Another Look at Relevance: Teaching Mathematics for Peace

(draft in review by *Mathematics Teacher*)

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Mathematics education is important to me, but I consider the quest for peace to be my vocation. When I ask myself what is more important – to live in a society replete with mathematically competent individuals or to live in a peaceful society – the answer is obvious. Although it may seem a lofty goal, I need this larger ethical framework to support my work in developing 'mathematically competent individuals.' My goal of a world at peace is unlikely to be attained in my lifetime. Perhaps it is the mathematician in me that is content to approach the inaccessible, the infinite. Or, perhaps it is my interest in the inaccessible that prompts my interest in mathematics. While student success in mathematics is not my principal aspiration, the mathematics education context is one in which I can work at bringing peace to my world.

The expressions on the faces of most people to whom I describe my idea of relating the teaching of mathematics to an interest in peace tell me that this idea is a strange one to many people. They see mathematics as culturally and socially neutral, sterile. I am quite familiar with this view of mathematics. It describes my own attitude when I started my mathematics-teaching career.

In my first five years of classroom teaching in Alberta, Canada, I strove to be a caring presence in the classroom. I listened to my students and tried to help them understand both their world and their mathematics – separately. I saw myself as a peacemaker who happened to be teaching mathematics, which was for me a neutral subject, unconnected with my students' experience outside the classroom. I disagreed with other mathematics teachers who constantly reminded their pupils that mathematics is the most useful of the subjects. Perhaps elementary and junior high mathematics is used in the "real" world, but few adults ever encounter high school mathematics in day-to-day life. For me the value of the subject was to be found only in its parallels to outside experience, not in its connection to the outside. I understood the desire to see the relevance of my profession, and I wondered if there could be value and relevance in mathematics education even when it does not directly address real world problems.

After my initial experience in Alberta, I taught mathematics in rural Swaziland for a few years and then returned to teach in Alberta. The juxtaposition between my experiences in Swaziland and my experiences with the new Alberta mathematics curriculum, which is strongly aligned with the recently developed NCTM standards, sparked my interest in the connections between mathematics and society. Both in Alberta and in Swaziland, the mathematics curriculum did not seem to address students' concerns as much as it sought to shape the students to fit a perceived need. I realized that curriculum was more about policy-makers' values and less about student needs.

As curriculum change raised questions about what should be in curriculum and about which teaching approaches are appropriate or desirable, I realized that the methods and values in mathematics classrooms were connected to the methods and values of the outside world. And with my new first-hand experiences with truly poor people, I began to see that mathematics is often used to bolster opposing forces: it is implicated in violence, and it is used in the name of peace and for humanitarian initiatives.

I am not alone in the critical investigation of my profession's relevance. Others are also questioning what mathematics is and, more importantly, what it does in our world. Ubiritan

D'Ambrosio, a Brazilian mathematics educator, drew the spontaneous applause of thousands of mathematics educators from around the world at the recent International Congress of Mathematics Educators (2004), when he called for reflective practice in mathematics classrooms:

> Mathematics is the dorsal spine of modern civilization, and it's a beautiful dorsal spine. It's so well-constructed. It's so beautiful. But the body supported by this dorsal spine is ugly. […] Maybe we should look closer [at] our beautiful dorsal spine.

His assessment of the connections between mathematics and society is also recognized in the NCTM's (2000) equity principle and in its connections and problem solving standards. This relationship between mathematics and society is also becoming increasingly recognized in scholarship. For example, the international Mathematics Education and Society conferences began in 1998.

D'Ambrosio's call for critical consideration of mathematics comes in the context of his ongoing recognition of the role of mathematics in this century's enormous technological advances, which include both wonders and horrors.

> Humanity has seen the smallest reaches of imagination and talks about reaching the boundaries of the universe. And yet, this same century has shown us a despicable human behavior. … Much of this paradox has to do with an absence of reflections and considerations of values in academics, particularly in the scientific disciplines, both in research and in education. (D'Ambrosio, 1994, p. 443)

I support his conclusion that more reflection is needed in and about the classroom. The reason I share my thoughts regarding peace and mathematics education is to prompt such reflection amongst fellow mathematics educators. Perhaps, as a result of our reflections, we will find ways to draw mathematics students into reflection that complements their mathematical technique.

