THE SOCIALLY RESPONSE-ABLE MATHEMATICS EDUCATION PROJECT

Introductory Notes for the Activities

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A brief introduction

These activities have been developed for teachers to use with students to help them grapple with some big ideas of importance to society and themselves (such as sustainability, healthy living and identity). Students will need to make judgements about what is or is not socially responsible, and using some mathematics that would be important in helping them come to these judgements. In other words, at the same time that students will be learning mathematics through their engagement with social issues, they learn about their social world through the mathematics they are learning. This approach to teaching mathematics allows them to see the relevance of mathematics and hence increase their interest and engagement in its learning. Similarly, this approach allows students to experience the power of mathematics, and hence increase their ability to use mathematics for real "real world" problem solving and decision making.

The overall aims of these activities are for students to:

1. Develop numeracy skills of choosing and using mathematics through engaging with data of social and personal relevance.
2. Realise that mathematics can provide a lens and a vehicle to help understand big issues in society
3. Realise that while mathematics is powerful for problem solving in the real world, decisions about socially responsible action cannot be answered by mathematics alone.

Some assumptions underpinning these activities are that that:

- Mathematics can provide a lens and a vehicle to help understand big issues in society.
- Our lives are often shaped by mathematics but that decisions about socially responsible action cannot be answered by mathematics alone.
- It is possible to develop powerful mathematics skills, concepts and applications through engagement in big issues in society.
- Using mathematics can help us understand some situations. But in some cases it may also mean that we reach a point where it is clear that we cannot decide conclusively one way or the other on a given question. At times this will be the most authentic position available.

Students are not expected to come up with a 'right' answer and a 'right' position or particular views. What is required is that they articulate an understanding of their values, the information they have gathered, and the beliefs they are shaping. Similarly, the mathematics involved in these activities is open ended. Through engagement in these activities, students can develop the ability to use mathematics and communicate their

understanding in a variety of ways to support certain points of views. Hence they will be able to develop an appreciation of the power as well as the limitation of using mathematics to understand social reality.

As they do this work students will improve their understanding of some important mathematical ideas and techniques outlined in the mathematics curriculum.

What is in a name?

These activities represent an approach to mathematics education based on the construct of ethical *responsibility* (see paper by Atweh & Brady, 2007) informed by critical mathematics education (Frankenstein, 1983; Skovsmose, 1994), ethnomathematics (D'Ambrosio, 1985; Powell& Frankenstein**,** 1997**)** and social justice pedagogy (Gutstein, 2006). As Atweh and Brady noted, ethics is generally associated with moral decisions, dogma and codes of behaviour and not seen as relevant to teaching and learning mathematics. However, they understand ethics differently. Based on the work of Levinas (1969), ethics is not understood as predetermined principles or commitment that is either manifested in a particular behaviour or not; rather, ethics is an adjective that describes an existing relationship with the other that precedes our knowledge of the other. Chritchley (2002, p. 11) puts it this way: "It is the relation which is ethical, not an ethics that is instantiated in relations" (p. 12).

The construct of responsibility, on which this approach is based is a key component of ethical discourse. Puka (2005) argues that the distinction some feminists make between responsibility and "response-ability" is a significant contribution to ethical thinking. Response-ability highlights the ability to respond to the demands of our own wellbeing and the ability to respond to the demands of the other. This is similar to what Roth (2007) points out, that responsibility "etymologically derives from a conjunction of the particles *re-*, doing again, *spondere*, to pledge, and *–ble*, a suffix meaning "to be able to."

Sources

The ideas of these activities have been developed by a group of middle school mathematics teachers involved in a project in Western Australia over 18 months. The activities have been trailed in schools and modified by the teachers and their support staff in the project. The teachers made presentations on their experiences at the Australian Association of Mathematics Teachers in Fremantle, Western Australia in 2009.

The materials

There are four examples of activities illustrated in this collection that vary in the extent to which they use open and closed activities.

1. **Is McDonalds Good for the World:** a guided research project with series of challenging questions for students either alone, in groups as a class can choose to explore.

2. **The Cost of Independence**: a series of activities for students to complete that help them explore the cost of leaving home and living on their own.

3. **Storms and Tides Project**: An example of a class project that explores a local issue - In this case whether a flood levee has been constructed sufficiently high to prevent floods.

4. **The Teachable Moment**: A few examples that explore how a topical moment that 'just happens' might be explored, (whether for a few minutes or developing into something more substantial) to demonstrate how mathematics can be linked to social responsibility.

Things to keep in mind

Choices

For the teacher there are always choices about what to do and how to do it. There is never one 'best way'. At times in these notes we will make reference to or describe some options, but many more exist. There are choices to be made about:

Getting started

- What social issues do we focus on and how to choose them?
- What aspects do we look at first?

