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NUMERACY PRACTICES OF YOUNG WORKERS¹

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This paper presents a summary of the first two years of a large research project investigating the numeracy practices of young people across a range of industries. Drawing on both quantitative and qualitative data, the project aims to identify the ways in which numeracy practices are perceived and enacted by young people (students in part-time employment, employees and job seekers) and their more senior counterparts (teachers, employers, and job placement officers). This paper presents a description of the project to date and provides exemplars of the data collected in order to demonstrate key findings.

The workplaces that young people enter in the new millennium are substantially different from those of the past. The nature of work is substantially different whereby the workforce has been highly casualized; there has been a decline in unskilled and semi-skilled occupations; and people are expected to demonstrate transportability of labour across sectors (Duffy, Glenday, & Pupo, 1997; Swift, 1997). Furthermore, people are predicted to change occupations a number of times across their working lives; people will create their own jobs; and that the positions that young school entrants will occupy do exist at the time they commence school. Within these changing conditions, other factors are impacting on the nature of work, the most predominant is that of technology. Not only has technology changed the ways in which is undertaken where work has become highly technologised and, by implication, reduced the need for unskilled or semiskilled labour, it has changed the ways in which work and thinking about work have been undertaken. The impact of technology on work and numeracy practices is central to this paper. It is proposed that a better understanding of this phenomenon is important to curriculum theorizing. It is suggested that the nature of work may be substantially different in this post-industrial period from that of the industrial period and that this has ramifications for school mathematics. In the past, part of the rationale for school mathematics has been for the preparation of young people for work and the wider society. But if this society is qualitatively different and has changed needs and demands of young people, then the school curriculum may need to be radically different if it is to prepare young people for this changed world.

NUMERACY: IMPLICATIONS OF WORK

A substantive body of literature exists that documents the numeracy practices of out-of-school practices. These include street sellers (Carraher, 1988); candy sellers (Saxe, 1988); pool builders (Zevenbergen, 2003); carpenters (Millroy, 1992); along with

¹ This project "Numeracy, youth and employment" is a three-year project funded by the Australian Research Council. The views in this paper are those of the authors, not of the ARC.

numerous other studies. These studies have been useful in highlighting the different ways in which mathematics is enacted in out-of-school contexts from that expected within school. They have been powerful in alerting educators to the situatedness of activities and the impact on how tasks are undertaken. For example, the plumber may need to know how much lagging (wrapping) is needed to insulate a pipe. In the school situation this would be calculated using the process for finding circumference from either the radius or diameter. However, in the world beyond schools, the plumber will use the diameter since it is the easiest dimension to find. This is found by pulling the metal tape across the pipe and oscillating until the widest dimension is found – this being the diameter. This is then multiplied by 3 (as opposed to pi) and an estimate of the lagging is known. Since error rates are built into the work of the construction – including plumbing – this calculation is more than adequate and much easier than the methods undertaken in school. The precision that is a central element of school mathematics is not a high priority in this situation so more situation-appropriate strategies have been developed by workers.

Within the Australian context, it is recognised that almost 50% of traineeships and/or apprenticeships undertaken by young people are not completed. There are many reasons for such non-completion but one of the most concerning reasons is that young people are unable to cope with the numeracy expectations of the formal study associated with these programs or the numeracy demands of the workplace. The literatures on post-industrial workplaces suggest that the nature of work is changing, in part, due to the significant changes brought about through the use of technology. Little is known of the impact of technology in the workplace and how this may influence the ways of working and of success for young people in today's work. This paper reports briefly on the major findings of the first two years of the study.

THE PROJECT - NUMERACY, YOUTH AND EMPLOYMENT

This is a three-year iterative study. The study is being conducted in a region of Australia (The Gold Coast) which best characterizes the post-industrial workplace. It is highly casualised, has low industrial base, and relies on tourism and other recreational/leisure industries as its main source of employment. The region is bimodal in its population with a significant number of retirees and increasingly a growth in the youth market – that is, young people between the ages of 14-25. A consortium of industry partners² work with the project as part of the Linkage Granting scheme. The Industry partners play a key role in guiding the project. The study involves three key phases – 2002 a large-scale survey was conducted across the region – with employers, teachers and employment placement officers representing those groups who worked with the training and placement of young people; along with young workers, students in schools involved in part-time work; and young people seeking work representing the range of young people in the youth labour

