An agenda for mathematics education in the decade of education for sustainable development

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The United Nations declared 2005 to 2014 as the *Decade of education for sustainable development*. This presents an opportune moment for mathematics educators and mathematics education researchers to reflect about the effectiveness that mathematics education has had in creating citizens for a sustainable future. There is an important distinction between education *about* sustainable development, and education *for* sustainable development; the latter is the more important, but also the more difficult and challenging. The paper examines some of the obstacles that mathematics educators face in educating for sustainable development, and identifies the need for some radical alternatives. These alternatives will need to challenge the dominant discourses that shape identities of both learners and teachers.

2005 to 2014 is the United Nations *Decade of education for sustainable development*. It is a critical moment in history for all educators including mathematics educators to reflect on the impact that their education has had and can have in educating citizens for a sustainable world. Sustainable development is a concept that has become a familiar one (though still a contested one) since the 1987 publication of O*ur common future*, better known to some as the Bruntland report, arising out of the work of the *World commission on environment and development*, chaired by the then Prime Minister of Norway Gro Harlem Bruntland. In this report, sustainable development is defined as:

> Development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.
>
> (WCED, 1987)

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This definition allows for a broad interpretation of the 'needs' of present and future generations and the factors that impact on the ability to meet these needs. This in turn suggests social and environmental justice as enabling factors in meeting the needs, both now and into the future. As expressed in the principles of *Agenda 21* which emerged out of the 1992 United Nations *conference on the environment and development* (also known as the *Rio earth summit)*, sustainable development requires us to think globally and to act locally; that is, understanding that every action we take as individuals in our local contexts has global consequences. Agenda 21 has become a key guiding principle for setting targets and developing strategies for sustainable development. Following the earth summit, individual nations have been mandated to develop a local Agenda 21 at various levels, for example, at national, state, and local council levels (Bennett, 2001). Thus local educational initiatives for sustainable development must also be considered in terms of how it can contribute globally, in practical terms of advancing social and environmental justice or in developmental terms of increasing consciousness and understanding about sustainable development.

The concern for a sustainable future dates further back in history than the Bruntland report. Some would argue that the concept already existed through the notion of stewardship in many traditional cultures and philosophies (see for example, Bennett, 2001; Hay, 2002). Much of the literature on recent environmental movements attributes a key source of inspiration from the publication of Rachel Carson's *Silent spring* (1962) that exposed the devastating impact of unfettered uses of chemical pesticides in the Great Lakes region of the United States. Since then, there has been a significant growth in both popular movements and academic studies around the general themes of environmental justice and sustainable development. The academic studies have necessitated both an interdisciplinary approach to take account of the interactions between issues of quality of life and the natural environment, and the birth of new specialisations such as environmental engineering, environmental sociology, eco-design, eco-tourism and so forth, to generate new knowledges and practices.

> Sustainability is complex and complicated, with no single discipline definitively addressing either the problems or solutions: it incorporates technological, philosophical, economic, social, ecological, political and scientific dimensions. This may be illustrated through an examination of real-world issues or projects that are motivated by concerns over sustainability – for example, in Green architecture, eco-design, gender and development; integrated and sustainable transport; global citizenship; and lifelong learning. (Blewitt, 2004, p. 2)

Why should we, as mathematics educators be concerned about education for sustainable development? And if we are concerned, what avenues are there for engagement and activism in this complex, complicated and interdisciplinary endeavour that needs to address the social and environmental justice issues of the current and future generations, both locally and globally? Critical mathematics education has made important contributions to illuminating the ways in which mathematics and sociopolitical power are interlinked. In the following section, I will show how the traditions of critical mathematics education have and can continue to have a role to play in mathematics education for sustainable development. Access to mathematics education, and the way in which mathematics education is used as a gatekeeper to further education and 'good' jobs remains a concern in many parts of the world. This dimension of mathematics education will be discussed in the third section as a dimension of education for sustainable development. In the fourth section, I will argue that there is a difference between educating *about* sustainable development and education *for* sustainable development, although the former is part of the latter. I will argue for the importance of this distinction, and in the fifth section, offer one possible radical alternative, at this stage just a 'thought experiment', that might contribute to imagining what mathematics education *for* sustainable futures might look like. I will draw on examples from Australia where I live and work; however, what is illustrated through these examples will draw resonance in many other parts of the world. Central to the project of education for sustainable development is the critical reflection and action upon the dominant discourses of consumerism that are shaping learner identities in ways that are contrary to educated citizens of a sustainable world.

