SUPPORT DOCUMENT

Thinking beyond numbers: Learning numeracy for the future workplace—Support document

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The importance of numeracy in today's workplace

Recent research indicates that owing to globalisation and the introduction of technology, workplace numeracy demands are growing rapidly (Hoyles et al. 2002) and will continue to increase in the coming years (National Research and Development Centre for Adult Literacy and Numeracy [NRDC] 2005) . More workers are now engaged in maths-related tasks of increasing sophistication (Service Skills Australia 2005). Numeracy is now recognised as an essential skill in the workplace and one of the most important in enhancing business goals (Balzary 2004; Dingwell 2000).

Not only has demand for numeracy skills and knowledge been extended, but there is increased need for their integration since they are often executed alongside one or more other essential skills, for example communication, IT and problem solving skills (Fownes et al. 2002; Hoyles et al. 2002; Millar 2001; NRDC 2005; Wedege 2003). Based on 6000 workplace interviews, the Canadian Essential Skills Research found that numeracy mistakes and inefficient methods in the workplace can cause accidents and affect production (Human Resources and Skills Development Canada (HRSDC) 2005).

Employers emphasise the need for sound numeracy skills such as estimating, reading and interpreting graphs and tables, to assist in problem solving at work (Australian Chamber of Commerce and Industry [ACCI] & Business Council of Australia [BCA] 2002). Unfortunately, business personnel perceive a lack of numeracy skills in both new and experienced workers, but they disagree over whether standards have fallen or "whether the new knowledge economy has created a demand for higher levels of proficiency" (Balzary 2004 p. x).

Numeracy is explicitly mentioned as an equity issue in *Shaping our Future: Australia's Vocational Education and Training (VET) Strategy for 2004–2010* (ANTA 2004). This inclusion is supported by evidence that adults with poor basic skills, particularly poor numeracy skills, are more likely to be unemployed or employed in manual occupations, to receive low wages, have lower promotion prospects and to have relatively low positions at work (Ananiadou et al. 2003; Falk and Millar 2002; Gleason 2005; NRDC 2005; Statistics Canada & OECD 2005). By comparing data from Australia and the US, Gleason (2005) found that adults with low numeracy skills were not only economically disadvantaged, but received fewer opportunities for training and development. However, when they did participate in on-the-job or apprentice training there were significant personal economic benefits.

In Australia, the importance of numeracy skills in the workplace is recognised by their inclusion in the nationally funded Workplace English Language and Literacy (WELL) program (DEST 2005). Other programs funded by national and state government bodies are designed to support the development of numeracy skills in the adult population, but not directly in the workplace training context. National governmental support for numeracy development is also evidenced by its incorporation into the key objectives of Australia's current vocational education strategy (Service Skills Australia 2005).

This research project seeks, in part, to explore the importance placed on numeracy skills by the industry stakeholders, employers and managers related to the case-study sites and any resultant strategies to support workers' acquisition and enhancement of relevant numeracy skills in the case study workplaces.

Definitions and conceptions of numeracy

Although the term 'numeracy' is now frequently used in policy and education circles of English speaking countries such as UK, Australia, Canada and the US, it is a relatively new word which has yet to gain popular usage in the community (2006). The term was originally coined as the mathematical equivalent to 'literacy', and just like 'literacy' it remains "a deeply contested and notoriously slippery concept" (Coben et al. 2003, p.9) the source of ongoing debate and discussion both in Australia (see for example ANTA 2002; Johnston 2000; Johnston & Tout 1995; Marr & Helme 1991; Marr & Tout 1997; Theiring and Barbaro 1991; Yusakawa & Johnston 2001) and internationally (see for example Coben 2000a; 2000b; Cockroft 1982; Gal 2000).

It is widely accepted that numeracy refers to a great deal more than basic number skills (NCVER 2005) which is an ongoing, and unfortunately common, misinterpretation. It encompasses the application of a broad range of mathematical skills, at different levels, when applied to real world purposes at home, in the workplace or in the community. It also incorporates the ability to interpret and communicate information (NCVER 2005).

The numeracy working group of the International Life Skills Survey (ILLS), now known as the Adult Literacy and Lifeskills survey (ALL), have attempted to encapsulate most of the aspects of this ongoing conversation in their description of numerate behaviour:

> Numerate behaviour is observed when people manage a situation or solve a problem in a real context; it involves responding to information about mathematical ideas that may be represented in a range of ways; it requires the activation of a range of enabling knowledge, behaviours and processes. (Gal et al. 2003)

ANTA (2002) identifies the range of mathematical skills as used in the Australian Quality Training Framework in the following terms:

> practical application of mathematical skills to absorb, use and critically evaluate information in numerical and graphical form. Depending on the context this can include basic number skills, spatial and graphical concepts, the use of measurement and problem solving. Numeracy may also involve literacy, for example when extracting mathematical information from written text (ANTA 2002, p.4).

A useful definition for the purposes of research into workplace numeracy comes from Coben:

> To be numerate means to be competent, confident, and comfortable with one's judgments on ***whether*** to use mathematics in a particular situation and if so, ***what*** mathematics to use, ***how*** to do it, what ***degree of accuracy*** is appropriate, and what the answer means in relation to the context (Coben 2000a, p.35, emphasis in the original).

Her description stresses the highly contextualised nature of numeracy; that is, that the mathematical strategies have developed appropriately for the physical situation, the tools available, and the degree of accuracy required in particular circumstances. For example, as Zevenbergen (2003) observed, pool construction workers can gain sufficient accuracy in measurement using a combination of visual judgement, hand spans and foot lengths to create pool frames which meet all expected standards, whereas such estimation would be totally inappropriate in cabinet making, manufacturing automotive parts or engineering (Bessot 2000; Dingwell 2000; Zevenbergen 2000).

Coben's definition also emphasises the importance of personal confidence or 'disposition' to use mathematics in appropriate situations, an aspect highlighted as vital by the formative Cockroft report (1982) "sufficient confidence to make effective of whatever mathematical skill and understanding is possessed whether this be little or much " (paragraph 37).

Although, as described above, there are many aspects of agreement on the meaning of the term 'numeracy', there is a divergence of views and ongoing debate regarding: the relationship between numeracy, mathematics and other generic skills (eg Coben 2000b; Wedege 2004); the meanings and descriptions of numeracy competence (see for example Marr 2002; Wedege 2004); what type of competence is required in the workplace and by whom (eg Bessot 2002; Fownes et al. 2002; FitzSimons et al. 2005; Hoyles et al. 2000; HRSDC, 2005) and finally, the implications which follow for education and training (eg Martin et al. 2005; Gillespie 2000; Wake & Williams 2000; Vergnaud 2000).

The invisibility of numeracy in the workplace

Researchers such as FitzSimons et al. (2005), FitzSimons and Wedege (2004); Kanes (2002); Fownes et al. (2002); Wedege (2000, 2003, 2004); Zevenbergen (2000) have found that endeavours to research the mathematics related skills valued and used in workplaces are complicated by the phenomenon of the invisibility' of numeracy. By this they mean that workers are not conscious of using mathematical skills at work, even when used frequently. For example, a café worker who said in a preliminary interview that she used no mathematics in her job, was observed frequently calculating change and capably estimating appropriate serving portions for effective distribution of the available food (Hansen 2005). Similarly, the Essential Skills Research in Canada found that workers focused on tasks, without necessarily recognising the maths within these tasks (HRSDC 2005).

Personal perception of adults in relation to mathematics

Coben's research into adults' 'mathematics life histories' reveals that many adults have such negative perceptions of themselves in relation to mathematics as experienced at school, that what they *cannot* do they regard as mathematics, whilst what they *can* do they see as 'common sense' or non-mathematics. The mathematics that they *can* do, such as measurement or numerical calculations, is taken for granted because to recognise it as mathematics would contradict their self-image as unsuccessful mathematics learners (Coben 2000b). At the same time as negating their own personal use of mathematical skills, almost all of the people interviewed by Coben and her colleagues remarked that mathematics was important, as was success in school mathematics exams. At the same time they found that many adults see themselves as competent adults without the need to use mathematics in their lives or their work.

Wedege (2004) describes this as the 'relevance paradox' — "the phenomenon of coexistence of the social significance of mathematics, with the invisibility and irrelevance subjectively felt by many" she postulates that when people reply that they don't need and don't use mathematics they possibly only refer to school mathematics not to mathematics at work which tends to be 'unrecognised' (p.2)

Unfortunately, as Wedege (2004) points out, this type of tacit or 'non-reflective' use (p.9) does little to alleviate adults' negative self image in respect to mathematics. This negative feeling is then likely to impact on their confidence to use mathematics and their willingness or resistance to undertake further training that involves explicit mathematics.

This view is supported by research findings from Marr and her colleagues (see for example Marr 2003; Marr with Helme 2002; Marr, Helme & Tout 2003). Their interviews with experienced numeracy teachers indicated the importance of numeracy learners' 'awareness' of their own existing skills and new learning. This awareness, or the lack of it, played an important role in the development of their personally held numeracy identities. According to Marr (2002) awareness of existing skills and knowledge and making personal connections to their own lives and work contributes in a two-way relationship to adults' confidence to use numeracy in relevant situations and continue with their learning.

Issues of personal disposition or confidence in relation to numeracy use and further training will be explored within the worker interviews for this study.

The embedded nature of numeracy in the workplace

Another frequent cause of the invisibility of numeracy is that, as described above, the means of performing numeracy related tasks in the workplace are highly dependent on the context, embedded within workplace developed routines and tools designed by experienced others and frequently intertwined with other skills or procedures, such as information technology or written communication (Dingwell 2000; Hoyles et al. 2000). The skills in use no longer resemble the 'mathematics' performed at school, and so are not appreciated or 'recognised' as mathematics or numeracy. Kanes (2002) differentiates between 'usable-numeracy' and 'visible-numeracy'.

Similarly, Nonaka & Takeuchi (1998) contrast 'tacit' and 'explicit' forms of knowledge. They draw on Polanyi's description of 'tacit knowledge' as a variety of skills and knowledge used without awareness whilst focusing on a task. According to Nonaka & Takeuchi, tacit knowledge is acquired from others through observation, imitation and practice during a form of learning they call 'socialisation' or 'tacit to tacit' learning by novices from experienced others. This type of learning is commonly found in 'communities of practice' such as workplaces (Lave & Wenger 1991; Wenger 2004). Lave and Wenger claim that far more effective learning takes place through these processes than in the more formal learning environments of schools and training institutions.

However, questions have been raised about the levels and type of competence that result from this sort of non-reflective learning, knowledge that is not 'externalized' (made explicit) in the minds of its users, and the resultant portability or transferability from one work situation to another, for example Buckingham 2003; Hansen 2005; Nonaka & Takeuchi (1998). These aspects will be discussed further in the following pages.

Numeracy in Australia's National Training Packages

Similar questions have been raised in relation to the 'integration' or embedding of numeracy (along with English language and literacy) into the 'Training Packages' which stipulate the desired outcomes of competency based vocational training in Australia (eg Haines & Bickmore Brand 2000; Julian 2004; Sanguinetti & Hartley 2000; Trenerry 2000.) Findings by Haines and Bickmore Brand that English language, literacy and numeracy competencies lacked visibility in early training packages were complemented by Trennery, who found that trainers considered the literacy and numeracy competencies in Training Package units to be insufficiently described to assist them in planning their training.

It is a current requirement that language and numeracy are integrated into Training Packages (ANTA 2004). Studies have found that this inclusion takes a variety of forms (Clayton 2003). It is found to be explicit or implicit, either as complete units of competence, as elements or performance criteria within a competency, or within the evidence guide or underpinning skills. However, Sanguinetti and Hartley describe research studies which indicate that in many cases the inclusion of language literacy and numeracy standards

> had made little difference to training practices and there was little or no evidence that any attention was being paid to literacy and numeracy needs (Sanguinetti and Hartley 2000, p.32).

Julian (2004) comments on the advantages and disadvantages of embedding employability skills (which include numeracy) in the units of Training Packages. He concludes that the main advantage is that "teaching and assessment of the skill becomes highly relevant and contextualized" (p. 91).

However, the main disadvantage is that the employability skills are subsumed in the vocational content. Embedding any generic or employability skills in the performance criteria, evidence guide or underpinning skills and knowledge acknowledges that the skills can make them very easy to ignore or forget (Julian 2004, p. 91)

In the three Training Packages reviewed for this study, numeracy was both explicit and implicit. In some cases it was found as the main focus of units of competency, in some as elements and performance criteria, whilst in others it was listed in the section on key competencies through the competency 'Use mathematical ideas and techniques', in range statements and the evidence guide.

Numeracy skills for workers

Several research studies have now been undertaken to identify the types of mathematical skills that are important for workers in a modern, globalised workplace. As mentioned earlier, these studies have been successful in highlighting the extremely contextual nature of numeracy used in different occupations and workplaces (for example Coben et al. 2003; Bessot & Ridgway 2000; FitzSimons et al. 2005; Fownes et al. 2002; Vergnaud 2000; 2003) and by diverse personnel with differing levels of responsibility in the same workplace (Bessot 2000).

Vergnaud, introducing an international collection of studies on the mathematical skills used in workplaces, poses questions about the school curriculum.

> Several mathematical ideas appear again and again in the routines used in the workplace: proportionality, graph reading, map reading, evaluation and approximation ... the fact that some parts of mathematics are used more than others in many professions raises the question of the room given to them in the curriculum (Vergnaud 2000 p. xviii).

His comments on particular commonly used skills are supported by FitzSimons (2005) who has found that the mathematical skills and knowledge underpinning many of the procedures observed in a range of workplaces included:

- algebraic thinking — for spreadsheets
- calculations — with and without calculators
- arithmetical estimation skills
- geometric thinking
- logic
- measurement
- accurate storage, retrieval, display and interpretation of data.