² Industry partners include Gold Coast City Council, Gold Coast Institute of TAFE, SCISCO, Centrelink, Queensland Schools Authority, and Adams Consultancy.

market. The survey sought a range of responses including the importance of a range of literacy, numeracy, ICT and generic skills in contemporary workplaces. Phase 2 was conducted in 2003 and involved workshadowing young people across a range of industries representative of the types of work being undertaken by young people. The workshadowing sought to identify the numeracy practices undertaken by young people in their fields of work. Phase 3, to be implemented in 2004, will involve triangulation of the young people's data from Phase 2 with employers and trainers. This has arisen as the outcomes of Phase 2 indicate discrepancies in expectations of older people of their employees in terms of the numeracy demands. Recommendations will be developed and trialled with employer groups.

Underpinning the project is a hypothesis that the numeracy and literacy demands of contemporary work may be very different from the past. The contemporary literature on literacy demands suggests that new forms of literacy are emerging in post-industrial times, largely due to the impact of technology (Unsworth, 2002). Less is known on how this impacts on numeracy demands of contemporary work. What is known is that technology has the potential to change elements of work (Straesser, 2001), but the impact on work is less known. As such, the project aims to identify if there are different demands of numeracy in the workplace and if there differences, what are they? The Industry partners are central to the project in that they represent the key industry and training groups associated with young people. They have provided insights into the experiences of workplaces for young people in and/or seeking work.

Phase 1: The Survey

In 2002, a survey was constructed with the guidance and input of the industry partners so that all key elements associated with employment of young people were identified. Key sectors, as noted above, were sought. Almost 900 responses were received across the 6 target groups. Aside from the job placement officers (which is a small group relative to the others) the group responses varied from 50 to over 300 thus making analysis considerably reliable. Participants were asked to rate on a Likert scale, the relative importance of various items (e.g. numeracy, statistics) in their current (or last) position. In each case, examples were given for each item. For this paper, the data were combined so that the senior (employers, teachers and job placement officers) and the younger (employees, students and job seekers) formed two cohorts. A step-wise multi-variant analysis showed weighted multiple linear combinations of the predictor variable best distinguished between the two groups. In step-wise order, the following variables were found to be statistically significant at less than $p \leq 0.001$:

- 1) Use computers of relatively general purposes (Senior);
- 2) Statistics (Younger);
- 3) Industry-relevant technology (Younger);
- 4) Non-verbal communication (Senior) ;

- 5) Computer technology to support numeracy/ maths (Younger);
- 6) Number (Senior);
- 7) Industry-specific technology (complex) (Senior);
- 8) Volume (Younger); and
- 9) Location (Younger).

These results suggest that aspects of numeracy and computers are key variables in the differences between older and younger people in this study. Five of the nine discriminating items related to numeracy/mathematics (statistics; computer technology to support numeracy/maths; Number; Volume, and location), three related to ICTs (use computers of relatively general purposes; industry-relevant technology; and industry-specific technology; and one to literacy (non-verbal communication).

These data suggest that there are significant differences between younger and senior people's perceptions of the importance of numeracy (and technology) in contemporary workplaces. Open-ended responses in the survey further added that younger people are less concerned about the use of technology in the workplace than senior people; and that younger people are more likely to see applied areas of numeracy (measurement, statistics and location) as being important while senior people are more likely to see number work (i.e. calculations, mental arithmetic) as important. In follow up interviews in a supermarket, young people offered comments such as:

Shop Assistant: I don't need to calculate exactly what the amount is, but I have guess to check that what the register says is likely to be right. Lots of old people come through my aisle and sometimes they get angry if I make a mistake, like as if I am supposed to add up everything. Sure, how can you add up some of the groceries that people buy.

In contrast, supervisors offered comments of the kind:

Register Supervisor: The young ones really don't have much of an idea on how much change to give and that sort of thing. I sometimes think they are a bit lazy and can't be bothered, you know, they let the register do all the hard yakka [work] for them.

