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Pedagogy for Socially Response-able Mathematics Education

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This paper discusses an approach to mathematics education based on the concept of ethical responsibility. It argues that an ethical approach to mathematics teaching lays the foundations for two focuses in the literature, namely social justice and critical mathematics. It develops a particular understanding of ethical responsibility based on the writings of Emanuel Levinas. Further, it discusses two dimensions of Productive Pedagogy, namely Intellectual Quality and Connectedness, from this ethical responsibility perspective as they relate to mathematics education.

The "social turn" in mathematics education (Lerman, 2000) is well illustrated by the intensification and diversity of research issues in the discipline during the past five decades that adopted social and critical perspectives. These include concerns about equity, participation and social justice (Burton, 2003; Secada, 1989); consideration of the political dimension of mathematics education (Mellon Olson, 1987); sociology and mathematics education (Dowling, 1998); cultural perspectives (Bishop, 1988); critical mathematics education (Frankenstein, 1983; Skovsmose, 1994;); ethnomathematics (D'Ambrosio, 1985; Powell& Frankenstein**,** 1997**)**; philosophical analysis (Ernest, 1994); and the history of mathematics movement (Furinghetti, Kaisjer, & Vretblad, 2004). While these agendas have different foci, and often are at variance in their conclusions and implications, they share a few characteristics. There is a strong rejection of the dominant view that mathematics is a singular, objective and value free discipline that is isolated of human interest. They also question the relationship of mathematics to the social and cultural context in which it arose and in which it is applied. Similarly, on the teaching of mathematics, they challenge the dominance of the traditional mathematics curriculum outlined in many syllabus documents and the traditional teaching practices in the main stream classes around the world. Further, they question the assumption that the teaching of mathematics should follow set procedures and pedagogies that, once supported by rigorous research findings, are generalisable to *all* contexts and for the teaching of *all* students.

In particular, concerns about social justice, or its variants of equity, and diversity (Atweh, 2007), are often raised in writings from this social perspectives. However, very infrequently the discourse of *ethics* is raised in mathematics education. This is not to say that there has been no concern about ethical conduct or ethical implication in the design of curricula and the teaching mathematics. Similarly, this does not mean that ethics and social justice are two divergent discourses. Here I argue that there are two reasons why thinking about ethics in mathematics education supports, and lays the foundation for the concerns about social justice. First, social justice issues are often constructed as concerns related to the participation of social groups in social activity and their enjoyment of their fair share of social benefits. It has less to do with the outcomes achieved by a particular individual - unless the outcomes are due to their belonging to a social group. They are often silent on issues related to the interaction between two people – say of the same social group. Ethics, on the other hand, is concerned with a face to face encounter and interaction between people. Secondly, ethical considerations highlight moral responsibility of one to, and for the other. This focus on responsibility establishes social justice concerns as a moral obligation, rather than charity, good will or convenient politics. In other words, adopting a social justices approach places knowledge as a servant to justice; while an ethical approach places justice at the service of the moral (Cohen, 2001).

Arguably, this absence of ethics discourse in mathematics education is paralleled by its absence from general discourses in education and humanities in Western culture. With the rise of scientific rationality, ethics was often associated with questions of morality, dogma, codes of behaviour and legal imperatives and often seen as belonging to the domain of metaphysis rather than philosophy proper. Cohen (2005) explains this avoidance of ethical discussion in philosophy as a fear of moralising, preaching and questions of values by philosophical discourses mainly focused on ontology rather than meaning. Similarly, in Western thinking there is a movement away from essentialist thinking represented in the universality of ethical principles (Christie, 2005) and their foundation on rationality as established by philosophers such as Kant. Going back to the philosophical and ethical discourses Socrates who established the primacy of the knowledge of the *good* over the knowledge of the *truth*, Cohen raises the question "has the philosopher abdicated responsibilities" (p. 39). However, this avoidance to deal with ethical discourse is slowly dissolving. As Critchley (2002) indicates, it was only in the 1980s that the word ethics came back to intellectual discourse after the "antihumanism of the 1970s" (p. 2). Further, the post-ontological philosophical writings of Levinas (1969, 1997) have been accredited by the re-introduction of ethics within philosophy by establishing ethics as the First Philosophy. As Christie (2005) argues, when it comes to ethics, it is possible to "work with and work against" (p. 240) the construct at the same time. In other words, we adopt a critical stance on the concept, its usefulness and its limitation.

