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School is out, but Numeracy is in!

**An exploratory case study of the out-of-school numeracy
practices of four Year 12 New Zealand students**

**A Thesis presented in partial fulfilment
of the requirement for the degree of
Master of Education
at Massey University**

**Meg Nicholls
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Abstract

This exploratory case study investigated the out-of-school and workplace numeracy practices of four Year 12 New Zealand high school students. Student participants were interviewed using a numeracy kit of everyday items as a stimulus for discussion about their use of mathematics out-of-school. The workplace numeracy practices of the student participants were investigated through workshadowing and stimulated recall (Zevenbergen, 2004).

Data from the case studies demonstrated that these young people involved in the Gateway programme were competent users of mathematics both in the workplace and in their everyday lives. Significant differences between school mathematics and out-of-school numeracy practices point to possible explanations of why school mathematics may not transfer to out-of-school settings. Inclusion into a community of practice, willingness to take on work for the purpose of learning and an ability on the part of the employer to offer work experiences that involve numeracy are shown to be key factors in the development of these student participants' development of competency. Workplace observations of the student participants' suggest that Lave and Wenger's conceptualisation of the "novice" may no longer apply to young people entering contemporary workplaces. A possible framework for the schools to assess the learning opportunities afforded by Gateway employers is given.

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Chapter 1

Introduction

1.1 Introduction

This research explores the out-of-school mathematics practices of four Year 12 secondary school students. The project arose out of concern over what I see as an increasing disjunction between the culture of the curriculum and the culture of senior high school students. It was motivated by anecdotal evidence that claimed that senior high school students are becoming less engaged with mathematics and that students do not see mathematics as having relevance to their lives. Part of this evidence comes from the poor retention rate of students in mathematics after Year 11 when it becomes an optional rather than core subject. As a mathematics teacher it is my feeling that our current mathematics curriculum is intended to prepare students for university and not the workplace and/or vocational training. Armed with a respect for peoples' experiences in the workplace/world, I wanted to investigate how senior students use mathematics in their work placements and in their everyday lives out-of-school. Motivation for this research also came from a theoretical interest in the concept of mathematics-as-practice, or numeracy practice, a concept akin to the more theoretically developed and researched concept of literacy practices.

1.2 Diversity of Learners

In the past the majority of students continuing on to Years 12 and 13 at secondary school were headed for tertiary education. In 1993 New Zealand raised the school leaving age from 15 to 16 years of age. Over a decade on, anecdotal evidence suggests this change has resulted in a more a diverse population of senior high school students, many of whom are staying at high

school for Years 12 and 13 with no immediate intention of studying at university. The advancement of technical expertise as a consequence, has become less critical than does the development of a capacity and disposition to apply mathematics in a range of settings.

The National Administration Guideline (NAG) 1.6 specifies that schools must provide appropriate career education for students identified by the school as being at risk of leaving school unprepared for the transition to the workplace or further education/training (Ministry of Education, 2007). In referring to teachers who care about the diversity of the students they teach Perso (2003) suggests that teachers have much to learn from their students. In conducting this research I have had the opportunity to gain an insight into the out-of-school numeracy practices of four "at-risk" students. In the reporting of this research it is intended that an "ethic of care" is demonstrated by allowing the view of the participants to come through in their own voice.

1.3 Learners in the New Millennium

It is a sobering thought that many young people today are exposed to learning processes outside of school which are richer and deeper than those they experience in schools (Gee, 2003). Gee investigated the learning principles associated with video and computer games which are a major cultural practice of young people. Here learning is based on situated practice where consequences for failure and taking risks are lowered; problems are ordered so that the first ones encountered lead to fruitful generalisations later on in the game; learning is interactive; and there are multiple routes to solving a problem. Players go online to seek and receive help and discuss strategy; there are spaces dedicated to particular games or types of games; the players orient their learning to issues of design and understanding the complexity of the game system. Such learning principles are well supported by a great deal of modern work on cognitive science concerned with how people learn best (Kirshner & Whitson, 1997). It is

speculated that such learning principles applied to mathematics would lead to an increase in students' capacity and disposition to use mathematics across a range of settings.

1.4 The Changing Face of Mathematics

Our current mathematics education system might be viewed as a reverse funnel. The narrow neck represents the narrow range of mathematics courses offered to senior students and the opposite, fanned out end of the funnel, represents the diverse range of post-school destinations students are headed for. The introduction of the National Certificate in Educational Achievement (NCEA) offers secondary schools the opportunity to be far more flexible, creative, and future-focused in the courses they offer. The question arises: how will secondary schools respond to this opportunity and how can they best prepare students for the diverse mathematical demands they face in the world beyond the school gates?