These brief comments are indicative of general comments within this initial phase of the project whereby differences suggest that there may be intergenerational differences in how people see numeracy in the workplace, and how technology often is implicated in that numeracy. This outcome aligns with the literatures on post-industrial theorizing whereby younger people have different expectations of and about knowledge than their older peers. As has been argued elsewhere (Zevenbergen & Zevenbergen, 2003), it appears that younger people are more likely to see numeracy in applied settings; older people frame numeracy within 'old basics' – that is, arithmetic; and younger people are more likely to see these basic skills as ones that can be undertaken by technology (such as calculators or cash registers). Indeed as the data suggest, younger people see their role as more holistic (problem solving,

estimation) and that technology is to be used for mundane and routine tasks (such as arithmetic) whereas senior people saw these later skills as foundational to numeracy. These findings have implications for how numeracy is undertaken and assessed within contemporary workplaces. This is particularly relevant when considering the assessment processes for obtaining staff and for formal studies associated with training where many aspects of basic skills are foundational to testing processes. We suggest that many of the numeracy skills being taught as part of apprenticeship training and traineeships may be framed within old or industrial frameworks whereas younger people are not seeing numeracy in these frames of reference. As the survey data suggest, it is possible that senior people who often assume responsibility for assessment of younger people, may perceive the ways of contemporary work very differently from their younger counterparts. This is most evident when considering the role of technology within working mathematically. Senior people were more likely to see core knowledge and attributes as mental calculations whereas younger people saw this work as the task of technology. That is not to say that there is no place for mental computation and accuracy with calculations, only that there are different weightings being applied by the two cohorts.

As survey data can be limited in terms of the responses offered, Phase Two sought to clarify and expand the results of Phase One. In this Phase, case studies have been undertaken of twenty work sites in order to identify the numeracy practices within those sites.

Phase Two: Workshadowing

In Phase Two of the project, we have been investigating the ways in which young people undertake their work, with an emphasis on the numeracy practices. This has been explored through the use of pre- and post interviews, with a period of workshadowing in between the two interviews. Depending on the nature of the work being undertaken, the workshadowing is usually for a period of three days, but this may be longer if needed. The three days enable a reasonable snapshot of the work undertaken. However, in some cases, they may be over a longer period. The field work is undertaken so as to gain a broad snapshot of the work – this may mean consecutive days in some sites, and staggered days in others. We have used stimulated recall (Walker, 1985) as the method for data collection. This entails taking photographs of the worker as he/she goes about work. The post-interview involves the young person talking about what they were doing in the photograph and how they were going about their work, including how they were thinking mathematically about their work. Twenty cases have been undertaken in 2003, across a range of industries including retail, construction, marine, hospitality, and service industries so that a broad range of occupations have been covered. The industries represent key industries that employ young people – both male and female.

Data analysis of these cases has highlighted the different approaches to undertaking numeracy-orientated activities across worksites; the levels of numeracy required for different worksites; and the ways in which young people rely on non-school

mathematics to undertake their work. These broad findings can be exemplified in the following highlights from the case studies of a baker and a boat builder.

The Case of a Baker

The workshadowing of the baker showed very different numeracy practices from those used in school. Prior to commencing the day's baking, the manager prepares a list of products and quantities for each product that needs to be produced. The baker needs to ascertain quantities of flour to make the nominated number of loaves of bread. A 'yield factor' is used to calculate the amount of flour needed for a particular type of bread. For example, if the manager had indicated that 50 white loaves were needed, the baker needs to know how much flour is needed to produce this many loaves. This amount of flour varies for each type of bread. If the yield factor for white bread were 0.4, then the baker needs 20kgs of flour to make the 50 loaves of bread. To obtain the correct amount of flour for a given bake, the baker places the bag of flour on the scales and removes the amount so that the quantity of flour needed is the difference between the start and finish weights. This process is quite different from those used in school settings where the quantity to be used is the amount weighed.