She also noted that beyond these identified mathematical skills, clear communication and problem solving were essential parts of workplace numeracy. In addition, those in positions of responsibility needed forward planning & organisational skills, an ability to keep an operation financially viable and satisfy legal requirements, as well as accurate and timely record keeping for accountability.

'Essential' or 'generic' skills

As well as generating lists of skills needed for particular professions, several national research projects have focused on encapsulating collections of desirable work qualities as 'essential skills' (see for example the Canadian Essential Skills Framework), often subsuming discussions about numeracy and literacy. For example, in Australia, numeracy is not specifically named in the Mayer Key Competencies but is generally considered as falling under the competency "Use mathematical ideas and techniques".

Of late, considerable work has been undertaken on generic employability skills — in particular the work of Curtis and McKenzie (2001) and Australian Chamber of Commerce and Industry (ACCI) & Business Council of Australia (BCA) (2002). Curtis and McKenzie consulted with industry to develop a draft table of employability skills. In this study, the term 'numeracy' is not used, rather, the study lists specific tasks or sub-skills, eg. "Understands tables of figures, able to interpret graphs, able to calculate" and "Allocates people and other resources (for example budgets, materials, space) to tasks" (Curtis & McKenzie 2001, p.51).

Curtis and McKenzie's list of employability skills (2001) was used as the basis for consultations with industry in the "Employability Skills Framework" study (ACCI & BCA 2002). The framework resulting from the study refers to numeracy in two of the eight broad skill-sets listed. Employers identified "using numeracy effectively" as an important facet of the skill "Communication that contributes to productive and harmonious relations between employees and customers"; and for the skill "problem solving that contributes to productive outcomes" an identified facet was "Using mathematics including budgeting and financial management to solve problems" (ACCI & BCA 2002, p.46).

Underpinning the Employability Skills Framework is the concept of literacy and numeracy as basic skills supporting many, if not all, of the Employability Skills (Waterhouse & Virgona 2004; Service Skills Australia 2005). Government documents also support the importance of English language, literacy and numeracy as "crucial underpinnings to learning to learn and generic skills and essential skills for the Australian population" (DEST 2005, p.17).

The importance of numeracy is highlighted in recent discussion of essential skills in Australia (McDonald & Goodwin 2005; Innovation and Business Skills Australia 2005). These discussions draw on work undertaken overseas, mainly in Canada and the United Kingdom. Work on essential skills is still developing in Australia.

Questions about the essential skills approach

There is, however, opposition to the type of analysis leading to lists of 'generic' or 'essential' skills, particularly in relation to literacy and numeracy needs for work. Following ideas of Stevenson (1996), Waterhouse and Virgona (2004) and others, (no paragraph break here)Jackson (2005) explains that the resultant statements of skills that are produced by these efforts are far too general to be useful in a particular context; appearing similar only "at a distance", where they are "stripped of meaning", but in fact having a different and particular meaning in each workplace situation.

For example, after observing workers' literacy use in call centres and aged care facilities, Waterhouse and Virgona (2004) explain how these workers' written and oral literacy practices are shaped by the expectations of their respective workplaces. Aged care workers learn to write in 'medicalese', which turns simple statements into drawn out jargonised sentences, and to confine their oral communications within strict ideologically guidelines for "respect". In contrast, call centre staff have to learn to write notes in the specific shorthand of their trade and to use a particularly "authoritative" tone in oral communications with customers. To classify these very different skills under generic descriptions such as "oral communication" or "writing" (HRSDC 2005) risks overlooking their very specific nature.

According to Waterhouse and Virgona (2004) one of the key challenges for trainers is to work out what the generic competencies mean in any given context and then determine how they can best be fostered and developed. However, whilst this approach will lead to 'procedural' or functional, performance knowledge and skills for specific workplaces, it does not address the capacity for adaptability and transfer.

Waterhouse and Virgona (2004) assert that flexible employability requires potential workers to possess more than generic versions of reading, writing and oral communications. They also need skills in social relations and a "capacity to read workplace cultures" (p.5) so that they can adapt their existing skills accordingly. These authors are concerned that specific on-site literacy training will not address this important aspect of literacy for ongoing employment.

Jackson (2005) supports these findings. She explains that there is a growing body of evidence indicating that belief in the transferability of generic skills may be deeply flawed. The capacity for transfer, she says,

> is not a ready-made property of the particular skills …the process of transfer is an active achievement of problem solving and interpretation on the part of an individual … transfer is achieved when individuals use problem solving skills to make sense of how old information fits each new context (p.41).

The relationship between school mathematics and workplace numeracy

Findings such as these, from workplace literacy research, complement a growing body of work which considers the transfer and/or "translation" of skills from one context to another, especially transfer of mathematics learning from classroom to workplace (e.g. Evans 2000; Nunes, Schliemann & Carraher 1993). Brown, Collins and Duguid (1989); Lave and Wenger (1991); Martin, LaCroix and Fownes (2005) and FitzSimons et al. (2005) follow early observations of Vygotsky, that maths taught in school is not readily transferred when required in vocational situations. Fownes et al. (2002) found that many adults "faced with solving workplace number problems don't know where to start, which numbers to use and what a reasonable answer might be" and even where operations are remembered, methods used may be inefficient in the context (Fownes et al. 2002 p. x).

Dingwell (2000) concludes that in workplaces, it is necessary to have a high level of competence in particular skills rather than an approximate understanding of a broad general mathematics curriculum (p.12).

Questions of transfer

Studies of workplace numeracy have highlighted many differences between mathematics as learned at school and the numeracy used in industry. For example, they have found that workers tend to use idiosyncratic methods of numerical calculation shaped by the tools and organisation of their jobs, rather than school taught processes; they also rely heavily on estimation both in calculation and measurement (see for example FitzSimons & Wedege 2003; Hansen 2005; Ridgway 2000; 2003).

Recent research by FitzSimons (2005) investigated the numeracy used in chemical handling and spraying. She concluded that

> most relevant learning is done in the contextualized workplace, through observation, reflection and creative adaptation to the artifacts and problems or goals at hand. However, these need to be supported by a firm foundation in school mathematics — beyond minimum grades necessary for school certification — together with a disposition to make sense of available data (present and historic) and a positive creative approach to problem solving (FitzSimons 2005, p.82).

These conclusions support prior findings regarding literacy, in that, they indicate workplace numeracy skills, like literacy skills, are highly contextualised. In addition, they point to the necessity for less definable aspects of competence — including a confidence to use numeracy skills when appropriate and the ability to problem solve.

Various attempts have been made to describe the extra qualities required by workers to go beyond defined routines and procedures to the type of thinking that contributes to critique and, thus, stimulates innovation in the workplace. For example, Buckingham (2003) refers to "decision making" judged on a scale of "readiness to act". Wedege (2004) refers to "readiness for action and thought" as part of numeracy competence and Hager (2003) talks of "productive learning" equipping workers for making "holisticjudgements".

Although, it is possible to conjecture that their findings may have been influenced by a degree of sophistication used to frame their initial questions, Hoyles et al. (2000) have attempted to encapsulate the mathematics related qualities[1] required for the modern UK workforce, which they maintain go well beyond a command of number. In addition to knowing how to calculate and estimate and to have a feel for numbers percentages and proportions, these include:

- analytical, flexible, fast and often multistep calculation and estimation in the context of work (with and without the use of IT tools)
- complex modeling (of variables, relationships, thresholds and constraints)
- interpretation of, and transformations between different representations of numerical data (graphical and symbolic)
- systematic and precise data-entry techniques and monitoring
- extrapolating trends and monitoring models across different types of work
- concise, clear communication of judgement
- recognising anomalous effect and erroneous answers. (Hoyles et al. 2000, pp.11,12)

It is interesting to conjecture which members of the workforce will require all of these capacities and how they might translate in the reality of particular workplace contexts.

This research project attempts to explore whether workers in the case-study sites use skills which might be described as judgement or problem solving beyond the routine numeracy-based procedures of their work.

Whether or not problem solving skills and the capacity to make holistic judgments will be the result of further school mathematics education, as advocated by FitzSimons et al. (2005), is problematic. Although identification of problem solving as a generic skill for workers is popularly used to justify the inclusion of *mathematical* problem solving in the school curriculum, some researchers observe that in fact 'problem solving' in the workplace differs significantly from that taught at school. Aspects of difference include the motivation for undertaking the task, since problem solving in the workplace is focused on a practical outcome rather than being an end in itself or generating further mathematical knowledge, and, in addition, in a work situation, the problem is usually 'owned' by, and has meaning for, the person solving it, rather than being presented by a teacher. In school mathematics, problems have absolute and correct solutions, but there are no real consequences if a wrong answer is given, whereas in the workplace, incorrect solutions can have serious and costly consequences, whilst the degree of accuracy or exactness of the outcome is not absolute, but negotiable according to the circumstances (Martin et al. 2005).

[1] Hoyles, et al. use the description 'mathematical literacy' rather then 'numeracy' — the latter they tend to qualify as 'basic numeracy'.

Recommendations for further research arising from the literature

Jackson (2005) calls for further detailed case study research "on the process and conditions of workplace learning and transfer" (p.43). She is also of the opinion that such research should question how individuals are supported (or not) to learn in their jobs; how the conditions and time for learning are created in the workplace, and how workplaces can be made safe environments for the application of new skills and encouragement of risk taking.

FitzSimons et al. (2005) have observed that there is a gap in the research findings regarding specific numeracy learning in the workplace. This study will seek to investigate how workers in the case study sites learned the numeracy skills that they use at work and how in their own minds they relate them to the mathematics learning experiences at school. The lists of commonly used numeracy skills which arise from the work of FitzSimons et al. (2005) Hoyles et al. (2000) and others, has been used within the interview proformas to help respondents appreciate the scope of the skills encompassed by the term numeracy. That is, since numeracy is not yet 'a household word', asking them whether they use particular type of skills, such as using formulae, or reading graphs or charts, is considered to be more helpful than general questions regarding numeracy skills.

In addition to interviews, observations of what people do in their jobs will be undertaken, as far as is practicable, to overcome the difficulties caused by the unconscious nature, or invisibility of workplace numeracy, as discussed above. Observations will be used to 'unpack' the numeracy skills underpinning the workers' roles and procedures. Zevenbergen (2000) argues that case studies of this nature should not be undertaken from the standpoint of justifying an existing curriculum or perception of numeracy and, thereby, attempt to "uncover hidden mathematics of the context". Rather they should seek to

> enhance our understandings of how participants come to work and understand their contexts from their perspective … to aid in constructing a better understanding of how people use, modify or reject the use of school mathematics in a non-school context (p.186).

The interview components of this research project will explore perceptions of numeracy, its relationship with school mathematics, and the type of competence sought in the case-study workplaces from the point of view of industry stakeholders, managers and workers.

Jackson (2005) also advocates that the case studies of literacy and numeracy use in the workplace should consider how people function in the context of the workplace culture and relationships, rather than as individual cognitive units. In saying this, she again draws on Waterhouse and Virgona (2004) who note that it is problematic to conceptualise generic skills such as communication, teamwork, and interpersonal or relationship skills as resting in the individual, when they are in fact social and collective in nature:

> on the whole they grow through practice, through 'doing' with other people. … [I]nvestigations of work in practice (show) how groups of workers are able to complete tasks in which they appear not to possess skills. The competence rests with the collective — the whole is greater than the sum of its parts (p.20).

This project will attempt to explore the social distribution of numeracy tasks in the case-study worksites through observation and interviews with the workers.

The themes identified in the literature, and described above, have guided the formulation of the questions and purposes of the research interview proformas (see methodology section).

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Consultation and support

Key stakeholders

An important aspect of the study was to investigate synergies between industry numeracy skill requirements, workplace contexts and stakeholder perceptions. For this purpose semi-structured interviews were held with a variety of 'key stakeholders'.

Key stakeholders interviewed for this research project were representatives from the following organisations:

- Australian Chamber of Commerce and Industry (ACCI)
- Business Group of Australia
- Victorian Employers' Chamber of Commerce and Industry (VECCI)
- Community Services & Health ITB (Vic)
- Department of Health and Community Services
- Automotive Training Australia
- Union representatives from AMWU and ACTU
- Two representative employers.

Steering committee

A steering committee provided strategic advice to the research team. Their input was sought through meetings, phone conversations and email at strategic points in the project.

A project steering committee has been established. The committee comprised:

- John Braddy, Executive Officer, Automotive Training Australia
- Robyn Jackson, Director, School of Social Sciences, Swinburne University of Technology — TAFE
- Ros Kempton, Health and Community Services Union representative
- Andrew Rimington, Education and Training Officer, VECCI
- Brian Spencer, Executive Officer, Community Services & Health ITB (Vic)
- Dave Tout, WELL Numeracy Consultant, Multifangled.

Critical friend

The project also used a critical friend, Betty Johnston, to advise on the methodology and to offer critical feedback and support to the project team. This support was invaluable to the project.

Interview schedules

Five different interview schedules were used in this project for:

- Stakeholders
- Workers at the case study sites
- Frontline supervisor at the case study sites
- Manager at the case study sites.