Mathematics as a resource

Mathematics is a powerful resource for describing the realities around us, including aspects of the social and physical environment in which we live. In particular, mathematics provides us with a tool for producing models of environmental processes such as: changes in the weather, population changes of endangered species, breakdown of different types of wastes; and of social trends such as changes in the distribution of wealth, levels of literacy and numeracy, access to services, and so forth. One therefore needs to be mathematically literate in order to be able to 'read the world'. Paulo Freire's work (1972) on emancipatory education has contributed to a view of literacy as a critical social tool; that is literacy enables people to understand their world in terms of the politics that place some people in certain social and economic positions, and others at the other

end of the economic and social spectra. This notion of critical literacy has prompted many mathematics educators to consider whether there is a parallel concept for mathematics. This has led to the formulation of related theories and practices of critical mathematics (Frankenstein, 1989), (critical) numeracy (Johnston & Yasukawa, 2001), mathemacy (Skovsmose, 1994), ethnomathematics (Knijnik, 1992; d'Ambrosio, 1985), matheracy (D'Ambrosio 1999) and mathematical literacy (Gellert, Jablonka & Keitel, 2001; Jablonka, 2003). Although these writers cast slightly different nuances on the notion of critical mathematics education, they share a view that mathematics education has the potential to provide people with the skills and inclination to question how mathematical information and methods are created, presented and used to construct the social and cultural world in which we live. Dorling and Simpson (1999) illustrate the mathematical construction of social disadvantage in *Statistics in society: the arithmetic of politics*. We could find numerous examples of these and other political appropriation of mathematics in the daily media, be it the extent of immediate responses needed to reduce greenhouse emissions, the decline in literacy and numeracy standards, and so on. Critical mathematics educators can educate people to notice these political dimensions of mathematics, and encourage people to develop their mathematical literacy so they can uncover and challenge the ideological basis of the arguments that are presented to them, and perhaps even formulate and create alternative ways of representing what is happening in their world. Mathematics, and critical mathematics education in particular, has the potential to offer important knowledge and tools for gaining a critical perspective on and analysis of social and environmental injustices that are represented and reproduced by mathematical models.

As Davis and Hersh (1986) point out, mathematics can not only describe aspects of reality; it also has predictive and prescriptive functions. Thus mathematics is a tool for predicting or forecasting what could happen if certain controls or interventions were not prescribed to stop it from happening. In education about the future, mathematics has a very important part to play. Indeed one of the most powerful examples of the role of mathematics in describing, predicting and prescribing conditions in which we live, was the project in 1972 undertaken by a group of economists, scientists and businessmen calling themselves the Club of Rome; their goal was no less than to simulate the world system through a necessarily highly complex mathematical model. The simulation enabled them, using what was advanced computing power at that time, to examine what the world would be like if the then current rate of growth continued. Their less than optimistic results and the caution against continuing with 'business as usual' was published in *Limits to growth* (Club of

Rome, 1972). While some of their methods and predictions are now critiqued as simplistic, *Limits to growth* did send a profound word of warning to the Western world about the pursuit of unlimited growth. Mathematics can and does carry critical social messages.

The descriptive, predictive and prescriptive powers of mathematics continue to be exploited in debating society's response to different future scenarios. In Australia, there have been exercises undertaken by the *Commonwealth scientific and industrial research organisation* (CSIRO) *Division of sustainable ecosystems* to construct several population, technology, resources, and environment scenarios to analyse Australia's options for the future (Foran & Poldy, 2002). There are also developments of different measures of progress to provide insight into the individual, economic, environmental and social wellbeing of the country (Australian Bureau of Statistics, 2006). Another Australian example that illustrates the importance of critical mathematics as a resource for understanding the future impact of current practices relates to the uncovering of "lies, damned lies and economic models" (Hamilton, 2001) that were used by the Australian government to campaign against the endorsement of the 1997 Kyoto protocol on reducing greenhouse emissions. Through critical examination of the mathematical models that were used to argue the government's case, Hamilton and his colleagues were able to uncover both the technical weaknesses of the model, and the interests of the people who constructed the model (interests groups in the coal industry), thus discrediting the claims made by the government.

