair. That is, rather than reflecting the students' preferences for creative and software-based applications that get them 'out there doing it', the elective focused increasingly on hardware and 'pulling apart'.

Student: Even if you have a hot interest … I was using computers but I don't really care like what makes them tick.

Student: It gets down to the little parts of the computer thing like at the end of Year 10 Computer Studies …

Interviewer: So you don't like the pulling apart bit?

Student: Yeah.

Student: Well basically at the end of Year 10 what we were doing we were almost wrecking stuff in the computer.

Student: Mother boards and that.

Student: We were always … breaking it into half and actually figuring out …

Student: … If you do computing in Year 9, 10 they've got to make it interesting enough for the kids to want to go to Year 11 and Year 12 not make it interesting at the beginning and then in the end make you drop dead bored.

Interviewer: What would make it interesting?

Student: Photoshop. [Laughter] …

Student: Doing the creative side of computers is great …

Student: Out there doing that instead of pulling apart a computer.

Together the girls at Magpielarks produced several intriguing discursive turns that suggest much more is going on than a mere misapplication of pedagogy. The girls worked hard to reinforce each other in their elaborations of what is 'relevant', and what is not, and of what is 'practical' and what is not. Skills which might appear to be eminently 'practical' to outsiders — being able to pull apart, repair and rebuild a computer — and which relate to *Core topic 4 'Hardware'* of their Syllabus (New South Wales BOS 2003a, p. 21), were dismissed by these girls as uninteresting and uncreative in relation to the fun that could be had with Photoshop. In contrast, at Budgerigar High these were the very features used by the girls to establish their high levels of competence with CITs. One of the girls had been on the school 'techie team' and another had built her own computer at home. Although applications still dominated their talk, they stressed their enjoyment (in Year 9) of learning 'all

the tags' and 'extra stuff that you don't get from Front Page and that' and using Notepad for web design which might be more difficult and 'much slower' but was more interesting. They stressed how their superior knowledge of applications advantaged them in other subjects, including History and English, and outside class as they are able to apply the 'tricks' they have learned and to make more effective use of computers in their homes. They also noted that gaining confidence and learning how to take risks have been important to them through and beyond their IST studies.

Instances were also found of explicit attempts by teachers to provide 'girl friendly' learning activities in CIT in order to increase student engagement in the subject. The high interest girls at Honeyeater High, a well equipped large urban school, prompted each other to remember enjoyable activities completed in the CIT elective:

Student*: And didn't you do that face thing as well? Where you have to like see yourself 10 years later?

Student: Oh we made, like we had to draw, use a program to make and draw a picture.

Student: That was more recent.

Interviewer: A picture of what?

Student: Oh we had to, like, it was a love theme thing.

Interviewer: Love theme?

Student: Yeah. You just had to pick a picture and draw it — in big love hearts.

Interviewer: Oh, okay. Mm, that sounds interesting.

This brief description of an image-manipulation activity meets outcomes from *Option 2 – 'Digital media'*. This teacher appears to have taken up the syllabus recommendation that activities should appeal to the needs and interests of students by developing an activity with a feminine slant — 'a love theme thing' — that was perceived positively by these female students. Although descriptions of the activities remain vague, the comment of the student marked with an asterisk above, who did not do the CIT elective but was able to prompt another girl about its content, suggests that news travels beyond the confines of the IST classroom. Even the interviewer (to her surprise in retrospect) entered momentarily into this pleasure with 'Mm, that sounds interesting'. Although not enrolled in CIT, three girls in this group recalled that, back in Year 8 their class (only) in the compulsory Computer Studies unit, they had spent an entire term on multimedia, mainly using Illuminatus™. The girls were enthusiastic about this experience and their teacher, and they appeared confident about their competence; although, none of those who spoke had selected IST as an elective in subsequent years. Although they did not continue with IST they agreed that all subjects in their school have some relation to computing. Design and Technology in particular made extensive use of computers, and even in Dance students choreograph some of their work using a computer program.

Their responses suggest that, although negative experiences with CIT pedagogies may be disincentives for future interest and enrolments, neither do positive experiences necessarily translate into enrolments in CIT subjects. The Head Teacher for Teaching and Learning at Honeyeater High School, responsible for CIT, Multimedia and Industrial Arts, stressed that she is:

> trying to get staff to see that it's now part of their everyday life. It's not something extra … like in languages we're doing webpage design and they're doing PowerPoint in the junior school. Keeps us seeing it more as a design-based activity rather than 'let's learn computing'.