Stakeholder interview schedule

Guidelines for interviewers

- ✧ To be conducted face-to-face or by phone. Interview schedule could be sent to the interviewee before the interview if requested.
- ✧ If stakeholder is from a particular industry sector use appropriate specific question formats and customise where appropriate
- ✧ If stakeholder is from a non-industry specific organisation then use the general forms 'industry' and 'the workforce', rather than the workers in your industry

1. Introduction

Interview with: Date:

Interviewer: Place:

Purpose of research explained using the Disclosure form ☐

Consent form signed ☐

Purpose **and *procedure***	**Questions**
2. Concepts and **definitions** of numeracy in the workplace	2. Government policy documents related to training all refer to the literacy and numeracy levels of the workforce. So to start with, can I just ask you what the term 'numeracy' means to you?
3. **Importance of numeracy** and mathematics in the workforce / industry	*Choose appropriate ending (see general guidelines above):* 3. How important do you think numeracy and maths related skills are for: o the workforce in your industry? o workers?
4. **Use** of numeracy in the workforce / industry *Present list of skills on a separate sheet.* ***'Numeracy in the Workplace'*** *Interviewers to mark on a **three** point scale the level of importance of each skill.* *Note: Need to move through this relatively quickly. If by the end of this question you are more than 15 minutes into the interview, you should be prepared to 'hurry' the interview along.* *Remember there is the possibility of coming back and delving into these skills further if time allows.*	4a. What numeracy and maths related skills come to your mind as important? 4b Looking at this list of skills — can you indicate the level of importance of each? Thinking out loud as we decide which box to tick will be useful. But we won't dwell too much on each as there are 15 listed. Perhaps if you mainly commented on the skills you think are the most important. i **Calculation** — with and without calculators or computers Very important ☐ Important ☐ Not important ☐ For all workers? Comments ii. **Mental calculations/ estimations** Very important ☐ Important ☐ Not important ☐ For all workers? Comments iii. **Calculation and interpretation of percentage** Very important ☐ Important ☐ Not important ☐ For all workers? Comments

	iv. **Measurement**: eg length, volume, weight, temperature, speed Very important ☐ Important ☐ Not important ☐ For all workers? Comments v. Use of **ratio and proportion** Very important ☐ Important ☐ Not important ☐ For all workers? Comments vi **Creation and use of formulas** (possibly using spreadsheets) Very important ☐ Important ☐ Not important ☐ For all workers? Comments vii **Display and interpretation of data** Very important ☐ Important ☐ Not important ☐ For all workers? Comments viii. Use and interpretation of **graphs, charts and tables** Very important ☐ Important ☐ Not important ☐ For all workers? Comments ix. Use and interpretation **of scale drawings, plans and diagrams** Very important ☐ Important ☐ Not important ☐ For all workers? Comments x. Recognition of **patterns and anomalies with measurement and data** Very important ☐ Important ☐ Not important ☐ For all workers? Comments xi. **Communication** of mathematically related ideas Very important ☐ Important ☐ Not important ☐ For all workers? Comments xii. Use of **computers/technology** in relation to mathematical tasks Very important ☐ Important ☐ Not important ☐ For all workers? Comments xiii. Use of **mathematical ideas and concepts to model or analyse workplace situations** Very important ☐ Important ☐ Not important ☐ For all workers? Comments

	xiv. Use of **mathematical ideas and concepts to evaluate and critique** workplace practices and monitoring systems Very important ☐ Important ☐ Not important ☐ For all workers? Comments xv. **Other** (space to be left for comments, additional skills, etc) Very important ☐ Important ☐ Not important ☐ For all workers? Comments
5. Numeracy in relation **to Quality control / accountability**	5. Are there any that you think are particularly important in relation to quality control / accountability? *Note responses in relation to the numbered skills above and any comments.*
6. Numeracy in relation to **OH&S**	6. What about for OH&S? *Note responses in relation to the numbered skills above and any comments.*
7. Numeracy in relation to **Innovation**	7. Are there any that you think are particularly important in relation to future innovation in industry? *Note responses in relation to the numbered skills above and any comments.*
8. Relationship between **workplace numeracy and school mathematics**.	8. How do you think these important numeracy skills (refer to list) relate to the sort of mathematics that people learn at school? Would you have any advice for school maths teachers?
9. **Changes** in the industry and relationship to maths/numeracy	9. Are there any changes in [your] industry that are likely to change the numeracy skills that workers will need?
10. Numeracy **related** training needs	10a. What are the implications for numeracy skills development of existing workers? 10b. What about for preparing people for employment [in this industry]?
11. **Effective learning** for workers	11. In general, from your experience what do you think are the most effective ways that workers learn? *Refer them to the list on the back of their sheet for examples if no response. Space has been left below after each example but comment on each example are not necessary.* These are some ways workers learn: observing other people being taught by another worker on the job being taught by your supervisor or manager on the job formal training in the workplace formal training elsewhere being taught at school other ___________________________
12. **Effective models** of training	12. Given your response to the last question, what strategies do you think are likely to be most effective for developing workers' numeracy skills? *May need to refer to the printed list.*
13. **Thank you**	13. Thank you for taking the time to talk to me ….

Worker interview schedule

To be conducted face-to-face and preferably after observation.

1. Introduction

Interview with: Date:

Interviewer: Place:

Purpose of research explained using the Disclosure form ☐ Consent form signed ☐

How long have you been working at ____

What is your role/position? ____

How long have you been working in this job? ___________________________________

Purpose and interview instructions /procedure	Questions
2. **Work tasks** related to maths & numeracy including frequency and importance	2a. Do you use any maths related skills in your work? What comes to mind? *or* What are the main things you just thought of?

Numeracy tasks and tools	2b. Because its hard to think of these things off the top of your head — can we go through this list and see how often you do any of these things:						
Present list of tasks. “Maths in the Workplace”	*Interviewers to mark frequency of use on the 4 point scale.*	Never	less than once a week	About once a week	Daily	Comp-uter	Calcu-lator
Interviewers to give a letter (A) etc to each type of example. *And make brief note of details of type of task*	i Do you do any measurement? Eg o Using tape measures, rulers, o Scales (for weighing), o gauges, dials, o callipers, or other things like that? o Other measuring of any kind						
	ii. Do you use any graphs, charts or tables eg: o entering data on charts, graphs or spreadsheets o reading graphs o constructing graphs						
	iii. Do you do any calculations, for example: o Adding, subtracting, multiplying, o Using percentages o Using fractions o Ratio, proportion, mixing solutions o Decimals — such as working out money o Use conversion charts						
	iv Do you use any formulas?						
	v. Do you read or create plans, diagrams, scale drawings?						
	vi. Any other sorts of things you do at work where you use your maths skills?						

Purpose	Questions
3. Use of **technology** to perform tasks *Mark answers on previous pages — against tasks*	3. Would you use a calculator or computer for any of these things? Which?
4. **Social distribution** of numeracy tasks	4. Do you do these things by yourself or do you ask someone else to help you with any of them? *Specify* Do you think this is an effective way of getting the task done?
5. **OH&S**	5. Are any of these maths tasks related to a) your safety and b) that of other workers? c) What about client or customer safety — are any of these maths tasks related to their safety?
6. Numeracy and mathematics **learnt at work** *Selection of tasks for 'drilling down' May need to give example from own experience*	6. Are there any of these tasks that you have had to learn here at work? Can you describe the task? What is the purpose of it? For example do you know what the information /result is used for?
7. Transfer of skills from different context	7. Have you done something similar before — in your job or at home? Can you imagine doing this type of task in a different workplace or at home?
8. Learning models	8. How did you learn to do this? For example: - observing other people - being taught by another worker on the job - being taught by your supervisor or manager - formal training in the workplace - formal training elsewhere Did you find this difficult to learn?
9. Relationship to **school maths** *Probe — around possible related skills eg. Did you learn to do graphs at school?*	9. Do you think this has any connection to maths you learned at school? How? What? Tell me about that.
10. Worker's relationship to school maths	10. How did you feel about maths at school? What was the highest level that you did maths at school? Why did you stop doing it?
11. Best learning model *Preferably get worker to talk about a task other than a calculation one.*	11. You said you *learned [insert the specific task learnt at work*] by *[insert method*] Do you think that was the best way for you to learn this, or can you think of other ways that might have been better?

12. Thinking **beyond operational** dimension	12. Can we just go back and talk some more about doing the task: What you do is …*[recap the procedure they described briefly]. [Interviewer to customise questions as required.]* Do you ever feel that the [measurement / result ……] isn't right? What do you do in that case? What do you feel about doing this task? Do you think this [measurement, result, information …] is useful in the work? Do you ever think about how this type of task / process could be improved? If you had an idea to make it, or something else, work better, would you be encouraged to discuss the idea? Do you think you would you get support from your boss/team leader/manager/other workers?
13. Compare with skill not learn in the workplace	*Select one other numeracy related task (preferably a calculation task) that workers perform at work but which wasn't learn at work.* You do ….[name task] …….. Have you done something similar before? Where? Where did you learn to do that? How did you learn to do it?
14. **Thank you**	14. Thank you for taking the time to talk to me ….

Frontline supervisor interview schedule

To be conducted face-to-face The interview should be customised as much as you can by finding out the local terminology used for the group of workers that this supervisor is in charge of, eg team, workgroup, staff and by using other relevant terminology.

1. Introduction

Interview with: ______________________ Date: ______________________

Interviewer: ______________________ Place: ______________________

Purpose of research explained using the Disclosure form ☐

Consent form signed ☐

How long have you been working at ____?

What is your current role ? ____

Have you worked in other roles here in that time? ______________________________

Purpose and interview instructions /procedure	Questions
2. **Importance** of numeracy in the workplace	2. How important do you think numeracy or maths related skills are for your [work team]?
3. **Use** of numeracy in the workplace [general]	3a. Do your [work team] use any maths related skills in their work? What were the first things you thought of?

Numeracy tasks and tools	3b. Because its hard to think of these things off the top of your head — can we go through this list and see how often your team do any of these things:						
Present list of tasks. 'Maths in the Workplace' *Interviewers to mark frequency of use on a 3 point scale.*		Never	less than once a week	About once a week	Daily	Comp-uter	Calcu-lator
Interviewers to give a letter (a) etc to each type of example. Use of technology to perform tasks	i. Do they do any measurement? Eg o Using tape measures, o rulers, o scales, o gauges, o dials, o callipers, or o other things like that?						
	ii. Do they use any graphs, charts or tables eg: o entering data on charts, graphs or spreadsheets o reading graphs o constructing graphs						
	iii. Do they do any calculations, for example: o Adding, subtracting, multiplying, o Using percentages, o Using fractions o Ratio, proportion, mixing solutions o Decimals — such as working out money o Use conversion charts						
	iv. Do they use any formulas?						
	v. Do they read or create plans, diagrams, scale drawings?						
	vi. Any other sorts of things you do at work where they use maths skills?						

Purpose	Questions
4. Use of **technology** to perform tasks	4. Would they use a calculator or computer for any of these things? Which? [*Mark answers on previous pages — against tasks and add any comments below]*
5. **Attitudes and difficulties** with numeracy	5. How do the workers seem to feel about doing the maths related tasks we have been talking about? Are you aware of any problems or difficulties they have with them?
6. **Social distribution** of numeracy tasks	6. Do all members of the team need to do the same maths related things? *Discuss some examples* Do they do these things by themselves or do they work together to get them done? *Discuss how this works* Do you think this is an effective way of getting the tasks done?
7. Use of numeracy in the workplace in relation to **OHS, quality control/ accountability**	7. Are any of these Maths tasks related to OH&S? What about quality control/accountability?
8. Thinking **beyond the operational** dimension	Do you feel that your team members think about the purpose of these tasks? Do they seem to think about the meaning of the results /measurements they get? Do they ever express opinions about the tasks or process that they use?
9. **Changes** in the industry and relationship to maths/numeracy	9. Are there likely to be any changes in the industry that might change the numeracy and maths related tasks your work team members need to do?
10. Support of acquisition and development of skills	How have your work team members learned any new numeracy and maths skills they need for the job? For example: o observing other people o being taught by another worker on the job o being taught by one of the supervisors or managers on the job o special classes as work o classes elsewhere o some other way
11. **Effective models** of training	11. Given your response to the last question, what do you think is the most effective way to assist workers to develop necessary numeracy or maths skills? *[Encourage alternative suggestions]*
12. **Thank you**	12. Thank you for taking the time to talk to me ….

Manager interview schedule

To be conducted face-to-face.

1. Introduction

Interview with: ______________________ Date: ______________________

Interviewer: ______________________ Place: ______________________

Purpose of research explained using the Disclosure form ☐ Consent form signed ☐

How long have you been working at ____?

What is your current role? ____

Have you working in other roles here during that time? ____________________________________

____

Purpose and interview instructions /procedure	Questions and procedure
2. Concepts and **definitions** of numeracy in the workplace	2. Government policy documents related to training all refer to the literacy and numeracy levels of the workforce. So to start with, can I just ask you what the term 'numeracy' means to you?
3. **Importance of numeracy** and mathematics in the workplace	3. How important do you think numeracy and maths related skills are in this workplace?
4. **Use** of numeracy in the workplace [general] Present list of skills on a separate sheet, 'Workplace numeracy skills' *Interviewers to mark on a three point the level of importance of each skill.* *Note: Need to move through this relatively quickly. If by the end of this question you are more than 15 minutes into the interview, you should be prepared to 'hurry' the interview along.*	4a. What numeracy and maths related skills do you think people use in this workplace? 4b Just to make sure we cover everything can you look at this list of skills and try to indicate the level of importance of each? Thinking out loud as we decide which box to tick will be useful. But we won't dwell too much on each as there are 15 listed. Perhaps if you mainly commented on the skills you think are the most important. **Calculation** - with and without calculators or computers Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Mental calculations/ estimations** Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Calculation and interpretation of percentage** Very important ☐ Important ☐ Not important ☐ For all workers? Comments

Remember there is the possibility of coming back and delving into these skills further if time allows.	**Measurement**: eg length, volume, weight, temperature, speed Very important ☐ Important ☐ Not important ☐ For all workers? Comments Use of **ratio and proportion** Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Creation and use of formulas** (possibly using spreadsheets) Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Display and interpretation of data** Very important ☐ Important ☐ Not important ☐ For all workers? Comments Use and interpretation of **graphs, charts and tables** Very important ☐ Important ☐ Not important ☐ For all workers? Comments Use and interpretation of **scale drawings, plans and diagrams** Very important ☐ Important ☐ Not important ☐ For all workers? Comments Recognition **of patterns and anomalies with measurement and data** Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Communication** of mathematically related ideas Very important ☐ Important ☐ Not important ☐ For all workers? Comments Use of **computers/technology** in relation to mathematical tasks Very important ☐ Important ☐ Not important ☐ For all workers? Comments Use of **mathematical ideas and concepts to model or analyse workplace situations** Very important ☐ Important ☐ Not important ☐ For all workers? Comments

	Use of **mathematical ideas and concepts to evaluate and critique** workplace practices and monitoring systems Very important ☐ Important ☐ Not important ☐ For all workers? Comments **Other** (space to be left for comments, additional skills, etc) Very important ☐ Important ☐ Not important ☐ For all workers? Comments
5. Use of computers	5. Do the workers need to use computers to do any of these? *Note responses in relation to the numbered skills above and any comments.*
6. Numeracy in relation to Quality control / accountability	6. Are there any that you think are particularly important in relation to quality control / accountability? *Note responses in relation to the numbered skills above and any comments.*
7. Numeracy in relation to OH&S	7. What about for OH&S? *Note responses in relation to the numbered skills above and any comments.*
8. Numeracy in relation to Innovation	8. Are there any that you think are particularly important in relation to future innovation in your workplace? *Note responses in relation to the numbered skills above and any comments.*
9. Changes in the industry and relationship to maths/numeracy	9. Are there likely to be any changes in the industry that might change the numeracy and maths related tasks the workers need to do?
10. Numeracy skills of potential employees	10a. When you are hiring new staff what are the main abilities you look for? 10b. Are numeracy and maths skills something you take into account? How? What do you look for?
11. Support of acquisition and development of skills	11. How do your workers learn any new numeracy and maths skills they need? For example: o classes/training at the workplace o watching another worker o explanation by supervisor, mentor or colleague o training at an education organization o other.
12. Effective models of training *May need to refer to list above.*	12. Given your response to the last question, what do you think are likely to be most effective strategies or ways of developing workers' numeracy skills?
13. **Thank you**	13. Thank you for taking the time to talk to me ….

