Citizenship and Numeracy: Implications for Youth, Employment and Life Beyond the School Yard

Robyn Zevenberger
Griffith University, Australia

One of the bigger tasks confronting contemporary schools is how best to prepare students for their future lives beyond schools. Within such a context, considerations need to be made as to what constitutes the demands of that society and what skills and knowledges are needed in order to work within that society. By no means is this a simple equation since to work within a society also demands skills and knowledges that not only allow young people to live within it, but also to ensure critique in order that notions of equity and fairness prevail. Educators and policy makers continually struggle and debate over what are the necessary elements of a good education. Changes over time reflect the dialectic of schools and society. Emphases and ideology are reflected in the terminology used to denote current trends and movements in schools and the wider social arena.

In contemporary times, greater recognition has been given to the notion of the individual who is able to contribute to and work within society in economic and social terms. This have moved the focus away from the role of work as central to identity, to a more encompassing notion that acknowledges a more rounded sense of who people are and their relationship to others within the broader society. Traditional or modernist versions of schooling and society are under considerable pressure to effect significant transformation in order to better prepare students for the new and substantially different workplaces in a postmodernist era. In these changed times old forms of work and working have been replaced with significant different patterns of work, employment and leisure. In concert with this vision of work, increasing recognition is afforded to notions of citizenship, but what is meant by such constructs when notions of globalisation and internationalisation enter the debate. Similarly within changing work, family and leisure relationships, what are the implications for a new citizen? These considerations are essential if serious effort is to be made into what government, education and communities expect of and for its citizenry. Modernist notions of citizenship closely aligned with nationalism, full participation in a productive workforce, and economic sustainability have been eroded by the changes economies, globabilisation, technology and community life. Within these changing times, questions need to be asked as to what it means to be a member of a community be it "Portugese" or "Australian" or even in grander terms such as "European" as trans-national boundaries and economies collapse. Similarly notions of identity tied to gender—such as "man", "husband", "fa-

ther" or "woman", "wife" or "mother"—have been challenged by the dramatic shifts in work and family relations. Increasingly notions of identity tied to nationalism or gender or any other category used to discuss roles in society need to be reconsidered when thinking about what 'citizenship' means to schooling, and in particular to mathematics education. Within newer conceptions of schooling and curriculum, the concept of 'citizenship' represents a much wider notion of understanding the goals of schooling.

Citizenship in New Times

Many curriculum reforms recognise the need to address notions of "citizenship" in and through curriculum. Australian curriculum reforms have recognised the importance of citizenship as a construct to be inclusive of understanding governmentality of states/territories and federal processes while other versions include notions of culture and identity. Within reforms in Australian education, all states have sought to include the notion in their curriculum reforms. Drawing significantly on the issues posed by postmodernist thinking insofar as new work and new societies, Education Queensland has proposed that curriculum and schooling needs radical reconstruction to reflect the changes in the wider society and global communities. Arising from substantive empirical work (Education Queensland, 2000) and careful theoretical deliberations, Education Queensland is currently trialling a curriculum reform which they refer to as the "New Basics". The approach consists of three key elements—the new basics (as opposed to the old basics); pedagogical reform (productive pedagogies) and curriculum/assessment practices to reflect reform in the previous elements (rich tasks). These key outcomes reflect what are seen as the new basics for living in new times and represent a radical vision for curriculum reform. Four key outcomes are foundational to the reform and reflect a serious challenge to current curriculum. Rather than base curriculum around traditional discipline boundaries, the reform centres on the following four themes:

1. *Life pathways and social futures* centres around the question: Who am I and where am I going?

2. *Multiliteracies and communications media* poses the question: How do I make sense of and communicate with the world?

3. *Active citizenship* poses the question: What are my rights and responsibilities in communities, cultures and economies?

4. *Environments and technologies* poses the question: How do I describe, analyse and the world around me?

These themes are succinct goals perceived to be the key learnings that schools should aim to achieve. They are seen to reflect the competencies that are needed for effective living in New Times. Of particular importance to this paper are the areas of multiliteracies which encompasses numeracy, and to which I will devote a significant portion

of the paper, along with the notion of active citizenship. Arguably, one cannot participate effectively in society, understand how communities work, without having some basic skills which include numeracy and literacy. Hence, numeracy is a key aspect of citizenship.

