Numeracies for Workplaces in New Times

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Published
2003

Conference Title
Enriching Learning Cultures

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Numeracies for Workplaces in New Times

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New Times are characterized by very different patterns of work and society brought about in substantive ways through the use of technology – either directly or indirectly. Technology has impacted significantly on how work is undertaken in many spheres of life. It also has impacted on communication and the breaking down of global boundaries. At the level of schooling and work, the impact of technology has been well theorized by literacy educators but less has been undertaken in mathematics. Whereas literacy educators (Lankshear, Synder, & Green, 2001; Luke, 2000; Unsworth, 2002) have identified how technology is impacting on literacy and the ways in which new forms of literacy are emerging, the same cannot be said of numeracy. Some work has been done specifically in the area of information literacy or statistical literacy (Steen, 1999) where the recognition of the importance of statistics as they abound in an information age is made explicit. The work undertaken in mathematics has tended to focus on using technology to support mathematics learning through the use of calculators including graphics calculators (Doerr & Zangor, 2000; Hennessy, Fung, & Scanlon, 2001) and through the use of spreadsheets (Godfrey, 2001). There has been little in the theorizing of the impact of technology on mathematical thinking and its interaction with other spheres of life, including the world beyond schools. The paper draws on data from a large study where the focus has been on the mathematics, or more specifically, the numeracy demands of contemporary workplaces and how young people work mathematically in a range of sites where young people are typically employed.

Where patterns of work have been radically altered, the impact on the forms of knowledge and ways of knowing can be profound. In the 1970s, school mathematics relied on the use of slide rules and log tables for students to work through problems. The advent of the scientific calculator has changed this aspect of school mathematics considerably. More recently, the growing use of graphics calculators in the secondary years is having a major impact on how mathematics is being taught and conceptualized. These two forms of technology met with considerable resistance initially, in part due to the high costs of the technology, but as the costs decrease the uptake of the tools increases. The patterns of work in school mathematics have changed due to technology but how have the patterns of work changed in the workplace, in part due to technology – and how are young people positioned and prepared for the contemporary workplace. In a society where young people have grown up immersed in technology two parallel considerations need to be made – the first is how young people work mathematically and second, how industry has taken up technology and the impact this has on the nature of work and thinking mathematically in situ.

As part of the research being undertaken for this project, consider the scenario described by one senior research participant. In an architect’s office, the senior partner brought in a problem for the staff to solve. It involved the mathematics typical of the field where they needed to solve the task which required drawing a plan. The senior partner, in
his late 50s, set to task with his drawing board and set square and drew out the plan with his calibrated instruments. A senior architect, in his late 40s, worked through the problem using a calculator to work out dimensions and then to draw the plan. A young employee, in his late 20s, sat at his computer and entered the data into the CAD program whereupon the computer then proceeded to draw the plan to within 0.01mm accuracy. The younger person solved the task much more quickly than his older colleagues. The scenario shows the ways in which people use technology very differently to produce similar outcomes. What becomes important in this scenario is the different forms of technology used by the staff. Of particular importance in this paper is the ways in which digital technologies have changed the ways of working in contemporary worksites.

This paper takes as central the notion that technology has had a powerful impact on young people’s ways of working and thinking mathematically so that old ways of working have been superceded by alternative ways. A commonly-heard justification for reforms in mathematics has been advocated by the wider community where there is a bemoaning of declines in young people’s numerical knowledge and capacity to undertaken mental computations. However, when these criticisms of modern education are critically examined, a number of assumptions underpinning the voices can be identified. First is a call for particular forms of working mathematically. These are in the areas of computation and number work. Similarly, the call also is limited to particular ways of undertaking such calculations where either the expectation is related to mental arithmetic or pencil-and-paper work.