Case studies

Case Study 1: Metals and More — a small manufacturer of metal products

The workplace

Metals and More[2] started operating in 1978 as an Australian-owned family business, manufacturing sheetmetal products. It produces slow combustion heaters and a wide variety of metal parts for various manufacturers, including automotive producers. The factory is situated on an industrial estate in the outer suburbs of Melbourne.

In many respects this workplace is representative of a traditional business: it is still family owned and appears to have a humane attitude to retention of workers, resulting in a largely stable workforce with varied levels of skill. Many of the work sections are comprised of only one or two people who seem to take personal responsibility for the output of their section. However, there is a spirit of cooperation which means workers occasionally lend a hand in other areas or call for assistance if time pressures demand. During this case study, which coincided with the end of the calendar month, personnel from dispatch and management were in frequent contact with production workers regarding customer pressure for urgent completion and delivery.

As staff numbers and the range of products have increased, it has become necessary to ensure more sophisticated OH&S and quality assurance systems are in place, and to develop communication systems to ensure the efficient flow of work both within teams and across the company. With the introduction of new systems and processes, the need for training has become apparent. There is no dedicated Quality Assurance role within the organisation, although a consultant was brought in to make recommendations. Currently, individual workers take responsibility for the quality assurance of their own work rather than operating on sampling systems which are often found in larger operations. There is some concern within the company of the potential threat of more competitive off-shore operations challenging the domestic market and making Metals and More uncompetitive; thus losing the associated metal engineering skills from the Australian workforce.

Worker profile

The company currently employs 70 staff with seasonal increases. The majority of employees are involved in production, undertaking a combination of assembly line work and operation of machinery. Approximately 10% of the workforce are from non–English-speaking backgrounds. The majority of workers and frontline supervisors from the process and warehouse areas exited school with minimal formal qualifications, and many lack literacy, numeracy and learning-to-learn skills. Many also lack the confidence to undertake training. For some, their school experiences were negative and they are reluctant learners, anxious and intimidated by formal learning situations. Only

[2] Fictional names have been used for the case study sites and the workers at those sites.

four employees were qualified trades people including the current Assistant Production Manager who holds a 'Sheet-metal worker - First Class' qualification.

The workers interviewed

The case study is drawn from informal conversations, a shadowing process and interviews with three workers from different sections of the company. 'Frank' was an operator of large automated laser cutting and stamping machines in the numerical control room. 'Elaine' was the assistant to the Paintshop Supervisor in the finishing section (where products were powder coated or painted, packed for dispatch and counted to ensure that quantities produced and sent matched the orders). Tracey' was filling in for the Dispatch Supervisor and was responsible for organising delivery of products, selecting appropriate means of transport, liaising with drivers and transport companies and calculating appropriate delivery charges in order to correctly invoice customers.

In addition, the study was informed by comments from a newly employed Storeman and formal interviews with the Production Manager and the Assistant Production Manager (the person responsible for the production floor and most communication with the production workers).

The numeracy skills they used

Interpreting and copying numbers

Products moving in, out and through the company are tracked by copious amounts of paperwork, order forms, delivery dockets, invoices, and travel cards (jobsheets). The majority of information on this paperwork is numerical, for example order number, delivery docket number, invoice number, customer part number, numbers of packs, quantity per pack, date, job number, shelf number, operator number, drawing number, machine number and so on. This numerical data is interpreted easily by staff and frequently copied by hand from one form to another as the raw material moves through the plant and dispatched. The correct copying of appropriate numbers, many with six or more digits, between different documents, computer screens and in a wide variety of formats is vital to the efficient operation of the company.

Arithmetical calculations

All of the workers interviewed used arithmetical calculations of varying complexity on a daily basis. Workers selected as they felt appropriate from a variety of pen and paper techniques, in-the-head strategies or use of a calculator. For example, 'Elaine's' 'counting' of products involved adding in 10s, 20s and 50s (usually in the head with interim tallies on paper) or multiplication of numbers in rows by numbers of rows (sometimes using calculator), and often subtraction (with calculator) to determine numbers of leftover products.

For 'Tracey', in dispatch, calculating freight costs involved multiplication and addition within a variety of formulas: whole number calculations in-the-head or using pencil and paper; those involving larger numbers, decimals and percentages carried out using a calculator. For her there was a complementary and comfortable movement between in-the-head, paper and pencil computations and the calculator, with 'Tracey' selecting whichever method felt appropriate and checking one with the other when in doubt.

'Frank' used a range of arithmetical operations daily, for example, adding for totals and subtracting for leftover numbers of products, tallying numbers of metal sheets available in stacks and calculating numbers of products he could cut from a stack: "Say we have an order for 120 parts and I've got 18 sheets of metal available to cut them from. If I know that each sheet gives me 16 parts, then I calculate 18 x 16 to see if it's enough". He said that these calculations were usually "in-the-head" or paper and pencil "because calculators have a way of straying". It was noticed that his strategies avoided division. In fact no-one interviewed mentioned using division.

Counting was mentioned at management level as an ongoing problem. Although superficially this may sound like a simple, straightforward skill, it involves making decisions about suitable tallying systems for each variety of product, depending on its size and type of packing. For example, a product might be packed in 8 layers of 8 items per carton, or in combinations of bubble-wrapped packs of ten objects. Large crates may be packed with ten or twenty items per row as the product comes off the finishing line, with a progressive tally kept as this happens. Small items might be placed in plastic packs of fifty and sometimes double-checked by weight.

The task of establishing and working with appropriate counting strategies to ensure that the exact quantities are sent to the customer was the responsibility of 'Elaine', a production worker in the paint shop and finishing section. There was a lot of multi-tasking in her job. For example, simultaneous with counting the products, she might be unhooking the product from the drying line, removing masking plugs, performing a visual quality check, and packing the product.

Fractions were not mentioned by any of the workers interviewed — they were no longer necessary with the shift to metric units of measurement.

Decimals were also used on a daily basis by most of the workers interviewed: for measurement (including calculations involving measurements of say 30mm + or - .5mm); calculations using decimal multipliers as well as addition and multiplication of money for costing; conversion of time to decimals (eg. 1hour 30 mins converted to 1.5 hrs), as well as addition and multiplication of the results for filling in timesheets and checking pay.

Percentages were used by some of the workers in the case study. In dispatch percentages were used to calculate the GST (goods and services tax) of 10% and a fuel levy of 10.4%, both based on the calculated freight costs.

Percentages were also used to express 'clearance' rates (eg 15%) for the metal parts used for punching and stamping holes. 'Frank' remembered these percentages by rote for each thickness of metal, claiming "They're second nature now". However, he said he had calculated them in the early stages of the job, and also used a chart (obtained from a former workplace) as a guide.

Measurement

All workers interviewed performed measurements frequently, using a variety of instruments. **Rulers and tape measures** were used throughout Metals and More for length, width and depth of products and components, and to ensure holes were stamped in specified positions. **Verniers** were used to check that the thickness of metal sheets being delivered matched the required specifications on the orders.

Measurements were made with **varying degrees of accuracy** depending on their purpose. For example, in the assembly room, products are measured within standard tolerance levels of 1mm in 500–1000mm. However, in dispatch, rougher length measurements were made with a tape measure because these were sufficiently accurate to determine the volume of the product both for calculating freight costs and determining the method of transport.

Weighing scales were used for weighing loads and products for the purposes of calculating freight costs, deciding on methods of packaging and transport, as well as ensuring safety for lifting and storage.

Estimation of weights and sizes was commonly mentioned — usually visual estimation. For example, after years of experience with sheet metal, 'Frank' could visually estimate weights as loads came on the delivery truck. This enabled quick decision making about appropriate lifting, storage and labeling of materials. He explained that at times he had argued with a forklift driver that he was about to lift weights which exceeded the 2.5 tonne limit for his machine and should split the load. In these cases scales were used to settle the disagreement. Similar estimations were described by the storeman in relation to packing. These included ensuring parcels remained under the 22 kg limit, deciding when to attach warnings to light and fragile items, and visual estimations of size to efficiently choose appropriately sized packing cartons or envelopes. Truck loading also depended on visual estimates of goods' size and weight, these variables influencing whether to use the larger or smaller vehicle so as to stay within their legal carrying capacity.

Estimation of time was mentioned frequently by case study participants. They were continually having to prioritise jobs according to short and long term timelines, estimate the time each operation would take, when items could be completed for delivery, when a job must be commenced in order to be completed by deadline, and how long the delivery round would take.

Use of formulae

In the cutting section, formulae underpinned the selection of correct sizes of dies and punches used in punching and stamping machines. Also a 'bend allowance' formula, dependent on the thickness of the sheetmetal, was used when cutting lengths of metal to ensure they would be long enough after bending into shape. However, according to the production manager, most of the resulting measurements figures were remembered through frequent use, rather than the operators regularly using the formulae.

Formulae were used in dispatch to calculate volume and freight cost. It was interesting to note that in describing her calculations for freight costs, only the volume formula ($V = l \times w \times h$) was immediately identified by 'Tracey' as a formula. Other, more complex sets of steps involved in costing were merely seen as a method of calculation. (Perhaps the volume formula, being the same as the one learned at school, was named as a mathematical formula, whereas the others, learned at the workplace were not thought of in the language associated with school mathematics.)

Spatial awareness

In addition to skills which were addressed specifically in the interview, there was evidence of a great deal of spatial awareness being applied by the workers in the factory. They constantly loaded cartons onto pallets, trolleys and trucks in a variety of configurations to ensure stability, and maneuvered forklifts and hand-pushed trolleys in and out of confined spaces.

Plans, diagrams, scale drawings

Complex and detailed 2D scale drawings were used by most workers to guide their work of cutting, folding, assembling, welding, and finally masking the necessary holes prior to the painting process. These plans were not generated by the production workers and, strictly speaking, they only had to attend to their own aspects of the drawing, for example, recognise which holes to mask with the aid of margin notes and symbols on the drawing, or differentiate between the drawing for right and left side components. However, it seemed that the workers also interpreted other aspects of the plans, identifying the meaning of particular symbols and lines that were not for their own task, and in some cases noting discrepancies between the parts they received from other sections and the drawings.

Maps were used as guides in the dispatch department, with loads for similar areas being grouped on the trucks to save unnecessary travel. On the notice board was a list of customers, addresses and map references to aid this process.

Numeracy skills related to Occupational Health and Safety

As described above — estimation of weights with occasional checks using scales was mentioned as an important OH&S consideration that involved numeracy.

The numeracy skills related to quality

At Metals and More quality checking usually involved both visual checks and measurement of individual items. For example, incoming metal sheets were checked using a vernier for thickness and tape measure for length and width to ensure they met specifications ("20 ml can be really significant in cutting — mistakes cost" [Frank]) and lengths of 'wicks' for heaters checked with a tape measure. A handheld electronic instrument (Elco meter) had recently been introduced into the company to measure the thickness of powder coating to ensure it is "within upper and lower measurements" [Elaine](ie. within tolerance levels).

Numeracy, technology and the future

Response to innovation by production workers in this company meant learning to use electronic measuring devices, databases and computer-operated laser cutting and stamping machines. The latter involved familiarity with information technology, interpreting measurements and angles from computer program outputs to guide the setting up of the laser cutting machines; as well as loading and deleting the appropriate programs so as not to exceed the computer storage limit. Databases were frequently used to check order numbers and other details and to generate invoices. The use of computers to find information seemed to be taken for granted by most of the workers observed.

Social distribution of numeracy related tasks

Most workers seemed to take responsibility for their own numeracy related tasks. However, they said that they could ask co-workers or supervisors for help, or to check if they were unsure, particularly in relation to a new process. For example, during the case study period, 'Tracey', (filling in for the Dispatch Supervisor) had to make adjustments to other workers' timesheets for the first time. This involved rounding times to within a quarter hour. As she had not performed the task before she had no hesitation asking a co-worker to clarify aspects of the task.

How workers learned numeracy related tasks

For the production workers in this study most learning was through demonstration by a supervisor, co-worker or technical staff from other sections (on-the-job training). For example, Elaine' was shown how to use the 'Elco-meter' for measuring the thickness of powder coating, by her supervisor.

