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RESEARCH REPORT

Investigating the 'crisis': production workers' literacy and numeracy practices

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Australian Government

Department of Industry, Innovation
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About the research

Investigating the 'crisis': production workers' literacy and numeracy practices

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In recent years in Australia there has been a renewed focus on the issue of literacy and numeracy in the workplace. This has been led, in part, by the 2006 Adult Literacy and Life Skills Survey, conducted by the Australian Bureau of Statistics (ABS), which indicated that around half of Australia's adult population had literacy and numeracy skills at levels 1 and 2 (on a five-point scale), levels typically seen as insufficient to enable an individual to fully participate in the modern economy. Both national and international research have also demonstrated a positive relationship between increasing literacy and numeracy skills and labour market outcomes, such as better employment opportunities and higher wages. On the basis of these findings and surveys of employers' views, key industry groups, such as the Australian Industry Group, have advocated greater investment in addressing the low literacy and numeracy skills of Australian workers.

This research provides an interesting perspective on this literacy 'crisis' by focusing on the workers' views of the extent of literacy and numeracy they require to undertake their jobs. Using an ethnographic approach, production workers in three manufacturing companies moving to lean production processes, along with their managers and trainers, were interviewed and observed. Manufacturing was chosen as it generally has a lower proportion of workers with formally recognised skills, while lean production is seen as requiring higher literacy and numeracy skills.

The key message from this research was that improving literacy and numeracy as a means for improving productivity was not considered necessary by workers, trainers and managers. Their general view was that tasks were done proficiently and there was no evidence to support the view that the workers' literacy was inadequate.

This does not mean that improved literacy and numeracy would not be beneficial; for example, improved literacy may well help workers to better understand their workplace rights and provide greater opportunities for leadership roles and greater labour mobility.

Tom Karmel
Managing Director, NCVET

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Executive summary

In Australian Government reports, as well as those of industry, skills and media organisations, there is a consistent message that many workers lack literacy and numeracy skills, which in turn leads to lower productivity levels in workplaces. Evidence for these low skills is provided mainly through the findings of large-scale adult literacy and numeracy surveys, such as the Adult Literacy and Life Skills Survey conducted by the Australian Bureau of Statistics (ABS; 2008), and also through surveys of employers' perspectives on their workers' literacy and numeracy. Some commentators and researchers refer to the extent and implications of these low literacy and numeracy skills as a 'crisis'.

The aim of this research was to investigate this crisis more closely. Using an ethnographic approach we examined literacy and numeracy as social practices (workplace practices in this research), rather than generic skills. We were interested in the ways in which literacy and numeracy were embedded in workplace practices and how workers managed these practices in their everyday work, rather than in their skill levels, which could be demonstrated on a standardised assessment. The following research questions guided the research:

- What are production workers' literacy and numeracy practices in manufacturing workplaces?
- What are the various perspectives of production workers, trainers, supervisors and employers, on the literacy and numeracy practices, problems and issues involved in production work in competitive manufacturing?
- How do production workers experience learning in their training programs and on the job?

The research aimed to identify insights from the findings that could form the basis of recommendations for improving how literacy and numeracy practices might be learnt and managed by production workers on the job and in training.

Production workers in manufacturing companies transitioning to lean production processes were the focus of this study, a focus largely due to the documented lower overall levels of manufacturing workers' formally recognised skills (compared with the Australian workforce as a whole). We also received advice from the relevant industry peak body that the shift to lean production resulted in the need to improve the literacy and numeracy levels of workers. In Australia, the term 'competitive manufacturing' is often used interchangeably with 'lean' production and describes a highly influential form of workplace organisation which derives largely from Japanese production methods. Increased efficiency, involving the ongoing reduction of resources, surplus production and stock, and waste, is the aim of this approach. Three manufacturing companies at different stages of introducing lean processes were chosen as sites for research. Each company was visited multiple times by the researchers to observe workers perform their work roles and to conduct semi-structured interviews with workers, managers and trainers. The interviews focused on identifying literacy and numeracy embedded in workplace practices, how literacy and numeracy practices at work were perceived by the workers, trainers and managers in the three companies, and what approaches to training were being adopted.

The observations and interviews revealed that literacy and numeracy were highly embedded in the various work practices. Job cards, for example, were a key workplace text common to all three companies and integral to efficient production. All workers used job cards, although for most workers this involved a routine with familiar textual features, resulting in very few mistakes. In two of the

workplaces, the workers used advanced computer-aided technologies, and in these contexts the literacy and numeracy practices could be described (following research by Hoyles et al. 2010) as ‘techno-mathematical literacies’ – the integration of mathematical, textual and technological meaning-making, in which mathematical calculations were often invisible because they were deeply embedded in the computer software programs. In most cases, neither the workers nor the managers described their work as involving a great deal of literacy or numeracy. In view of the embedded nature of literacy and numeracy and the high degree of skills demonstrated by workers undertaking their specific work tasks, it was difficult to see how any literacy or numeracy training delivered separately from these work tasks could improve job performance.

In all three companies none of the workers and trainers interviewed perceived the need for improving the literacy and numeracy levels of their workplaces. Managers also generally failed to see a direct link between improving workers’ literacy and numeracy and improved productivity in their companies. Workers were performing their job tasks proficiently, despite the workers (and trainers and managers) acknowledging that in a normative sense the workers may have lacked spoken English, literacy and numeracy ‘skills’. Thus, the situation in these companies was at odds with national policy messages, which see low literacy and numeracy skills linked to low productivity.

All three companies were involved in training programs to introduce or further implement lean production processes. The training approaches were different across the three sites: in one company a limited introductory lean course was delivered only to groups of workers assessed to have literacy and numeracy needs. In another company approximately half of the production workforce and two managers had completed the Certificate III in Competitive Manufacturing, and some lean processes had been introduced across the production work. In the third company lean production training was obligatory for the whole production workforce and the lean production ‘culture’ was entrenched in the company. A taxonomy of embedded literacy and numeracy in workplace learning developed recently by Derrick (2012) was used as a framework to describe the training models in the three sites.

One area of workplace literacy and numeracy practices identified in the research was workers’ conditions of employment, an area neglected in the training conducted in all three companies and in the research literature generally. Aspects such as the role of literacy and numeracy practices in how workers understand and negotiate their employment rights and conditions rarely feature in policy messages as part of the literacy and numeracy crisis, even though, from the workers’ perspectives, these are important aspects of their work.

The insights from the findings provided suggestions for change. Adopting a social practice approach was found to uncover different types of understandings about literacy and numeracy in the workplace. As indicated, from the perspectives of workers, trainers and management little support was found for the notion of a literacy and numeracy crisis in workplaces. The study suggested that ethnographic studies, which enable a social practice approach, be considered alongside other sources for informing workplace literacy and numeracy policies. The study also suggested that social practice models of workplace learning should be supported; in particular, this related to encouraging the view that cultural and linguistic diversity in the workplace could potentially be productive assets in a workplace. Finally, the study suggested the need for highlighting literacy and numeracy related to workers’ employment conditions and rights. In this regard, the development of a ‘Workplace Champions’ program should be explored.

Context

Introduction

In this report we investigate what can be termed a literacy and numeracy ‘crisis’ in Australian workplaces, and in particular in the manufacturing sector. For many years, but specifically the last few, the message from a range of industry and employer groups and many adult literacy and numeracy organisations is that low levels of literacy and numeracy among Australian workers are affecting productivity. This is seen to be a critical issue for Australia’s competitiveness in the global economy. This human capital argument linking literacy and numeracy levels with productivity currently frames government policy in relation to adult literacy and numeracy and can be seen to be a key element of the more general ‘skills crisis’ that underpins government policy in the area of vocational education and training (VET), and indeed, all levels of education in Australia. The basis for this message of a workplace literacy and numeracy crisis mainly comes from findings from national survey data on adult literacy and numeracy levels and surveys of employer perspectives. To date, almost completely absent from workplace literacy and numeracy debates in Australia has been research which includes a focus on the perspectives of the workers themselves, whose skills are the subject of this crisis. The research for this report does just that: we use an ethnographic approach to conduct an in-depth study of three manufacturing companies at different stages of restructuring their workplaces to accommodate ‘lean’ production processes.¹ This research represents one of very few studies of literacy and numeracy in Australia to include worker perspectives. It also provides insights and alternative perspectives to mainstream understandings of workplace literacy and numeracy.

Some issues of nomenclature need to be addressed at this stage. We make reference almost exclusively to literacy and numeracy in this report, although other workplace reports refer to LLN – language, literacy and numeracy. In these reports the word ‘language’ refers specifically to spoken English, and ‘literacy’ to reading and writing in English. We have chosen to focus primarily on the terms ‘literacy’ and ‘numeracy’ because these are the key skill areas that government, industry and skills organisations identify as being in crisis (and generally literacy more so than numeracy). Nevertheless, we do include language – mainly spoken English – as a factor for analysis in our study because it features so prominently in the three companies, although we often subsume it within the terms literacy and numeracy.

The literacy and numeracy crisis

Some of the academic literature on workplace learning uses the term ‘crisis’ as a way of describing the perceptions of key stakeholders on the literacy and numeracy skills of the workforce (for example, Evans & Waite 2008, 2010; Ivanic et al. 2009; Black & Yasukawa 2011a). Certainly, there are stakeholders who make strong claims that the literacy and numeracy skills of workers represent a major problem for the productivity of individual enterprises and, more broadly, the nation’s prosperity. For example, a leading national industry organisation, the Australian Industry Group (AiG), surveyed employers and found that 75% of their respondents reported their business was affected by low levels of literacy and numeracy (2010, 2012).

¹ A description of ‘lean’ production processes follows later.

Skills Australia,² the nation's leading policy advisory authority on workforce development and vocational education and training, states that literacy and numeracy are 'fundamental to workforce productivity' (2010, pp.35–7), referring to 'the imperative' to lift foundation skills (2011, pp.113–16) in the interests of the nation's prosperity. Note that the term 'foundation skills' is now often used by industry and skills organisations and governments as a generic term to describe English language, literacy and numeracy and also employability skills (Standing Council on Tertiary Education, Skills and Employment 2012, p.2). Recognition of the need to increase the literacy and numeracy skills of Australian workers for mainly economic ends has been acknowledged in recent Australian Government budgets with substantial funding increases for workplace and jobseeker literacy and numeracy programs (Australian Government 2010). The Industry Skills Councils (2011), with their report *No more excuses*, claim there is a national urgency to address workplace literacy and numeracy issues.