Increasingly governments, communities and educators are recognising that students need to leave school with enough confidence and competence to be effective participants in the wider society. Inevitably, literacy and numeracy are central to these debates. However, less is agreed upon as to what these constructs mean. In the reforms in Queensland schools, the more encompassing term of "multiliteracies" has been used. Such a term is seen to reflect the dynamic nature of literacy so as to include reading and writing, but also social literacy and technological literacy. In some instances, numeracy has been described as constituting a specific form of literacy. However, I would argue strongly against this formulation since it denies many of the unique aspects of numeracy or mathematical thinking that is substantially different from literacy.

In terms of numeracy, different definitions exist. These include those used in the UK reforms where it is seen to refer to number (numeration and operations) whereas in other contexts it is seen to be far more encompassing so as to include being confident with the application and use of mathematics in everyday contexts. The application of school mathematics to contexts such as work and activities including shopping, banking, measuring and so on are seen to be important in how people live sustainable and quality lives. In contrast, being innumerate severely restricts the potential of individuals in how they live their lives and the quality of their lives. Indeed, numeracy has been identified as the key indicator of life success (Lamb, 1997). As such, numeracy is a key consideration for schooling and life beyond schools. But, the question as to what constitutes numeracy in these New Times and how it relates to citizenship have been relatively uncontested in the mainstream literature. While debates in literacy have forced educators and policy makers to consider what it means to be literate in New Times, less debate has been undertaken by mathematics educators. In the remainder of this paper, I will consider what it means to be numerate in these New Times and the links this has with citizenship.

Numeracy in New Times

In considering what it means to be numerate in these New Times, it is necessary to consider what forms of numeracy are needed. In concert with the perceived needs identified by various interest groups and stakeholders, consideration needs to be afforded to the changing times and new skills that are needed for these changing contexts. Technology features strongly in these deliberations. Employers often bemoan the poor numeracy levels of their young employees but in fact are referring to arithmetic skills. With the advancement of technology, such as calculators and computers, and its ready availability, questions need to be raised as to whether arithmetic should retain its relatively high emphasis within school mathematics and, rather, that it is replaced with skills such as estimation and problem solving become more central. That is not to say that arithmetic is replaced, rather, its emphasis within the curriculum is called into question. As young

people enter the workforce, the demands to be able to calculate and measure have been significantly reduced (Zevenbergen, 1997) and have been replaced with tools that effectively reduce error. In such contexts, young people need to be able to check the outputs from the tools they are using (eg calculators, cash registers, electronic scales) to evaluate the reliability of the output. For example, weighing goods in a delicatessen demands that the worker is able to estimate that the amount shown corresponds with the good purchased and its weight. Keying in the wrong item code can produce significant error and this should be detected by the employee. As such, the process of weighing is not the essential skill but evaluating the output becomes more important. Similar examples abound for amounts owing or change to be tendered when considering checkouts so that the skills of calculating become secondary to the evaluation of the amount being tendered by the shop assistant.

Drawing on the work of Habermas (Habermas, 1972) and his tripartite theorising of knowledge, I have argued elsewhere (Zevenbergen, 1995) that three clear distinctions between numeracy can be identified—technical numeracy where basic skills can be seen as central. Processes of calculating, measuring, and so constitute this level of knowing. In essence, being able to 'do' mathematics but within the confines of school mathematics. That is to say, for example, calculating out tasks which are typically found in school textbooks. The second theme is that of practical knowing—being able to apply the technical knowledge to contexts in ways that are appropriate and competently undertaken. For example, in considering numeracy in the workplace, workers need to have the technical numeracy to be able to undertake calculations and/or measurement, as they apply to their immediate context. Consider the case of a plumber who is installing the spouting on a house. It is necessary for plumber to be able to apply measuring and calculating skills to the development of quotations; the purchase of equipment; the correct measurement of resources such as lengths and angles of pipes when installing plumbing lines; calculate profit margins so as to be competitive but to ensure he is able to make a reasonable wage. For this he/she need to have the technical numeracy to be able to undertake the calculations and measurements, but also to know how to apply that knowledge within the immediate context. These two aspects of numeracy tend to dominate current curriculum and policy thinking.