So mathematics is a powerful resource for us now and in the future for understanding the social and physical world we live in, and the predicaments associated with a 'business as usual' approach to our social and natural environment. People's access to mathematical knowledge and skills is an important part of education for sustainable development if we want people – young and old – to be involved in shaping a sustainable world.

Access to mathematics education

However, access to mathematical knowledge and skills remains a challenge for many groups of people around the world. The projects of many mathematics educators and mathematics education researchers in pursuing the democratic access to mathematical knowledge (see for example Skovsmose & Valero, 2001; Penteado & Skovsmose, 2002) will therefore play a particularly important role in education for sustainable development.

It is not only because mathematics is a resource for students to learn about their social and physical worlds that access to and equity in

mathematics education are important. It is also because mathematics remains a critical gatekeeper for access to higher levels of education generally, and for employment. Furthermore, emerging research in mathematics and work (Bessot & Ridgway, 2000; Wedege, 2000; Zevenbergen, 2004) suggest that new technologies and new forms of work require different forms of numeracy that are more relevant to the competencies that are required in the workplace; not only is attention needed in improving access to mathematics education, but attention is also needed in reviewing what type of mathematical skills and knowledge are necessary. They are supported by Castells' writing about work in the new *e-economy*:

> The e-economy cannot function without workers able to navigate, both technically and in terms of content, this deep sea of information, organising it, focusing it, and transforming it into specific knowledge, appropriate for the task and purpose of the work process.
>
> (Castells, 2001, p. 91)

Thus, ongoing research about the types of mathematical skills and knowledge is needed as work practices and expectations for entry in the workforce change. Furthermore, in many countries, including Australia, there have been changes to the labour market which have meant "the death of career, the decline of standard hours and the rise of casualisation" (Hamilton, 2003). An increasing number of people are employed on short-term or casual contracts with limited career prospects (Watson, et al., 2003). This implies the need for people to be prepared not only to update their knowledge base in their field, but in the more precarious areas of work, to refocus their knowledge base altogether.

However, it is not only the knowledge and skills needed to 'do' the job that is subject to change in countries where the traditional role of trade unions in protecting workers' rights and conditions are being marginalised,like in Australia where the conservative party is in power. In Australia, as a result of changes to the industrial relations legislations over the last decade, the power of the trade unions has been severely curtailed, and an increasing number of workers are forced to negotiate their wages and conditions on an individual rather than collective basis (Watson, et al., 2003). Without a collective forum for determining and understanding entitlements and conditions of a workplace, being critically numerate is even more important for individual workers so that they can decipher the terms and conditions of, and make informed decisions about possible employment in a workplace. Mathematics educators need to respond to the changing socio-political contexts in order to ensure that the knowledge and skills that students access through the education processes are meaningful and useful to them, and empower them to negotiate the changes in their future world of work.

Mathematics education *for* sustainable development?

How can the abovementioned aspects of mathematics education – mathematics as a powerful resource for modelling the world, and access to mathematics education as a critical prerequisite to an individual's chances of survival and success in society – be part of an agenda of mathematics education for sustainable development? What more is needed so that we can move beyond analysis and critique of the state of the world and towards an action for a more sustainable world? Mathematics education has been acknowledged to help people analyse and critique the state of the world around them and to advance their own chances of success in the world; however, it has not been as clearly acknowledged for its potential to also help 'ordinary' people (as opposed to scientific experts) imagine and enact changes for a more sustainable world. The latter requires more careful reflection and action.