Apart from the occasional employer surveys (for example, Pearson 1996; Australian Industry Group 2010, 2012), the primary source of data for these claims of low literacy and numeracy skills among Australian workers is the Australian Literacy and Life Skills Survey (ALLS; see ABS 2008), which forms part of the International Adult Literacy Survey (IALS) managed by Statistics Canada and the Organisation for Economic Co-operation and Development (OECD). The Australian survey, undertaken in 2006, shows levels of literacy according to four domains: prose literacy, document literacy, numeracy, and problem-solving, with five levels of skills within each domain (only four in problem-solving). The Australian Bureau of Statistics (ABS; 2008, p.5) reports that over 40% of the adults surveyed in the survey had literacy and numeracy levels in the lowest two levels, and they identify level 3 as the 'minimum required for individuals to meet the complex demands of everyday life and work in the emerging knowledge-based economy' (2008, p.5). The recent National Foundation Skills Strategy for Adults (Standing Council on Tertiary Education, Skills and Employment 2012, p.5) argues that literacy and numeracy training for workers would 'enhance their ability to keep up with technological changes in the workplace, retrain in other areas or change careers'. However, the arguments for higher levels of literacy are not straightforward, and recent research by Ryan and Sinning (2012, pp.39–40) indicates that non-native English speaking migrants are often found in low-skilled jobs with few literacy demands.

Manufacturing and 'lean' production

The manufacturing sector in Australia is seen to be particularly affected by the low literacy and numeracy levels of its workers, partly because this sector's workforce has a lower overall level of formally recognised skills than the Australian workforce as a whole (Manufacturing Skills Australia 2012). The sector is currently experiencing difficulties, contracting in employment terms – by around 5.7% in the last 12 months (Manufacturing Skills Australia 2012, p.2) – and suffering a shortage of skills. However, it is also undergoing major changes, with a shift to competitive (lean) manufacturing, and accommodating significant technological innovations (Manufacturing Skills Australia 2011). Reports from the sector consistently highlight the urgent need to improve the literacy and numeracy levels of production workers in order for companies to remain competitive and sustainable (for example, Australian Industry Group & University of Technology Sydney 2012; Manufacturing Skills Australia 2011, 2012).

Lean production is an important element to our study and features at different stages of development in the three manufacturing companies investigated in this report. In Australia, the term 'competitive

² Renamed in 2012 the Australian Workforce and Productivity Agency.

manufacturing' (the previous name of the industry qualification, which is now called 'competitive systems and practices') is often used interchangeably with 'lean', and describes a highly influential form of workplace organisation which derives largely from Japanese production methods (for example, Monden 1994). Efficiency is the aim, involving the ongoing reduction of resources (people, equipment), surplus production and stock, and waste. It is often characterised by a 'just-in-time' approach – producing parts in the right quantity and at the right time – and high technology and seamless production stages. It usually involves small teams of multiskilled workers who take increased responsibility for meeting production targets. Drawing on the knowledge of the teams to provide insights and suggestions for greater efficiencies, the aim is continuous improvement (Womack, Jones & Ross 1990; Nicholas 2011). Increasingly in Australian manufacturing the application of lean principles is seen to be 'at the heart of modern enterprises' (Manufacturing Skills Australia 2012, p.57), which is reflected in the increasing number of companies delivering the 'competitive manufacturing' courses developed by the peak manufacturing organisation, Manufacturing Skills Australia, and ranging from certificate III to advanced diploma level. The impact of lean changes on workers is significant, as they are expected to radically change their work practices, cooperate in teams, promote a common vision of the company, actively participate as problem-solvers, and engage in continuous training (for example, Olivella, Cuatrecasas & Gavilan 2008).

The problematic transfer of learning and skills

According to the government and industry reports noted above, having low levels of literacy and numeracy makes it difficult for manufacturing workers to engage fully with the more sophisticated skills required to work in lean production (for example, Australian Industry Group 2012, p.84). Part of the remedy is seen to be the provision of workplace literacy and numeracy programs which promote a smooth transfer of skills to facilitate improved lean production performance (for example, Department of Labour 2009). However, the research literature on the increased 'textualisation' of workplace knowledge (for example, Jackson 2000; Farrell 2006; Scheeres 2007), including compliance with quality standards (Kleifgen 2005), suggests this transfer is far from straightforward, involving complex issues of worker identity and political dynamics in workplaces.

Researchers in workplace mathematics and numeracy have also focused on the concept of transfer of skills learning (for example, Lave 1988; Harris & Evans 1991; Nunes, Schliemann & Carraher 1993; Araújo et al. 2010; Evans 2000a, 2000b). These studies argue that mathematical skills learned in one context, for example, school, cannot be assumed to transfer in a straightforward, unaided manner to new contexts. They find that in workplace contexts mathematical skills may be deeply embedded in practices that are not manifested as clearly bounded tasks or problems. Some of the research on workplace mathematics has introduced alternative notions, including 'consequential transitions' (Beach 1999), 'boundary crossing' (Hoyles et al. 2010), and 'translation' (Williams & Wake 2007) in order to describe and explain the complex relationship between the mathematical activities undertaken by a person in one context and those performed by the same person in another context. Questions of worker identity and political dynamics are also highlighted as complicating factors in workplace mathematics research (for example, Williams & Wake 2007; Wedege 2000). Recently, from their research in contemporary workplaces, including lean production sites, Hoyles et al. (2010) have suggested the term 'techno-mathematical literacies' to capture the complex embedding of mathematics into technological, particularly computer-based tools, workplaces. They argue that the skills that are needed in many contemporary workplaces are no longer captured sufficiently by the term 'numeracy' or 'mathematics'.

Alternative perspectives on literacy and numeracy in workplaces

Of interest to this report is a number of studies in the past two decades which have served to contradict elements of the policy discourses on literacy and numeracy in workplaces. Gowen (1992, 1996), for example, in early studies of hospital and manufacturing workers, demonstrated the ‘politics’ of workplace literacy, and the way management used literacy issues to privilege their own more powerful positions. Other North American studies³ and limited Australian studies⁴ similarly indicate that literacy and numeracy problems identified by employers in their workplaces are rarely straightforward. In fact, in a technical sense they are often not found to be problems at all. As Hull, Jury and Zacher (2007, p.304) in their study of Silicon Valley production workers commented:

In 4 years of documenting work at two large companies, we simply did not find literacy problems of the sort that once were popularised by the press as accounting for US failure to compete economically.

Rather, the key problems arising in workplaces and affecting productivity levels can often be seen to occur mainly in the context of relations of power, as attempts are made to change the way workers work, not just in terms of their skills, but in their identities, attitudes and motivations to work. Gowen (1996, p.26) encapsulated this point in her study of a manufacturing company in the United States, in which she wrote of the need to better understand ‘the deeply embedded power relations that drive productivity and commitment much more than literacy skills ever will’. Also relating to power relations, Williams and Wake (2007) found in their study of mathematical practices in manufacturing workplaces in the United Kingdom, that an unequal distribution of power in the workplace often restricted access to the mathematical knowledge and the basis of the deeply embedded mathematics in the ‘black boxes’ (for example, algorithms, whose mathematical basis and design principles are rendered invisible to the users) that the workers on the production floor operate. In these cases, those who were supervisors or managers saw themselves as the sole ‘keepers’ of the mathematics knowledge and withholding that knowledge from the workers was an expression of authority and control (Williams & Wake 2007, p.34).

Understanding the role and significance of literacy and numeracy in workplaces thus requires the additional perspectives of the workers themselves: what they are experiencing and learning (Foley 1999; Castleton 2002, 2006; Black 2004; Livingstone & Sawchuk 2005). Many studies of worker perceptions view literacy and numeracy primarily as social practices, building on the body of literature known as the ‘New Literacy Studies’ (for example, Gee 1990; Baynham 1995; Street 1995; Barton & Hamilton 1998; Barton 2007). These researchers focus on the many and varied literacy and numeracy practices (or literacies and numeracies) which people engage in and value in their everyday lives – and in this research, in their working lives. The social practices (that is, New Literacy Studies) view acknowledges that literacy and numeracy practices in the workplace are contingent on the contexts of particular work tasks, which are in turn influenced by the culture and politics of the workplace. Researchers such as Barton (2007) and Street (2000, 2012, pp.36–7) explain that literacy and numeracy ‘practices’ incorporate specific literacy and numeracy ‘events’ or activities linked to broader cultural contexts, showing how meanings are constructed. Examining these literacy and numeracy practices can best be achieved through the in-depth, ‘thick’ descriptions provided by ethnographic research approaches (Geertz 1975, pp.6–10).

³ See Hart-Landsberg & Reder (1995); Hull (1993, 1997); Gee, Hull & Lankshear (1996); Darrah (1996); Tannock (1997); Jackson (2000); Belfiore et al. (2004); Hull, Jury & Zacher (2007); Jackson & Slade (2008).

⁴ For example, Black (2004); Castleton (2002, 2006); Farrell (2006); Black & Yasukawa (2011a).

There are clearly tensions between the crisis messages based on a large-scale population survey of literacy and numeracy and findings from qualitative research studies in specific workplace contexts. Wolf and Evans (2011) identify the two contrasting perspectives as: ‘literacy as human capital’, linking higher levels of skills with higher levels of income and job opportunities, and ‘literacy as social practice’, viewing learning as complex and contingent on various aspects of workers’ lives. Their own research was longitudinal, spanning four years of data collection across 53 workplaces in the United Kingdom. They used a mixed methods approach and drew upon both the human capital and social practices perspectives. Their findings concurred largely with those of Ryan and Sinning (2012): that low levels of literacy and numeracy in the workplace did not necessarily impact on workplace performance or productivity. They also found that the motivation of workers to participate in literacy and numeracy programs varied across a range of factors, including their personal goals and prior educational experiences and the support they received from their employer. The type of large-scale longitudinal research undertaken by Wolf and Evans in the United Kingdom has not been undertaken in Australia.

Pedagogical models of workplace literacy and numeracy

The concept of ‘embedded’ literacy and numeracy is central to this study. ‘Embedded’ is a term used in a number of current workplace literacy and numeracy studies (for example, Derrick 2012), and is commonly used in United Kingdom vocational education and training contexts (for example, Roberts et al. 2005; Casey et al. 2006), although the conceptually similar term ‘integrated’ has often been popular in Australian workplace studies and VET contexts (for example, McKenna & Fitzpatrick 2005; Black & Yasukawa 2011b).