The rapid evolution of society, particularly under the influence of information and communication technology must have profound consequences for education. New developments bring new tools, concepts and ways of thinking which are increasingly integrated into everyday life. Up until now, changes in society have been more marked than changes in education (Cornu, 1999). If we are to integrate new developments into education how far should schools follow the lead of society? Are there alternative visions for the future of education? (Cornu, 1999). It may, for example, no longer make sense to require students to learn techniques that can be carried out much more efficiently and reliably by machines. To do so may restrict students to the "grammar" of mathematics at the expense of the "literature" (Mukhopadhyay & Greer, 2001). This research is not primarily concerned with developing mathematics curricula and therefore it is not my position to suggest how schools may address the issue of mathematics curricula for the diversity of senior high school students; rather it is to shed light

on how well current school and classroom practices are preparing students to meet the numeracy demands they might face in the workplace and their everyday lives.

1.5 International Adult Literacy Survey (IALS) and Adult Literacy and Life Skills (ALLS)

Up until about twenty-five years ago official New Zealand publications stated that our literacy rate was '99%'. However, this figure was based on the assumption that because most New Zealand adults had had at least had some primary schooling, if not two to three years of secondary schooling, they would be literate (Benseman, 2000). In the late 1990s a series of International Adult Literacy Surveys (IALS) was carried out within 22 of the industrialised nations of the OECD. The survey measured adults' literacy across three fields:

1. Prose literacy – the ability to understand and use information from texts such as the newspaper.
2. Document literacy – the ability to locate and use information from timetables, graphs, charts and forms.
3. Quantitative literacy – the ability to use numbers in context, such as balancing a chequebook or calculating a tip (Johnson, 2000).

Instead of defining a person as either literate or illiterate the report put literacy skills on a continuum from level one at the lowest to level five at the highest. Level three on the continuum is considered to be the point at which a person has attained the "minimum level for competence" in everyday life.

New Zealand took part in the IALS in March 1996. Results from this study provided us with the opportunity to benchmark ourselves against the other twenty-one countries which took part in the survey and to establish a baseline against which to measure changes in literacy skills in our population over time.

IALS has since been followed up in 2006 by the Adult Literacy and Life Skills (ALLS) survey - a large-scale comparative study that profiles the skills of adults in 15 OCED countries and also provides national snapshots. ALLS rated peoples' ability to deal with everyday literacy demands.

Key findings from the IALS for New Zealand were:

1. The distribution of literacy skills within the New Zealand population is similar to that of Australia, the United States and the United Kingdom.
2. Approximately one in five New Zealanders is operating at a highly effective level of literacy.
3. New Zealanders do less well at document and quantitative literacy than at prose literacy.
4. The majority of Maori, Pacific Islands people and those from ethnic minority groups are functioning below the level of competence in literacy required to effectively meet the demands of everyday life.
5. Labour force status and income are related to level of literacy.
6. Increased retention into senior secondary school appears to be associated with improving literacy levels.
7. Maori with tertiary qualifications have literacy profiles similar to those of tertiary educated Europeans/Pakeha.

[Http://educationcounts.edcentre.govt.nz/publications/assessments/adultliteracy](http://educationcounts.edcentre.govt.nz/publications/assessments/adultliteracy)

In addition to these key findings the study also found that one in five (approximately 200,000) New Zealand adults is at the lowest level on the continuum mentioned above and that a further 25% have poor literacy skills (level 2). Literacy skills were found to peak between the ages of 20 to 24 and 35 to 39 and then trend downwards after 50. The high points are considered internationally to be caused by the increase of certain literacy skills during adult and working life.

Given the poor outcome for New Zealanders in the IALS and the fact that it takes approximately 30 years for the workforce to be replaced by the next generation of school graduates, school based solutions need to be well researched before their implementation. Employers also have a responsibility to acknowledge the disparity of literacy levels of their workforce. BusinessNZ (2005) published the following statement:

Recently announced government initiatives to improve literacy and numeracy in the workplace are a useful response to currently patchy levels of literacy and numeracy that hold back productivity. Business can assist by staying engaged with skills issues, operating ongoing rather than intermittent training programmes, and taking advantage of skills-related assistance offered by government or other parties. (p. 4)

This statement demonstrates that BusinessNZ has already given careful consideration to how they might best support employees in their development of numeracy skills.

1.6 The Mathematical/Numeracy Needs of School Leavers

Mathematics is often considered the 'gatekeeper' school subject, with many tests and qualifications regulating entry into jobs, education and training opportunities. According to Gal (1992) this is an ironic understanding as the academic mathematics used as a 'gatekeeper' does not necessarily reflect the aptitudes and skills needed on the job or in life. Instead Steen (2001) argues that students require both mathematics, which he says needs distance from context, and quantitative literacy "which is anchored in real data that reflect engagement with life's diverse contexts and situations" (p. 58).