This paper attempts to establish the discussion on the social aspects of mathematics education on the construct of ethical *responsibility*, with one particular interpretation of the term as *response-ability*. It attempts to argue for the need to raise ethical concerns as a basis for principles of politics, critique and social justice in the discipline. It bases this

understanding on one approach to ethics as the 'first philosophy' principles espoused by Levinas. Secondly, it discusses the implication of such an approach to mathematics education. Finally, using two constructs of Productive Pedagogy (Hayes, Mills, Christie & Lingard, 2005) namely Intellectual Quality and Connectedness, it discusses some of the implications of a response-ability approach to the classroom pedagogy in mathematics education.

Ethical Response-ability

The demand for responsibility, or more often in its synonym accountability, is an increasing concern in educational discourse, policy and practice. However the term is used with a variety of meanings. Responsibility is often presented as a requirement or duty that restricts (as in, it is the teachers responsibility to cover the curriculum) as well as enables (as in, evaluating students' learning is the teachers' responsibility) or sometimes in the placement of blame (as in, who is responsible for the students' lack of achievement?). It often posits a conflict between the self-interest and the interests of the other, or the collective - giving a priority to the latter. Ethical codes are constructed under the assumption that norms and regulations need to be set and agreed upon otherwise our "natural instincts" would find teachers lazy or dishonest, and leave students under the threat of marginalisation or exploitation.

In mathematics education the demand for accountability or responsibility is also portrayed in the world-wide push towards standards and testing. These are often justified as a need for teachers and school systems to demonstrate the students' achievement of desirable outcomes. Neyland (2004) argues that this increase in "regulation at a distance" in many educational policies related to mathematics education reflects a 'scientific management' rationality that posits institutions and norms as the cause of ethical behaviour. Using Levinas writings, he goes on to argue that such institutions externalises and mechanises ethical behaviour and thus "sometimes erodes a primordial ethical relation between people" (p. 517).

If the law or the system does not form a valid foundation of ethical responsibility, what does? Philosophy? As discussed above Western philosophy as often avoided the consideration of ethics. Further, as Levinas argues philosophy is mainly concerned with question of being (ontology) and knowledge (epistemology). The discussion of being and knowledge are achieved by reducing the other to the same (Critchely, 1992) and by dealing with consciousness (Bergo, 1999). For Levinas, ethics is before any philosophy and is the basis of all philosophical exchanges. It precedes ontology "which is a relation to otherness that is reducible to comprehension or understanding" (Critchley, 2002, p.11). This relation to the other that precedes understanding he calls "original relation". Chritchley goes on to point out that the original contribution of Levinas is that he "does not posit, *a priori*, a conception of ethics that then instantiates itself (or does not) in certain concrete experiences. Rather, the ethical is an adjective that describes, *a posteriori*, as it were, a certain event of being in a relation to the other irreducible to comprehension. It is the relation which is ethical, not an ethics that is instantiated in relations" (p. 12, italics in original). Using a phenomenological approach, Levinas argues

that to be human is to be in a relationship to the other, or more accurately, in a relation *for the other*. This relation is even prior to mutual obligation or reciprocity. Roth (2007) argues that this original ethical relationship discussed by Levinas consists of an "unlimited, measureless responsibility toward each other that is in continuous excess over any formalization of responsibility in the law and stated ethical principles".

In his later work, Levinas (1997) introduced the distinction between *saying* and the *said* in the face to face encounters with the other. The *said*, for example, philosophical dialogue, is propositional while the saying is the ethical. Neyland (2004, 517) explains the distinction in this way:

> When I speak to another person, I *acknowledge* him or her as another person. Thus, he puts it, before every 'said" there is a "saying". When I acknowledge another person, when I focus on his or her "face" I do more than just gaze, I actually *encounter* him or her. This encounter, Levinas argues, is, at its deepest level, an awareness of the other as one who in some way needs me. This … is the source of the social bond. He emphasises that there is compulsion involved. I am not obliged to respond to the other. I can choose to break the encounter. But in doing so, I weaken the social bond. Further, because my selfhood- my self concept and self identity – depends on my responding to the need I recognise in another, when I break the social bond, I impair my selfhood.