Recent work on embedded literacy and numeracy in workplace learning by Derrick (2012) is particularly relevant for our study. He develops a continuum of four ‘models’ of embedded literacy and numeracy in workplace learning: decontextualised, technical, situated-restrictive, and situated-expansive. According to Derrick, the first three of these models is characterised by a deficit view of learners (see also Wolf & Evans 2011 for a discussion of a deficit model of adult learners). Derrick’s (2012, p.27) ‘situated-expansive’ model reflects a social practice approach, in which literacy (and numeracy) learning ‘would be so thoroughly embedded that it is indistinguishable from organisation learning’. This model draws on Engestrom’s expansive learning theory, which seeks to explain how under certain conditions, ‘culturally new patterns of activity’ are learned and sustained by organisations and workplace teams (Engestrom 2001, p.139). The introduction of lean production processes comprises ‘culturally new patterns of activity’ in our study, and we later relate the lean training programs in the three companies in our study to Derrick’s four-model taxonomy.

Methodology

An ethnographic approach

Drawing on the research approaches adopted in many of the New Literacy Studies of workplace literacy and numeracy cited in the previous section, we use the term ‘ethnographic’ to describe our research approach. Ethnography relates to describing the everyday cultural life of social groups, providing insider perspectives (Bloomer 2012, p.9). Street (2012, p.75) describes ‘adopting an ethnographic perspective’ as allowing ‘non-anthropologists to make good use of many of the features of ethnographic methods without having to become fully fledged anthropologists’. ‘Adopting ethnographic tools’ involves using research methods favoured by ethnographers, including: observation (‘a more systematic way of watching what is going on’, Street 2012, p.76), photographs, asking questions, which are often open-ended and informal, and field notes. Most of these methods feature in our study, as we outline later in this section.

Research questions

To investigate the workplace literacy and numeracy crisis and to focus in particular on production workers, this study has the following three research questions:

- What are production workers' literacy and numeracy practices in manufacturing workplaces?
- What are the various perspectives of production workers, trainers, supervisors and employers, on the literacy and numeracy practices, problems and issues involved in production work in competitive manufacturing?
- How do production workers experience learning in their training programs and on the job?

Research sites and methods

Three manufacturing companies in two Australian states were selected for this research study. The criteria for the selection of companies included that the companies were:

- recommended by leading industry and commercial training organisations
- implementing lean production methods and training
- medium-sized companies in terms of the size of their production workforce
- willing to cooperate in a research project
- accessible to the researchers for regular visits for observations and interviews.

The process of selecting the three companies included discussions with and recommendations for follow-up from the following: the Chief Executive Officer (CEO) and staff at Manufacturing Skills Australia (MSA), which is the industry skills council representing Australian manufacturing; the CEO of a national training provider of ‘lean’ courses; and training staff from a large public VET provider. Company representatives were initially contacted by email to gauge the possibility of a research study, and this was followed by face-to-face meetings with production managers and other staff at each of the three companies to clarify the aims and methods of the research and to confirm arrangements for initial visits.

The three selected companies were diverse in a number of ways, for example, in their products and the way the companies were organised, but similar in the composition of their workforces – with workers mainly born overseas and with English not their first language. For this report we use the following pseudonyms for the three companies: Hearing Solutions, Secure Windows and Insulation Products. The specific research activities undertaken at each of the companies were as follows:

At Hearing Solutions, a company producing hearing aids, we undertook the following:

- on-site visits (six) by the research team
- observations and field notes of a wide range of the work tasks in the production areas
- attendance at team meetings (all work teams), and a diploma-level ‘lean’ training session
- in-depth, recorded and transcribed interviews with production managers (several interviews), the human resource manager, production team leaders (seven members), team members (five). Team meetings, a training session of the diploma course, and team member explanations of their work roles were also recorded
- in-depth recorded and transcribed interviews with the CEO of the company providing the lean production training course and the course trainer working with this company.

At Secure Windows, a company which produces a range of window and door products, we undertook the following:

- on-site visits (five) by the research team
- observations and field notes of selected assembly teams at work
- observations of ‘presentations’ by lean production teams to industry and training representatives
- recordings of early morning ‘tool-box’ team meetings (two)
- in-depth recorded and transcribed interviews with production managers (two), team leaders (three), and team members (five)
- in-depth recorded and transcribed interview with the competitive manufacturing course trainer.

At Insulation Products, a company which produces a wide range of gaskets and other insulation products, we undertook the following:

- on-site visits (11) by the research team
- observations and field notes of selected production areas
- observations and field notes of one literacy class, one computer class undertaken through the WELL⁵ program, and four lean production classes
- in-depth recorded and transcribed interviews with the CEO of the company, production manager, quality assurance manager, team leaders (three), team members (ten)
- in-depth recorded and transcribed interviews with the literacy/numeracy teacher, ‘lean’ course coordinator and the course trainer.

The timeframes for this study necessarily limited the amount of field work that could be undertaken at each site. Following university ethics approval and the preliminary organisational processes

⁵ WELL = Workplace English Language and Literacy.

(meetings, selecting the companies, contacting them and planning the research), the main data collection period covered November 2011 to June 2012.

While there were many informal discussions with workers and other company personnel, much of our data was obtained through recorded interviews, although this was often problematic on noisy factory floors. For the most part, interviews were conducted in training rooms, boardrooms, lunch rooms, supervisors' offices and other locations deemed suitable. While the researchers did have a series of focus questions⁶ and often the interviews commenced in a standard way (exploring the backgrounds of the workers, for example), the course of each interview varied.

Analysis

Field notes and observations collected during the site visits were not collated, but formed the basis of on-site and off-site dialogue, as findings were shared, discussed and analysed between the three researchers. Some preliminary theoretical frameworks were developed and presented at both a national VET research conference and a workplace education research forum in an international mathematics education conference, allowing peer review and feedback (Yasukawa, Brown & Black 2012a, b; Yasukawa, Black & Brown 2012). Similarly, as a process of obtaining industry and peer feedback, some preliminary findings were circulated to the members of the research project's reference group, which included industry, union and academic representatives. Preliminary findings were also presented for feedback at an industry training forum in New Zealand (Black 2012), and later formed the basis of international dialogue at a Canadian forum on workplace literacy and numeracy.⁷

The recording of interviews resulted in more than 50 full transcripts, most (70%) with workers or team leaders. Each transcript was analysed for relevant themes. Items of data, which could comprise several transcribed words or whole sections of transcribed texts, were then coded against the themes for each interview. Some of the broader categories of the many themes that emerged included: technological changes and workplace practices; lean training and production methods; how workers learnt new skills; and perceptions of literacy and numeracy practices and problems. These themes are drawn on extensively in the following section.

Derrick's (2012) taxonomy of embedded literacy (and numeracy) in workplace learning provided an underpinning framework for analysing the findings. In particular this related to the third research question, which focused on how workers experienced learning, linking this to the broader organisational approaches to implementing lean production processes in the three companies.

⁶ See appendix.

⁷ The Centre for Literacy <<http://www.centreforliteracy.qc.ca/node/1516>>.

Findings

Three manufacturing companies

The brief description of each of the three manufacturing companies that follows demonstrates the diversity in the three companies and provides a framework for a better understanding of the literacy and numeracy issues analysed later in this report.

Insulation Products

Operating for approximately 40 years, Insulation Products is a family-owned company, whose head office and factory are located in an industrial area on the outskirts of a capital city. With several sales branches in different states, the company produces custom-made insulation products for the Australian market, mainly a large variety of industrial gaskets, but also thermal and electrical insulation products. Most of these are produced using computer-aided design (CAD) and advanced computer-controlled water jets or laser cutting machines.

Approximately 70 people are employed by the company, of whom 30–35 are production workers, including supervisors. The production workforce, which is the main focus of our study, comprises predominantly male workers (only three are female), most of whom were born in countries where English was not spoken as the first language. Many of the workers are Fijian Indians and Sri Lankan Tamils. There are also workers born in Malta, India, the Netherlands, Vietnam, China, Bolivia and Chile, along with several Australian-born workers. The workforce is relatively stable in employment terms, with several workers mentioning they had been with the company for between 12 and 18 years. Each worker is in a team of between three and seven workers, with the team specialising in particular tasks (for example, stores and warehouse, cutting machines, sewing thermal blankets). The workers generally lack formal educational qualifications recognised in Australia, although a few were qualified in areas such as science/engineering (university level in one case) and accountancy prior to arriving in Australia.

At the time of the research the company was in the very early stages of introducing 'lean' production processes. The only employees in the company to receive any specific training in lean production were a group of around ten production workers undertaking part of the competitive manufacturing course. They were undertaking the course in work time for two hours per week for 12 weeks through the WELL program. All of these workers had been formally assessed as needing literacy and numeracy support. Prior to the lean course they had received separate literacy and numeracy and beginning computer classes in work time over a period of several months.

Secure Windows

Secure Windows is a privately owned manufacturer of locks for residential and commercial windows and doors, its main market being in Australia. The company has an office and factory in an industrial site in the outer suburbs of a capital city. Much of the work involves routine assembly line tasks such as inserting screws and packaging locks.

There are approximately 50 production workers, most of whom were born in countries in Southeast Asia with English not their first language. Overall there are approximately equal numbers of males and females, although female workers dominated in some assembly areas, while males dominated in other

areas such as warehouse and stores. Ethnically, the largest groups are from Laos (and there are two language and ethnic groups among the Laotians), Cambodia and Vietnam. Many had arrived in Australia as migrant refugees. There are smaller numbers from China, Sri Lanka, Fiji, the Philippines and several Australian-born workers. Some of the workers in the production sections have been working at Secure Windows for close to 20 years. Their educational backgrounds vary, but all except one of the production workers interviewed had left school early. Some of the workers had completed classes in the Commonwealth-funded Adult Migrant English Program (AMEP) when they first arrived in Australia.

Secure Windows started training workers in lean production in 2009. An external trainer was engaged, with 18 production workers, supervisors and two managers undertaking the course in competitive manufacturing. At the time of this research these 18 workers had completed their course (mainly at certificate III level) and some continued to receive support from management to apply what they had learned in the lean course and to propose and develop projects that could improve the way they work.

Hearing Solutions

Hearing Solutions is a company that produces a variety of customised hearing aids. Its Australian factory is located in a light industrial area of a capital city. Its parent company is located in northern Europe, where much of the high-level design and innovation work are undertaken. The company established its Australian office about 20 years ago, and its main function is to assemble and undertake repairs of hearing aids for its Australian clients.