As a result of having access to mathematics education, and learning the theories and skills of mathematics, a person may be able to gain an insight into their social and physical world in ways that were previously not possible for them. They may even reflect on what they are now able to see with the aid of mathematics, and gain an understanding of the political, economic and cultural assumptions that have led to the state of the world as it is, and the future that it is heading to. But none of this may lead to the individual actively influencing the direction the world is heading. That is, we cannot assume that simply because people are aware of the problems that face us and our future generations, they are going to take educated action to shape the world into one that is more sustainable. One way of understanding this distinction between education *about* and *for* sustainable development is to consider the following comment about sustainability:

> Sustainability is both a practical and moral subject. It is interdisciplinary as much a matter of concern to the humanities (Said, 1993) as to the sciences. It is, at once, an inescapable dilemma of our time, a matter of study and reflection, and challenge to action. It raises questions about globalization and personal responsibility. It constitutes, in fact, all that a discipline calls for: a greater understanding and a basis for moral authority of knowledge.
>
> (Cullingford, 2004, p. 250)

In other words, mathematics education for sustainable development will require what Mezirow calls *perspective transformation* whereby a person becomes critically aware of how their ways of understanding the world have been shaped by existing presuppositions, then reformulating those assumptions to generate "a more inclusive, discriminating, permeable,

and integrative perspective; and [to make] decisions or otherwise [act] upon these new understandings" (Mezirow, 1990, p. 14). In some of the conceptions of critical mathematics, numeracy or mathemacy mentioned earlier, this link between reflection and action is implied. That is, critical mathematics/numeracy/mathemacy should empower people to take action to change the situation they see themselves in towards something that is closer to what they desire and envisage, not just for themselves as individuals but for the society that they live in and leave for future generations. The idea of paying closer attention to the learners' aspirations is discussed by Skovsmose (2005) when he argues that mathematics educators should perhaps pay less attention to theorising influences of students' backgrounds, and pay greater attention to their *foreground* in order to understand the *politics of learning obstacles*.

There are indeed some formidable learning obstacles, if by mathematics (or any) learning for sustainable development, we are expecting learners to gain understandings and skills to take action based on a moral stance. These obstacles are not isolated social phenomena that can be challenged by individuals or localised groups; they are dominant ideologies that in many ways allow little power for individuals to express and enact upon alternate value systems. They are ideologies of 'progress' and consumerism.

The German sociologist Beck (1995) has written about living in post-industrial society which he characterises as a *risk society* where

> the dark sides of progress increasingly come to dominate social debate. What no one saw and no one wanted – self-endangerment and the devastation of nature – is becoming the motive force of history. (ibid., p. 2)

In the risk society, Beck argues that there is a crisis of identity where:

> ... people become vulnerable to the expansive grasp of flourishing sensation industries, religious movements, and political doctrines. Fun and joy, pain and tears, fantasy, memory, and attention to the moment, hearing, seeing, and feeling all lose their remaining traditional responsibilities for the self and are determined by facts driven by market-expanding fashions. (ibid., p. 59)

In the Australian context, Hamilton (2003) talks about the *growth fetish* and that

> social democracy is being superseded by a sort of market totalitarianism. When older people bemoan the corruption of modern politics, they nevertheless feel that it is a historical aberration impinging

> on the constancy of democratic rights and that in the end the people can still have their say. Disturbingly, younger people hear only the accusation that the system is incurably corrupt – and they believe it. (ibid., p. 21)

Such an assessment of the 'system' is debilitating and paralysing for any young person hoping to make a difference in the world.

A study on young people's consumption patterns (UNESCO & UNEP, 2001) provides some clues as to how the forces of consumerism can be understood. 5 322 survey responses from young people aged 18 – 25 in 24 countries led to the following conclusions:

> The young public in the survey believes that the environmental impact of consumption is linked to the use of products and the recycling process, rather than to shopping behaviour.
>
> They seem to prefer unorganised forms of everyday action to organised mobilisation as a strategy to improve the world. (ibid., p. 44)

While the report shows that young people are concerned about issues of sustainability, the report pays attention to the disjunction between this concern and young people's capacity to change some of their very behaviour that may be threatening the environment. A close link between consumer products and personal identity formation of young people emerges; this then highlights obstacles when a young person sees the need to change their consumption pattern for the greater project of sustainability. By changing their consumption patterns, they change who they are in relation to the world.

In another study about young people, based in Germany, Tully (2003) examined how technologies such as the cell (mobile) telephones, computers, the Internet and cars acquired meanings closely linked to their personal identify formation, and were very different to the utilitarian meanings that these technologies may hold for the older generations. Tully argues that young people's understanding of the relationship between technology and society is constructed through these 'personal' technologies, rather than the big technologies of industrialisation such as nuclear power plants, large dams and factories that have both supported and generated critiques about the notion of technological determinism. Tully calls the latter category of technologies *Technology I* and the personal, 'gadget' category of technologies *Technology II*. He argues that Technology I is based on rational, utilitarian purposes, whereas, Technology II is oriented towards emotional and experiential purposes.