Neyland, using Keman specification how this 'original relation' can be eroded specifies three conditions "(i) particular procedures are *authorised*, (ii) actions are *routinised*, and (iii) people are *dehumanised*" (2004, p. 817, italics in original).

The construction of ethics based on the "original relation" with the other is not apolitical. Critchley (2002) points out that many of Levinas writings present ethics as a critique of politics. He adds that Levinas "wants to criticise the belief that political rationality can answer political problems" (p.24). Rather, ethics inevitably leads into political concerns of social justice (Caygill, 2002). In a chapter on the Politicizing of Mathematics Classroom, Noddings (1993) discusses the role of the mathematics classroom in hindering the development of students as responsible persons. She highlights the need to involve students with shared responsibility of content assessment and the level of mathematics they engage in and assessment. The challenge is not only to produce competent mathematicians and mathematics users but ultimately to promote "the growth of students as competent, caring, loving and loveable people" (159). She calls for increasing needs for mathematics educators to "consider the ethical and political dimensions of learning mathematics as well as the cognitive aspects" (159).

Puka (2005) argues that the great contribution to ethics is the feminist[1] distinction between responsibility and "response-ability." Response-ability highlights the ability to responds to the demands of our own well being 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." Responsibility therefore denotes the

[1] For diverse feminist stances with respect to Levinas see Chanter, T. (Ed.). (2001). Feminist interpretations of Emmanuel Levinas. Pennsylvania: Pennsylvania State University.

ability to pledge again, a form of re-engagement with the Other who, in his or her utterances, pledges the production of sense. Each one on his or her own and together, we are responsible for the *praxis* of sense, which we expose and are exposed in transacting with others" (p. 5).

Puka goes on to state that

> A "response-ability" viewpoint makes better sense of our responsibilities toward ourselves as well, including our growth or development and our personal integrity. The standard picture of self-responsibility, where we force ourselves to do things, cannot represent the self-discipline or self-determination involved as true freedom--except through sleight of hand abetted by self-delusion. And ethics must be free; it must organize voluntary cooperation, not cooperation-or-else. By contrast, self-response-ability focuses us on our own worth and the value of our talents or potentials. It enhances our self-appreciation and rests on our predictable response to what we really are and can become.

Towards a Socially Response-able Mathematics Education

This ethical response-ability discussion applied to mathematics education posits the primary aim of mathematics education to enable the response-ability of the student in their current and future lives as citizens. (Naturally, the achievement of this aim and the achievement of a more ethical education system also call for enabling of response-ability of the teacher to design learning activities that supports the students' response-ability, which in turn implies the response-ability of education system to support the teacher needs to play their role effectively. In this paper, however, I will only discuss the meaning of enabling student response-ability and its implications for developing learning environments to support it.)

Undoubtedly, mathematics is an important subject in the curriculum and in the current and future lives of students. In the minds of many such importance is given to the subject due to the increasing importance of technology and science two essential areas in problem solving and raising living standards. Mathematics, like science, is often associated with economic development of a country (Kuku, 1995). At a personal level, of the student, mathematics is often justified as opening the doors to many careers and courses of further study.

However, these assumptions about the value of mathematics education for the student and society should not be accepted uncritically. First, the relationship of mathematics to the general economic development is far more complex than is often assumed. For example, Woodrow (2003), citing the example of the development of the Asian economies and their high achievement on their students on international testing, argue that increases in mathematics education standards have occurred after their economic development, and arguably as a result of it, rather than the other way around. Further, Ortiz-Franco and Flores (2001) demonstrate how during the period between 1972 and 1992, the mathematics achievement of the Latino students in the USA have increased with comparison to the other students, however their socioeconomic status has decreased.