The image of mathematics socially, paradoxically, engenders a general belief in the necessity of mathematics alongside a sense of cultural aversion, which often has its roots in students' experiences of mathematics at school - a view which is subsequently promoted by public opinion and media (Cornu, 1999). School

activities need be directed at creating a willingness on the part of students to approach problems from a mathematical perspective as well as being directed at encouraging a capacity to critique mathematical applications and the use to which mathematics is put in society.

A decade ago Knight et al (1996) researched the mathematical needs of New Zealand school leavers. They listed the specific skills, required by school leavers as:

- Mental and calculator arithmetic skills

- Basic computing skills

- Measurement skills

- An understanding of everyday statistics

- Simple geometric skills

- Estimation skills

- Being able to use a variety of strategies to solve number problems

- And most importantly having the confidence and ability to use skills in everyday real life situations

At first glance these skills appear well aligned with our current mathematics curriculum. However, it is debatable whether our current curriculum allows time for students to be given adequate opportunity to apply newly learned skills to a range of new contexts. Such opportunities are important if students are to leave school prepared to face previously un-encountered challenges. This issue of the application and transferability of mathematics will be taken up further in the next chapter.

1.7 New Zealand Research and Initiatives in Transition to Post-secondary School Destinations

Little information is available on New Zealand students' experience of vocational education and training in secondary schools and their transition to post-secondary school destinations (see section 1.9). However, the "Education Employment Linkages" (EEL) collaboration between the New Zealand Council for Educational Research (NZCER), Lincoln University and Victoria University of Wellington is exploring the issue of how formal support systems might best help young New Zealanders to match education choices and employment outcomes to benefit themselves, their communities, and the national economy. This project has been funded by the Foundation for Research, Science and Technology from 2007 to 2010.

The "Careers Education Systems in New Zealand Schools Survey" conducted by Vaughan and Gardiner (2007) feeds into the EEL project. This study aimed to provide insight into the future direction and focus of careers education in New Zealand schools. Results from this survey form baseline information about how schools currently organise career education.

Other initiatives and projects in the area of transition include:

- The Creating Pathways and Building Lives (CPaBL) initiative. It aims to reorganise careers education and help schools to implement careers education as part of their curriculum. CPaBL is aimed at building a school-wide approach to career education. The programme builds on the pilot programme, Designing Careers, which was introduced to 75 secondary schools in 2005. Through provision of career information, advice and guidance within schools, CPaBL aims to assist students in making a smooth transition from school to further training and employment.

- The Secondary-Tertiary Curriculum Alignment Project at Manukau Institute of Technology. This project is funded through the Innovation Development Fund to conduct a national project on secondary tertiary curriculum alignment. The project started in 2002 and aims to create barrier free pathways from secondary schools into tertiary studies. Schools and local technical institutes negotiate alignment to ensure that there is a good fit between the two institutes and future employment. This helps to facilitate the movement of students from one level to the next without experiencing gaps or overlaps in their education. This project has expanded to include 4 technical institutes and their local schools. An example of a programme which has arisen as a result of this research is the SmartPaths Marine Studies – Bay of Plenty Polytechnic's marine studies curriculum alignment programme delivered to Year 13 Biology classes at Mount Maunganui College, Otumoetai College and Whakatane High School. Success of the programme was demonstrated when over half of one schools' Year 13 class enrolled for further studies in marine biology at tertiary level.
- The Secondary Tertiary Alignment Resource (STAR). This initiative provides all state secondary schools with additional funding to access courses that provide greater opportunities for students. The objective of STAR is to enable schools to better meet the needs of students by personalising learning pathways and facilitating a smooth transition to the workplace or further study.

1.8 Gateway

Of particular relevance to the research project at hand is The Tertiary Education Commissions initiative, Gateway. The scheme involves high schools from decile 1 - 6 and has been in operation since 2001. Gateway was designed to enable secondary school students to undertake formal workplace learning whilst

continuing to studying at school. One of the main objectives of Gateway is to enhance partnerships between schools and local businesses. Schools receive funding to ensure that students educational and subsequent employment needs are met.

Structured workplace learning set in an actual workplace over a sustained period of time (usually one day a week for the school year) is integrated with clear objectives about the knowledge and skills to be gained, and involves the assessment of achievement and/or unit standards. Students continue with their general education on the other school days of the week. This programme dovetails with Modern Apprenticeships and the National Certificate of Educational Achievement, providing recognition of a broader range of achievement.