In several instances learning took place through independent initiative on the part of the workers, who sought advice from outside the company. For example, after making some initial costly errors, Tracey' learned how to correctly calculate freight costs by phoning someone at the transport company. 'Frank' obtained copies of charts from his former workplace to guide him in selecting the appropriate 'dies', 'slugs' and 'clearances' according to the metal used, to ensure optimal operation of the complex punching and stamping machinery: "I need to see it in writing — I don't trust word of mouth." ['Frank']

Recent attempts at formal numeracy training (a short course requested by the company and delivered by a local TAFE unit at the worksite) provoked interesting reactions from two of the workers in the case study. Although both admitted they had learned *some* new skills in the training, it was obvious from their reactions and comments that the experience had been threatening to them, apparently awakening strong anxieties associated with past school experiences. [Both had left school in the first and second years of secondary school respectively after very negative experiences, neither had been in a maths class beyond the first year of secondary school. Judging from their remarks, they were not accustomed to formal training situations, although it was not clear how much was the classroom association and how much a negative reaction to mathematics. "She was a really nice lady but I really used to dread Thursdays"['Elaine']

"I felt a bit agitated, a bit threatened. I wondered why I was learning this stuff — after all I'm nearly 48 years old. " ['Frank'] He thought, however that as well as learning to calculate areas with 'pi', mainly he had "learned to think beyond the square", and the experience had helped get his mind going.

'Elaine', on the other hand, reflected that she must have learned something because the teacher said she had passed.

Some of their comments indicated that they were looking for a direct relationship between their current work area and the training, both spontaneously mentioning aspects of disconnection 'Elaine' said "I would rather have done something useful … it was mainly the men's stuff — for the Numerical Control room." 'Frank': "When they did the course here they worked in centimetres which we never do on the factory floor."

Beyond operational

There was some indication that learning from co-workers did not address **underpinning knowledge** (deeper learning) associated with the numeracy procedures. For example, when calculating volumes, 'Tracey' explained her rote procedure to change between centimetres and millimetres as "taking away or adding the dot", but she was unsure why, or in fact what the resulting units were. She just knew it worked. Similarly, 'Tracey' was unaware of the origin or meaning of transport industry based multiplying factors when calculating 'cubic weight' to determine freight costs.

However, this lack of understanding was not a concern for 'Tracey'. Her clear grasp of the bigger picture – the consequences of using the method - were clear from listening to her placate an irritated customer by explaining that freight costs were just as high for light items which took up a lot of truck space as they were for heavy but compact items.

Similarly, 'Elaine', having been shown by the supervisor, was able to perform measurements of paint thickness with the 'Elco meter' but was very unsure about explaining the procedure to the researcher during the case study shadowing process. She was particularly unclear about the units (μm) the machine was measuring in, or their relationship to the millimetres normally marked on the plans.

Beyond operational use of mathematical procedures — personal initiatives

The workers in this case study of Metals and More could all see the consequences of numeracy related tasks they undertook and, as described above, responsibility for ensuring they were done well. In some cases they also took individual actions and established their own systems to save costs and time.

'Tracey' in dispatch had created her own updated charts of the dimensions of regularly produced parts and products to save time in re-measuring them when she needed dimensions for freight purposes.

'Frank' created a labeling system which simplified the metric information on stacks of sheetmetal, using imperial measurements which he found easier to read at a distance, so that 1830 x 1220 x 1.6 became 6 x 4 x 1.6 in large numerals on the label. To do this, Frank used a remarkable collection of conversion facts kept in his head, or if unsure, for example, was 915 mm equivalent to 3 feet, — he remembered 6 ft was 1830 mm, so he just added 915 and 915 to check. He also described other systems he had instituted involving colour coding and progressive totals on stacks of leftover sheets of metal, to avoid wastage and unnecessary re-ordering.

The workers appreciated being able to discuss procedures with the production manager and were happy that they could make changes, such as those described above, within their own sections.

However, some workers did not feel that suggestions for improvement which might involve other workers were taken seriously by management. Perhaps this was not the case, but was felt to be so because of insufficient feedback as to why suggestions were not implemented.

Other influences on learning

Judging by the Metals and More workers who were selected to participate in the case study, there was some flexibility or movement in job roles within this workplace. Workers described how they were sometimes required to step into other roles and assist someone else when needed (because of time pressure or the unexpected departure of staff). Filling in like this seemed to result in greater understanding of the workings of the company and increased workers' capacity to have their job role expanded with greater responsibilities or to be moved in to newly vacated positions. It would appear that giving workers new responsibilities will encourage learning.

Transfer

Evidence suggests that a great deal of transfer took place from one workplace to another, with workers learning the basics in one place and building on them or adjusting the skills in other contexts. 'Elaine' was not really conscious of having learned about counting systems, nor that there was really any knowledge involved. However, during the research conversation, she reflected that the systems she learned from supervisors in her former workplace had influenced the way she established them in her present work environment.

'Frank' was aware that a great deal of the knowledge he had gained through his prior work experience was fundamental to the type of work he did and that he could transfer it from one job to the next: "In a new place the forms will be set out differently — you just have to look harder at first until you recognise what everything is" "Dies, spring loaded punches and settings all work on the same theory, even though the parts are different somewhere else." "You learn the basics then you make individual adjustments." Having learned the 'inward goods' procedures on-the-job in this company 'Frank' thought he could take it on elsewhere. However, this confidence only extended to metal products "I'm OK with metal because I know the goods". [Whether his reservation was due to lack of confidence, or self-consciousness about his low educational achievements, or just a personal disposition about having to learn more at his age, was not really clear.]

'Tracey' was confident that she could take on a similar dispatch job in another company having mastered the calculations and other procedures in her current workplace.

Context specific mathematical knowledge and associated language

The workplace has a language of its own, and the numeracy within it is also couched in particular, idiosyncratic language. School mathematics [even if it includes attention to mathematical language] will not help a new worker understand the meaning of terms like 'dead weight', 'cubic weight' and phrases like "sometimes it cubes out bigger". Freight costs calculated in the dispatch department are based on either 'dead weight' (actual weight in kg) or 'cubic weight' (based on volume multiplied by a constant – a process called 'cubing'.) Whichever result turns out larger is the quantity which has to be used for cost purposes — "sometimes it cubes out bigger" refers to this process.

Case study 2: Vehicle Parts Victoria — an automotive manufacturing company

The workplace

Vehicle Parts Victoria is located on an industrial site in the outer suburbs of Melbourne and is a large manufacturer of automotive components. Part of a larger international corporate organisation, Vehicle Parts Victoria was established in 1989 and currently employees 570 staff. Vehicle Parts Victoria designs and manufactures automotive components for domestic and export markets and their products include air-intake systems, air conditioners, engine cooling systems, instrument clusters and fuel pump modules.

Vehicle Parts Victoria workplace is typical of many large manufacturing sites. The departments include administration, purchasing, engineering, IT, and production — including product design and manufacture. There are two factories which include both fully automated sections and manual production lines. The production workers are responsible for areas such as product manufacture and assembly, data collection, stocktake, ordering and dispatch.

Teams of three to ten production workers undertake a combination of assembly line work and the operation of machinery. Individual workers take responsibility for job tasks and output in their section but are fully supported by fellow team members, a team leader and supervisor who take final responsibility for production.

The company has an ongoing interest and focus on quality assurance (QA). There are well established quality assurance structures and procedures in place that ensure quality is maintained. QA roles are distributed from team members through to management to ensure quality operational procedures are adhered to. Sampling systems are used in all areas and extensive data collection completed. As the business focus is on both local and global markets QA issues are vital for success.

The company has a well established training culture and is a Registered Training Organisation (RTO). Production workers are encouraged to participate in the Certificate II in Automotive Manufacturing in which employees work through a set of manuals designed to cover the units of competency of the Certificate. Pay rates are linked to completion of the Certificate II in Automotive Manufacturing. The company is in its third year of Workplace English Language and Literacy (WELL) training supporting workers to attain this Certificate. A range of other training is available to workers at all levels.

Worker profile

Approximately 570 people are currently employed at Vehicle Parts Victoria, and almost 35% of them are from language other than English backgrounds. Employment is relatively stable and most are long-term employees.

The workers interviewed

Five interviews were conducted at Vehicle Parts Victoria. The interviews were taped and notes written. The interviewees consisted of a manager, a frontline supervisor and three factory workers. The production workers interviewed, all male in their late twenties to early thirties, worked in different parts of the factories. All are from English speaking backgrounds and had completed Years 10–12 at school. 'Max' was involved in making radiator components and uses various measuring equipment such as tape measures gauges, verniers, scales for quality checks and data recording. 'Ron' has worked in different areas of the two factories and is now responsible for stock control. 'Sam', also classified as a production worker, works as a quality assurance inspector. All three were confident in the tasks they undertook, including those that included the use of numeracy skills.

Interviews with the manager and frontline supervisor were conducted to gain a perspective on the views and roles of management. In addition, the study was informed by shadowing one of the production workers and taking a tour of the factory. The shadowing provided an understanding of the tasks performed and numeracy skills and levels involved, and the factory tour enabled the interviewer to build a picture of the scale and size of production and how the 'high tech' automated systems operate.

The numeracy skills they used

There were a variety of numeracy skills used by the workers interviewed, and the tasks undertaken were various but tended to be predictable and structured. Tasks included filling in all necessary running sheets and charts, and using various measuring tools. Production workers undertook calculations and estimations, were involved with data collection, graph plotting, reading gauges, recording percentages and reading measurements from equipment. The manager and frontline supervisors used computer spreadsheets and Excel®, interpreted and analysed data, and were involved in report writing, statistics, quality control recording and reporting.

Interpreting, transposing and recording numbers and numerical information

Reading and the recording of information to and from graphs, tables and charts is commonly undertaken by workers at Vehicle Parts Victoria, including reading jobsheets in relation to the number of items to be produced, recording the number of units produced, the number and percentage of defects, date and time. Depending on the work, data may be entered onto computer screens or hand written onto a prepared sheet. Recording of measured data is undertaken on an hourly basis or at the start and end of a shift.

Decimals: In some instances gauge readings need to be checked to 0.01 mm or 0.001 mm accuracy for the first unit off a machine at the beginning of a shift or production run.

Arithmetical calculations

The production workers all perform arithmetical calculations of varying complexity from counting to calculating percentages and working with ratios.

'Ron' needs to count the number of components produced. Components are packed into a box, generally in lots of 5. 'Ron' has to carry out a 'five piece check' to make sure he gets the exact quantity. Any extra product not boxed is quarantined if the exact batch number is not reached. For example, if the number of products is not a multiple of five, such as 294, four products will be quarantined. The total quantities made are recorded on the chart.

'Sam', in his role as a QA inspector at the end of the line is involved in tasks that require counting and addition of whole numbers. 'Sam' must count and record the total units made (16 units are produced in a run) and the number of defects. Runs are recorded and multiples of 16 are recorded as stock. Any extra units produced are put aside for the next run and defective products are recorded and quarantined. Totals produced, runs completed, defects, and the number of quarantined units are all recorded on running charts. 'Sam' referred to the creation of these running totals, by adding on in lots of 16, as 'counting on.'

Percentages are used frequently by some workers in relation to the production of defective products and are calculated using a calculator and a given procedure.

Ratios are also used by some workers. For example, one production worker has to mix water and flux to the ratio of 950g flux to 1400g water. 'Sam' uses **ratio:** he is required to calculate how fast the production belt runs according to how many staff are available. For example, the number of staff working on the production line governs the belt speed which determines the total number of units produced. This data also has to be recorded on a daily basis.

Formulas are used by some production workers to calculate production and cycle time. The formula is provided on the side of the sheet on which the data is recorded.

Measurement

All workers interviewed performed measurements. This mainly involves measuring **length**, **width** and **weight**. Tape measures, verniers and pre-made jigs are used to measure accurately and to check that products meet the dimensions and/or weights shown on the specification sheets for each product. This can mean accuracies of up to + _ .001 millimetres in some cases.

Digital and analogue scales are used, which means that workers require familiarity with both types of readouts. Scales are used, not only to check product weights, but also as a counting mechanism for small items such as screws. This involves calibrating the scales by first placing the empty box on the scale and setting its digital readout to zero, then placing 10 screws on the scale and 'setting' it so that the machine registers that weight as recording 10 screws. The 'setting' is then checked by placing another 10 screws on the scale and ensuring that it now indicates 20 items. Once the machine is set this way the entire batch can be counted by placing them all on the scales. The time, date, production quantity and batch number are then all recorded.

Estimation is also used. For example, 'Sam', in his QA role, inspects a unit for defects by sight and touch.

Numeracy skills related to occupational health and safety (OHS)

The factory is very 'high tech' and automated. Safety is paramount and OHS guidelines are integrated into all aspects of operations (eg. factory layout, line procedures and processes) to the point where OH&S is not immediately obvious and workers found it difficult to articulate how numeracy related to OH&S.

Numeracy skills related to quality

In Vehicle Parts Victoria company product quality is seen as a vital component for business success. The gathering and analysis of data was the basis for work practice efficiencies. Much of the data collection and analysis involves measurement of individual components and requires the accurate use of a range of measuring equipment including tape measures, scales, callipers, gauges and verniers. Visual checks are also carried out on production belts and in stocktake and packaging sections. All measurements need to meet specifications (eg: +/-3mm, +/-90g within the upper and lower limits).

Data collection is mainly undertaken by production workers. Data is checked by the team leader then the supervisor and finally overseen by the production manager.

The up-skilling of staff to enable them to take an active role in quality assurance processes, which requires numeracy skills, was seen as important by the frontline supervisor (the manager identified quality issues as his area of responsibility). Production workers have responsibility for collecting and reporting data but aren't required to have a conceptual understanding of the processes and do not receive feedback about the data collected. A number of the quality related tasks required the recording of digital readouts from measuring instruments. However, the interviewer observed that an apparent lack of feedback limited the conceptual understanding and knowledge development of production workers.