The company assembles two main types of hearing aids: in-the-ear (ITE), and behind-the-ear (BTE) under three different brand names. The main production work of the factory is modelling and producing the hearing aid shells for the former to meet the individual requirements of the clients sent in from audiology clinics. The remaining components, which are inserted and assembled to produce the final hearing aid, are produced elsewhere.

The company employs approximately 60 production workers, with about equal numbers of males and females, whose tasks vary from routine manual production work to more advanced computer modelling and the service/repair/testing of hearing aids. The large majority of the production workers were born overseas and English is not their first language. The main countries of birth include: the Philippines, Vietnam, China and the Balkan states. There is little turnover of workers at the company, and many (up to 12 workers) have been at the company 15 years or more. The production workforce is divided into seven teams, each with a team leader and comprising between four and 12 members.

There are no formal education and training qualifications required to be recruited as production workers at Hearing Solutions beyond 'soldering skills, good hand skills and good eyesight' (Production Manager's comment).

For the past two years Hearing Solutions has been involved in a major training initiative – the adoption of lean production processes, involving every production worker in the company. While the company had already adopted some lean principles, the on-site lean production course enabled the principles to become embedded in workplace procedures and the culture of the company in a structured and sustained manner.

Workplace literacy and numeracy practices

In this section we address the first research question: *What are production workers' literacy and numeracy practices in manufacturing workplaces?*

Our focus is on three domains of workplace literacy and numeracy practices: firstly, the routine 'technical' work practices – the main production tasks or activities the workers engage in; secondly, literacy and numeracy practices specifically related to various aspects of 'lean' production work; and, thirdly, the conditions of employment related to 'earning a living', involving, for example, negotiating pay schedules and contracts. As previous research has shown (for example, Worthen 2008), conditions of employment can be seen to represent an activity system in workplaces separate from those relating to productivity.

Technical work practices: job cards

In all three companies, producing or reading and interpreting job cards (the record of the customer's order) was the first-mentioned routine technical work task involving literacy and numeracy. Generating a job card is usually the first stage in the production process, and the card usually accompanies the development of the product as it moves through the various production stages until final despatch to the customer. Job cards, although they all differ in specifications, have generic features: they are usually one-page proformas that identify the job, with sections detailing dates, customers, addresses, technical data, including the specific details of the type of material, the dimensions and quantity of the item to be produced, and the names/signatures of workers or supervisors. Sometimes the job card is generated by data entry clerks and forwarded to work stations electronically. The job card is a key workplace text to be read, checked and signed by the relevant workers and then passed on to the next production stage.

Job cards are integral to efficient (and lean) manufacturing. If they are misread by any workers along the production stages, considerable delays may arise, along with wastage of resources and costs to the company. Usually there is very little writing involved, often just signing off when the job task is complete. Mathematical calculations often feature, as workers produce items according to the card's specifications. One worker, for example, sometimes receives a job card with specifications in inches, and she is then required to calculate the conversion to millimetres, which she does using a known algorithm.

An individual worker's level of interaction with the job card varies according to the job they perform. Often, it involves simply checking a few details in the production process. However, a couple of the work roles at Hearing Solutions require more complex interactions. Workers in the 'modelling' section (producing the three-dimensional computer images of in-the-ear hearing aids), for example, make the effort to check that not only what they read on their computer screen is correct, but that it matches exactly with both the in-house job card produced by the data entry section, and also, as one modeller expressed it, 'the real clinic form ... which we have to read to make sure they've interpreted it properly'. Modellers are also occasionally required to follow up the contact on the job card (usually the audiology clinic) if they realise that the hearing aid requested by a client may not be appropriate, or in some cases not possible (for example, where the electrical components physically will not fit in the hearing aid requested). In these cases the modellers email their customer service section with a short and concise query.

Other routine technical work practices

Literacy and numeracy practices feature quite extensively in data entry and despatch/warehouse work, which often involves a process of calculating transport costs to ensure that products are despatched efficiently at minimum cost to the company. One of the despatch workers at Insulation Products provides an indication of the complexity of these practices:

For the transport – how much they charge? Some transport big stuff, big pallet – cheap, right? Small one expensive ... I got that experience, which transporter, different distance, some inter-state, local. So I know which ones here for Melbourne. If I send something I know Toll IPEC cheap for ... Sydney. Riteway is good for Brisbane areas, Melbourne areas ...

In undertaking this work role, workers need to research the different transport companies with phone calls and internet enquiries, comparing the costs, while taking into account the volume of the products and the distance they need to be transported.

Reading instructions in workplace ‘manuals’ might also be expected to comprise literacy and numeracy practices in a range of activities. However, there was little evidence in the three companies of the need to refer to such manuals. Only in one section of Hearing Solutions, the service/repairs team, did a team leader refer to the need to look up a manual, and it involved using the company’s intranet to remain up to date with new products. Beyond this example, we found no evidence in the mainly routine work of most job roles of workers referring to manuals to learn how to perform their job role, or indeed to troubleshoot when problems arose. Instead, workers learnt by observing and receiving help from their fellow team members, confirming that much workplace knowledge resides in the collective minds of the teams and that there is often little need for the workers themselves to document this knowledge in written texts.

Mathematics/numeracy practices — visible and invisible

Mathematical or numeracy practices in some instances feature more prominently than literacy practices. For example, at Insulation Products precise measuring is required to produce a range of gaskets and other insulating products and to eliminate wastage. One job involves producing the insulation blankets that surround large pipes. These are custom-made blankets, with the worker undertaking this role required to calculate the circumferences of the pipes and take into account the thickness and flexibility of the material, possible abrasion at key points, and also large joints and taps. These are sets of calculations worked out by hand by the worker and attached to the job card. At the time of the interviews, this worker had been sponsored to attend a CAD course at a VET college, the intention being to reduce these hand-produced calculations.

Stores and despatch workers in this company also spend time measuring and counting material distributed to other work sections and checking final products and readying them for despatch to customers. As one despatch worker stated:

So when we are doing the con [consignment] note, I actually need to take the weight of the carton – I mean the total weight – gross weight – and get the size dimension. But most of the couriers they use centimetres. So you need to get the centimetre or the size – the diameter and you need to write it on the con note.

One significant set of work practices about which it is difficult to be specific or recognise the embedded mathematics or numeracy involves the use of numerically controlled machines and computer-aided design software. This type of highly technical work features in all three companies,

but in particular at Hearing Solutions and Insulation Products. Modellers, for example, at Hearing Solutions work exclusively on computer-generated three-dimensional images of in-the-ear hearing aids. The images are obtained from scans of the impression or mould of a client's ear canal sent by the audiologist. The modeller, by manipulating a dual mouse system, is required to reshape the image to produce a model of an optimum-fit hearing aid 'shell', incorporating the specific electrical components required to fit the client's hearing needs. This model is then sent to a three-dimensional 'printer', which produces the acrylic outer 'shell' of the hearing aids. The modelling calculations clearly involve highly complex mathematical algorithms, but these are not visible either to the modeller or to those observing their work practices. The embedding of the calculations in the CAD software renders the underlying mathematical calculations behind these actions invisible. Invisibility, however, does not equate with absence.

Lean production

All three companies were at different stages of introducing lean production. This section will focus primarily on the two companies where lean production processes were more developed: Secure Windows and Hearing Solutions.

As noted earlier, lean production promotes greater efficiencies and usually involves the re-organisation of work into self-directed teams. At Hearing Solutions, as a means of encouraging team members to actively participate in improving their team's performance, a set of processes was established. These included daily team meetings, and collating and monitoring the team's productivity (measured in unit output), which was usually displayed on the team's 'board' (a large whiteboard), demonstrating the team's performance in the form of graphs. The seven work teams at Hearing Solutions appeared to operate smoothly and effectively. Every team had a daily ten-minute meeting, usually in the morning and located around the 'board', where the previous day's production was reported and analysed, current daily work demands discussed, suggestions made for further improvements, and any other issues/problems in the team raised.

Language, literacy and numeracy were embedded in all aspects of these team-based lean work practices. The key element for many of the workers was public speaking (in English) to the whole team. Convening and chairing team meetings was rotated weekly so that every team member undertook this public speaking role. Further, the daily team meetings encouraged, and were an opportunity for, workers to express their views on many aspects of the team's work, and this required the use of spoken English. One manager stated, for example, 'I find they open up a lot more ... sometimes you get brilliant suggestions on how to do things'.

Collating the team's daily productivity in the form of graphs and reading the graphs to determine the team's productivity at any point in time and determining whether performance targets were being met constituted the most obvious numeracy practice. Literacy practices were in evidence in all written documentation in the teams, especially those displayed on the team boards. They included, for example, corporate 'vision' statements for each team, the names of team members and their photographs, along with details of social events such as the birthdays of team members. There was also overt labelling at work stations to indicate the correct placement of workplace tools and the location (in specific cupboards, for example) of any workplace documentation. In the everyday work of team members, however, there were very few writing practices, with reading constituting their main literacy activity.

At Secure Windows the lean processes were less developed. Early-morning meetings, called ‘tool box’ meetings, were held, at which the team leader addressed the whole team, indicating how the team was progressing in terms of productivity and targets and providing a forum for team members to raise any issues. The Production Manager acknowledged that much of this information was not being understood or used by the workers since only some of the team members had undertaken the lean training, mainly the team leaders.

At Insulation Products there was little evidence of the specific re-organising of work roles to accommodate lean practices. The workers were already working in teams based on their different work roles (for example, cutting machines, warehouse/despatch, sewing), but there were no regular team meetings or team boards indicating productivity levels. Some of the workers who had been assessed as lacking in literacy and numeracy skills were attending weekly lean training sessions, and attempts were being made by them individually to monitor their job performance using charts provided by the trainer in the lean course.

Conditions of employment

The third domain of literacy and numeracy practices involves conditions of employment: ‘earning a living’ issues, including how workers understand the terms and conditions that govern their work, including pay rates, sick leave, safety and workers compensation if injured at work, and how they negotiate changes and improvements in their working conditions. Such a focus has largely been neglected in studies of literacy and numeracy in workplaces, but from the workers’ perspectives this is a critical area.

Conditions and rights for workers varied across the three companies. In two of the companies there was no union representation, while in the third company it was very limited. In Hearing Solutions and Secure Windows workers were employed under standard award conditions and received written employment contracts at the time of their initial employment. In Insulation Products employment conditions from the time of recruitment were far less formal and workers did not receive written details of their conditions of work such as award rates. Workers in this company were thus required to make individual representations to the Production Manager (a significant language/literacy practice) if they wanted improved working conditions. All three companies had notice boards which featured written examples of various working conditions. In one company these included the minutes of meetings between management and workers.