In order to prompt reflection, I will ask some simple questions that have no simple answers. However, I assert that the consideration of these questions can be a potent beginning for thoughtful adjustments to teaching practice. I am not interested in saying what *must* be included and what *must* be rejected in classroom practice. Instead, I hope to prompt my fellow mathematics educators to consider various possibilities within their particular contexts. Each classroom has its unique challenges and needs.

What is peace?

Before thinking about how we might structure mathematics classroom experiences to promote peace, it is important to ask what we might mean by *peace*. The word *peace* can be used to describe vastly different things.

After two airplanes were flown into New York's World Trade Centre towers on September 11, 2001, I heard a radio reporter on the scene exclaim in panic: "The worst thing is that no one knows what will happen next." I wondered when anyone knows what will happen next. In the days that followed I reflected on my choices for living in an unpredictable world.

One approach to my complex existence in an unpredictable world is to try to control the environment, to build a network of security. With this approach, I decide how a "peaceful" world should look and then try to structure it so. This approach equates peace with *security*. Wars against terrorism and jihads against infidels are extreme examples of this approach.

An opposite approach is to recognize the complexity and changeability of the world and to find my place within it. This approach focuses on awareness and equates peace with *harmony*. With the security approach I try to tune the world to match the standard I have in mind. With the harmony approach I try to attune myself to the world and find a place in its symphony.

To ask which is the better approach oversimplifies the situation. Any person's image of peace is somewhere on a continuum between these two extremes. I am writing about the polar ends of the continuum to sharpen reflection, not to suggest that one of these extremes must be adopted to the exclusion of the other.

Securing a Right World – Mathpower

How would mathematics pedagogy look if we were to try to *secure* a peaceful world? The security approach embodies teleological ethics, in which the ends justify the means. Mathematics and other tools are important in proportion to their utility for pursuing a particular end.

Although this view favours *applied* mathematics, *pure* mathematics may still be valued because of its history, in which applications have been found after the development of the mathematics. Even within pure mathematics, distinctions can be made. What Richard Skemp (1976) calls *instrumental understanding* — knowing what to do in a given situation — would be the important part of mathematics education with an ends-based ethic. *Relational understanding* — knowing both what to do and why — may still be valued as it supports competency (instrumental competency), but the end result is still what matters. The solution is what counts.

If we think that the ends justify the means, then our interest in the mathematics class would be to train students to use technology and knowledge efficiently and powerfully. These values are represented in the NCTM's (2000) technology principle. We would also be more interested in the answer to a question than in the process of arriving at the answer, so we would use multiple choice and numeric response examinations. Students' "right answers" would be credited no matter how they are found. Words that relate to effectiveness and power would appear in our scoring rubrics and in our classroom resources and decorations.

For example, in a Canadian middle school textbook series, the cover image of each book displays a large predator – a cougar, a grizzly bear and a killer whale. Classroom texts can be even more explicitly connected to power. A recent survey of a high school mathematics classroom environment saw a textbook called *Mathpower* on every desk and posters with large text emblazing slogans that included "What do I need math for?" (with a large list of its *uses*) and "Math: Power for All" (an NCTM poster).

Indeed, mathematics provides tools that can be used to solve problems in our world. Problem solving has long been an important part of mathematics pedagogy. What if we used our mathematical word problems to ask students to make calculations about fair wealth distribution or efficient structuring of peacekeeping forces? There are many ways to use mathematics to improve our world. The NCTM's advocacy for mathematics applied to real world situations affirms this possibility for mathematics: "In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures" (NCTM, 2000, p. 5). It is possible to use future-shaping power to improve the world, to confront injustice.

However, it is appropriate to question exactly how mathematics addresses real world problems. Susan Gerofsky (1996), in her exploration of mathematical word problems, questions this and other expectations of word problems:

> The claim that word problems are for practicing real-life problem solving skills is a weak one … unlike real-life situational problems, no extraneous information may be introduced. (p. 41)

Still, word problems that express an interest in a peaceful world are preferable to politically loaded or overtly violent problems such as "If one Confederate soldier kills 90 Yankees, how many can 10 Confederate soldiers kill?" (cited in Elson, 1964, p. 329).

Gerofsky's critique can be addressed with more realistic mathematics projects that defy word problem stereotypes and embrace complexity. Futhermore, teachers can make students aware that typical word problem contexts are unrealistically simple. When students have real problems to address outside of the mathematics classroom, we *expect* them to consider all the related information. We would expect this of them as young people and hope this for them as they mature into adulthood. If they select a few numbers that relate to a real life situation and simply manipulate the numbers using mathematical algorithms, it is likely that they will exacerbate the problem rather than solve it. Healthy problem solving requires us to acknowledge complexity.