The third form of knowing is that of critical or emancipatory knowledge. In terms of mathematics education, and more specifically, numeracy, this level refers to using numeracy and mathematics in developing social and ideological critique. I will focus on this form of numeracy in a later section of the paper. In the following sections, I draw on the notion of technical numeracy and its implications for New Times and citizenship. In the following sections, I note a number of forms of numeracy that are needed in these New Times, proposing that they represent significant breaks from traditional forms of numeracy where there is an emphasis on basic skills (technical knowledge).

Statistical Numeracy

In considering the new demands of numeracy in society, mathematics educators have identified three key areas that need consideration. Steen (1999) has been a strong advocate arguing that new forms of numeracy need to address issues of statistical numeracy. This position within New Times is justified since one of the defining characteristics of this era is the move from a society where industry and production were central to one where information is central. The information society and information producers are key constructs in these New Times. As such, the role of data is central to this conceptualisation of society. Furthermore, students need to proficient in reading and interpreting data as well as collecting and producing data. As such, issues related to the technical knowledge of producing and interpreting data are foundational, but as Steen and others (e.g. Watson) have argued, the capacity to undertake the routine aspects of data construction and interpretation are important but equally important are the practical knowledge skills. In this context, being able to make sense of what the data are representing, evaluate the validity of the claims being interpreted from the data and so forth. These are key skills in New Times. For example, newspapers rely heavily on data, and such data can be used or misused depending on the author's intention. People need to be able to evaluate the validity of claims such as "the average home in the region has increased by $150K". In order to do so they need both the technical and practical knowledge of how the data is being used and what is being interpreted from the data. Currently, many people have exited from schools with low levels of statistical knowledge and are disempowered by their inability to evaluate the validity of the claims as they are represented through the media. In many cases, they are seduced by statistics such as these so as to understand that the value of all or most homes in the regions has increased by a significant amount. However, having the technical knowledge of mean, median and mode, they are able to deconstruct the text so as to realize that the authors are using a particular measure of central tendency to make their assertion. Using this technical knowledge and applying it to a practical context, they are then able to evaluate the validity of the claim. In so doing, they are able to interpret the newspaper article so as to identify the claims to be restrictive and only apply to some houses as having been sold and that these are homes in the upper price brackets. In applying technical numeracy to a practical context, the participants have been able to identify the processes through which statisitics have been used to create an illusion that all homes have increased dramatically in value.

Economic Numeracy

Within these New Times, economic reasoning is a central feature. Fundamental to the ethos of these times is a sense that economics permeates a significant portion of public reasoning. Economics of the local, national and global communities impact significantly on people's lives and a sense of what this means and how it affects daily life is important. In this times, a cashless economy seems to becoming something closer to reality

for many citizens so different ways of keeping track of finances emerge. Many families and workplaces have limited access to cash so new ways of thinking about finance and budgets are emerging, along with associated problems. One aspect of this cashless society is the role of cards—credit and debit—which shifts considerably from old forms of thinking in relation to money and bartering. Citizens may have the technical numeracy to be able to calculate money transactions, but synonymous with this change is the practical numeracy to understand how credit cards work and their impact on lifestyles. For example, the notion of revolving credit has been heralded by many financial consultants as an effective means by which to reduce financial debt. Having the technical and practical numeracy to understand the processes through which this works is central to it working to maximum benefit. Yet, figures currently being released suggest that for many people undertaking the practice end up in considerably more debt than previous to their revolving credit as they fail to make payments on their credit card, thereby accumulating considerably higher debts at very high interest rates. The Australian community has a significant debt within local populations, in part, due to massive debts on credit cards. Currently schools are trailing a system where students use a debit card for purchasing lunches through the school tuck shops. The rationale for the practice is to prevent students being harassed by school bullies in order to take food from younger or less assertive students. The indoctrination of credit or cashless purchases is reaching younger students. Practices such as these help to support the adoption of cards for later years. The practice, however, also shifts emphasis on reasoning practices away from the immediacy of an operation on cash transactions to one of a longer and less immediate transaction.