**The Study**

The study reported here is a three year project where the first year involved a large survey of the region to examine the perception of a range of clientele in terms of numeracy, literacy, ICT and general skills. The groups surveyed involved young people in work (students in schools; young employees and job seekers) and people involved with working with young people (teachers, employers and job placement officers). Over 800 people were surveyed. The second year of the study has involved work shadowing of young people in their workplace. Using a stimulated recall methodology, the participants are shadowed for three days and then asked to talk about the work they were doing and what processes they used as they worked through their tasks. This stage has not yet been completed but will involve 20 case studies across a wide range of industries. Interviews have been conducted with educators and employers to ascertain their perceptions of young people and the demands of the tasks they undertake. In this paper, we draw on one of the cross group comparisons from the survey data, and then draw on comments offered by participants.

**Discussion**

**Survey Outcomes**

Combing the six data sets into two sets where younger people (students, employees

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1 This project is funded through the Australian Research Council Linkage Grant system. The industry partners include Gold Coast City Council, Gold Coast TAFE, SCISCO, Queensland School Authority, Centrelink and Adams Consultancy.
and job seekers) all aged under 22, could be compared with the more senior people (teachers, employers and job placement officers), it was found that there 9 areas of significant difference between the two cohorts. As the data collection did not ask age of the senior people, no mean age can be provided, but by the very nature of their positions, it can be assumed that the mean age would be significantly higher than for the younger cohort. The survey consisted of a likert-style ranking system where participants were posed a stem relevant to their position and asked to rate the importance of various aspects of numeracy, literacy, ICT and general skills in the workplace. Examples of the items were provided with each item (as shown in Table One).

A step-wise multi-variant analysis shows the 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 $p \leq 0.001$.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Item</th>
<th>More important</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use computers of relatively general purposes</td>
<td>Senior</td>
</tr>
<tr>
<td></td>
<td>(e.g. Word processing, spreadsheets)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Statistics</td>
<td>Younger</td>
</tr>
<tr>
<td></td>
<td>(e.g. Creating or interpreting reports using data or information</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Industry-relevant technology</td>
<td>Younger</td>
</tr>
<tr>
<td></td>
<td>Use industry relevant technology (e.g. theodolites, calibrated instruments)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Non-verbal communication</td>
<td>Senior</td>
</tr>
<tr>
<td></td>
<td>Reading non-verbal cues effectively</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Computer technology to support numeracy/ maths</td>
<td>Younger</td>
</tr>
<tr>
<td></td>
<td>(e.g. using spreadsheets for graphing, analysis)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Number</td>
<td>Senior</td>
</tr>
<tr>
<td></td>
<td>e.g. Counting, calculating</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Industry-specific technology (complex)</td>
<td>Senior</td>
</tr>
<tr>
<td></td>
<td>(e.g. CAD, Multimedia packages)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Volume</td>
<td>Younger</td>
</tr>
<tr>
<td></td>
<td>(using measurements such as litres, mls, cubic cms or cubic metres)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Location</td>
<td>Younger</td>
</tr>
<tr>
<td></td>
<td>(reading maps, using compass points)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Senior and Younger Participants ranking of items

Of the responses, 5 were identified as numeracy, 3 as ICT and 1 as literacy. That is to say, when younger and more senior people were asked to rate the relative importance of the nominated skills in industry, these differences were statistically different between the two cohorts. This data confirms much theorizing in contemporary education that in New Times, there are different demands on young people, in part, brought about by technology. This is evident in this data set. Furthermore, the differences between perceptions of numeracy demands was a significant component of the response, that is, five out of the nine significant differences were related to numeracy demands. In order to explore the reasons for these differences, we draw on the open-ended responses in the surveys and some interview data to better understand the results.

**Numeracy and Calculations**

What became clear for us as we moved through the more open-ended responses and interview data were common themes appearing in the younger people and senior people’s comments. These related to the use of technology, and how technology was seen by the cohorts and how numeracy was defined. Comments indicated that younger people are not
intimidated by technology and saw it as a tool for undertaking menial tasks. In contrast, senior people have a respect for technology and mental computation where the latter is seen to be a human endeavour that enables work to be undertaken in a productive manner. Together, these comments have implications for theorizing and understanding the role and nature of numeracy (and ICT) in contemporary work.