I am reminded of a conversation I had with a respected politician. We were talking about legislation that forced binding arbitration to settle a teachers' strike. The legislation demanded that the arbiters look only at salary and ignore all the other concerns teachers were raising, including work conditions and classroom composition (e.g. class size and integration of special-needs children). In answer to my query about the reasoning behind this legislation, the politician said it is the mathematical way, the logical way (using these words synonymously). Not knowing that I was a mathematics teacher, he said that in mathematics we address only one issue at a time. I expressed shock, and asked him if he would ever approach a problem in his business in such a one-dimensional way. "No," he said, "I wouldn't." This power-broker's approach to real-world problems was formed in his mathematics classrooms, where he was encultured to ignore complexity.

Mathematics provides helpful tools for solving local and global problems. But there are other good tools. An important part of wisdom is to have a diversity of tools available and to use them appropriately. Wisdom knows when to use interventionist tools and when to find ways to exist in a present order.

Building Awareness – Connections

How would mathematics pedagogy look if we were most interested in finding our fit with the world? With an interest in harmony, we would look at our place in an interconnected system. Potential for building awareness would be the standard by which we evaluated mathematical tasks. Students would be encouraged to see their relationships with each other and with their world.

Many mathematicians say that mathematics is fundamentally about *connections* between things. A classroom environment that values connections might have desks arranged in groups rather than in traditional rows that isolate students from each other. Words that relate to connections, interactions and relations would appear in scoring rubrics and in classroom resources and decorations. There are textbook series named *Interactions* and *Connected Mathematics Project*, for example.

Researchers who examine mathematics communication often ask about mathematical objects: What is it that we are talking about when we communicate mathematics? Most find that the objects of classroom conversation are elusive. They are abstract, not concrete. Anna Sierpinska (1998) writes, "mathematics is not about things that can be shown, nor is it even about relations between such things. Most of the time it is about relations between relations" (p. 38). A focus on connections is not at all a departure from what mathematics really is.

While the NCTM promotes empowerment through mathematics, it also promotes awareness of connections. One of the five process standards in the *Principles and Standards for*

School Mathematics is called "connections." This standard relates to a security-minded peace when it encourages applications of mathematics – "School mathematics experiences at all levels should include opportunities to learn about mathematics by working on problems arising in contexts outside of mathematics" (p. 65). However, the connections standard also encourages other approaches to connections: "Mathematics is not a collection of separate strands or standards, even though it is often partitioned and presented in this manner. Rather, mathematics is an integrated field of study" (p. 63).

I see three planes of connection-making that can complement instrumentalist connections between mathematics and the real world. While engaged in mathematical activity, students can be mindful of the connection between different forms of mathematical thinking, the connection between themselves and their mathematics and the connection between themselves and their culture.

Mathematics can be taught in an integrated fashion, though it is often compartmentalized. Curriculum is typically fragmented, as it divides mathematical activity into pure and applied streams, into broad categories within these streams (e.g. geometry, algebra), into smaller categories within each broad category (e.g. within algebra there are equations, factoring, etc.), and within these narrower categories into concepts (e.g. within factoring there are differences of squares, second-degree trinomials, etc.).

When students are given a problem, they are often expected to classify it according to known types. In doing this, they ignore the people and places involved. After classification, they follow a standardized procedure designed for problems of that particular category. Only one result is acceptable. By drawing boundaries between "classes" of problems and between "useful" information and "extraneous" information, students are encultured to ignore the interconnectedness of mathematics and, at the same time, to ignore the connections between problems and their mathematical or real-life contexts.

Alternatively, we can open up possibilities for connection-making within mathematics by presenting students with open-ended questions and problems, giving no clue as to how they might be answered. Indeed, for something to be a real problem there must be no obvious way of approaching a solution. These open-ended tasks can be given as part of formal assignments or informally in class discussion. Either way, students need to consider the breadth of their mathematical experiences to find some mathematical knowledge that might apply. They then need to decide how it applies and how they can know if they are applying it correctly. Students in such an inquiry setting are likely to see their classmates use a variety of approaches to any given problem. This variety points to the connection between these approaches. Such a problem-centred approach may include pure mathematical investigations such as the one I described in an earlier issue of *Mathematics Teacher* (Wagner, 2003) or applied mathematics investigations such as the one about drug testing, which was contributed by Irina Lyublinskaya (2005) in another issue of this journal.