How can mathematics (or any education) generate a critical response to patterns of behaviour that are so closely linked to young people's

personal identity? Do mathematics educators have a role in posing such a challenge? Susan George (2004) claims that educators have precisely that responsibility in her book *Another world is possible if ....* She says that that possibility exists "if educators educate" (p. 211). Furthermore, she argues that

> [t]hose who genuinely want to help the movement should study the rich and powerful, not the poor and powerless. [...] Although wealth and power are always in a better position to keep their secrets and hide their activities, [...], any knowledge about them at all will be valuable to the movement. The poor and powerless already know what is wrong with their lives and those who want to help them should analyse the forces that keep them where they are.
>
> (George, 2004, p. 211)

In other words, mathematics educators need to find ways of engaging with the politics of learning obstacles in the classroom, that is, foreground the study of how powerful groups in society operate in a way that may be endangering the future of the earth and the whole of humanity. What can this mean in practice?

An agenda for change?

What I have posited so far is that education *for* sustainable development means educating for action, not just educating about change or the need for it. I have also identified dominant ideologies that attempt and succeed in constructing people's identities more strongly as consumers rather than citizens or stewards of existing natural and cultural assets that we enjoy. Identifying with the role of a consumer can paralyse people's imagination of alternatives to a consumerist value system and orientation for society. Consumerism is powerful because it promises to deliver immediate and instant gratification; consumerism is not generally promoted for delivering products and services for longer term benefits to humanity. But the one affects a person's capacity to imagine the possibility of the other.

In a recent newspaper report it was reported that a transport consultant who undertook a study of Sydney residents' perception of the costs of different forms of transport found the following:

> His analysis of the real versus perceived costs of transport shows motorists believe it costs them about 13 cents per passenger per kilometre to use the car. That covers costs such as petrol (even at $1.40 a litre), tolls and parking.

> The actual cost – when car insurance, registration and maintenance, plus wider costs to society from congestion, accidents and air pollution are taken into account – comes in at 81 cents per passenger per kilometre.
>
> "All we really think about at the time [we choose to drive] is what it costs us in petrol and maybe parking, and that's only a couple of dollars," Mr Glazebrook said.
>
> As a society we pay one way or another, but as motorists we don't pay as we go, so there's an incentive to overuse the car. We actually are fooling ourselves. We have the fourth-lowest petrol prices in the world [...] we have built our lifestyles around cheap petrol and the point is: that will not last. (Nixon, 2006)

This example suggests that when people activate their mathematical knowledge and skills to estimate the cost of a particular mode of transport, say, the use of their private car, they factor in the most immediate and personal costs, and neglect the longer term costs both to themselves and to society more generally. Neither the idea of stewardship of the physical environment nor the need to consider the quality of their own and others' life in 10 or 15 years time are factors that come naturally into the costing. Caring for others, the future and the environment do not typically feature in discourses of consumerism. Yet discourses shape people's identities; and as Holland et al. (1998, p. 5) say "identities are a key means through which people care about and care for what is going on around them". Thus in order to understand how mathematics education can contribute to education for sustainable development, we need to engage with questions of how mathematics education can counter the dominant discourses of consumerism, nurture agencies in learners to imagine and act differently to what a consumer is expected to do, and help learners contemplate alternate identities to that of the consumer.

Measures of progress (2006) published by the Australian Bureau of Statistics provide data that suggest how improvements in individual wellbeing can occur without corresponding improvements in areas that relate to the social and environmental wellbeing of the country in which the individuals live. For example, the data show improvements in education and training, but measures of progress related to the natural environment – the natural landscape, air and atmosphere, and oceans and estuaries do not show significant improvements and in some areas show marked declines (Australian Bureau of Statistics, 2006). How can improvements in educational outcomes (access, participation and knowledge) lead to and become correlated with improvements in social and environmental wellbeing? How can education be made accountable to future generations of

people whose lives and environment are shaped by how the current generations apply their knowledge and skills? How can mathematics education locate itself more firmly in debates about what is happening in the world?