Similarly, the assumption that mathematics is needed to increase access of students to jobs as a justification of its place in the curriculum should be regarded with care. The dominance in school mathematics of content needed for careers that are seen as mathematically based – mainly science and engineering, is unwarranted and, perhaps, is a residue of times when few students finished high school and went to university. Notwithstanding the importance of jobs in science and engineering for social technological development, only few students end up in such careers. Further, with advances in technology, the demand for most calculations and algorithms that still dominate the majority of school teaching are increasingly becoming obsolete. Arguably, the nature of mathematics used in society has changed more rapidly than school curricula.

Here I argue that all students need mathematics for effective citizenship in an increasingly mathematised world of today. Not only a significant amount of mathematical thinking is behind most day-to-day decisions that people make, but also as Skovsmose (1998) asserts, mathematics plays a role in "formatting" the world. In other words it creates a social and physical world after its own image. This power of mathematics is, of course, double edged. On one hand great achievements in science and technology are mathematically based. But also mathematics is implicated in technoloically caused catastrophes ala wars and mass destruction (D'Ambrosio, 1998). Hence, a *utilitarian* approach to mathematics falls short of developing a response-able student. As Ernest (2002) argues a critical approach to mathematics and citizenship is needed.

Developing mathematical knowledge and capacity helps the students not only, using Freire's (in Gutstein, 1003) terminology, to "read the world", i.e. understand it, but it should lay the foundation for their capacity to "write the world", i.e. change it. In traditional wisdom of school mathematics, reading the world (at least some aspects of it) is the function of the school; while writing the world is often constructed as a possible capacity that might arise later when the students enter the work life and civil society. Borrowing the terminology from Down, Ditchburn and Lee (2007), the role of mathematics education as it relate to citizenship can be at three levels. Mathematics education can contribute to the ability of students to function as effective citizens in the world. The authors call this a *conforming* ideal. This is consistent with the dominant justification of mathematics as developing skills and knowledge useful for preparation for jobs. However, mathematics can also be used to enable student to understand how the world works (or does not work) in order to change aspects of their world. This, the authors call *reforming*. However, mathematics has an additional capacity. It can be used to create the world in a new way. The author calls this the *transforming* capacity. This focus on mathematics education is consistent with the critical mathematics movement. Some examples of activities designed with this focus will be discussed below.

In the following two sections, I will discuss some implications for this response-able approach to mathematics education for classroom teaching. In particular, I will discuss two dimensions of the Productive Pedagogy (Hayes, Mills, Christie & Lingard, 2005), namely Intellectual Quality and Connectedness, from this ethical response-ability perspective as they relate to the teaching of mathematics.

Responsible-ability and Intellectual Quality

In the dominant traditional mathematics education discourse, intellectual quality is often understood as the mathematical abstraction and the rigor of academic mathematics. This includes formalized symbolic language, axiomatic thinking, standard efficient algorithms and proofs. It also includes sophisticated modelling of mathematically-based problems-usually from areas such as physical reality, engineering and the economy, in which there is a unique or best fit solution. This is often contrasted with practical mathematics that focuses on real world applications, routine problem solving – on personalised (often called student-invented) algorithms, solutions and presentations of mathematical arguments. In many Australian curricula these two types of mathematics are contained in separate alternative streams that students chose between depending on their previous mathematics performance (often taken as a sign of ability) and post school aspirations. This construction of intellectual quality of mathematics as a dichotomy between formal and practical mathematics is presented as a *common sense* argument for providing a greater choice (a valuable endeavour in neo-liberal politics) for students and to cater for the needs of a larger number of students. However, this binary might be counter productive by denying the majority of students taking the so called social or practical mathematics the opportunity and the ability to develop their generalised abstractions of mathematical concepts and procedures. Further, in spite of the rhetoric of curriculum documents, and the assurance by many teachers that the two streams deal with equally valuable mathematics – albeit for different needs - for many students a hierarchy of values exist between them giving higher status to the formal academic mathematics.