Numeracy, technology and the future

Vehicle Parts Victoria, as previously mentioned, is a 'high tech' work site. Some aspects of production are fully automated, others partly automated. Technology plays a major role in the operations of the company and both the manager and frontline supervisor commented that technological advances and the need for cost and efficiency measures could mean changing and greater demands on the numeracy levels of workers.

Social distribution of numeracy related tasks

The workers interviewed seemed to take responsibility for their own work tasks; machine operations, measuring, and data collection. They all stated that they could ask each other, team members and team leaders for help or induction. If new to an area, they were inducted by team leaders and members on how to use a machine, how to use the measuring equipment specific to a product, and how to record all data on running sheets, charts and graphs. All workers were comfortable with this process and found it an effective way to learn the processes and procedures.

How workers learned numeracy related tasks

All three workers interviewed stated that the most effective way for them to learn was by practical application of a task. They all stated that initially they learnt from their team leader or a fellow worker. There was little enthusiasm about learning in a classroom setting or from training manuals. They had a strong preference for learning 'on-the-job' and Vehicle Parts Victoria has implemented a mentoring program for staff. Those interviewed appeared to be comfortable with these programs.

The three production workers interviewed exhibited some maths anxiety which was related to their past school experience. However, they could see the benefits of what they learnt at school and how it related to their current work practice. They could identify the transferability of skills learnt from school to the work context and this appeared to validate their school experience.

For all three production workers interviewed most of their learning has been done through 'on-the-job' training. Formal training is provided at work. For example, a four-hour training session on 'measuring and scales' is offered to new production workers which introduces them to the range of equipment used (eg: verniers, gauges) and shows them how to use and read data.

Production workers also provided examples of some tasks that were learnt on the factory floor:

- how to measure stock weights during stocktake
- how to inspect products received. For example, quantities come into the area in lot sizes. The worker does 'in the head' calculations mainly with multiples 5, 10 , 20 (he says it is quicker than using the calculator, but that 'they'— managers — like you to check things with a calculator). When recording, for example, total product received, he multiplies the number of boxes received by five because items are in batches of five.

Beyond operational

The workers interviewed could see the connection between numeracy and the tasks they undertook, particularly data collection and measurement. They had and took responsibility for their work and seemed competent at completing tasks.

They also showed initiative in customising tasks to suit their way of working. 'Max', for example, is responsible for measuring fins on radiators. The fins go in between the tubes of the radiator. He has to measure the width and length and also the width of the initial material (roll of metal), all in millimetres with an accuracy of 0.001mm. Callipers are used and specifications given with a range provided. Accuracy is vital for quality and 'Max' devised his own sheet for recording the data because he found the previous record sheet was overly detailed. 'Max' commented that the other workers also find it easier to use.

'Ron' provided another example of how he works beyond the operational. Being responsible for the quality of products in his team, if a product doesn't look right he will take it to the pre measured jig and check it. 'Ron' will assess which measurement is wrong (width, diameter, tube length etc) and consider what might have happened further up the production line. He will check the machinery and note the problem. He then reports it to his team leader, and is confident to analyse and problem solve. 'Ron' likes to find out why the product is faulty: "It saves everybody a lot of time" ['Ron']

Case study 3: Hillside Park — an aged care facility

The workplace

Hillside Park is a not-for-profit organisation that manages three aged care facilities on one site. It is located in the outer suburbs of Melbourne and provides options for independent living, a hostel and a nursing home. As a workplace it is typical of many aged care facilities; it employs staff to undertake nursing and personal care of residents, food and domestic services, administrative, maintenance and gardening duties.

There are increasing requirements for accountability and documentation in the aged care sector and for workers to gain Certificate III in Aged Care Work as a minimum qualification. In light of this, the management of Hillside Park have implemented a number of programs to improve quality and to meet the accountability requirements. These improvements include creating a training culture and providing a range of training opportunities including a Workplace English Language and Literacy (WELL) program to support workers to develop communication skills and to gain the Certificate III.

Worker profile

The organisation reflects the general profile of workers in aged care, i.e. predominately female and over 40 years of age. Hillside Park employs staff from languages other than English backgrounds as well as English speaking background staff, many of whom have limited formal education, have not been in formal education for many years and have return-to-study needs. Of the 93 employees across the three facilities, management has estimated that approximately 85% have problems with English language, literacy, numeracy or learn-to-learn skills.

Of the 93 workers employed at Hillside Park, 64 are permanent part-time; 11 full time; and 18 are casual. All employees have access to training in the workplace. The majority of staff are longer term employees, with only 15 employed less than twelve months. Eighty-six staff are female and seven are male.

Workers interviewed

Staff interviewed for this case study worked in the nursing home facility, are all female and over 40 years of age. "Alex" is a TAFE trained nurse (referred to as a Division 2 nurse in Victoria). She is currently working as a group activity leader and involved in occupation health and safety within the organisation. "Alex" is confident of her maths skills. She loved maths at primary school but found secondary school maths 'useless for life' and dropped out of maths at Year 10. 'Alex' has worked at Hillside Park for approximately two years. 'Yolanda' is from a language other than English background and completed her school education overseas. She is a TAFE trained nurse and, like 'Alex', is confident of her maths skills which she thinks of in practical terms. She completed Year 12 maths. 'Zana' had worked at Hillside Park for three and a half years, initially as a kitchen hand. She has trained and now works as a Personal Care Attendant and is currently training to be a TAFE trained nurse. 'Zana' is from an English speaking background. She completed maths to a year 10 level but is less confident than the others of her maths skills, which she struggled with at school.

The interviews with a manager and supervisor aimed to gain perspective on the views and roles of management in relation to the current and future use of numeracy skills and their attainment.

The numeracy skills they used

Calculations, measurement, recording, interpreting numbers and numerical information were the main numeracy skills used at work by those interviewed.

Interpreting, transposing and recording numbers and numerical information

Reading and recording numerical data was commonly undertaken by the workers. This includes recording client falls, infections, times, date and reading and recording temperatures, blood pressure and weight. Data is entered on to charts and, less commonly, graphs. Graphs and charts are used for reporting blood sugar levels, fluid balance and continence management. 'Alex' is also involved in construction of graphs and uses them to inform OH&S procedures.

The recording of data is vital to aged care facilities as funding from the Federal government is related to the resident classification scale (RCS). The RCS is used for assessing the type and amount of care required by each resident. This requires workers to fill in assessment forms for 20 different areas (mobility, hygiene, toileting, etc) which then are converted to numerical values that relate directly to funding.

Arithmetical calculations

All workers regularly undertook a range of tasks that required arithmetical calculations: counting, adding, subtracting and, multiplying. Percentages, fractions and ratio were also used.

Counting was commonly mentioned (counting the number of residents on outings and counting tablets).

Other tasks workers at the aged care facility were expected to perform included **calculating** petty cash, client weight gain or loss, changes in the blood pressure or temperatures of residents, as well as checking their own pay and work hours. It is unclear what type of calculations were used to perform these tasks.

Some workers also needed to **estimate** supplies (eg. pads) required for the following week.

Only one of the workers interviewed used **percentages** and this was to calculate the percentage of clients who were sick at any one time. **Fractions** were only mentioned in relation to half a tablet, or calculating their own pay.

Ratios were more commonly used although the pre-mixing and packaging of many solutions has lessened the use of calculations using ratios. However, some solutions still need to be mixed, for example, food supplements such as Metamucil and Sustagen, and disinfectants.

Decimals are mainly used in calculating work hours and pay and one worker needs to calculate petty cash (ie. money). Decimals were also mentioned in relation to taking blood sugar level readings.

Formulas were not used by any of the workers interviewed, although one felt it was necessary to understand formulas for medications.

Measurement

All workers interviewed performed measurements and mentioned measuring in relation to TED stockings, wounds and leg swellings. 'Alex', who is responsible for activities at the facility, identified the use of **tape measures and rulers** in craft and woodwork.

Weighing of clients was also mentioned by the three workers interviewed and one also mentioned weighing food items. In relation to both client and worker safety, it is also necessary for staff to ensure slings for lifting people are the appropriate size for the clients' weight.

Medical equipment was used for measuring temperature, blood pressure, oxygen flow and other procedures. This required the reading of gauges and the recording of the information.

Time was also mentioned by the manager, particularly the importance of reading the 24-hour clock as well as recording times.

Plans, diagrams, scale drawings

'Alex' contributes to the Building Committee which requires her to read plans and visualise if they meet client and worker needs. 'Alex' and 'Zana' also draw floorplans. This is necessary as government guidelines indicate space and ventilation requirements in vital areas and floorplans are drawn as part of the residents' care plans. This is done on a monthly or quarterly basis.

Yolanda draws scale drawings of skin tears of clients.

Numeracy skills related to OH&S

Workers identified that a number of the tasks described were important for client safety and wellbeing (eg. measuring wounds, swelling, ensuring sling can carry the weight of clients). However, staff were less inclined to see the tasks they described in relation to their own safety.

Numeracy skills related to quality

In an aged care facility, quality and client safety and wellbeing are closely related. This became apparent in the interviews with the manager and supervisor, as well as the workers. In particular, the manager was acutely aware of the need for 'good data' in the overall operation of the organisation and to input into the continuous improvement process.

Numeracy, technology and the future

Computers are currently being introduced into Hillside Park and workers are undertaking training to gain or upgrade their computer skills. However, at the time of undertaking this study, little use was made of computers by those workers interviewed.

Other technology, particularly medical equipment, is commonly used, primarily in relation to measurement, in particular to measure blood pressure and body temperature.

One worker had previously used a handheld palm pilot to input observations and information. Although not confident with computers, she found the handheld device to be efficient and easy to use. The devices are being introduced at a number of aged care facilities and are likely to become commonplace in the future.

Social distribution of numeracy related tasks

The workers interviewed believed, for efficiency, tasks involving numeracy are best done alone. However, 'Alex' has someone check her calculations relating to petty cash and the roster because they "have to do with other people's money" [sic]. At times 'Zana' also checks calculations with a Division 1 nurse. Both 'Alex' and 'Zana' identified their system of asking for help when required as effective.

How workers learned numeracy related tasks

The three workers interviewed learned numeracy skills both at school and at work. 'Alex' (confident of her numeracy skills) uses them in a range of ways at work, identified primary school maths as directly relevant to her work; less so secondary school maths which she did until Year 10. Her reason for discontinuing with maths at school was that the "teacher couldn't relate it to real life". Alex' also believes she has learned a number of tasks requiring numeracy skills at work, both at Hillside Park and at previous workplaces.

Of the three workers, 'Zana' was the least confident of her numeracy skills. She admitted to struggling through maths at school until Year 10 when she left school to do hairdressing. 'Zana' saw no connection between the numeracy skills she uses at work and the maths she experienced at school. 'Zana' felt she has learnt the majority of numeracy at work (measuring for pressure stockings, measuring wounds).

'Yolanda', who attended school in Europe, is confident about her maths skills. She completed maths as a final year subject and only stopped because it was not part of the course she went on to do. Yolanda' identified maths as being important "for stretching your mind". In terms of work, she identified calculations as being the most important skills. Unlike the others, Yolanda felt she learned at school most of the skills that enable her to undertake numeracy related tasks at work.

Previous jobs (especially those related to nursing) allowed for some skill transfer from job to job. All workers interviewed at Hillside Park identified the possibility of future skill transfer as possible in nursing or medical contexts. One worker mentioned that she had been able to transfer skills learned at work to other contexts (helping her children's school gain accreditation in terms of playground equipment). This worker was also able to draw on her previous experience of dress making in making scale drawings of rooms.

The three different workers had different experiences of learning maths and numeracy. However, all three are satisfied with how they have learned their skills. The manager, perhaps recognising the diversity of the people working in the organisation, sees a range of training options (eg. WELL program, buddy system, informal training by supervisor) as being essential to ensure workers have the skills they need now and will require in the future as "the industry is continually delivering more complex care" and workers will need more sophisticated numeracy skills.

Beyond the operational

Workers in aged care are, generally, well aware of the need to use maths accurately or they may compromise client care. They need to be able to identify anomalies in eating, sleeping, weight loss/gain, all of which are recorded on charts and graphs. All workers interviewed were confident in the tasks they undertook and have strategies to deal with problems as they arise and to refer problems to supervisors when necessary.

The workplace also encourages workers to consider how procedures could be improved and there seems to be evidence that they are pro-active in considering opportunities for improvement.

Stakeholder and case study managers interview analysis notes

<table>
<tr><td>Purpose and procedure</td><td>Questions and procedure</td></tr>
<tr><td>2. Concepts and definitions of numeracy in the workplace</td><td>2. Government policy documents related to training all refer to the literacy and numeracy levels of the workforce.
So to start with, can I just ask you what the term ‘numeracy’ means to you?

All respondents conceptualised numeracy as including the application of number skills - described in a variety of detail and level of complexity – beginning from ‘“ability to add and subtract” to “working with numbers for the 4 operations, spreadsheets, algorithms and formulas” - Complexity of vision seemingly dependent on different prior exposure to discussion and reflection on the term.

Several respondents also mentioned measurement.

Some referred to reading numerical information from forms and other documentation and having understanding of its meaning, [example — reading tables in the workplace — being able to identify units and magnitudes of numbers in data presented as tables — eg the meaning of ‘$bn’ on top of a column — something as simple as that can be misunderstood as perhaps only a few dollars when in fact it’s a much more significant amount in the industry context].

But these were not majority responses.

No-one mentioned spatial skills

Most stakeholders included the notion of a ‘basic’ or ‘low level’ mathematical skills in their initial response , even though this was amended in some cases as the interview questions provoked further reflection on scope and breadth.

One respondent expressed concern that numeracy is “caught up in LLN (language, literacy and numeracy), but not mentioned specifically”. He thought it was interesting that most of the resources went to literacy rather than language and numeracy — even though these were so important for his workforce.

Reflection

All respondents focused on number related tasks, they recognised numeracy as application in context — rather than abstract skill.