However widely accepted the importance of teaching and learning 'in context' has become in the mathematics education field, educational outcomes in mathematics is still measured in terms of knowledge and skills in mathematics, not on how individuals and groups activate these knowledge and skills in their school and out of school contexts. Contexts are still largely seen as a vehicle for instruction and motivation, rather than factors that shape the purpose of mathematics teaching and learning. Furthermore, the field of education itself, in a more and more privatised system like in Australia, is itself becoming a site for 'consumption', that is, education is seen as a commodity, and learners as clients or customers who are wanting their 'money's worth'. There is an expectation of 'relevance' to learners that is more to do with meeting the perceived needs of the 'clients' rather than with encouraging meaningful engagement in learning. Education – both through schooling and popular culture – is arguably contributing to constructing students' consumer identities by promising to deliver what will benefit individual learners with lessening interest on what will benefit society more generally.

A recent report on the views of *Generation Y* (18 to 24 year olds) in Australia found that young people were unashamedly instrumental in their approach to education:

> These young people had a strictly instrumentalist view of education. It was there to provide you with the skills and knowledge necessary to get a job, at whatever level suited you.
>
> (Saulwick & Muller, 2006, p. 7)

The report also found that the young people who were the subjects of the study were confident and optimistic about their future. It attributed much of their positive outlook to the political and economic contexts of their upbringing; most of them were born after or would not remember the period when Australia experienced major economic restructuring that led to corporate downsizing and recession, shift to a more knowledge based economy, and the ups and downs of the IT sectors. They have never experienced a highly unionised workplace that they could reminisce about. They have grown up in a society and culture that celebrates individualism, and so far this has been working for enough of them. What if the social and economic contexts change for them? What about the social and economic contexts that other young people live in that are not as optimistic?

In order to be accountable to the wellbeing of society, now and into the future, mathematics educators may need to consider how they engage with the issue of learning as a process of identity formation. Facilitating discussions and critical self-reflection of learners' values and visions of a better world would still be in keeping with theories and research that demonstrate the power of 'relevant' contexts in the design of teaching and learning activities. My experience with learners at several levels (colleges, university undergraduates and doctoral levels) is that they are not averse to expressing their views about how they view the world, hearing about how others may view the world, and exploring contradictions and tensions in society. However, as educators we need to be there to open the doors to allow such expressions and discussions to take place, particularly in mathematics learning environments.

If we have a commitment in the field of mathematics education to contribute to education for sustainable development, then we need to critically reflect on what we can do to engender values for positive social change through our role as mathematics educators. This for many of us would require a radical shift in how we think about mathematics teaching. Let us imagine a hypothetical teaching scenario.

While many of us actively encourage discussions and debates about social issues and values as they emerge in learning activities in the mathematics classroom, how many of us use these values, ethics, and principles as the starting point and rationale for teaching and learning activities? Principles such as fairness, stewardship, and diversity are central in the project of sustainable development. Although many of us are aware that people's ideas of fairness are shaped by their experiences throughout life, how often does fairness feature explicitly as the central rationale for studying mathematics (and for learning more generally)? Can we imagine a school curriculum that is organized around 'values' such as: fairness; trust; cultural diversity; peaceful co-existence; bio-diversity; stewardship of the environment? If mathematics (and science, history, languages, and other traditional bodies of knowledge) were indeed integral and necessary for people to be educated, then would we not expect knowledge and skills in these traditional disciplines to emerge as necessary theoretical or methodological tools in the course of learning about values that shape the discourses with which we live?

For example, in the earlier years of schooling, a discussion with children about 'what's fair' might reveal a number of different ideas about what fairness means to children. Some may talk about sharing toys fairly with their friends. This may mean having the 'same' toys for some children. For others, it may mean similar but not exactly the same toys. Still for others, it may mean the same number but not the same type of toys.