Seen in this way, intellectual quality of mathematics is measured primarily from within the discipline itself rather than the usefulness of that knowledge to the current and future everyday life of the student. In other words, intellectual quality is measured by the level of decontextualisation and abstraction of the discipline and in isolation to social questions and issues into which it can be applied. In particular there is a resistance by many mathematics teachers and curricula to deal with controversial social issues as a source of examples of mathematical problems. Perhaps because of the common belief that mathematics deals with objective reality, less often does school mathematics deal with issues of socio-political aspects in society such as distribution of wealth, disadvantage and demographical changes. These social issues are often seen by mathematic teachers and curriculum designers as belonging to other subjects in the curriculum. This demarcation is consistent with the separation of the realm of the *know-how* of science and technology and questions of values and morality dealt with in the social sciences and philosophy.

Undoubtedly, developing the capacity of students to master the language and findings of mathematics, and even its formality is a contribution to students' response-ability as active citizens. As Ernest (2002) argues empowerment of students in and through mathematics necessarily includes *mathematical empowerment* which consists of the ability to critically read and produce mathematical texts as well as pose their own problems and solve problems. With the *transforming the world* aim of mathematics

education, perhaps a different type of mathematics and different ways of teaching may be necessary. First, the development of mathematics in isolation to the capacities developed in other areas of school curriculum limits the role of mathematics in achieving its transformative potential. A more interdisciplinary approach is essential. Further, the privileging of abstract knowledge over contextualised knowledge becomes problematic. As Christie (2005) argues, "current times require the consideration of both universalistic, abstract knowledges and particularistic, contextualised knowledges" (244). Seen from this perspective, intellectual quality looks different to the above construction. Quality in mathematic education is measured not as, or not only as, formal abstraction and generalisation, but by its capacity to transform aspects of the life of the students both as current and future citizens.

Does this focus on quality education disadvantage students that are already marginalised in the discipline? In other words does quality agenda conflict with equity concerns? Education is often posited as the most effective solution to disadvantage in society and between societies. After at least fifty years of development and reforms in education, it is important to raise the question as to whether education has been able to achieve this challenge. Perhaps the evidence is not very encouraging. In a study commissioned by the USA congress, Coleman (1996, in Hayes, Mills, Christie & Lingard, 2005) reviewed the long term effect of many interventions to alleviate economic disadvantage through education and have concluded that schools do not reduce social inequality. Research is rather consistent in showing that the family socioeconomic wealth is the best predictor of educational success. Similarly, the increasing gap between the rich and poor in many western countries and in between countries does not support this utopian view of education. Perhaps Basil Bernstein (1971) was correct in his conclusion that schools do not compensate for society.

However, there is some good news. Coleman and his colleagues demonstrated that under school reform the most disadvantaged students benefited the most. In other words, while good teaching benefits all students, under correct conditions it also closes the gap between the least disadvantaged and the rest of the students. As Christie (2005) commented, "it is for the most disadvantaged children that improvements in school quality will make the most difference in achievement" (p. 245). Further, out of all the school factors that effected students' achievement was the teacher. Hence good teaching "can make a difference, but not *all* the difference" (Hayes, Mills, Christie & Lingard, 2006, p. 178). Research evidence points to the fact that quality education assists *all* students. The danger is not in challenging disadvantaged and under achieving students to higher intellectual quality, but in "dumbing down" the curriculum for them - thus locking them into marginalization and disempowerment.

The above interrogation of the concept of intellectual quality in mathematics education is consistent with many of the writings in the discipline from critical mathematics and social justice discourses. What does the focus on the ethical response-ability add to the discussion? Ethical response-ability places the primacy of ethical considerations in the teacher-student encounter. There are two dangers in this encounter that erodes ethical response-ability. First, to deal with student as individuals with no regard to their gender,

ethnicity or socioeconomic background – factors that are demonstrably related to student achievement in mathematics, is to relate to an "abstract" student. Not only is this a recipe for failure – it also is dehumanizing and is unethical as argued by Nayland (2002) above. Similarly, the other extreme of seeing a student *only* as of a particular gender, ethnicity or social status is equally counterproductive. This stereotyping also limits the possibility of an authentic encounter with the real other. An ethical encounter attempts to be open to any possibility that exposes itself and responds to the students' needs and aspirations rather than in a stereotypical fashion. In supporting the students' response-ability a teacher can provide the opportunity to develop the high intellectual quality to the maximum of the students' needs and capacities.