Inquiry mathematics, whether it is pure or applied, also addresses a second plane of connection-making. Besides opening up the possibility for seeing connections within mathematics, open-ended tasks can help students develop ownership of their mathematical ideas. The mathematician is connected to the mathematics. As students listen to each other's mathematical ideas or look at each other's mathematical writing, they can be directed to see a diversity of viable approaches and forms of presentation. With this realization they may see that the form of mathematics is closely connected to the humans who construct it in response to particular problems.

The connection between the mathematics and the mathematician can also be acknowledged by a third plane of connection-making, the attention to the relationship between mathematicians and their societies. The study of mathematical aspects of artefacts and games from various cultures is often called ethnomathematics. There is a wealth of resources available to mathematics teachers, including the NCTM's *Changing the Faces of Mathematics* series edited by Walter Seceda (2000 and 2002) and some very good internet resources that can be found easily by performing a search on "ethnomathematics" on the web. An awareness of the way any mathematics is situated in a particular culture opens up the possibility for classroom conversations about how the people in that culture used mathematics to fulfill their intentions or aspirations. This kind of conversation can also lead to discussion about students' intentions and how they relate to the mathematics they may choose to do.

As students engage in mathematical discourse, they have to negotiate. This relationship can exist either in pure mathematical settings or in applied mathematics problem-solving settings. The students' intentions may conflict with each other and they will need to justify their reasoning to each other. This kind of discourse is encouraged in the NCTM's reasoning standard. Such discourse reminds us that mathematics is a social phenomenon. Mathematics can be described as an activity in which particular people exercise their intentions in particular environmental and interpersonal contexts. Ironically, while students work toward making generalizations, which are by nature impersonal, their awareness of the persons with whom they work becomes obvious.

Whether students are working on pure or applied mathematics problems, they are engaged in a human activity. They can see themselves in relation to their mathematics, in relation to the people with whom they are working and in relation to the greater world around them. Their awareness of these connections helps them find a place in their world.

Thoughtful Action – a Middle Way

I place my own view of peace somewhere in the middle between the two polar approaches to peace – the security view and the harmony view – a little closer to the harmony end of the spectrum. Although I consider it necessary to be aware of my place and the interconnectedness of things in the constantly changing, complex world, I still need to act, to live. If I spend all my time merely noticing, I cannot participate. Somewhere in between the two extremes of thoughtless action and detached analysis there is a place for thoughtful action. I suggest that a degree of engagement with the world is necessary for more thorough understanding, for higher awareness.

It is important to be aware of one's context when considering how to approach teaching mathematics for peace. It is tempting for people like me, with my relative wealth and status (i.e. high *cultural capital*), to advocate education that promotes connection-making and harmony, with its implied acceptance of the world as it is now. Why should I want change when the present world order is treating me so well? But it is different for victims of the world order. It is not fair to bar them from empowerment. I suggest that the NCTM's equity principle is all about ensuring the empowerment of people who do not have social and economic privilege. It is about educating children so that they can find ways to change their position in the world.

By contrast, children who already live in settings of wealth and status may need a different approach to mathematics. Our world will be a better place if the people with power have a better understanding of their connections to (or relationships with) the rest of the world. I hope for all children to be empowered in both ways – to have the tools for making change and to have the understanding that will allow them to live well with their neighbours and in their environment.

Ole Skovsmose (2000) describes how traditions of activity in mathematics classrooms format society by providing a framework for addressing problems in the world outside the classroom. It is my hope that mathematics classrooms can format the world for peace by establishing traditions of classroom mathematics activity that can be characterized as thoughtful action.

Conclusion – Doing Good

In my first year of teaching, a grade 11 student asked me, "Did I do good on yesterday's math test?" I responded playfully: "No. Doing good is feeding the hungry, clothing the naked, healing the sick, bringing hope to the poor. You did none of that on this test. You did, however, do well. You got 87%." This little experience has prompted me to wonder how I, as a mathematics teacher, can do some good for my students and for my world – how I can be an agent for peace. As a teacher it is my responsibility to set tasks for my students in such a way that if they follow my instructions well they will be doing something good.

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