Summary of workplace literacy and numeracy practices

This section has sought to answer the question: *What are production workers’ literacy and numeracy practices in manufacturing workplaces?* In the first of our workplace domains, routine technical work, understanding the job card was the almost universal literacy and numeracy practice, although for the majority of workers this was a straightforward practice, honed through everyday use and involving little active engagement. Some work practices, such as those involving data entry clerks, modellers and repair/service workers at Hearing Solutions, and warehouse and despatch workers generally, involved greater engagement with job cards, and greater engagement generally with literacy and numeracy practices. In jobs that require operating computerised technologies, mathematical calculations in particular were often invisible to the workers, being deeply embedded in software programs. Lean production comprised our second workplace domain, and additional literacy and numeracy demands were made on workers in terms of spoken English, as they were expected to actively contribute to daily team meetings. Lean production also led to new literacy and numeracy

practices such as workers collating and understanding their team's daily productivity data located on the team 'boards'. The final workplace domain, conditions of employment, is often neglected in workplace literacy and numeracy studies, and involves workers understanding their work contracts and other aspects of working conditions such as sick leave, safety and workers compensation.

Perspectives on literacy and numeracy practices

In this section we address the second research question: What are the various perspectives of production workers, trainers, supervisors and employers, on the literacy and numeracy practices, problems and issues involving production work in competitive manufacturing?

We focus first on the perspectives of the workers themselves, including team leaders, followed by the trainers in workplace programs, and finally the managers.

Production worker perspectives

Hearing Solutions can be seen generally as the most advanced of the three companies, both in terms of technology and lean processes and the company in which, based on industry literature, we might expect to find any literacy and numeracy 'problems and issues'. As we have outlined, in terms of the technical work practices, work roles at Hearing Solutions varied from the more complex work of the modellers – shaping hearing aid 'shells' – to fairly simple 'manual' tasks, such as individually lacquering the hearing aid shells (described by a manager as 'the same as doing your nails'). However, in not one of these technical work roles did any worker identify that there were any literacy and numeracy problems.

Many workers spoke of the importance of reading the job cards properly, but this was not considered a problem, even for workers with little formal education in English. As one Vietnamese-born modeller at Hearing Solutions indicated, 'we have to read the form. But not hard for me read the form every day ... the form is all the same'. Another Vietnamese-born worker further explained that, if she did encounter something she could not read, the situation was easily resolved within a team context: 'if I cannot understand, I come and ask the team leader'. If mistakes did occasionally occur with the job card, the workers attributed this to a loss of concentration or a temporary distraction, but not the inability to read the card.

In the two other companies, across all work roles, reading and, in particular, understanding the job cards, was also not considered a problem and was therefore a non-issue. Because the format of job cards changes little, workers become familiar with them and rarely make mistakes. One Chinese-born worker at Secure Windows said that when she started in the company 14 years ago she spoke no English and had never been to school, but the daily contact with the job card meant this was not a problem for her: 'I know how, what customer writing and what they want to do, I know straight away'.

As indicated by the workers, in no other aspects of the technical work practices was the issue of literacy and numeracy perceived to be a problem. In the work involving highly technical computerised machine tools, such as the modellers' computer interface at Hearing Solutions, or in programming water or laser cutting machines at Insulation Products, the key issue was not literacy and numeracy ability, rather the workers' computing knowledge and experience. There can be little doubt that this highly technical work is specialised, and literacy and mathematical concepts may well have been present in this work, although often invisible to the workers and us as researchers. The main point, nevertheless, is that no worker claimed that operating these computerised machines successfully was contingent in any way on their literacy and numeracy abilities. Moreover, the workers using these

machines tended generally to undervalue their skills in undertaking these work roles. One of the modellers at Hearing Solutions, for example, provided a detailed description of the many complex factors he needed to consider in his work, but then described this work as ‘just like playing a video game, basically’.

Writing in English might well have been considered a problem by many of these workers, but very little writing was actually required in these work tasks. For most workers in all three companies, the main writing involved signing off the job card or appending details to the card. The only routine production work task we were made aware of that required any prose writing was when the modellers occasionally emailed their customer service officers with technical queries about particular client orders. So the point to be made here is that even if the workers believed their written skills were not particularly good, they were nevertheless quite sufficient for undertaking all their current job tasks.

Given the extent of the linguistic and cultural diversity in each company, spoken communication in English was potentially a problem in the production work in all three. But our observations of workplace practices, including team meetings, indicated that poor spoken English caused only an occasional misunderstanding or irritant, and there appeared to be no production implications. In one of the companies, where there was an official ‘English only’ policy, a group of Tamil workers in the same team nevertheless spoke in their native language to each other much of the time. A few fellow workers expressed the view that they were not always happy at being excluded from conversations in languages they didn’t understand, but this was not a major problem among workers. One Australian-born worker in such a situation simply said to her fellow workers: ‘you’ve got to talk English, and they do’. But in practice multilingualism in these workplaces was a strength, enabling wider communication on the factory floors. There was a high degree of tolerance of difference and recognition by those workers interviewed that the multilingual workforce was a positive aspect of their workplace.

Spoken English might potentially be an issue in some specific lean processes and especially in the daily team meetings, where workers were expected to run the meetings and contribute to discussions in English. However, in our observations of several team meetings in two of the companies and in interviews with the workers, there was no evidence of any major misunderstandings resulting from the workers’ spoken English, although inevitably there were grammatical and pronunciation errors and problems with accents. Sometimes it meant team members were required to have a certain level of cross-cultural understanding and patience. Grappling with different accents and some poor English pronunciation was seen as an accepted aspect of working in a linguistically diverse workplace. In some respects the team meetings were a positive opportunity for workers to improve their spoken English. One worker at Hearing Solutions said he specifically asked not to be placed in a team with fellow Serbian-speaking workers so that he could improve his English. For him, therefore, the problem would have been speaking his native language at work, rather than speaking English.

In the main, workers did not identify specific literacy and numeracy problems in relation to their working conditions, our third domain of literacy and numeracy practices, although in one company workers were unable to understand the written minutes of a meeting between management and workers over workplace roles. Many of the workers did indeed have problems with their working conditions (low pay, few opportunities for advancement, lack of documentation about pay awards at one company etc.). One related problem at Insulation Products was how their pay could be improved, given the lack of documentation. In such a case it was left to the worker to ask in person, as one indicated: ‘Nobody knows to whom to ask. So maybe we need to go and ask [the Production Manager] or he will say, okay, leave it to me, leave it to me for eight months, nine months’. The act of asking

the Production Manager for a pay rise, requiring spoken English practices, may well present as a problem for workers in the company.

Safety was not mentioned and appeared not to arise as a specific literacy and numeracy problem. Some workers had attended first aid and occupational health and safety courses. Safety itself, however, was an issue at one company, Insulation Products, with a worker claiming multiple safety problems, including eye glasses not being worn, fire extinguishers being blocked by equipment and materials, and dangerous areas not being sectioned off.

Trainer perspectives

In this section we refer to comments the trainers in the three companies made in relation to the literacy and numeracy embedded in the routine work of the production workers. The trainers were all external to the companies, but very experienced in delivering lean production training programs.

Consistent with the views of the workers whose opinions were given in the previous section, the workplace trainers failed to identify literacy and/or numeracy problems on the part of the workers. No examples could be provided of workers not performing their job roles effectively or productivity being affected negatively in the companies. Clearly, spoken English, in view of the language backgrounds of the workers in all three companies, was a discussion point, but not a problem. As one trainer indicated, if in a normative sense it was felt workers might experience some difficulties with their level of spoken English, this was more than compensated by their other work skills, and besides, their spoken English was deemed sufficient for the jobs they were doing. For example, a trainer recounted the situation with a team leader at Hearing Solutions:

You'll notice he feels not that confident with his English, but some of his graphs on Excel that he has done are amazing. So it's more the spoken English rather than the technical ... in fact, he just went to Poland for a couple of weeks to train them over there ... it's just that English is not their first language.

The trainer considered Hearing Solutions to be a 'fairly sophisticated' company, and the issues affecting productivity were not linked to the literacy and numeracy abilities of workers, but other skills: 'sometimes it's computer illiteracy that's hurting them these days'. Moreover, according to this trainer, the real literacy and numeracy problems in manufacturing companies were seen not to reside with the workers, but in the way documentation was produced and presented to the workers. This trainer noted that much of the workplace documentation could be simplified visually, making it easier for everyone. Job sheets, for example, were often complex and very poorly presented and unreadable, even to the trainer: 'I said you've got a sloppy work order here. So, sloppy work order, sloppy work. You don't really expect too much out of it'.

Similarly, the trainer at Insulation Products indicated that literacy and numeracy issues in the workplace were related to 'systems' and not a matter of individual workers lacking skills. She stated:

Most of your paperwork gets taken away from you in manufacturing ... the team leader does it, so there's no demand on your literacy or language skills. You start losing it if you're not using it ... We've dumbed down the workplace.

Part of this workplace trainer's role was to analyse each area of the company's production work to determine the language, literacy and numeracy demands and whether there was any need for literacy and numeracy support of some kind. Her overall assessment of Insulation Products represents a useful summary of literacy and numeracy issues/problems at this company:

I went and did a process map with every person ... to look at their job and analyse how much LLN there was. There's a fair bit of writing up in the warehouse, but they seem to be coping with that ... we talked to management, we talked to the operators ... about where the problems were. There didn't seem to be anything coming up from people misreading or writing incomprehensibly. There's a bit on the verbal communication, but people understand that they have to work a little bit harder at that, so I don't think that was a major one. So I think really, possibly some pronunciation stuff would support people, but people seem to be able to read their job cards. They can read the programs to put information into, to put the design into the machines. There's really not that much call for it [for literacy and numeracy support].

Employer perspectives

The managers interviewed in the three workplaces included those responsible for operations/production, quality assurance and specialised technology. The owner–manager of one company was also interviewed.

The specialist technical manager at Hearing Solutions was asked a hypothetical question by the researchers: whether, if the English language, literacy and numeracy skills of all the workers improved, it would make a big difference to productivity. He answered: 'To be honest, no. I would say no. I don't think it would. Not on the productivity level, no'. This manager currently spent much of his time travelling overseas training hearing aid production workers. He had many years of experience in the company, having worked his way up from the production floor. He explained that it was the practical skills, knowledge and experience of the workers and, in particular, the modellers, that counted: 'they need to understand how that hearing aid looks like at the end of the day ... they've got to have that picture in their head and how small they could make it ...' Asked if there were errors or inefficiencies resulting from workers' literacy and numeracy levels, he answered: 'Hmm to a certain respect yes ... when you're looking at certain comments that they put in order forms and all that'. He then qualified this statement by saying: 'yes and no – you know, I never thought that it was a major drawback to what we have to do here, no'.