Older people were more likely to comment on the levels of young people’s numeracy where numeracy was seen very narrowly as being the ability to compute mentally. Furthermore, there was often a link between this concern about skill level and a reliance on technology. This can be seen in the comment below by a numeracy educator working with young people:

Numeracy Educator: When the kids come into class now they can’t do their multiplication – they have to get out a calculator to multiply 3 and 2. They rely on the calculator so much that they do not think anymore.

Similarly, employers raised concerns about young people’s computation skills:

Employer: Young people do not seem to have the ability to calculate [mentally] things like we use to. They need to use a calculator to work out change when the cash register does not work. They do not know when the change they are giving is incorrect.

Industry specific comments were also raised. In the case below, the employer bemoans young people’s inability to calculate percentages:

Employer: It gets frustrating when the young guys can’t work out percentages. If they don’t know how much petrol and oil is needed for the engine, then they will blow it up and that costs me a lot of money.

Interestingly, all job placement offices (n=15) were most critical of young people’s calculating prowess (or lack of):

Job Placement Officer: One of the big problems placing these guys into jobs is that the employer comes back to us and tells us they can’t work out simple problems. We get them back and have to try and get them another job.

The emphasis on calculating featured very strongly in the open-ended comments of the senior participants. While the scope of the survey and interviews enabled other comments to be made (including literacy and general skills), the focus of (in)numeracy was high and confirmed the statistical data in terms of it being an important skill. However, in the comments offered, numeracy was almost always confined to computation (or arithmetic).

In contrast, younger people did not see calculating a key part of their work. Consider an interview comment by a younger person as she describes her job (as a cashier in a department store):

Shop Assistant: When it is peak time, you get people through all the time and some of them are really nasty. You have to be nice to everyone. One day I had this grumpy old man come through and I rang up his stuff wrong. Well he ripped right into me. Told me I was dumb and I needed to go back to school and that the company should give my job to an intelligent person. I got upset, but when I looked at his docket, I could see that I rang up one item twice and that’s where the mistake was. I called my supervisor over to alter the till and he was going mad. I started to cry and my supervisor asked him to come over to the inquiry desk to fix it up. It is so hard when it is busy and it is easy to make a mistake but I could see what I did wrong, he just wouldn’t listen.
This story is not atypical in terms of how younger people (in this type of job) saw their work. This young woman did not see the task of adding the items as her role whereas the older customer saw it as central. In contrast, the younger person saw it as important that she could identify where the error has occurred and then address the problem through this means. The menial task of addition was the role of the technology (in this case the cash register).

The deferring of the lower order tasks, such as addition of items, was seen by younger people as something that could be undertaken better, more accurately and more efficiently with technology. This is implicit in the comment offered above by the shop assistant and also in the earlier section by the numeracy educator. More explicitly, the following comment reinforces this process:

Console Operator: In this job, all I do is punch in the items and then the register does the rest for me. I then put in the money they give me and it tells me how much change I have to give them. I don’t do anything else except if there is a mistake – like I put in the wrong petrol pump or the wrong money or scan too many other items they buy. I have to have a bit of an idea of what I should cost but that comes almost automatically when you been her long enough. I have to work out where the mistake is, but then you just reenter it into the register.

Here, the young man talks about the ways in which the technology undertakes the arithmetic component of his work and his role is more about problem solving and estimation. Being familiar with the job and its demands, he has a sense of what the total should be rather than having to undertake calculations. His role is one of having a sense of what a reasonable amount would be and then when a problem arises, he relies on problem solving strategies to work out where the error occurs. This is a substantially different process than those taught in schools, and articulated by the numeracy educator.