They might think about the 'fairness' of children in one school having access to certain resources and facilities while children in another school having much less. It can lead to explorations of what being 'equal' means. When it comes to discussing fairness about other things, the criteria for fairness among these same children may be completely different. The child who sees fairness among friends in terms of having an equal number of toys, may think that it is fair that they have to go to bed at 9 pm and their much older siblings are allowed to go to bed anytime they please. By widening children's imagination and contemplation about the notion of fairness to a mathematical notion of 'equality', children may learn to challenge 'fairness' that is argued purely on simplistic, quantitative terms. Learners might also be encouraged to think about 'fairness' over time; would it be 'fair' if children in the future are not able to enjoy what the children now enjoy in terms of what the natural environment offers; what does it mean in terms of what the children in the current generation can expect and must do, in order to be 'fair' to future generations. What did children in the past have, compared to what they have now?

Designing a curriculum around values and principles allow for a richer engagement with ideas and issues than designing mathematical activities that have social contexts as an 'add on' feature. Starting from learners' experiences and orientations with certain values and principles without the constraints of a 'mathematics lesson' can allow for different meanings including historical, cultural, linguistic and other meanings, *but also* mathematical meanings to be explored. Over the formal educational career of a learner, a curriculum focus on 'fairness' can easily lead to much mathematical learning including learning about the mathematical concepts of equality and inequality, fractions, percentages, different types of averages, including weighted averages, distributions, graphs, money, trends, and cost-benefit analysis. A curriculum focus on any other value frames is likely to lead to equally rich mathematical learning experiences too.

A curricular approach that takes values as the rationale and starting point would almost certainly mean a loss of the privileged position that mathematics and other traditional disciplines have in the curriculum. It will therefore force us to critically reflect on our own identities and values as mathematics (or other disciplinary based) educators. We will also need to be politically astute so that the sort of values-based education described above does not get confused with any conservative agenda for indoctrinating values that help to maintain dominant paradigms. If we are seeking to challenge the influences that would otherwise shape our learners' identities so that they are not only 'consumers' but also, and hopefully more strongly change agents or activists for a better world,

then that may mean repositioning ourselves differently too, perhaps as activist educators.

Conclusion

The ideology of the market and consumerism is strongly entrenched in the social and political mindset. To challenge this requires us and our learners to reflect on our identities as teachers, learners and citizens, and contemplate identification with and as social change activists. The strength of the consumerist discourses means that they can also claim and appropriate the language of fairness (for example 'fair trade') and other values that are critical to the project of environmental and social justice. Educators for sustainable development will need to be able to reclaim the language of fairness, freedom, diversity and other values that mean something different to the individualistic self-interested meanings of these values that are promoted by the market and consumerist discourses. Education for sustainable development requires collaboration and cooperation across all those interested in creating a sustainable future; it is an interdisciplinary project that has a lot of room for debate but little room for competition between disciplines because its power is generated from the interconnections and networking. Can mathematics educators, particularly critical mathematic educators rise to the challenge of education for sustainable development?

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References

Australian Bureau of Statistics (2006). *Measures of Australia's progress*. Canberra: Commonwealth of Australia.

Beck, U. (1995). *Ecological enlightenment: essays on the politics of the risk society*. New Jersey: Humanities press.
Bennett, D. (2001). Development of sustainability concepts in Australia. In J. Venning J. Higgins (Eds.), *Towards sustainability: emerging systems for informing sustainable development* (pp. 22–47). Sydney: UNSW Press.
Bessot, A. & Ridgway, J. (Eds). (2000). *Education for mathematics in the workplace*. Dordrecht: Kluwer.
Blewitt, J. (2004). Introduction. In J. Blewitt & C. Cullingford (Eds.), *The sustainability curriculum: the challenge for higher education* (pp. 1–9). London: Earthscan.
Carson, R. (1962). *Silent spring*. London: Penguin.
Castells, M. (2001). *The internet galaxy: reflections on the internet, business and society*. Oxford: Oxford University Press.
Club of Rome (1972). *Limits to growth*. New York: Universe Books.
Cullingford, C. (2004). Conclusion: the future – is sustainability sustainable? In J. Blewitt & C. Cullingford (Eds.), *The sustainability curriculum: the challenge for higher education* (pp. 245–252). London: Earthscan.
D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the learning of mathematics*, 5 (1), 41–48.
D'Ambrosio, U. (1999). Literacy, mathemacy, and technocracy: a trivium for today. *Mathematical Thinking and Learning*, 1 (2), 131–153.
Davis, P. J. & Hersh, R. (1986). *Descartes dream: the world according to mathematics*. London: Penguin Books.
Dorling, D. & Simpson, S. (Eds.) (1999). *Statistics in society: the arithmetic of politics*. London: Arnold.
Foran, B. & Poldy, F. (2002). *Future dilemmas: options to 2050 for Australia's population, technology, resources and environment*. Retrieved February 20, 2004 from http://www.cse.csiro.au/research/futures/futuredilemmas/index.htm
Frankenstein, M. (1989). *Relearning mathematics: a different third r – radical maths*. London: Free Association Books.
Freire, P. (1972). *Pedagogy of the oppressed*. London: Sheed and Ward.
Gellert, U., Jablonka, E. & Keitel, C. (2001). Mathematical literacy and common sense in mathematics education. In B. Atweh, H. Forgasz & B. Nebres (Eds.), *Sociocultural research on mathematics education* (pp. 57–73). New Jersey: Lawrence Erlbaum.
George, S. (2004). *Another world is possible if*.... London: Verso.
Hamilton, C. (2003). *Growth fetish*. Sydney: Allen & Unwin.
Hamilton, C. (2001). *Running from the storm: the development of climate change policy in Australia*. Sydney: UNSW Press.
Hay, P. (2002). *Main currents in Western environmental thought*. Sydney: UNSW Press.