At this school, technology infuses the curriculum much more broadly and the teacher's comment suggests that a design-paradigm is central to its take-up in all subjects. The dilemma at this school is whether a place still exists for a stand-alone computing subject in school and how that subject might be differentiated. Her words reflect the discursive slippage that has arisen through our project between diffuse cross-curricular information and communication technologies and dedicated CIT subjects, such as the Information and Software Technology elective in Year 9 and 10. In the focus group interviews, students move readily back and forth between discussion of dedicated CIT subjects and discussion of their broader use of information and communication technologies. They tend to lack recognition, or appreciation, of IST's possibilities as a distinct discipline-based curriculum offering. This resonates with Downes' discussion in Chapter 4 of the discontinuity between the instrumental literacy-focused purposes of CIT education in the junior years and the discipline-based purposes of CIT subjects in the senior years of schooling. Honeyeater was included in the project as a school with 'low enrolments' yet the teacher notes that enrolments have been increasing in multimedia subjects throughout the school where students 'use the software as a tool rather than where they … learn about the tool'. Although elements of the *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a), such as *Core topic 4 'Hardware'*, cannot be comprehensively addressed in other subjects in Year 9 and 10, our interviews suggest that there are some schools where girls and boys are using computer applications across a wide range of curricular contexts in sophisticated and complex ways.

Student interviews discussed in this section suggest that perceptions of the subject, from 'within' as it were, are not as positive as we might have expected from 'high interest' girls in schools implementing the new *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a). Indeed, rather than engaging the interest of girls in more CIT studies, the snapshots that the interviews provided seem to indicate that studying the CIT elective might — in some instances — even diminish their interest. In a context where teachers and faculties must compete for students and for a dedicated niche in the curriculum, this should be cause of great concern for those with investments in a dedicated CIT subject area. This suggestion is reinforced by work conducted elsewhere. Preliminary findings

from a parallel Queensland-based Australian Research Council project indicate that girls in Queensland experience middle school CIT subjects as overly structured, uninspiring, disconnected and purposeless (Anderson et al. in press; Timms et al. 2006). The notion that CITs are 'boring' for girls, both as experienced at school and as projected into future professions was a dominant theme in the Queensland research.

In terms of pedagogies that are advocated for CIT education, particularly the 'project-based learning' detailed in the IST syllabus and supporting document, student comments suggest that the pace of change is slow. None of them reported any of the exemplary project designs described in the syllabus documents. Students did not recognise how distinct and separate activities (e.g. the copyright essay) contributed to anything larger or might be in any way 'project' oriented or problem-based. There is little evidence in these fragments of commentary of the 'integrated learning experiences, instruction and assessment' that the *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a) recommends. If these students were working within a project-based pedagogy where learning experiences, instruction and assessment were integrated, they seemed to be unaware of it, or to consider it not to be so different (or engaging) as to warrant comment. Overwhelmingly, students indicated that they work individually, rather than in project teams. Although the syllabus rationale stresses that 'experiential and collaborative tasks' are central to the subject, this is not reinforced throughout the remainder of the document (New South Wales BOS 2003a, p. 8). This may be exacerbated in NSW with its well-entrenched penchant for formal testing as the measure of learning. Assessment regimes in secondary schools are weighted towards generating individual results, and therefore are often taken up as though they dictate solely individual learning experiences.

Conclusion

This chapter has looked at the state of play in the implementation of the *Information and Software Technology Years 7–10 Syllabus* (2003a) from the point of view of female students who have had some experience in the subject. It has raised a number of issues based on how these students perceive and report on their learning experiences in IST classes. The responses discussed in this chapter suggest that the girls in our study, in a variety of schools, have tended to lose interest as they progress in the subject. They express clear preferences for certain types of activities — particularly those they call 'creative' which often involve software applications — over others. Rather than representing innately gendered aspects of girls' interests, however, this chapter argues that female students are 'put off' the subjects by a number of factors that include ambiguity and inconsistency in IST implementation. Theoretical insights explored in this volume, including Downes' curriculum framework (Chapter 4) and notions of teachers as bricoleurs and curriculum as assemblage (Honan 2004a, 2004b), deflect critique away from simplistic blaming

of teachers or of the syllabus. Characterising teacher practice as 'resistance to change' neglects to address the context of practice, the points of view of teachers and the effects that they have as active agents (Lynch 2003, n.p.). The new syllabus appears to embed good practice in CIT education in its design and framing.

Elements of Nielsen and Von Hellens' call in the *Real Time* (1999) report for schools to simulate 'the types of work and work situations' of the real world in CIT curriculum appear to be partially met in the *Information and Software Technology Years 7–10 Syllabus* (2003a) in NSW. However, a number of factors mitigate against its potential for changing classroom pedagogy. The 'networked and organic' structures of industry require 'collaborative rather than individualistic technologies' (Taylor, Nielsen & Von Hellens 1999, p. 259). Yet individualistic assessment regimes and learning experiences continue to be the norm in NSW schools. The syllabus itself appears to be ambivalent about the centrality of collaboration to project work. The syllabus is fairly new and the professional development opportunities attached to it have been erratic. Some of the teachers we spoke to were on the teams that wrote this and other CIT syllabuses, whilst others were isolated and have had to adapt the new syllabus to familiar pedagogical practices and available resources. Investment in textbooks and practices surrounding their use may also impact upon classroom pedagogies. The Computer Skills Test and a range of other factors are contributing to the increased use of information and computing technologies across the curriculum. Particular technology-oriented subjects (e.g. Multimedia) also take up enrolments in some sites and may mask the problem of student enrolments and experiences. In some schools where low enrolments are indicated for CIT subjects, the numbers of girls enrolling in other technology-dependent subjects may be high, but these numbers do not mitigate the problem of low enrolments in the CIT discipline-based subjects discussed by Downes.