The Production Manager at Secure Windows was relatively new to the company, and he mentioned that the previous Production Manager had attempted to assess the workers for their literacy and numeracy levels. However, only in one particular production area, the warehouse, did he perceive literacy and numeracy could be an issue. Asked if lack of literacy and numeracy inhibited production in the company he stated: 'I don't perceive it as a problem, no'. In the main assembly area of the production work he said the workers did not have to do much reading and writing on a day-to-day basis.

The findings from the third company, Insulation Products, were a little mixed. The owner–manager indicated the importance of measurement accuracy in ensuring that his company's products (gaskets mainly) were made properly, and that this related to literacy and numeracy:

If it didn't work or if the wrong material or the wrong thickness or something like that actually got made wrong and people didn't read the job card properly, yeah we could get into a lot of trouble.

His main concern involved spoken English at work. In this respect, he tried to implement an 'English only' policy at work. He also spoke of encouraging workers to speak English at home, but he acknowledged this was not successful:

Unfortunately some of them leave work and they go home to their wives and their wives aren't very good at English, so they need to speak their native tongue there, and the wives never move – you know, move into the English [speaking] society, unfortunately.

It is difficult to gauge the extent to which spoken English was considered a problem or an issue for this manager. For example, in relation to a production supervisor whose spoken English was difficult to understand, the manager claimed this did affect his work performance: 'Absolutely. It definitely makes his job frustrating for people having to deal with him'. An alternative was workers speaking their own languages at work or interpreting for others, which he accepted was not ideal, 'but the next best thing', and that sometimes this was 'the quickest way'.

The manager also considered maths and numeracy were important in this production work. But when asked directly whether communication and maths problems were a serious problem in this company, the manager responded: 'No, it's not serious. Because, I mean, we do undertake supervision and things like that, that try to prevent it becoming a serious problem'.

Other managers in the same company had different perspectives. The Production Manager flagged the importance of communicating well and the possibility of conflict resulting from misunderstandings relating to the 'tone' of spoken English used in the workplace. But the only specific literacy and numeracy problem he identified was the difficulty workers experienced in understanding the formal written notes of meetings he had with workers. He made the interesting observation that, based on annual audits, 80% of production mistakes were caused not in the factory, but in the sales area. As we mention later in this report, a standardised literacy/numeracy assessment of all workers in this company found the sales staff were not in need of literacy/numeracy support: their scores were too high.

The manager responsible for quality in the company, who works very closely with production supervisors, did not think that speaking other languages (than English) or different accents presented barriers to communication in the production area, claiming that the key factor was worker attitude. He claimed that in this company there were positive attitudes, and so, regardless of their spoken English or literacy and numeracy, workers could be taught the jobs they needed to do. He stated:

Factory work is not a sophisticated thing. The operator even – the machines here are sophisticated, but the operator basically puts the material into the machine, presses the button. Everything is controlled from the top. The only thing they have to write down in the job card is how – what time do you start, what time do you finish. With your name, that's all, nothing else.

An area where the literacy and numeracy concerns from the perspective of managers was highlighted was the working conditions of workers. The Production Manager at Secure Windows, without going into details, explained that there had been some spoken communication problems in the company involving workers' compensation. One worker was used as a translator but this led to a situation in which the message 'wasn't getting across ... it seemed to be different than the message that was being conveyed'. In another example, when the company was experiencing a downturn, the message conveyed to workers regarding possible redundancies was translated into seven languages to ensure the information was communicated to all workers.

Accidents resulting from workers not being able to read safety signs are often flagged in the mainstream industry literature as a problem, but it was not an evident problem in these companies. At Secure Windows the Production Manager stated that the main form of injuries related to repetitive strain. The manager for quality at Insulation Products made it clear that in his opinion accidents were not related to reading problems:

I would say it's a problem of attitude rather than literacy ... all the signs are strictly made so you don't have to read a thing ... they put a picture of a forklift, it's something visual ... Nearly everything – all the signs work in that way where you have to read nothing.

The managers in all three companies indicated language, literacy and numeracy were not their main concerns when recruiting workers. At Hearing Solutions, for example, the technical specialist manager was quite clear that language in particular was not a factor in employing workers:

I'd never make language a big or the number one basis of do we employ someone because of that. It was always the skill level. It was always the person's ability to be able to adapt to certain things. Hand skills were the most important that we needed here.

Summary of perspectives on literacy and numeracy practices

Our responses to the second research question, which sought various perspectives on literacy and numeracy practices and problems and issues in production work, indicate that, for the large part, few such problems exist, at least in relation to the productivity of workers. The workers claimed they had little difficulty with managing literacy and numeracy in their routine work, and if mistakes did occur they were usually unrelated to the ability to read. If workers did encounter problems, asking for the assistance of fellow team members was an established and promoted strategy to resolve the situation. This is especially appropriate in lean production as teams worked collectively to support each other in all aspects of their work. In areas relating to working conditions, these workers experienced a number of problems, but they were not necessarily related to literacy and numeracy, rather, to the prevailing workplace cultures. Pay negotiations and safety were particular examples in one company. Workplace trainers largely confirmed the perspectives of the workers, making the point that if workers did appear at times to lack spoken English skills, this was more than compensated by their other qualities, such as superior technical knowledge or computer skills. Trainers indicated that part of the problem of workplace literacy and numeracy was poorly written and designed workplace documentation. Most managers did not perceive literacy and numeracy practices to cause problems for their workers in terms of productivity.

Production workers' experiences of learning

In this section we address the third research question: *How do production workers experience learning in their training programs and on the job? What supports and hinders their learning, and to what extent are literacy and numeracy influencing factors?*

Most of the workers' experiences of training in this study relate to lean production training, and because the approaches to training differed markedly across the companies, we will outline the approach of each company separately.

Lean training at Insulation Products

By comparison with the other two companies, lean training at Insulation Products was in its infancy. The owner–manager of the company said that the company had been looking at lean processes for quite a while. He recognised that lean training would not reap rewards in the short-term, but that it was 'essential for any industry these days, to be part of their culture'. However, in his view, before the company could embark on the journey properly, there were 'lots of small background things ... to get out of the way'. The training described in this section can be seen to represent some of these issues because language, literacy and numeracy issues were viewed by this manager as essential in the shift to lean production:

Oh, big time, yes ... The concept of lean is quite simple to explain in English, but just try to explain that to someone who's not really fluent in English and ... it's a bit more of an effort.

The Production Manager thus contacted a VET provider and together they obtained Commonwealth funding for a program designed to improve the workplace English language and literacy levels of the production workers (WELL funding).

The teacher and a manager from the VET provider agreed that the language, literacy and numeracy demands on workers would increase in a lean environment. They provided examples, such as: 'you have to be able to express your ideas and participate in problem solving'; 'present your toolbox talk and talk about the idea you came up with'; and 'be able to quantify the waste, be able to be persuasive. It's like a process of negotiation'. They also indicated that 'between 20 and 80% of the class' of the production level workers doing the lean manufacturing course (the Certificate III in Competitive Manufacturing) usually needed some sort of support to get through the course.

Following negotiations between the company and the VET provider, the first stage in the training program was to assess all workers in the company to determine the extent of their literacy and numeracy needs. The VET providers used a modified workplace assessment tool obtained via a government website and reported workers' levels of literacy and numeracy according to the national standardised measure, the Australian Core Skills Framework (ACSF). This assessment is obligatory for providers receiving WELL funding, and most of the production workers were found to be at level 3 or below on the 5-point scale, which qualified them for the program. Interestingly, the sales staff in the company scored above level 3 (the benchmark), which meant they were unable to access the funded training programs. As noted previously, annual audits in this company had determined that the major causes of production problems at this company were mistakes made by sales staff.

With administrative delays of several months before the commencement of the lean course, it was decided first to deliver stand-alone literacy and numeracy classes to the workers for a period of approximately six weeks. The VET manager explained that this was to build the literacy aspect of the workers' underpinning knowledge prior to their commencing the lean production course. A total of 22 workers of the approximately 30 production workers in the company were identified as being in need of such a course, with each attending a literacy class at the factory for two hours per week in work time.

The literacy/numeracy teacher indicated that she had adopted a flexible approach in the literacy/numeracy classes, using a great deal of discussion and incorporating workplace tasks, but also generic English skills. The teacher claimed that working on aspects of language and grammar was appreciated by the workers: 'They just love it'. However, several months later when workers were interviewed and asked about the classes, recollections were more restrained, although still favourable. One worker, for example, said it was 'like a refresher course ... when we learnt many things in English, verbs and things ... where we use full stops'.

A computer class – an introduction to using computers/laptops – was also held over several weeks, again for two hours per week in work time and involving mostly the same students.

The lean production course was delivered over a period of 15 weeks, with the workers enrolled in selected units of the competitive manufacturing course. There were two classes, each comprising six to seven workers and held for two hours per week in work time. Lean concepts, such as continuous improvement and various problem-solving strategies were introduced in the classes. Four of the lean course sessions were observed by the researchers. Active participation and motivation in the sessions varied. The teacher was asked whether, had the workers been operating according to lean methods with team meetings every morning, literacy and numeracy issues would play a role. She replied:

No ... because you'll see the language just keeps coming up. The language is consistent, it's contextualised to the workplace, but that language is easy to pick up because it's very familiar

and it will come up every day at your team meeting or your toolbox talk, you'll have the same. So it develops.

In the research literature lean production is usually presented as a 'whole of organisation' approach if it is to be effective. In this company, only a limited number of workers – those assessed as having literacy and numeracy needs – were receiving the lean training. The lean course trainer stated in response to this limited focus: 'I don't think it hurts', her rationale being that: 'I think these guys will be able to present a good range of data to show management that they could change and could be doing better. Whether management acts on it, who knows?' From some workers on the course there was a degree of cynicism expressed in terms of whether managers were really serious about making lean production changes. One worker, for example, stated 'everybody knows what can be done, how it can be done. But I think the problem is most of the heads in our company, they're not into it'.