Similar comments were offered by other young people in other roles. For example, a young landscaper did not see much of the formal measurement processes (such as length and area) he used in school in his work. Often the school mathematics programs are embedded with problems of laying out land in order to provide meaningful contexts for application of length and area. However, as this young man indicates, this type of mathematics or numeracy is not part of his explicit thinking. Rather he has a strong sense of the demands of the task, that is, he has a bigger picture of the task rather than seeing it as calculating areas and lengths. Again, problem solving using the objects of the field features strongly:

Landscaper: I don’t use much maths in my job – only on pay day! There is a bit of work when setting the site out but that is not really maths, it is more about understanding the layout of the site and you have to think about a lot more than just putting something on paper. You have to think about rocks, clay beds, trees protected by the Council, water or sewerage pipes, and drainage. I use a plumb line to make the retaining walls level, but that is about it.

The comments here suggest that young people use different forms of thinking about their work than those expected by senior participants. Whereas arithmetic computations featured largely in the comments offered by senior participants, younger people articulated a stronger orientation towards problem solving, estimation, application to the immediate context, and using technology to undertake the menial aspects of the task.
Technology and the Workplace

In the work shadowing phase of the project, what is becoming evident and supports the initial phase of the study, is that intuitive methods are used most often by younger people in the workplace. However, of importance to this paper is that in many workplaces, technology has taken a significant role in restructuring the workplace. This was borne out in some of the comments in the preceding section.

In many retail sites, the cashier does not enter any amounts but rather relies on a scanning process or in the case of sites such as McDonalds and Bakers Delight (two places studied), the register is marked with product items. This entails the cashier pressing the pad that corresponds with the item/s purchased – e.g. loaf of white bread. This process is useful for stock control for the business manager, but means that there is minimal, if any, mathematics or numeracy being used in this process. Where problems or mathematization of the work occurs is when errors occur and the assistant needs to work out where the problem lies.

In other sites, technology has impacted significantly on how tasks are undertaken. For example, in a cabinet makers, the cutting out of material and drilling of holes has all be computerized. Once tasks that needed to be calculated out by the apprentice or tradesperson, they are now undertaken by a computer software program. This can be seen in the comment offered by the owner of a large cabinet making company:

Employer: We have spent a stack of money on this new computerized system that lets you put in the information and then it sets all the things in place. It cost us an arm and a leg but should reduce wastage and mistakes. So many of the people here would make a blue [mistake] and the whole job could be ruined. Now that won’t happen.

The demathematization of the workplace was evident in many sites studied and through the initial survey. Computers and other forms of technology replaced many of the tasks that previously had been undertaken through laborious methods or through mental computations.

Herein emerges a contradiction in the data. Young people were able to articulate that they did not need to undertake calculations in the workplace yet senior participants were more likely to propose that younger people needed to undertake these calculations. This was despite recognizing that the workplaces were being more technologized and that such technology could undertake the calculations more reliably. This poses the question as to why senior people hold on to old values of computation when technologies are embedded in the daily practices within workplaces. In contrast, younger people were more likely to see technology as a tool to do the mundane aspects of the tasks and that their role was to provide a more global picture of the interactions so that when a problem occurred, they would be able to identify it and use the technology to solve the problem.

Dispositions Towards Using Technology

Associated with the technologizing of workplaces and the subsequent impact on numeracy, it was also noted through interviews that younger people were more likely to take technology for granted and use it as a tool for everyday tasks.

Employer: Young people come here unafraid of technology. They don’t have the respect for it that older people do. They see it as something they take for granted. As we get more technology here, I can see that we will need to employ more young people. They rush into learning with the new cash registers and don’t really want to listen when we are training them. They are quite happy to play
with them and make mistakes. Sometimes, this can create huge problems when they push wrong buttons and customers get angry but they don’t seem too worried about the mistakes – only that the customers are yelling at them.