Response-ability and Social Connectedness of Knowledge

Mathematics can only contribute effectively to student response-ability if it engages with the world of the students. Perhaps every teacher of mathematics at one time or another has faced the question from a distressed student "but why are we studying this". Perhaps not surprisingly, the usual answer that you need this for future jobs leaves many students unsatisfied, if not unconvinced. Here I argue that the usefulness of mathematics should not only be demonstrated by using examples from the real world of the student as applications of mathematics, but also mathematical knowledge should be developed through such activities. The development of mathematical knowledge through real world activities demonstrate the usefulness of mathematics at the same time as engaging students. Further, this engagement of mathematics with the life of the student should be an engagement not only with the physical world and the economic world, but also with the social world; not only with the world as the student will experience as an adult, but their current world; it should aim at developing an understanding not only of mathematics but also an understanding of the world. Finally, such engagement should aim at not only *reading the world* but also, whenever possible, at *transforming the world* – even to a small degree. Let us consider some examples of mathematics activities described in the literature that aimed to establish such a connection with the world of the student.

One example of activities designed for a critical reading of the world are those reported by Mukhopadhyay and Greer (2001), based on activities reported by Mukhopadhyay (1998, 2005) who used the all too familiar "icon of American culture", the Barbie doll, to develop the capacity of students to turn a "critical gaze" about taken for granted assumptions of our social life. Although the activities varied, they often commenced by attempting to translate measuring the body dimensions of the doll and to transform them into real life measurements by developing a human body with proportional dimensions to the doll. Such activities often gave rise to a discussion about the *average* human body in the context of gender and racial mix of the class. Mukhopadhyay and Greer point out that "although the task begins with measurements of height and various body parts, the act of sketching out a 'life-size' Barbie and the striking implications of the comparison contribute to an overwhelming 'aha' experience for the students. The discourse that results is not limited to the acts of measuring, figuring out the mathematics of scaling, and rendering the drawing, but also encompasses the interpretation of the task on personal, social and political levels" (p. 308-309). The authors concluded that "as a

modeling exercise, the task generates exceptionally rich activity … as the students discuss in depth the implications of what they have discovered and … as they become aware and confident of their ability to use mathematics as a tool for critical analysis of an aspect of their culture" (p. 309).

The second example reported in the literature is by Gutstein (2003) who reported on a series of 17 mathematics activities spaning two years in a Latino urban school in which his students were involved in to highlight inequalities in their social world. In describing the activities, Gutstein commented that in his class he normalised the discussion of "taboo subjects" in many mathematics classrooms including racism, discrimination, power and justice. One example of such an activity was the distribution of wealth where the students compared the wealthiest 1% pf the USA with the bottom 80%. Prior to giving the data, students were asked to guess the distribution – with an interesting pattern that most guesses were more equitable than the real data showed. Inevitably, such an activity did lead to strong emotions of anger and sense of unfairness with some of the students. In another activity students looked at racial and socioeconomic data as they are portrayed in the SAT test distribution.

Both examples above illustrate how students can be engaged in real world data to develop their ability to critically understand aspects of their social world as they are developing mathematics concepts and skills. The last two examples given here, even though they have not evolved from within the mathematics classroom, required a significant amount of mathematical thinking and data handling. Further, they illustrate how mathematics knowledge can be used to change aspects of the students' world. Holdsworth, (2004) reported on a study that about 80 students from an area where young people constitute a significant percentage of road fatalities have formed Student Action Teams to conduct research and suggest changes to traffic conditions around their schools. Working collaboratively, the students made decisions on what to study, what questions to ask and who needs to be investigated. Some students have looked at the traffic conditions around their schools while others conducted interviews and surveys. What is significant in this project is that the research teams were asked to come up with recommendations as well as plans towards the achievement of these recommendations.