Summary

According to Derrick's (2012) taxonomy, the training undertaken at this company can be characterised as a 'technical' model of embedded literacy and numeracy. The content of the course was largely workplace-specific in both the literacy/numeracy sessions, using some authentic workplace texts, and in the lean course. As Derrick notes, the technical model is underpinned by a deficit model of learners. The workers at Insulation Products were pre-assessed to determine their individual needs. There was some acknowledgment from the trainers that for the kind of whole-of-organisation learning and change required in the introduction of lean processes, the exclusion of the remaining staff from the training limited the impact of the lean training. This was particularly the case at Insulation Products, where sales staff were excluded from accessing literacy and numeracy support because they scored above level 3 on the Australian Core Skills Framework, despite production problems being identified in their area of work.

Lean training at Secure Windows

According to the external trainer of the course at Secure Windows, 18 workers undertook the Certificate III and IV courses in Competitive Manufacturing, with the majority completing the former. The course was undertaken in work time and on-site. At the time of this research, the workers had completed the course in the previous year and had received their certificates. Lean production projects, however, extended beyond the course, and every three months groups of workers presented their projects to gatherings of management and invited guests, including industry and training representatives.

The external course trainer explained that it was a business decision of the company to provide the lean training to fewer than half of the 40 or more workers on the factory floor. He said that in order to keep the business running – 'to maintain level of service' – the course included some middle managers, supervisors and 'some workers that weren't like line leaders or leading hands'. The trainer commented that the workers 'all could basically speak English – the majority of them could' and 'one or two that couldn't relied on a leading hand to translate, which is fine'. This in fact was central in the course: workers who felt their spoken and written English was causing them problems were assisted by other workers and in some cases by managers in a mentoring program.

The course delivery was incorporated in the regular work at the company, rather than as a separate or formal 'training' activity. Literacy and numeracy played a role, and the trainer indicated 'reading English was a challenge', but he stated that the workers in the course nevertheless 'understood what the tasks were'. He said the focus was not so much on lean theory, but its application on the

production floor, 'you know, showing competency rather than just a mere test ... it's competency based training'. An in-house company literacy/numeracy test was used at the beginning of the course to identify those who might have some difficulties with the course.

The mentoring program was largely a consequence of the course reaching a crisis point part-way through: one trainer had left and a new trainer came on board, with some workers deciding not to continue with the course. It then required the efforts of the mentoring program and, in particular, the direct intervention of the Production Manager, a key proponent of the course, to keep the course going. According to the course trainer, the idea was to provide a mentor for each worker, often a manager or production supervisor (sometimes referred to as leading hands). Mentors 'looked at, reviewed, engaged the worker during the training and then they would remove any roadblocks or facilitate as required'. Other assistance was provided by fellow Vietnamese or Laotian-speaking workers.

Not every worker completed the course. One worker, for example, explained that halfway through the course she decided to stop, saying that she felt confused and stressed and that the course was 'really hard for me'. Another worker said she rejected the course from the time it started: 'I think my English is not good enough. I say I can't do that course'.

Other workers, however, completed the course successfully, although largely through the assistance of their mentors. One of the team leaders explained how he provided mentoring assistance in his team, linking theoretical lean concepts to actual workplace practices in his team:

I've got about five people in my team ... we sit down and we put the material out. We learn through our workplace and then we think through ... So we try to demonstrate, we try to refer this terminology into the reality of what they're talking about there.

According to the Production Manager, some workers had changed remarkably as a result of the lean course, demonstrating increases in confidence as they presented their projects to management. However, as the Production Manager acknowledged, it was only those workers who completed the course who were thinking lean at work

Summary

At Secure Windows the lean production course was considered a success although it did not extend to the whole production workforce. There was concern, however, expressed more among the workers themselves, that there would be difficulties with the course due to spoken English, literacy and numeracy issues, and it was largely the mentoring program that enabled many of the workers to complete the course. Many of those who completed the course were implementing lean processes with further projects, and it would appear some of those who did not do the course were not engaging sufficiently with lean production. In this regard, the approach taken at Secure Windows lies somewhere between Derrick's (2012) characterisation of the 'technical' and the 'situated-restrictive' model. The literacy pre-assessment would indicate a 'deficit' model of learners, although the primary focus of the course was on the completion of the competitive manufacturing course, in which literacy and numeracy were strongly embedded, rather than treated as separate skills.

Lean training at Hearing Solutions

At Hearing Solutions, every single worker in the production area and several managers had completed the competitive manufacturing certificate course; it was a part of every worker's training and job role at the company, whether they were existing workers or new to the company. Training and work

became indistinguishable, and thus lean production was built-in and company-wide. The Production Manager stated:

It has to be from top to bottom. If the management doesn't believe lean and is not involved, it doesn't work; simple as that ... and you have to constantly remind people it's not just another initiative which will die in 12 months or six months or two years. Lean is a continuous process.

Like Insulation Products and Secure Windows, the Hearing Solutions production workforce is culturally and linguistically diverse. Reflecting back to the beginning of the course, the trainer considered that there might have been the need for translators due to spoken English problems, but, as she noted, 'Usually there's someone in the groups ... that can sort of do a quick interpretation for someone'. In fact, assistance from team leaders or fellow team members was always available. It was this assistance, together with a training philosophy which focused on the complete integration of training and work and an emphasis on verbal and visual communication (that is, spoken English and images, as distinct from text-based literacy/numeracy) that ensured the lean training was effective and eliminated potential literacy and numeracy problems.

The CEO of the training company providing the lean course explained what he called 'visual work-based management'. It was a process that he believed largely removed the potential for English language, literacy and numeracy issues in the training and implementation of lean principles in a company. He explained that the process began by engaging the workers with a mini 'business board' owned by the team, which showed the team's objectives and performance across a whole range of measures. The aim was to apply lean principles directly to work with which they were already very familiar. The lean process, he explained further, takes some time to develop and initially there is some suspicion by workers, but the ten-minute team meetings each day introduce a new level of communication in the workplace. For the first time workers are being asked for their opinion on their day-to-day work and are being listened to. According to the CEO, because the work is so familiar to the workers and the communication is verbal, they do not need high levels of literacy and numeracy. He said that initially many workers are reluctant to participate in a lean production course due to literacy and numeracy problems and the fear of formal assessments, but after they understand that the training is based on what they do, participation improves markedly.

The lean course trainer at Hearing Solutions implemented these processes with apparent success, not even referring to the course as 'training'. Most of the training took place on the production floor rather than in the training room, with the trainer spending time with each team and in particular with team leaders. Time was spent with the team leaders to help them develop the skills to enable them to communicate more effectively with their team.

A great deal of visual material was used, primarily because it made communication easier for everyone – not necessarily as a way to eliminate literacy and numeracy difficulties. The trainer explained that performance statistics represented largely as graphs and which were a key focus in team meetings could be presented more effectively in visual terms, with, for example, red and green indicating the under- or over-achievement of performance targets. Every team member needed to understand the performance graphs.

Their learning related to the day-to-day work issues they were used to dealing with, explaining in part why so few literacy and numeracy issues arose in the introduction of lean production. By way of illustration, the trainer recounted how she had provided a maths example involving manual handling and risk assessment whereby workers documented their movements:

All of a sudden they're going, okay, we've got two shifts, it happened 3000 times and that times that and all of a sudden – all of a sudden it's 142,000. I went, holy crow. So the manual handling is very much numeracy, but it's stuff that's important to them. Because what it is, if it's over 30,000 movements then it's a risk ... all of a sudden they're throwing these numbers around that are really quite easy. Then it applies to a lot of other things too, but it's personal for them.

Interviews with the workers and the observations of how they worked indicated the apparent success of the introduction of lean production to Hearing Solutions. Work was more systematic, and it seemed the workers were largely accommodating in terms of their perceptions of how their work had changed. One of the team leaders commented that initially there had been resistance to the increased documentation of work. But later he said he realised there were advantages in recording performance and discussing them with the team, advantages such as preventing future mistakes. He also noted that 'nobody ever complains' and, moreover, the daily team meeting 'brings a little bit of life into the team'. He now considered there should be more time set aside for teams to discuss work issues and problems.

As we suggested earlier, assistance from fellow workers was a central factor in the success of lean production at Hearing Solutions and this assistance was provided as part of everyday work. One of the team leaders commented: 'It's better to ask than not asking at all because if you ask then you're not creating a problem'.

While the lean course was designed to improve communication across all levels of the company's operations, it seemed to be particularly important at the level of team leaders. Before lean production was introduced, team leaders were concerned primarily with their own areas and had little knowledge of other teams. Following lean training, team leaders met once a week to ensure all were aware of each other's teams and performance. Team leaders, because of their important role, were required to undertake further studies in lean production – the Diploma in Competitive Manufacturing. This did present a few additional problems for the team leaders, mainly because at this level they were required to do more theoretical work on lean principles. It made extra demands on the team leaders' time and motivation.

Overall, according to the Production Manager, the lean training had been effective in engaging the workforce and enabling them to take greater responsibility for their work. He commented on how they had changed: 'They're asking questions now. In the past you could drop something in one corner of the company and if you don't go and pick it up or ask for it, it will be there forever'.

According to the Production Manager, as far as literacy and numeracy were concerned as influencing factors in how the training was delivered or how effectively lean production took hold in the company, they were not the main issues or indeed an issue at all:

I guess we find a way around it. So it didn't stop anyone getting training or learning something. It may limit access to some things. So probably if you have someone who's got problems speaking and reading English you wouldn't put them in position where they have to read something and write. That didn't happen ... No it's not blocking us.

Summary

Lean production training is considered successful at Hearing Solutions, with every single worker, team leader and some managers completing the lean course. The training model at Hearing Solutions is not underpinned by a 'deficit model' of their workers as learners – either in relation to their literacy and numeracy or their work skills. Using Derrick's (2012) taxonomy, the training model implemented here

could most closely be characterised as the 'situated-expansive' model. The lean training is designed around the improvements negotiated with the workers for their particular local context – their teams – and the focus of the training is situated in this team context. The training focuses on what the organisation wants to improve rather than on what each individual may need or want to achieve; that is, the learning is expansive in its focus on improving the organisation's processes and the individual workers' engagement and contribution. Literacy and numeracy are not seen as a barrier; rather, literacy/numeracy practices that are conducive to learning and communication in the workplace are developed as part of the lean process.

Discussion and conclusions

Employers are primarily concerned with workplace practices and questions such as how well jobs are being undertaken and whether there are better and more efficient ways of doing jobs. In our study we have adopted a social practice approach based on the New Literacy Studies to focus on how literacy and numeracy are embedded in workplace practices, and how workers use and manage these practices. As discussed by Wolf and Evans (2011), the social practice approach is different from the human capital approach, in which literacy and numeracy are viewed as generic skills that can be transferred in relatively straightforward ways from one context to another. The different approaches uncover different types of understanding about literacy and numeracy in the workplace.