Holland, D. et al. (1998) *Identity and agency in cultural worlds*. Cambridge, MA: Harvared University Press.

Jablonka, E. (2003). Mathematical literacy. In A.J. Bishop, M.A. Clements, C. Keitel, J. Kilpatrick & F.K.S. Leung (Eds), *Second international handbook of mathematics education* (pp. 75–102). Dordrecht: Kluwer.

Johnston, B. & Yasukawa, K. (2001). Numeracy: negotiating the world through mathematics. In B. Atweh, H. Forgasz & B. Nebres (Eds.), *Sociocultural research on mathematics education* (pp. 279–294). New Jersey: Lawrence Erlbaum.

Knijnik, G. (1992). An ethnomathematical approach in mathematical education: a matter of political power. *For the learning of mathematics*, 13 (3), 23–26.

Mezirow, J. (1990). How critical reflection triggers transformative learning. In J. Mezirow & Associates (Eds). *Fostering critical reflection in adulthood*. (pp. 10–20). San Francisco: Jossey-Bass Publishers.

Nixon, S. (2006, May 26). If only they knew – car's true costs so much more. *Sydney Morning Herald*. Retrieved May 28, 2006 from http://www.smh.com.au/news/national/if-they-only-knew/2006/05/26/1148524888415.html.

Penteado, M. G. & Skovsmose, O. (2002). *Risks include possibilities*. Roskilde: Centre for Research in Learning Mathematics, Roskilde University.

Skovsmose, O. (2005). Foregrounds and politics of learning obstacles. *For the learning of mathematics*, 25 (1), 4–10.

Skovsmose, O. (1994). *Towards a philosophy of critical mathematics education*. Dordrecht: Kluwer.

Skovsmose, O. & Valero, P. (2001). Democratic access to powerful mathematical ideas. In L. English (Ed.), *Handbook of international research in mathematics education* (pp. 383–407). New Jersey: Lawrence Erlbaum.

Tully, C. (2003). Growing up in technological worlds: how modern technologies shape the everyday lives of young people. *Bulletin of Science, Technology & Society*, 23 (6), 444–456.

UNESCO & UNEP (2001). *Youth, sustainable consumption patterns and life styles*. Retrieved January 20, 2005, from http://unesdoc.unesco.org/images/0012/001242/124238e.pdf

Watson, I., Buchanan, J., Campbell, I. & Briggs, C. (2003). *Fragmented futures: new challenges in working life*. Sydney: The Federation Press.

WCED. (1987). *Our common future*. Oxford: Oxford University Press.

Wedege, T. (2000). Technology, competences and mathematics. In D. Coben, J. O'Donoghue & G. E. FitzSimons (Eds.), *Perspectives on adults learning mathematics: research and practice* (pp.191–207). Dordrecht: Kluwer.

Zevenbergen, R. (2004). Technologizing numeracy: intergenerational differences in working mathematically in new times. *Educational Studies in Mathematics*, 56, 97–117.

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Sammandrag

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