Classroom pedagogy emerges in an assemblage of practices that includes syllabus documents and directives, policy and professional development, textbooks and other resources, teachers' individual career trajectories and interests, school organisation and capacities, and assessment regimes in local and state contexts. Although my intention when I first sat down to write this chapter was to ascertain how the new pedagogies of the *Information and Software Technology Years 7–10 Syllabus* (New South Wales BOS 2003a) impact on students' perceptions of the subject, the comments of the girls we spoke to suggest that they are not consistently experiencing the project-based pedagogy as envisaged by the syllabus writers, or recommended by industry and researchers. This makes it impossible to venture any evaluations of that pedagogy and how it might impact on particular groups of students, including girls. Girls in the IST elective suggested that they dislike the 'all individual' mode around which their teaching and learning is structured yet research suggests that girls particularly enjoy working with each other in CIT contexts (AAUW 2000; Margolis & Fisher 2002). Future work might focus on bringing collaboration to the centre of the project-based pedagogies underpinning

Information and Software Technology and other CIT subjects. Although this chapter concentrated on a particular curricular site, the issues raised resonate outside NSW and Australia and they invite analysis of pedagogic assemblages — including mandated curriculum — in other sites. As well as the specific details about that subject that the girls in this chapter provided, their comments also indicate that perceptions of CIT continue, at times, to be ambivalent and complicated by gender-inflected readings of what is creative (and not), what is interesting (and not) and what is practical (and not). ■

APPENDIX

Participant school profiles by female participation, socioeconomic status and location

School pseudonym	Female participation in CIT[1]	Socioeconomic status	Location
New South Wales schools			
Bowerbird High School	High	Low	Rural
Budgerigar High School	High	Medium	Regional
Currawong High School	Low	Medium	Rural
Fairy Wren High School	Low	High	Rural
Frogmouth High School	Low	Medium	Rural
Galah High School	High	High	Metropolitan
Honeyeater High School	Low	Medium	Metropolitan
Lorikeet High School	High	Low	Metropolitan
Magpielarks High School	Low	High	Metropolitan
Plover High School	High	Low	Metropolitan
Rock Dove High School	High	Low	Metropolitan
Yellow Robin High School	High	Low	Rural
South Australian schools			
Calcite High School	Low	Medium	Rural
Copper High School	Low	Low	Regional
Dolomite High School	High	Medium	Rural
Lava High School	Low	Low	Regional
Mount Quartz High School	Low	Medium	Regional
Opal College	Moderate	Medium	Metropolitan
Sediment High School	Low	Medium	Metropolitan

1. Because of the low overall percentage of girls enrolled in senior CIT subjects in Australia, a Year 12 participation rate above 40% was described as *high*, while a rate between 20% and 40% was considered *moderate*, and a rate below 20% was considered *low*.

School pseudonym	Female participation in CIT[1]	Socioeconomic status	Location
Victorian schools			
Angelfish Secondary College	Low	Low	Metropolitan
Bandicoot Secondary College	Low	High	Regional
Black Mare College	Low	Medium	Regional
Crocodile Secondary College	Moderate	Low	Rural
Dragon Secondary College	Moderate	Low	Metropolitan
Otter College	Low	Low	Rural
Sheepdog Secondary College	High	Low	Rural

LIST OF ACRONYMS

AAUW	American Association of University Women
ABC	Australian Broadcasting Corporation
ABS	Australian Bureau of Statistics
ACM	Association of Computing Machinery
ACT	Australian Capital Territory
ARC	Australian Research Council
BOS	Board of Studies
CIT	Computing and Information Technology
CPU	Central Processing Unit
CRT	Casual Relief Teacher
CSF	Curriculum Standards Framework
DET	Department of Education and Training
DETYA	Department of Education, Training and Youth Affairs
ENTER	Equivalent National Tertiary Entrance Rank
GaIT	Gender and Information Technology research project
HSC	Higher School Certificate
ICT	Information and Communication Technology
IPM	Information Processing and Management
IPT	Information Processes and Technology
IS	Information Systems
IST	Information and Software Technology
IT	Information Technology
K–12	Kindergarten to Year 12
KLA	Key Learning Area
MCEETYA	Ministerial Council on Education, Employment, Training and Youth Affairs
MSN	Microsoft Network
NSW	New South Wales
P–12	Primary to Year 12
pITA	Perceived Information Technology Ability
SACE	South Australian Certificate of Education
SD	Standard deviation
SDD	Software Design and Development
SES	Socioeconomic status
SMET	Science, Mathematics, Engineering and Technology
SMS	Short Messaging Service

TAFE	Technical and Further Education
VCAA	Victorian Curriculum and Assessment Authority
VCAL	Victorian Certificate of Applied Learning
VCE	Victorian Certificate of Education
VELS	Victorian Essential Learning Standards
VET	Vocational Education and Training
VET-IT	Vocational Education and Training Information Technology
VP	Vice President
WinIT	Women in Information Technology Project

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