In order to better understand economies, students need to be introduced to the effects of globalization and global economics. Currently, the USA is placing a 30% tariff on steel imports. The US government claims that practice will help protect US steel industries while they restructure in order to position themselves more strategically in the global markets. In order to better understand practices such as this, students need to understand the practical numeracy related to basic economics, but also the practical numeracy of how economics in one country impact on others, particularly in New Times when local economies are influenced by national and international forces. The US steel tariffs will impact significantly on other economies. For example, within the Australian economy, the steel industry has been subject to savage cutting in the past decades to a point where steel towns have almost died. Some have been able to reconstitute themselves but need significant export markets—including the US. Where governments are unable to offer similar protectionism, local economies will be under considerable pressure to survive. The need to understand economics from local, national and global perspectives is central to understanding how communities are effected by actions beyond the control of those who appear to be immediately involved in the process. For example, the technical numeracy for understanding how Newcastle (an Australian steel city) has been able to revive its steel industry needs to be considered within a broader conceptualization of numeracy as being a part of global community where, regardless of how well workers may be able to reconstitute their workplace, if another community

(such as the US) can offer protection through levies or subsidies, their efforts may be rendered useless in the longterm survival of the industry.

Business Numeracy

Within New Times, a further change in employment has occurred where people are less likely to have full-time employment and more likely to engage in employment where they are self-employed. The old modes of work are replaced with workers who engage in job creation and where employment is less likely to fit into the traditional 40 hours per week (or thereabouts). In order to be an effective participate in this new form of society, citizens need to be competent in developing a business etiquette, including the necessary numeracy skills to manage this aspect of their lives. In many cases, this may involve complex tasks such as accounting systems for taxation purposes through to more practical aspects of the immediate tasks including profit and loss; quotations; and general problem solving skills. Within the Australian economy, for example, approximately 40% of the population is employed in small business. Most businesses are family run or employ only a small number of people, but overall represent a significant component of the national workforce. Within this context, many people need to acquire skills to operate and manage their businesses. While so many people may be employed in these business, poverty statistics also indicate that while these people are engaged in employment, many live below the poverty line.

The introduction of the GST (Goods and Services Tax) correlated positively within a rapid increase in the number of small business becoming bankrupt. In part, this increase in bankruptcy can be linked to the fact that many small business operators were unable to cope with the complex numeracy demands of the new tax system. Reports to government suggested that many small business operators operated with small and unreliable profit margins. The new tax system created extra demands on this group of people. The system demanded greater and more accurate account keeping procedures that needed to be undertaken regularly as small business became tax collection agents for the State and hence needed to place their GST payments to the government regularly. This demanded considerable accuracy in accounting practices which were beyond the limits of many people in these small industries since many of the people working in these areas did so as they were unable to gain work in mainstream fields. Furthermore, the profit margins were considerably low, so the incredible amount of book keeping required by the Tax Office created considerable cost if undertaken by professional accountants—costs beyond the capacity of the small operators. While the Tax Office later reviewed its procedures when so many businesses were going bankrupt, the tax system still creates considerable burden on small (and large) businesses.

In order to participate and compete effectively in these New Times, citizens need to have the numeracy skills that will provide them with the knowledge—both technical and practical—for business. In terms of technical numeracy, a sense of the demands of the business are needed in terms of how to create quotations that will allow the business to survive and thrive. In terms of practical knowledge, the citizenry need to have the

knowledge to allow for flexibility in their business worksites. For example, it may be possible to have the technical numeracy to quote effectively on a concrete patio with appropriate markups to allow for profit. However, other considerations need to be made. For example, the business may be inundated with work and hence unable to complete the job, so many businesses may create an unusually high markup to allow for casual.

Technological Numeracy

The final form of technical/practical numeracy to be considered is that of technological numeracy. In these New Times, the influence of technology, particularly computers is a central and dominating feature. It exerts considerable influence over how work is organised and knowledge produced and disseminated. Technology has become a tool for undertaking considerable aspects of mathematical work. For example, the calculator has the potential to reduce mundane calculations, thereby creating considerably more opportunity for mathematical thinking and problem solving. As such, the tedious calculations undertaken as a significant part of mathematics classrooms can be replaced with much higher order thinking. Similarly, computers and in particular software packages such as spreadsheets, databases and specialized programs (Microworlds, Geometers Sketchpad, Cabri) have allowed greater exploration of mathematical ideas. No longer is it necessary for students to spend considerable time constructing pie (circle) graphs but rather, new skills and thinking are needed. Students need to have the technical skills to be able to construct such graphs, but the computer is able to undertake the tedious aspects of graph construction (with greater accuracy assuming data are entered correctly on the spreadsheet). What are needed in concert with the technical skills are knowledges that allow the student to decide what is the most appropriate graph from, being able to estimate and evaluate the effectiveness of the visual form of the graph. Furthermore, it is also important for the student to be able to plan and identify the types of data that will be necessary and the purpose of the graph. While such skills were always a part of good teaching (and learning), their emphasis has changed. Along with these changed emphasis, is the need for technological skills to be able to enter, interpret and evaluate the data being used. Being able to use the computer as a tool for using, interpreting and analyzing information is a key part of numeracy in New Times.