Unlike school recipes where the quantities for each item are expressed as individual quantities, the recipe for bakers is substantially different. Due to confidentiality agreements, the recipes cannot be reproduced so a mock example is provided opposite. The quantities needed are expressed as percentages (rather than amounts). These percentages are in relation to the yield factor that is related to the amount of bread needed for the front end of the shop. Unlike school mathematics where percentages generally are expressed as parts of a whole and usually added together to make 100%, the baker's recipe expresses the individual amounts (such as currants, yeast, etc) as percentages which are then compared to the original amount of flour needed for the bake. This allows for a high

Fruit loaf
Flour 100%
Sultanas 50%
Currants 25%
Mixed peel 7%
Yeast 3%
Salt 2%
Water

degree of flexibility with the baking process since different quantities of bread will be needed on any given day, thus requiring different amounts of constituent ingredients. When calculating the quantities needed for each ingredient, the baker would do the calculation mentally. The apprentice indicated in the interviews that he originally relied on a calculator in the "first few weeks of the job but now can do them in my head... You just get a sense of what is right coz you do it so often."

The case of the baker shows how the numeracy practices of workplaces can be demanding in what is expected to be undertaken. The manager indicated that they had considerable difficulty keeping young people as they were not able to undertake the calculations needed in baking. The case of bakers suggests very different ways in which numeracy practices are represented and undertaken in this context from those used in schools. Most diverse was the recipe genre where quantities are expressed differently from the school (and home) practices. The numeracy embedded within this

genre is very different in terms of how quantities are expressed (as being related to the initial amount of flour); are weighed; the calculation of quantities for each bake (as opposed to a standard quantity); and how percentages are represented.

THE CASE OF BOATBUILDING

There are many aspects of boatbuilding so three cases were developed for this industry. The industry offers apprenticeships across a range of occupations (electrical, boat building, furnishing, upholstery etc). Unlike the industry of the past, current practices are radically different in terms of building products and construction methods. The luxury boat industry (in which this study was conducted) had the boats pre-formed in two parts (hull and deck) which are then joined. The boat builders are responsible for fitting out the hulls and decks. As pre-formed boats, fittings are relatively standard so the apprentice's task is to install and repair since many of the installations are not correct. As part of this work, the apprentice is required to mix an epoxy material (fiberglass) where hardener is added to the base in order to make the resin set. There is a standard ratio that needs to be calculated depending on the type of materials being used. However, the apprentices rarely (if ever) used this method.

Jack: I go by feel, if it looks right and works right, then I can use it. It depends on the size of the job – if it is a big one you don't want the bog to go off too quickly or it might set before you finish so you add a bit less. If is a hot day, you will also add less coz it sets quicker on hot days. You just get to know what is right.

Throughout the boatbuilding workshadowing, informal methods were used often. For example, when needing to align objects – such as a door to be hung – the apprentices used a pencil as this 'looked good' and ensured that they had the same distance at the top and bottom of the door in relation to the fixed wall from which it was hung. Aesthetics were important as products needed to "look right" or "look good" but this was achieved through the use of convenient tools (in this case, pencils) rather than formal measurement. In this industry, despite the manager's suggestion that the apprentices needed considerable mathematics in their work, there was evidence to suggest that the young men tended to rely on estimation, intuition, and aesthetics to perform their work.

SUMMARY

This paper has sought to provide an overall summary of the project in terms of method and outcomes. Exemplars of the data and outcomes have been provided to illustrate the key points that have been found. The survey has identified a number of areas where there are significant differences in perceptions of importance of various aspects of numeracy and ICT between younger and senior people. It was thought that literacy would have featured more significantly but this has not been the case, suggesting that there may be considerable congruence between younger and senior people's perceptions of literacy demands. Interestingly, elements of numeracy featured strongly in the differences in perceptions of importance between younger

people and senior people. To better understand these differences, workshadowing has highlighted numeracy-in-action across twenty worksites. It has been identified that the numeracy demands of most of the worksites are minimal; that the numeracy is highly situational – that is, it is governed by demands and needs that are unique to that context; that the young people appear to be performing the tasks in ways that are substantially different from the approaches advocated in schools (such as the baker example); and that young people have different orientations to approaching their numeracy work than their older peers.

Further qualifications are needed from senior staff to validate or challenge the views of the young people in terms of numeracy demands and this will be the focus of the next phase of the project. The outcomes of the project have implications for how school mathematics is considered in terms of both content and process if young people are to be prepared for the changing work demands. Similarly, senior people need to recognize the impact of technology on working mathematically.

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