Workplace practices are constantly changing and there is increasing recognition of the factors responsible for these changes, including technology and, specifically, computerisation. Traditional understandings of literacy and numeracy skills however remain relatively constant and may be increasingly detached from, and thus may possibly limit our understanding of, workplace performance (as Wolf and Evans 2011 also found in their larger-scale study in workplaces in the United Kingdom).

In this final section we discuss our findings and make policy and practice suggestions for various stakeholders in the area of workplace literacy and numeracy. The discussions focus on three key workplace literacy and numeracy issues: productivity, training programs, and employment rights and conditions.

Literacy, numeracy and productivity: re-examining the determinants

We began this report with accounts of the policy-informing view that low levels of literacy and numeracy among Australian workers are correlated with low productivity, with implications for the competitiveness of individual companies and the whole nation. This is the 'crisis' we investigated in three manufacturing companies in this study. But the findings of this study, based on the voices of many workers, trainers and managers, provide an alternative voice, one strong enough, we believe, to warrant a re-examination of the relationship between literacy/numeracy and productivity.

Our research findings reflect situated experiences and perspectives on workplace literacy and numeracy practices that by definition cannot be found through large-scale survey research or through surveys of the views of employers only. Workers, trainers and most managers were clear in their views that improving the literacy and numeracy levels of workers in isolation would make little difference to productivity outcomes in these companies; that is, literacy and numeracy were not seen to be barriers to how workers performed in their existing jobs or in other production work in their respective companies.

We are not claiming that no benefits accrue to workers from receiving literacy and numeracy support in or outside the workplace. One of the conclusions in the Wolf and Evans (2011) study was that, as with our findings, the productivity benefits of workplace literacy and numeracy programs were difficult to establish. However, they also found there were individual benefits for some workers, such as a changed attitude and an interest in additional formal learning and small gains in measured English language skills for workers for whom English was an additional language. In our study, the one literacy/numeracy class we documented was viewed quite favourably by workers, and other workers in the study had voluntarily attended external adult literacy/numeracy classes and were keen to improve their spoken English, literacy and numeracy. Nevertheless, we found little evidence that

these efforts would necessarily translate to improved productivity on the factory floor, largely because these workers already possessed sufficient skills for the work they were undertaking, an observation confirmed by comments from production managers. Moreover, depending on opportunities available to them, workers had demonstrated the capacity to learn and adapt to ‘disturbances’ to existing workplace practices, such as the introduction of new technologies, changing organisational structures and new product lines. We consider our findings to be significant because this link between literacy/numeracy and productivity is the key element of the workplace literacy and numeracy discourse in Australia. It is currently used to justify the increasingly significant allocation of public resources for particular adult literacy and numeracy programs and products.

In light of the above discussion, we suggest the findings from ethnographic studies of workplace literacy and numeracy be considered alongside other sources to inform workplace literacy and numeracy policies.

Workplace training programs: towards expansive learning

Each of the three companies in this research had different approaches to training and lean training in particular. It is useful in this section to refer to the four models for embedding literacy and numeracy in workplace learning identified recently by Derrick (2012): decontextualised, technical, situated-restrictive, and situated-expansive. We observed the training at Insulation Products and Secure Windows to fall largely within the technical and also the situated-restricted models, which Derrick (pp.17–18) identifies as underpinned by the notion of workers as deficient, insofar as the focus is on building specific skills based on worker assessments. In some respects the training at Hearing Solutions more closely resembles the situated-expansive model, in that it was not based on a deficit training model. Other aspects of this model proposed by Derrick, such as its democratic ideals, were not explored sufficiently in this study. Nevertheless, the role of the ‘key educator’, the lean course trainer at Hearing Solutions, did appear to approach Derrick’s (p.31) ideal:

The key educator is a facilitator whose aim is to help workers examine and question all aspects of their work situation to understand it better, and to use this understanding to propose improvements in job design, to pose and solve problems, while at the same time improve their learning.

This model is consistent with the aims of lean production: involving workers in continuous improvement in job design for organisational sustainability and competitiveness. It appeared to be highly effective in its implementation at Hearing Solutions.

Our research shows that the situated-expansive (or social practice) model of workplace learning, especially as it relates to lean production and as demonstrated at Hearing Solutions, appears to best support training where whole-of-organisation change and learning are being pursued. Moreover, trainers involved in whole-of-organisation change programs would benefit from additional professional development in ethnographic approaches to training and organisational needs analysis.

Drawing in particular from the training model at Hearing Solutions, examples have been given in this study of team leaders and fellow work colleagues informally providing support to workers with work tasks as required. All workers were seen to have strengths in their work roles, and individual characteristics relating to diverse language backgrounds, such as poor English pronunciation, were simply considered part and parcel of working in a culturally and linguistically diverse work environment. They were usually insignificant issues in relation to workplace performance, and ways were found to circumvent problems that did arise. As the Production Manager at Hearing Solutions

commented, 'there is always someone from the same ethnic group who is able to explain in their native language'. Managers were themselves from culturally and linguistically diverse backgrounds and such diversity in the workforce was not viewed in negative terms, rather as an asset which brought a level of harmony to the workplace and which was seen to promote productivity. In some ways, following the theme of diversity as an asset, the views held by managers and workers at Hearing Solutions fit what Cope and Kalantzis (1997) called 'productive diversity' in workplaces.

As occurs at Hearing Solutions, employers and workplace managers should be encouraged to view cultural and linguistic diversity in production workplaces to be less a problem requiring remedial language and literacy interventions and more an important cultural and potentially productive asset for the workplace.

Ryan and Sinning's (2012) recent study proposed that workers in low-paid, low-skilled jobs for whom literacy training was unlikely to make significant improvements in their job performance may nevertheless need such training in order to seek higher-skilled jobs. Our research focused on current not future job roles for workers, and therefore we did not address this issue. Nevertheless, we would suggest, based on existing research on situated learning and the transferability of skills, that workplace literacy and numeracy training conducted in workers' current job contexts may not necessarily be transferable in a straightforward way to new employment contexts. This is not to discourage literacy and numeracy training; rather, it is a reminder that a range of social, technological and personal factors need be taken into account as determinants of success in workplace learning.

Literacy, numeracy and employment rights

In this study we outlined workplace literacy and numeracy practices in relation to: the technical aspects of work (workers' routine practices); specific lean production work; and aspects of work relating to 'earning a living' – workers' conditions of employment. This latter aspect rarely receives attention in studies of workplace literacy and numeracy, particularly those studies that focus on employers' rather than workers' views. Nevertheless, it does represent a distinct domain or activity in workplaces (see Worthen 2008), and an effective production worker should, arguably, have knowledge not only of their work roles but also of their entitlements and information about issues such as pay and opportunities for advancement.

A number of significant aspects of working conditions featured in the interviews, in particular, knowledge of pay entitlements. We have seen how in one company production workers did not have this knowledge, and according to one worker, had to 'sort of beg' for a pay rise. This informal process required workers to make personal representations to the Production Manager. In other companies, documents outlining pay and conditions were provided at the time of appointment. In one of the companies, documentation describing a possible downturn in the company's operations had to be translated into seven languages in order to reach all workers on the production floor. Workers' compensation issues also caused problems in this same company, requiring the intervention of someone who could convey information in a community language. Thus, workers' individual or collective negotiations and actions to improve their working conditions and rights are also workplace language, literacy and numeracy practices. These practices would necessarily be affected by changes in the workplace, for example, the introduction of lean processes. An implication of what Derrick (2012) calls the situated-expansive model of workplace literacy and numeracy is that learning in lean production training would also encompass workers' learning to negotiate their changed working conditions, but this degree of expansive learning was not in evidence in any of these sites.

In some countries there are union learning representatives in workplaces who broker learning for workers and who can address literacy, numeracy and working conditions (Yasukawa, Brown & Black 2012b). Such approaches enable a number of the indicators of the situated-expansive model of learning to be achieved; for example, 'the involvement of workers/unions' for effective workplace learning (Derrick 2012, p.32). The new National Foundation Skills Strategy for Adults suggests the introduction of 'workplace champions' as 'ambassadors and promoters of foundation skills training [who] would help employers and employees with information on foundation skills' (Standing Council on Tertiary Education, Skills and Employment 2012, p.18). This discussion on employee rights highlights the need for further research into the literacy and numeracy practices embedded in workers' understanding and negotiation of their workplace conditions and rights.

The development of a 'workplace champions' program involving union representatives and designed to support workers in understanding, exercising and negotiating their workplace rights and conditions should be explored. Piloting and researching innovative programs that foreground what workers consider to be significant in improving the quality of their working lives may uncover different insights about the ways in which the workers value literacy and numeracy learning. This in turn will develop a richer and more complete picture of what constitutes workplace literacy and numeracy practices and how or whether workplace literacy and numeracy programs can assist both the workers and their workplace needs.

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Appendix: Focus questions

In view of the ethnographic approach of this study, a structured interview format was not appropriate. We outline the areas and topics we planned to focus on in the interviews with production workers.

- 1 Current work details
 - Job title
 - Status: for example, permanent/on a fixed-term contract/seasonal, temporary or casual
 - Full-time or part-time
 - Hours worked per week
 - Overtime details/times
 - Period of time with current employer
 - Supervision roles
- 2 Formal education
 - Age when finished school
 - Years since formal schooling
 - Formal qualifications gained
- 3 Workplace training programs
 - Details of courses
 - Qualifications obtained
- 4 Specific training for improving communication/literacy/numeracy/English skills?
 - Responses to the training
 - Benefits of the training
- 5 English language background (a focus mainly for workers for whom English is not their first language)
 - Details of language background
 - Use of English and/or other languages at work
 - Spoken and written language at home and in other contexts
- 6 Workers' views of the language, literacy, numeracy/ communication requirements of the workplace
- 7 Workplace changes since they started work
 - How they work with other workers
 - New technologies
 - New procedures
 - Pace of work
 - Variety or specialisation of tasks
 - New skills and knowledge
 - Forms of communication
 - Literacy and numeracy demands

- Need for training
 - Perception of job security
 - Perception of promotion prospects
 - Culture of the workplace -camaraderie/ friendships, fairness, openness to new ideas from the workers
 - Quality of the products being produced
- 8 Knowledge and views about competitive manufacturing
- Familiarity with the terms: competitive/lean/agile/high performance manufacturing
 - Understanding of the rationale for the introduction of these new forms of work

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