In part, this comment sheds some light into different dispositions towards technology by younger and senior participants. Here the employer sees the technology (cash register) as being a complex tool that must be respected whereas he perceives young people as seeing it as no different from any other tool they would use. His comments reinforce those of the young female shop assistant at the start of this paper, where she saw her role as more of a problem solver and the technology as a tool through which she would be able to solve and, if necessary, rectify problems. The employer notes similar behaviours. What is of interest in this comment is the interpretation of technology. For young people having grown up in a technology-rich environment, it is just part of their repertoire of experiences. In contrast, senior people were more likely to be in awe of the technology. As evident in the comment above where young people “don’t have the respect for it”, the employer sees the technology as something of which to be in awe. This may be, in part, due to the economic costs of the equipment but the dispositions towards technology appear to be generational. Young people have grown up surrounded by technology to do menial work such as cook porridge in the microwave by pushing the porridge button or changing television stations via the remote control. Having grown up in substantially different periods, impacts on how technology is interpreted.

In this study, the focus was on the use of ICTs in order to make a break from technology per se. Although this was defined as relating to computers, the employer in the above comment saw a cash register as being a computer. If one can recall the cash transactions of the 70s where the bill was tallied on the side of an old newspaper and then entered into the till by pushing down the buttons simultaneously, then it is little wonder that an older person may be in awe of the contemporary cash register. In even earlier times, the money and docket was placed in a tin and sent across the building via a pulley system to an accountant sitting in a room above the store to work out costs and change! Little wonder some people see the cash register as a computer!

When younger people are inserted into workplaces, their familiarity with technology reinforces the comment made by the employer above. In this case, the young person is in a school-based traineeship and is undertaking one day a week in the workplace as part of his traineeship. This is a young person who works in the cabinet making business cited earlier in this paper. In the employer’s comment, it was clear that he saw the investment in the computerized technology as a boon to his business. In contrast the young employee was not fazed by the technology and even goes so far as to say that there is very little computer technology in the workplace:

Student in school-based traineeship: We learn all this computer stuff at school but when you get into the workplace, there is not a lot there. I mean, we have some stuff in the factory, but not a lot. There are some machines that you have to set things with [settings for drills] but that is about it.

The comment made by the trainee may be a reflection of the work that he is undertaking since he is only in the early years of his apprenticeship (one year into it) and may not be required to undertake complex tasks. However, we would suggest that it is also the case, that young people and senior people differ in their interpretations of technology-rich environments. Young people have taken-for-granted many of the technologies of post-
modern times whereas senior people have known other social conditions so see the technology as something quite different from earlier times. Their interpretations of technology prioritizes the role and status of technology whereas younger people having grown up in a technology-rich (almost saturated) environment have greater expectations of technology.

**Technologised Numeracy**

What has become clearer to us as we move through this project is that there are very different interpretations of numeracy; the ways of interpreting the nature of working mathematically; and the expectations of technology in contemporary workplaces. Whereas senior participants were more likely to describe issues of mental computation as foundational skills and attributes needed for working effectively, younger people were more likely to see these as low order tasks that should be undertaken by technology and that their role was to identify problems and solve them using technology to support that solution. This differential prioritizing of numeracy could be seen as key disposition and life skill of modern and postmodern times. People, having grown up in particular environments, develop different strategies for resolving problems. Senior people, having grown up in a technology poor society have relied on particular strategies for working through their daily tasks. Not having access to calculators, there is a greater emphasis on accuracy in mental computation. In contrast, younger people having grown up in a technology-rich environment where even simple technology such as a calculator is commonplace, have developed different dispositions to working mathematically. Menial tasks, such as calculations, can readily and more reliably undertaken by technology and that the task of the employee is more about problem solving and estimation. Similarly, the dispositions towards using technology are very different. Older people are more likely to be respectful (and fearful in some cases) of technology and expect others to be the same. In contrast, younger people see it as a tool, or even a toy, which is used to serve their needs.

**References**


**Acknowledgement:** Thanks to Dr Phil Harker for his analysis of the quantitative data.