Finally, I have been involved with a few of my colleagues in a long term project (Atweh & Bland, 2005) where a group of students from low socioeconomic, non English speaking backgrounds and Indigenous students from a large number of schools over the past 15 years have collaborated with their teachers and university staff to investigate hindrances for university participation by students from their communities. As in the above project, students here planned their research, conducted it, analysed the data and wrote a research report. Further, using action research, they planned and conducted activities to deal with some of the issues arising from their research data. In writing their reports the students made well considered decisions about the type of data representation that is most appropriate to display their findings. Further, they demonstrated considerable "research sense" and a critical appreciation of the research process itself. This was clearly illustrated in the research reports they produced. For example, they were able to identify the strengths of using questionnaires for data collection in order to "question a large

anonymous audience, within a minimal amount of time" (p.6). They also identified that the attitude of the data collector towards the respondents was a major factor in obtaining valid information. They concluded "one must commit oneself to the task, taking a professional outlook and reflecting this image toward the respondents" (p. 6). Similarly, they were not afraid to go beyond the data and raise hypotheses about its causes. For example, in noting that 71% of the young men and 29% of the young women surveyed have university aspirations in spite of the fact that girls indicated that they enjoy school more than boys, the young researchers were able to offer the explanation that: "Possibly this may be due to a lack of female role models who have completed university other than teachers, as well as early motherhood which is common in [this suburb], rather than women concentrating on careers" (p.7).

The above interrogation of the concept of connectedness of mathematics to the life of the student is consistent with many of the writings in the discipline from critical mathematics and social justice discourses. What does the focus on the ethical response-ability add to the discussion? The focusing of critical mathematics on social issues and data is in harmony with the principles argued here. Arguably, the focus on supporting response-ability of the student highlights the need for activities that are designed to change the world rather than merely to read the world – albeit critically. Response-ability for transforming the world has two implications for mathematics education. First, the isolation of mathematics from other discipline areas hinders the development of the ability to deal with social transformations. Issues of values, politics and social action have to be joined with mathematical knowledge in order to identify factors that need change as well as to implement them. The call here is for a more interdisciplinary approach to mathematics education and the willingness to deal with controversial topics in which debate and difference of opinion and interests are part of the equation rather than nuisance variables. The challenge to the mathematics teacher is to identify areas for activities that are not only of interest to students, but also that are important for students to know and engage with. Second, in working towards social transformation, the teachers and students develop a new relationship of co-inquirers or co-learners in contract to the traditional construction of expert and novice. In such real life activities, while the teacher is not the source of knowledge about what needs to be changed, the students need support in identifying these needs and in negotiating change. As Atweh and Bland (2005) conclude in discussion of the roject mentioned above, there needs to be a balance between the teachers abdicating their duty of care by minimizing the risk of student failure and the silencing of student voice and their willingness to take risks when needed.

Summary

While the mathematics education literature during the past fifty years have taken a “social turn” by adopting a variety of sociocultural perspectives, there is a noted absence of discussion of *ethics* as it relates to the discipline. This absence is paralleled by a lack of consideration of the topic in general education and philosophy in our Western culture. This paper argued that ethical responsibility provides the concerns about social justice, and the construction of critical mathematics education, with moral foundations that, consistent with the writings of Levinas, precede philosophy and forms its basis. Ethics

relates to the face to face encounter with the other that precedes concepts and reflection. Deconstructing the concept of ethical responsibility for the other as its etymological meaning of response-ability, I have considered its implications to mathematics education.

I argued that the aim of mathematics education in this perspective is to support student response-ability as members of society. This support must necessarily go beyond the provision of mathematics that is needed for a minority of jobs and economic development to include mathematics that is needed by the majority of students and adults as active citizens of an increasingly mathematised society. School mathematics should support students' response-ability not only to *read* the world but also to *transform* the world.

Likewise, I have considered the ethical foundations and implications of two dimensions of Productive Pedagogy, namely Intellectual Quality and Connectedness. From this ethical response-ability, intellectual quality is not measured from within mathematics as a discipline but by its ability to develop powerful mathematics that enables the student to both *read* and *write* the world. This approach to understanding intellectual quality is consistent with social justice concerns about the exclusion of students from certain backgrounds that may not traditionally participate and achieve in mathematics.

Similarly, from this ethical perspective, in order for mathematics to contribute to the response-ability of the student as citizen, it should attempt to engage the student in meaningful and real "real world" problems and activities that not only develop the mathematics but also develop an understanding of the social world and contribute to its transformation whenever possible.

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