In these New Times, information is a new commodity. Students are in a data-drenched society. A significant amount of the information that is available to them is via technology—through the internet, world wide web and so on. Students need the technological skills to be able to access this information, and the technical numeracy to be able to interpret and evaluate the validity of claims being asserted through this medium.

Critical Numeracy

The third form of numeracy draws on Habermas' final form of knowing—critical or emancipatory knowledge. Within the mathematics education field, the work of Franken-

stein (1990; 1994) has been central to this position. Critical numeracy extends the earlier positions outlined in order to develop critique (and action). Extending Freire's notion of critical literacy where literacy is for empowerment, critical numeracy also seeks to empower participants. This is in stark contrast to most experiences of school mathematics where up to 80% of the population leaves school believing that they are unable to do mathematics and hence disempowered by and through school mathematics.

The need to be able to critically appraise information is increasingly a skill needed for contemporary living. In "the information age" where the production of information is seen to supercede the production of goods, young people need to have the skills to be able to assess information for its validity. Steen (1999) has strongly argued this position arguing that contemporary life is data-drenched and young people need the skills to be able to make sense of what they are surrounded by. The difficulty for many people—young and old—is that once information takes on a mathematical tenor it is beyond challenge. Many of the activities undertaken in school mathematics, and mathematics beyond school remain unchallenged and seen as unproblematic. Critical mathematics seeks to identify the political struggles within a seemingly apolitical context. Consider many of the examples outlined above. The imposition of a Goods and Services Tax resulted in many small businesses going bankrupt but it was described as due to poor numeracy skills. The average house prices in a region rising by a considerable amount of money is seen as a measure of central tendency and needing to understand how statistics can be used to manipulate data. Critical mathematics extends thinking about these forms of information to pose questions of a political nature. For example, why are houses of a greater value being sold at a higher rate than houses in a lower price range? Who is benefiting from this inflation? What are the consequences for people with lower priced homes? What are the effects of such inflation on the overall economy? These questions become central to understanding how numeracy impacts on people's lives and how can numeracy be used to challenge the status quo.

Numerous examples exist of how critical numeracy has been implemented in classrooms in order to facilitate students' understanding of their social, cultural, political, and environmental worlds. Two common examples are when students collect data on an aspect of their local environment - such as the water quality of the local creek. A significant amount of mathematics is needed to plan, collect, collate and report the data. When creek quality is found to be of concern, critical numeracy extends the process beyond simply developing a report, to enacting on that report. Actions to challenge what are seen as environmental effects are enacted—lobbying local councils, reporting to newspapers, lobbying local groups, meeting with industries associated with the polluting of the creek are all potential sites for action. Less action-orientated practices can also be developed whereby ideological critique is also undertaken. Challenging taken-for-granted information can raise awareness of issues. For example, the world economies are considerably influenced by OPEC, oil is a natural non-renewable resource. In countries such as Australia it costs approximately 80cents per litre. It must undergo considerably refining in order to produce the final product. All these factors are important but questions as to why other companies, such as Coca-Cola, are able to produce and sell a renewable

product that does not require anywhere near the production as oil at a cost of $1.25 per litre (50% more than oil) can be posed.