The benefits of Gateway are threefold: (i) senior students in Years 11 to 13 are provided with the opportunity to gain specific vocational skills and many students make significant progress towards qualifications, (ii) business benefits through the opportunity to gain more effective and efficient recruitment, which can increase productivity and enhance the company's skills base, and (iii) schools benefit by gaining greater credibility with local communities through their leadership role in easing the transition beyond the school gate.

An evaluation of Gateway shows that the programme has been particularly effective for transition into employment, apprenticeship, and further training as well as for retaining students in secondary school. Integrated school-workplace learning has been shown to provide an effective learning environment for senior students and workplace learning can reinforce and extend students' school-based study (Tertiary Education Commission, 2003).

1.9 Numeracy in Vocational Education and Training

A range of vocational qualifications is now being offered to secondary school students. These courses attempt to motivate students by being vocationally centred. Here mathematics underpins both general skills and more specialised skills depending upon the course. Students taking these courses have chosen not to study 'academic' mathematics; rather mathematics is seen as being of value to their chosen vocational studies. The role of mathematics in these courses is every different here than it is in the traditionally offered senior school mathematics courses (Williams et al., 1999). It is reasonable to speculate that the workplace mathematics for students entering the workforce directly after school will be different, though not necessarily, easier than for those who go on to higher education before entering the workplace. Inclusion of workplace and everyday mathematics does not necessarily mean a reduction in the depth of content covered by the curriculum. On the contrary, it is speculated that contexts give students the opportunity to increase their depth of knowledge and raise their level of conceptual understanding.

1.10 Research Objectives

The transition from dependent student in the classroom to workplace employee is an important milestone in all young people's lives. However, the shift from initial formal education to work no longer implies the front-end loaded model of education. It is increasingly common for working life to be interspersed with periods of training, and for the workplace itself to become a place of learning. It is therefore important that we equip our young people with the skills and attitudes required for them to become life long learners.

This research broadly aims to extend the knowledge that we have about how students develop knowledge, skills and attitudes required by life in the 21st

century. Over the past decade researchers have become increasingly aware of the need to talk and listen to students in order to understand their unique perspectives (for example, Ruddock & Flutter, 2000; Young-Loveridge, 2005; Young-Loveridge & Taylor, 2005; Young-Loveridge, Taylor, & Hawera, 2005). It is these perspectives that are sought in the research at hand. Specifically, this research aims to explore the extent to which students' "school maths" is aligned with students' "out-of-school" numeracy practices, how students develop mathematical competence in the new contexts such as in the workplace, and how schools best support students' numeracy development in preparation for the transitions that they face.

1.11 Choice of Method, Data Collection and Analysis

Descriptive case study methodology, using multiple strategies to gather data was employed. Data gathering included "Work Shadowing" (Zevenbergen, 2005). This research method involved the researcher following participants at work and taking photographs over a period of several days. The photographs were then used to discuss work related numeracy practices in a way that did not pre-empt the participants' responses. Participants were also interviewed using a kit containing everyday materials to stimulate discussion about everyday numeracy practices. This technique was developed by Johnston et al. (1997) to provide a non-threatening, non-judgmental way of gaining insight into how young people use mathematics in their everyday lives. Employers and teachers involved in the vocational education of the participants were interviewed and the mathematical content of participants' vocational course work was examined.

This eclectic approach to data gathering was undertaken in order to develop a multi-dimensional view of how the participating students use mathematics outside of the classroom. Workplace shadowing allowed me to observe first hand how the students used mathematics in the workplace. Informal interviews with students, employers and tutors/teachers meant that I was able to triangulate data

collected from students, thus strengthening the reliability and validity of the research findings. Interviews using everyday items allowed students to share how they used mathematics in their lives outside of school and this enhanced the study by providing a glimpse of how the students coped with the mathematical demands they faced outside of school.

1.12 Chapter Overview

Chapter 2 analyses some of the research which provides the conceptual basis for how I understand mathematics or numeracy in this project. The studies reviewed contribute to an understanding of workplace numeracy training and practices, mathematics as social practice, situated cognition and the transfer of learning of mathematics. The literature examined is drawn mainly from North America, South America, the United Kingdom and Australia.

Chapter 3 discusses methodology and the research design including the details of the data gathering techniques employed. Justifications of the research design and data collection methods are also provided.

Chapters 4 and 5 report on the findings of this exploratory study. Chapter 4 presents detailed results and some analysis of the four case studies. Chapter 5 discusses the extent to which students' out-of-school numeracy practices were observed to align with our current mathematics curriculum and the mechanisms which were seen to facilitate students' transfer of mathematical knowledge and skills across contexts. Implications from the research in terms of how schools can best support students' development of transition numeracies are also discussed.