Content

- Which big questions to ask?
- Who defines the topics?

Order

- in what order do we examine the topics?

Process

- Do all the students do everything at the same time?
- Should students in small groups tackle one challenge in depth? [Inevitably there is cross-over of questions, ideas and activities. Each challenging question is not completely unique or stand-alone]
- How much should students work alone and or in groups or as a whole class?
- What support do students need from the teacher?

Approach

- What is negotiable?
- What is not negotiable?
- How much research is for the students to do?
- How much of the information is made available to them?
- How much of the mathematical understanding is dealt with prior to a topic?
- How much mathematics can be developed through the project?

Assessment

- How can the mathematics that students do be assessed?
- What skills and concepts are worthwhile to be assessed?
- How to assess higher order thinking skills such as mathematical thinking, communication and reasoning?

Working together

Throughout we make reference to pairs, group work and whole class discussion.

We believe students need to talk about mathematics and how it is used, and not just write mathematical symbol and perform mathematical processes.

We believe that by working in pairs and groups we provide a way for everyone to join in.

We believe that working with others also provides a safe space that encourages some students to participate; however other students need to be taught and supported to work in a group – it won't just happen.

We believe that the groups need to work together long enough to build cohesion but short enough so that through the year everyone gets to work with everyone else in the class.

We also think that once students have had a go working in pairs or a small group then they are more likely to be able to participate in a class discussion.

Working together in pairs, groups and whole class is also about generating substantive conversation (see *Productive Pedagogies*, or the NSW *Quality Teaching* framework).

Working in groups is a social responsibility issue itself. Young people need to learn to work with each other across and beyond friendship groups.

Making conclusions and taking action

Students may be expected to prepare a response to their chosen challenge outlining their conclusions which are supported by evidence.

All students can be asked to describe these things:

1 How answering this question required them to use mathematics?

2 What the mathematics was that they used?

3 How the mathematics helped [or did not help] them understand the question and the information?

4 How mathematics helped [or did not help] them come to some sort of a conclusion?

The Mathematics

There is a tendency of activities such as these to focus primarily on social issues at the risk of neglecting the development of the mathematics or only developing very low level mathematical of calculations and procedures. It pays to remember that this is doing dis-service to students and the mathematics teaching in the school. Teachers always need to reflect on the adopted curriculum in their school and school systems. In particular, they need to identify how these activities may contribute to the higher order thinking outcomes of the curriculum such as problem solving, communication and reasoning.

It might be helpful to name some of the mathematics that is used in these activities. The following list is only a start and is not meant to be exhaustive. Each unit provides opportunities for more mathematics.

- Understanding and using large numbers
- Understanding and using percentages
- Comparing size or quantity [such as calculating the difference in values in absolute terms and as a ratio]
- Calculations
- Using data [such as reading and creating tables and graphs]
- Imperial units and metric units
- Working mathematically [doing things like problem solving or searching for patterns].
- Communicating mathematics and reasoning.

Engaging with the mathematics

In this sort of activity something might happen that will change the intended focus of your lesson or the student's activity. It might be that:

- students do not understand a mathematical idea or skill that they encounter or need
- students get interested in another aspect of the work that you hadn't foreseen but it is important and you follow it

There will always be a balancing act for the teacher:

- Do we stop and practice that skill before moving on?
- Do we just notice it for now and spend time on it another time?
- Do we just push on because it simply feels too hard to deal with as a whole class and just get some small group attention to those who need it later?

- Do we look ahead to see what mathematics we think is coming up and practice it before we get there?

The answer to all of these questions is 'sometimes … but not all the time'.

There are good reasons to do that and good reasons not to. It always comes back to your professional judgement.

Assessment

In these units the teacher has the opportunity to observe the students doing many things such as working in groups, using research techniques and communicating to others. In particular the teacher will see how each student deals with the mathematics. As mentioned earlier aspects of this include:

- capacity with identifying the mathematics
- facility with the mathematics
- using the mathematics in their discussions and work.

Students can be assessed by the teacher as the work unfolds, to inform any need for particular lessons on concepts and skills at the point of need. Likewise the teacher can assess students who successfully manage and understand the mathematics they need to complete the task. This can be noted.

In the students' presentations at the conclusion of this section the teacher can assess the extent to which students have successfully and correctly used the appropriate mathematics to support their argument.

All students can and should be assessed on how well they responded to the task of describing:

- How answering this question required them to use mathematics?
- What the mathematics was that they used?
- How the mathematics helped [or did not help] them understand the question and the information?
- How mathematics helped [or did not help] them come to some sort of a conclusion?

Ultimately any assessment should include some focus on learning. In this unit this focus could include what each student has learned about:

- mathematics
- social responsibility
- social responsibility and mathematics.