Numeracy and Citizenship: An Example

In concluding, I would like to draw on a recent event to exemplify the relationship between numeracy and citizenship. A small county town near Sydney was suffering the demise of many Australian country towns—low employment, lack of industry and economic downturn. The town needed some new form of work for its people. A company proposed a new industry—a dumping ground for the effluent of some Sydney suburbs. The proposition meant that approximately 15 people would be employed at the site and through related activities. The town council supported the bid seeing it as an opportunity to provide much needed jobs. However, a group of primary school students rallied and orchestrated a campaign against the dumping ground. They did not believe that the environmental and social cost of the dump was worth the low levels of employment being offered. In order to mount a strong case, the students had to gather evidence to support their case. They needed to have data about the environmental impact of the dumping site along with the social costs to the community, in other words - the 'real' effect of the dump on the town. In this case, the students needed to technical numeracy in order to collect and collate the data related to the issue, the practical numeracy on how to use the data in a way to support their case, and finally the critical numeracy on how to use the data to challenge the power of a very large corporation (and the council).

The students' commitment to their community was evidenced in their claims that they were very happy in their town and wanted their own children to grow up in an environment free from toxic and other environmental wastes and a countryside that retained its rolling hills and pristine creeks. These views draw on notions of citizenship—a sense of community and identity—as it relates to students and their town. The students were concerned about their identity as residents of the town, the community being overpowered by a large corporation threatening to damage the values that were central to the townspeople, and the potential damage to the environment by the dumping site. Using a range of numeracy skills, the young students were able to challenge the large company (and win). Initial development of plans and research into the issues, environmental impact studies, presenting information in ways to the wider community so as to convince townspeople of the potential dangers to the community, and a critical analysis of the overall impact on the town draw on the three forms of numeracy as identified in this paper. Without a sense of technical, practical and emancipatory numeracies, the students would not have been able to enact their sense of citizenship in order to challenge the waste company. By having the collective knowledge, the students successfully mounted a full challenge to the large company and were able to protect those aspects of their community that were valued by them.

References

Education Queensland (2000). The Queensland Longitudinal Reform Study. Brisbane: GoPrint.

Frankenstein, M. (1990). *Relearning mathematics: A different third R - Radical maths.* London: Free Association Books.

Frankenstein, M., & Powell, A. B. (1994). Toward liberatory mathematics: Paulo Freire's epistemology and ethnomathematics. In P. McLaren & C. Lankshear (Eds.), *Politics of liberation: Paths from Freire* (pp. 74-99). London: Routledge.

Habermas, J. (1972). *Knowledge and human interest.* Boston: Beacon.

Lamb, S. (1997). *Longitudinal study of youth labour markets.* Melbourne: Australian Council of Educational Research.

Steen, L. A. (1999). Numeracy: The new literacy for a data-drenched society. *Educational Leadership, October*, 8-13.

Zevenbergen, R. (1995). Towards a socially critical numeracy. *Critical Forum*, 3(1&2), 82-102.

Zevenbergen, R. (1997). Situated numeracy: Mathematical Saturation. In S. Billett (Ed.), Good Thinking, Good Practice: *Research perspectives on learning and work.* (Vol. 1, pp. 203-214). Brisbane: Centre for Learning and Work Research, Griffith University.

Resumo. As formas de numeracia necessárias para a vida actual numa sociedade pós-moderna representam modos de conhecimento e processos qualitativamente diferentes dos necessários em épocas anteriores. A partir de alguns exemplos situados na realidade australiana, defende-se a ideia de que as escolas, os professores e os alunos jovens podem adoptar formas de conhecimento, no sentido de Habermas, no desenvolvimento de novas numeracias para exercerem uma cidadania informada e actual. Defende-se a ideia de que os alunos precisam de desenvolver novas formas de numeracias, incluindo numeracia crítica, se se pretende que sejam cidadãos competentes e confiantes nas sociedades pós-modernas.

Palavras-chave: Educação matemática; cidadania; multi-literacia; numeracia.

Abstract. Forms of numeracy needed for contemporary life in postmodern society represent qualitatively different forms of knowledge and processes than those of previous times. Drawing on some examples from Australia, it is argued that schools, teachers and young students can adopt Habermas' forms of knowledge in the development of new numeracies for contemporary, informed citizenship.°It is proposed that students need to develop new forms of numeracies, including critical numeracy, if they are to be competent and confident citizens in postmodern societies.

Key-words: Mathematics education; citizenship; multiliteracies; numeracy.

■■■

ROBYN ZEVENBERGEN
Griffith University
Australia
r.zevenbergen@mailbox.gu.edu.au