Is the word ‘number’ a shorthand for many other things in peoples’ minds, or does the term ‘numeracy’ convey mainly number skills? Does using the single term limit the conceptualisation required?</td></tr>
<tr><td>3. Importance of numeracy and mathematics in the workforce / industry</td><td>Choose appropriate ending:

3. How important do you think numeracy and maths related skills are for:
• the workforce in your industry?
• workers?

The majority of stakeholders agreed that numeracy was very important - with words like “critical”, “fundamental”, “vital” used to express the degree of importance in their minds. One respondent remarked that there wasn’t anything in the workplace that didn’t have some elements of numeracy — another saw it as even more important than language.

Some reservations expressed
- That the degree of numeracy required was dependent on the workplace role of an employee.
- One representative employer thought there were sections of his workplace where innumeracy was not important but recognised its extreme importance in others.
- One union representative was adamant that numeracy should not be tested as a prerequisite to employment — rather, employers should ascertain what skills were important in their own workplace and train workers where necessary.

Many people commented that the changes taking place in work practices in their industries meant changing [and possibly increasing] demands on workers’ numeracy:</td></tr>
</table>

	- Increase of documentation in workplaces [leading hands given more paper work and needing to communicate more with others about their reports — mechanics reading and interpreting manufacturers' specification and tolerance limits] - Increasing isolation of workers and added responsibility for quality control, measurement and documentation. For example, aged care workers were more distant from supervisors — making more decisions on dosages, checking use-by dates on medicines [it is imperative that care-workers are accurate and medication is dispensed correctly, a dosage out by a factor of 10, so that 5ml is given rather than .5ml would have serious consequences.] - More technology being introduced in workplaces. In some cases increasing computerisation, but in others palm pilot technology for example in aged care for recording and entering patient data, and in trades for taking and recording measurements, generating costings and invoices. Several respondents commented that changing technology in industry meant it was important for workers to understand the significance of numerical output, to appreciate what magnitude of number to expect, and what the number's significance was, rather than blindly accept readings and measurements, whether from machines or co-workers in the chain of responsibility — "knowing what you expect to see and knowing when its out of whack"
4. **Use** of numeracy in the workforce / industry *Present list of skills on a separate sheet.* ***'Numeracy in the Workplace'*** *Interviewers to mark on a **three** point scale the level of importance of each skill.* *Note: Need to move through this relatively quickly. If by the end of this question you are more than 15 minutes into the interview, you should be prepared to 'hurry' the interview along.* *Remember there is the possibility of coming back and delving into these skills further if time allows.*	**4a. What numeracy and maths related skills come to your mind as important?** The following provides an idea of the initial responses of individual respondents regarding important numeracy skills. These were six answers given prior to consulting the prepared list of possible skills: - Estimation - mentioned frequently - Measurement of volume - Estimation of angles (such as knee bending for mobility) - Percentages - Calculating and estimating time on task for prioritising work and for billing - Conceptual development of children in relation to mathematics (children's services) - Spreadsheets everywhere in community development, *"even for running a fete!"* - Arithmetical operations - Making sense of tables and charts - Computational skills for checking calculators and machines, spotting errors - Visualisation and estimation - Mathematics' meaning and its language (for Workplace English Language and Literacy [WELL] clients) - Mean and standard deviation - Using common sense - Four (arithmetical) operations - Following instructions - Adding, using calculators and mental arithmetic (sales staff) - Measuring tolerances within manufacturers specifications - The meanings of the numbers and readings **4b Looking at this list of skills — can you indicate the level of importance of each?** ***Thinking out loud as we decide which box to tick will be useful. But we won't dwell too much on each as there are 15 listed. Perhaps if you mainly commented on the skills you think are the most important.*** [See table following for tally of quantitative responses] **Note:** Getting a rating was problematic — in many cases it was hard to decide on the difference between important and very important — some respondents seeing various skills as *becoming* important — others seeing some skills as important for some but not others. As one person in health and community services observed in relation to many of the calculation and measurement skills: "*importance is not the same as frequency — at some*

	stage it is important for all!" In many cases, although a skill was important for the industry as a whole, it was less clear who, within the industry, needed to have the skill. This is likely to be an important issue for the future, in relation to widening divisions of workers and the future possibility of career progression. 1 Calculation — with and without calculators or computers 2 Mental calculations/ estimations 3 Calculation and interpretation of percentage 4 Measurement: such as length, volume, weight, temperature, speed 5 Use of ratio and proportion 6 Creation and use of formulas (possibly using spreadsheets) 7 Display and interpretation of data 8 Use and interpretation of graphs, charts and tables 9 Use and interpretation of scale drawings, plans and diagrams 10 Recognition of patterns and anomalies with measurement and data 11 Communication of mathematically related ideas 12 Use of computers/technology in relation to mathematical tasks 13 Use of mathematical ideas and concepts to model or analyse workplace situations. 14 Use of mathematical ideas and concepts to evaluate and critique workplace practices and monitoring systems 15 Other (space to be left for comments, additional skills, etc)
5. Numeracy in relation to **Quality control / accountability**	**5. Are there any that you think are particularly important in relation to quality control / accountability?** For some respondents (both high level union and employer representatives) there was a tendency to see quality assurance (QA)and accountability as the domain of middle management, rather than workers' responsibility. This reaction is anomalous with requests from several enterprises for workplace training by Swinburne's Workplace Access Unit in relation to QA awareness. Several other employer and union representatives identified workers' 'basic' skills as vital for minimising risk in relation to both OH&S and QA. Mental calculations and estimations, along with understanding of processes, serve as guide if production is going right or wrong. These estimation skills can influence decisions by workers to stop the machine before further damage done. In health and community services, much of the accountability relates to patients' safety. Numeracy skills related to correct dosage of medication, reading and interpreting data (ensuring patients' immediate quality of care) are important. (Overlap with OHS question.) However, the drive for cost cutting efficiency and accountability for funding is also demanding of skills related to "Use of mathematical ideas and concepts to model and analyse workplace situations and to evaluate and critique workplace practices" in interesting ways within the health and community sector. Twenty percent more toilet paper being used in a child-care centre would be identified as a positive measure of attention to toilet training. However, a decrease in the numbers of bandages or incontinence pads used in an aged care facility, are indicators of a decrease in numbers of bed sores, and an increase in the frequency of patients getting adequate attention to toilet needs.] Display and interpretation of data, such as averages and percentiles, is a vital component of these types of measurement and reporting systems on which funding decisions are based. Data and reports all input and analysed on computers by workers (at level 6 and above?) and in the future increasingly direct from data input by workers using handheld technology (palm pilots). "Use of mathematical ideas and concepts to model and analyse workplace situations and to evaluate and critique workplace practices" underpin modern QA techniques for ISO 900 as are interpreting of graphs and charts "Judgements about cost-time elements" - important in increasing numbers of industries including" "auto-servicing" and health care [**Note:** from case study: Time management — judging time for tasks — juggling what tasks to fit in available time slots, prioritising according to long term timelines [project management — formal and informal] were obvious skill demands of workers with individual responsibility for their small sections in a small to medium sized business]
6. Numeracy in relation to **OH&S**	**6. What about for OH&S?** Client safety in health care is summarised in the '5 rights mantra': right person, right medication, right dosage, right time, right route". Of these two fifths have numeracy skills of

	measurement and calculation embedded. Errors by a factor of 10 in medicinal dosages are enough to kill someone. Estimation of measurement is important also. For example, area (1cm of cream on an arm), time elapsed since last pain relief. Measurement and ratio and proportion important for mixing antiseptics and cleaning solutions in health and community work Estimation of weights for lifting and storage of heavy loads is important in health and most other workplaces. One respondent recalled an instance when a forklift driver placed a heavy object on a storage shelf. It crashed through and killed another worker. Apart from the more obvious human implications, the management was held liable for negligence. Judgements about distance and speed are also vital when driving forklifts. Knowing the difference between mm and cm when interpreting and inputting data Two employer stakeholders saw no numeracy related skills involved for their workers **Reflection** Whilst some key stakeholders saw OH&S as the direct prevention of accidents as the focus, many of them took a more overall or long term stance, identifying the interpretation and/or analysis of data in tables, charts and graphs and the recognition of patterns and trends as the important numeracy related skills in this area. As one union representative said, *"All staff should be involved in looking at accident rates."*
7. Numeracy in relation to **Innovation** 9. **Changes** in the industry and relationship to maths/numeracy	**7. Are there any numeracy skills that you think are particularly important in relation to future innovation in industry?** & **9. Are there any changes in [your] industry that are likely to change the numeracy skills that workers will need?** Question 7 interestingly pointing to a widening gulf between workers, those 'creating' innovation and those 'coping' with it. In the automotive industry this gulf was seen in relation to technical innovation and the operation of technology, divided according to those with and without numeracy and physics/electronics knowledge. Several respondents including those from industry and employer groups and training organisations discussed the importance of data analysis as a major tool for innovation; data display and interpretation is needed for best practice in quality and used to analyse and make decisions. Collecting and analysing data to look for patterns and understand what is happening to the workforce- *"establishing patterns is a key to change" — "things come from being able to aggregate data."* [Within health services patients' average calorie intake is linked to their percentage above or under weight; Understanding of Body Mass Index and percentage changes - increases, reductions - relates to dietary advice. Also quantities of products used related to increase in quality of care (as described earlier)] Most stakeholder respondents did not identify the numeracy of lower level workers as related to *creation* of innovation. They spoke only of workers' need to respond to innovation such as using more sophisticated equipment [thus the two questions were put together. From most there was a feeling that the continual search for improved efficiency was driving technological 'advances' which then were driving workplace change. Workers needed to be able to deal with these changes. For example, car mechanics increasingly need to use computer measurements rather than instinct and experience to make judgements about car performance and to consult more graphs and charts supplied by manufacturers. One respondent thought it possible that in the future there might be a split between diagnosticians and routine workers. A training board representative said that in the automotive industry it was the servicing sector that was seeing the biggest growth and needing to remain competitive. In the future mechanics will need to: be more efficient; diagnose faults; time manage their work; balance when to cut losses (pass it on as not a cost effective repair); follow circuit diagrams to find faults and interpret manufacturers' information in charts and tables. As part of trend awards prevention of illness and home care rather than institutionalisation of clients, aged care workers (with low qualifications) increasingly work on their own without supervision. Therefore they have no other colleagues or supervisors to assist or advise them. This mitigates against the 'social distribution of skills and tasks' described in the research literature. Instead many workers in this industry will be increasingly isolated from other colleagues. In addition they will take on new tasks they have not been responsible for before, such as charging for service in the new user pays system, collecting cash at the time of service, measuring and monitoring insulin levels with an 'epipen' and entering data into palm pilots. Many of these tasks have been introduced into their work responsibilities because of technological innovations. [The research indicates that the use of handheld technology such as palm pilots is becoming a major trend in workplaces. For example palm pilots are increasingly used for

	lodging orders and measuring and calculating quotes in building trades. In health aged care they are used for inputting data, reading the care plan from the device and immediately invoicing for the service by pressing one key for the service supplied and inserting the length of time taken for it). The data input into these machines, including patient statistics goes to a centralised computer thus making more data available instantly and allowing a more detailed and timely analysis. **Note** : The Use of Handheld technology has also increased in other industries. Handheld Global Positioning Systems (GPSs) are used in firefighting, agriculture, and leisure activities such as bushwalking and orienteering. Since many of these technologies seem to operate on graphic displays there is likely to be less reliance on keyboard skills than with computers. From the union perspective technological advances and changes mean the ongoing need for retraining. Community services and health industry representative perhaps saw all workers as becoming more involved with innovation and industry change, naming skills 7–14 (see table following) as relevant. Employer representatives predicted a trend towards the increased need for specialist skills as opposed to generalist skills. They talked of a narrowing scope for application of skills, but with deeper understanding of a worker's particular area or responsibility. For instance in the future one specialised person may work only on communication systems in the home (systems which link appliances to computers). The specialist would be required to install as well as service them. Businesses would not only buy in technology, they would buy in the expertise to help them run with it. Similarly, multi-tasking of home-based aged care workers includes servicing , billing, collecting money and entering data, all in one operation. Union representatives claimed that some of the technology introduced may lessen reliance on numeracy and literacy for some workers. However, in some instances it may mean more. There could be a few workers needing more numeracy skills and others needing less (manual estimations — and calculations). For some workers the routine processes may become simpler but at the same time they may have to understand how more complex machines work. The *creators* of technology, such as electronic measuring equipment *utilised* by other workers, apply a range of high level mathematical knowledge to their technological designs. A respondent in this industry expressed concern about his staff developing the necessary 'people skills' of communication and teamwork to complement their numeracy and technical expertise.
8. Relationship between **workplace** numeracy **and school mathematics**.	**8. How do you think these important numeracy skills (refer to list) relate to the sort of mathematics that people learn at school?** **Would you have any advice for school maths teachers?** ▪ Most stakeholder respondents assumed that schools successfully developed the basic number and measurement skills needed by [lower level] workers. In many cases, however, their most recent contact or point of reference for school education was through the experiences of their own children whose socio-economic circumstances are likely to be very different. ▪ There were two exceptions to the positive view of school preparation for numeracy. o An employer organisation representative said that students in traineeships and in higher level business courses were leaving their respective levels of schooling without the mathematical confidence they needed. In his experience, students dropped out of tertiary business courses to avoid compulsory mathematics-based subjects. He thought that perhaps this flowed from mathematics teachers' lack of specialist knowledge, confidence and passion for their subject. o One respondent, who had worked in mathematics education, was also less than confident that the school system was providing adequate foundations for numeracy. He expressed concerns that the necessity of covering too much mathematical content too quickly meant that skills were largely taught without reference to use, purpose or application. He thought that school mathematics could be made meaningful if it was linked to physical and practical applications and combined with industry visits that illustrated first hand how mathematical concepts were used in a meaningful way. "The kids need to know why they are learning the stuff — not have it presented in abstract and theoretical terms.' o He was also concerned that more should be done in teaching number skills, for example, using practical concrete aids such as multi-based arithmetic blocks that assist students to visualise numbers, understand the operations and thus help them with important estimation skills. ▪ The emphasis on making mathematic education practical was echoed by other respondents also. As one employer said "I don't recall much — I remember a lot not used —eg logs (sic). Teachers should look at the practical side not just the theory" [later this company manager did say he used algebra occasionally to go backwards in sales tax calculations]

	▪ One respondent involved in community and health industry training thought that workers in their industry were 'a skewed sample'. He thought there was a mindset within education that working in the community and health sector was good for individuals with people skills but without mathematic skills. Those with mathematical inclinations are steered elsewhere. He felt it was important to change this view of the sector since the focus on improving well-being through early intervention and monitoring and on home care rather than institutional treatment means that all levels of the workforce need numeracy skills. ▪ An employer of engineers and electronic designers said he thought that the young graduates received excellent mathematical training within their degree courses. ▪ Mechanics apprentices were seen as having adequate preparation by one representative employer in automotive industry.
10. Numeracy **related** training needs	**10a. What are the implications for numeracy skills development of existing workers?** ▪ All were agreed that there are probably ongoing training needs associated with keeping up with industry changes. ▪ Union representatives were adamant that employers should appreciate the capacity of current workers and invest in training with foresight and planning. ▪ There were differences of opinion about how this numeracy skills development should take place. ▪ Some respondents favoured individually tailored training plans based on workers' existing skills and further needs for empowerment in relation to their job role. ▪ Others suggested less direct and embedded /integrated approaches to avoid using a deficit model, They advocated taking a positive approach and 'rebranding' intervention programs, integrating numeracy skill development into other things, such as computer technology or quality control training, for example, '5 S' training or other programs with innovative titles. ▪ One employer representative commented that employers are aware of a growing need for numeracy skills, but there are lots of workers hiding their lack of numeracy skills therefore it is necessary to approach the numeracy training in more positive way. ▪ A training board representative explained that the numeracy is embedded in the Certificate III Automotive but its meaning and interpretation needs to be given a focus — not theoretically, but in relation to concrete situations with more emphasis being placed on the meaning underpinning formulas like Ohm's law. Other wise there is a danger of producing unskilled "factory fodder who need only the absolute basics". ▪ Another training board spokesperson said that competency standards in Health and Community services will need to become more specific, at the moment they are not tight enough. ▪ He also thought WELL programs should be more specific with regard to numeracy. He expressed a view that WELL trainers tend to neglect numeracy in favour of literacy. ▪ This training board representative also spoke of the need to broaden understanding of what numeracy means, including the literacy of numbers, (eg understanding what % increase means) knowing that as they talk they use numeracy, it is embedded in English language. ▪ He thought the Mayer competencies should be written explicitly for each work position or role. ▪ There was a need to embed numeracy explicitly into other competency statements, perhaps within the underpinning knowledge section. **10b. What about for preparing people for employment [in this industry]?** Suggestions included: ▪ Engage the excitement of young people with pedagogic practices — link Employability skills framework with schools curriculum (VALS review looking at this? VECCI) ▪ In automotive there is necessity for more underpinning background in mathematics, physics and electronics, design ▪ Overcoming the perception that workers don't need maths — they do need practical application at lower levels of the workforce as well as at higher levels ▪ There needs to be some formally recognised training for sales people in the automotive industry. ▪ Mechanics apprenticeships seen as adequate preparation by one representative employer in auto industry. Apprentices learn to use the instruments at TAFE — but learn how to interpret it on the job
11. **Effective**	**11. In general, from your experience what do you think are the most effective**

learning for workers	**ways that workers learn?** Practical and hands on were common 'top of the head' responses to this question. As one respondent put it "being involved is much more effective than reading about it." After the initial response was recorded respondents were given the following list of possible training options and asked to comment on usefulness. o observing other people o being taught by another worker on the job o being taught by your supervisor or manager on the job o formal training in the workplace o formal training elsewhere o being taught at school o other ▪ Most respondents thought combinations of all the methods listed were important depending on the type of tasks/learning. ▪ Concrete application at work with some theoretical underpinning in a more formal training situation was popularly selected as ideal for many forms of training. Kolb's experiential learning cycle was named and described by one training oriented respondent. ▪ There was a general agreement that if formal training was used it needed to be less school-like. It is important not to create an environment reminiscent of school because workers at lower skill level employment often had very negative associations with school learning. "Not in a classroom" "too much baggage" were typical comments from key stakeholders. ▪ Others were specific about the use of adult learning principles ▪ The 'traineeship model' (training on the job coupled with one day a week of 'book learning' and simulated training) was described as an effective model by one respondent. This opinion acknowledged the usefulness of RTOs for providing the knowledge base behind the practical skills. ▪ There was a leaning towards observing others and being shown by peers or supervisors for more practical tasks. ▪ Although some reservations about purely 'on the job' training were expressed by one union representative "because it's possible to pick up bad habits without realising … it is important to learn from high quality people" ▪ Another reservation was expressed about training by supervisors invoking "other emotional factors" since workers do not want to expose themselves as an idiot with the boss. ▪ One representative thought formal training in the workplace was often the least effective method because proximity to the workstation meant many interruptions and consequent lack of participant focus. ▪ There are reservations about formal training outside the workplace. One concern is that such training is often ineffective because it fails top make direct links to person's job whereas training needs to be more tangible and real. ▪ However, union representatives were adamant that internal training should be formalised and recognised at industry level, so that the qualifications and the skills behind them are portable. ▪ Encouragement and a positive attitude by employers was seen by union representatives as necessary factors to successful training strategies. ▪ One respondent expressed a view that training provides an opportunity to experiment and try new things; opportunities which used to happen in workplaces, but no longer, with workplaces suffering as a result. **Other effective learning strategies suggested by respondents were:** ▪ Group discussion — using case studies to draw out issues — i.e. using adult learning principles ▪ Simulation work environments ▪ Computer simulations ▪ Mixed mode — with some opportunities for independent study as preferred by people with particular learning styles ▪ Self -paced or on line learning although there is a tendency to expect it to happen in workers' own time ▪ Experience and an element of trial and error ▪ Role models and mentors ▪ Participation with supervision: the gradual increase in difficulty of task and responsibility associated with apprenticeship training is an effective system on the

	whole [however one manager thought that longer block training periods would be better.]
12. **Effective models** of training	**12. Given your response to the last question, what strategies do you think are likely to be most effective for developing workers' numeracy skills?** A combination of formal training with on the job application seemed to be universally advocated by respondents. There was acknowledgement that a formal element does have to be included in numeracy learning, but that it should be done "in a very supportive atmosphere because those who don't have it (mathematics) are frightened of it — it is strongly emotionally charged." Training needs to be manageable on the job. It should be incorporated into work time rather than out of hours, and the training done 'off the line', (in the training room), needs to reinforce what is learned on the job and vice versa. Important that numeracy training is meaningful for workers because it should be about empowering them within the workplace so they can realise some career progression. **Some suggestions** ▪ Simulated workplace situations in which the skills such as estimation and proportions are practiced in practical situations without jeopardising real client/patients would be effective: "do - reflect - get it right", rather than trying procedures with clients the first time round. ▪ Numeracy training needs to be based on an understanding of the levels of the individuals in the group, as well as what is needed by the employer and pitched at an appropriate and attainable level. ▪ Ideally numeracy training should be based on an individual training plan for each learner. ▪ Numeracy training needs to be meaningful and experiential, with strong links to immediate work situations and opportunities for reflection on applications outside of the formal training situation. ▪ General trainers in health and community welfare areas are likely to need to increase their skills and awareness about effective numeracy training.

Table 1: Stakeholders' ranking of the level of importance of numeracy skills for workers in their industry sector

Numeracy Skill	Very Impor-tant	Impor-tant	Not Impor-tant	
1. Calculation - with and without calculators or computers	13*			Time fractions, budgeting, counting,
2. Mental calculations/ estimations	10*	3		Checking in conjunction with calculators and computers or vice versa Capacity to have a first sense understanding of the direction you're going in, whether it's "… mixing flour and water to make dough or thinking about how much wood you would need to build a window frame."
3. Calculation and interpretation of percentage	2*	10	2	All should have an understanding of its meaning and use even if not directly calculating it Related to applying for funding, GST % used in football — maths in the lunch room Beyond basic tasks in the workplace — starting to get into specialised fields
4. Measurement: eg length, volume, weight, temperature, speed	8*	5		Volumes vital in health care Differences between centimetres & millimetres important Length in room plans Mechanic use micrometers and computer aided measuring devices Distances to travel Weighing people Medication Drivers taking short cut — distance v time, cost of petrol Brickie working out how long it will take to lay a pile of bricks & where likely to finish for the day so can leave work on time and not ruin the job Critical
5. Use of ratio and proportion	2*	5	6	Mixing solutions and antiseptics Not key for most automotive/metal workers Nutritional guidelines Proportioning time according to tasks Preparing mixtures — if put a 0 on the end of a number then need to assess/evaluate if the proportion makes sense Medically trained people eg. Nurses, need to be able to assess/evaluate what has been prescribed — proportions come into this
6. Creation and use of formulas (possibly using spreadsheets)	5*	5	3	Very important for some — especially in administration Spreadsheets commonly used in community work People who use spreadsheets tend

				to "watch the process" rather than engaging with formulas or understanding them While some workers may use formulas on a regular basis they are [usually] predetermined for them — can be applied without knowledge of the formula itself.
7. Display and interpretation of data	3*	9	1	"Increasingly needed with handheld computers — lots more information to be interpreted" For particular roles in workplaces Needed by all workers to understand posted info re OHS, accident rates etc Sales staff — comparisons and trends At higher levels use of data sets to compare population statistics with predictions and organisation's user profile Comes into most people's work. Where work is repetitive the interpretation of data isn't likely to be particularly complex. But move quickly into areas where it's about applying info to new situations
8. Use and interpretation of graphs, charts and tables	5*	7	1	Underpins quality control and analysis Many workplace matters set out in this way "… becoming a necessary skill because so much of work now, and information, is presented that way" eg. Assessment of on the job performance, targets, customer satisfaction surveys "5 years ago I would have said not very much [use] but with the development of technology the expectation of people being able to use and understand things like graphs, charts and tables changes substantially" "Starting to move beyond basic skills that you would expect everyone in the workplace to have"
9. Use and interpretation of scale drawings, plans and diagrams	3*	6	4	"Small proportion of workforce only" "Sketch plans important in aged care" Mechanics — electrical diagrams Plans of facilities. For maintenance workers to read plans of homes, buildings Developers of plans and diagrams and technical people who have to work with plans
10. Recognition of patterns and anomalies with measurement and data	4*	8	2	Seen as important for QA In health and aged care reportings are all about abnormalities — departure from norms or patterns — often estimations dependent on judgements — more, slower Required by governance committees

11. Communication of mathematically related ideas	5*	5	3	"When working in teams you need to explain to others" eg. About getting from point a to b 2 main instances where communication is important (1) tradesman supervising an apprentice and explaining concepts and giving instructions; (2) supervisors telling operators what to do. It's a management or supervisory skill Important for workers to understand not just what they are doing but why they are doing it — so supervisors need to communicate mathematical concepts where these are intrinsic to the work being done
12. Use of computers/technology in relation to mathematical tasks	7*	6		"Increasingly important for all — eg point of sale, data inventory systems" "Cars all have computers fitted now"— no room for backyard mechanics these days. Use of technology particularly handheld devices such as laser devices to measure, eg. size of room; to quote on a job; to record information Very important for those who work in technical areas
13. Use of mathematical ideas and concepts to model or analyse workplace situations	2*	8	3	Important for project management and for innovation through data analysis Worker's satisfaction survey
14. Use of mathematical ideas and concepts to evaluate and critique workplace practices and monitoring systems	3*	7	3	"All staff should be involved in looking at accident rates" "Judgements about cost-time elements important in auto-servicing" Increasing collection of data — increasing need for these skills
15. Other				"Problem Solving — [see employability skills Framework]" "Accounting and bookkeeping — time sheet analysis" Estimation of body weight re use of hoists and load limits Time and time intervals in relation to medication Mixing mortar by the "feel" rather than by measuring quantities. Needs to take into account the type and size of the building

* These responses include those of an employer of graduates who *design* electronic measuring systems — a contrast to the workers who *use* this type of equipment in their workplaces. Note he has rated *all* of the numeracy skills on the list as very important for his workers.

Table 2 Importance of numeracy skills for workers in stakeholders' industry sector

Numeracy Skill	For QC/QA & Account-ability	For OHS	For Innovation	Comments
1. Calculation - with and without calculators or computers	1	1	1*	
2. Mental calculations/ estimations	2	1	1*	
3. Calculation and interpretation of percentage	2*	2	1*	
4. Measurement: eg length, volume, weight, temperature, speed	2*	2	1*	OH&S"For lifting weights" Estimation important
5. Use of ratio and proportion	1	1	2*	"For cleaning fluids/antiseptics"
6. Creation and use of formulas (possibly using spreadsheets)			2*	
7. Display and interpretation of data	3	3	4*	
8. Use and interpretation of graphs, charts and tables	2	2	3*	
9. Use and interpretation of scale drawings, plans and diagrams	1		4*	
10. Recognition of patterns and anomalies with measurement and data	1		3*	
11. Communication of mathematically related ideas			3*	
12. Use of computers/technology in relation to mathematical tasks	2*		5*	
13. Use of mathematical ideas and concepts to model or analyse workplace situations	4*		3*	
14. Use of mathematical ideas and concepts to evaluate and critique workplace practices and monitoring systems	4	2	4*	
15. Other				

* These responses include those of an employer of graduates who *design* electronic measuring systems — a contrast to the workers who *use* this type of equipment in their workplaces. Note he has rated *all* of the numeracy skills on the list as very important for his workers.