Mathematics, Peace and Ethics
An Introduction

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The threat of another World War is real. We don't have to assume that it is normal to solve regional conflicts by military means and that isolated wars can be tolerated. Although isolated, the violence and violation of human dignity going on in these conflicts are abhorrent. Besides, history has shown us the high possibility of a larger involvement of nations and the escalation of these regional conflicts into World War III.

The possibility of final extinction of civilization on earth is real. Not only through war: We are witnessing an environmental crisis, mounting social crises in just about every country and above all the recurring threat of war. And an alarming lack of internal peace for individuals, leading to drugs, violence and nihilism.

To survive we have to achieve peace, in its several dimensions: Inner peace, social peace, enviromental peace and military peace. This means peace with dignity. In a correspondence to Albert Einstein, Sigmund Freud said "These two factors – man's cultural disposition and well-founded fear of the form that future wars will take – may serve to put an end to war ... but by what ways or byways this will come about, we cannot guess." We all, particularly mathematicians and mathematics educators, have a responsibility in finding these ways.

The ZDM-analyses *Mathematics, peace and ethics* are an attempt to support this task by providing justifications, pointing out ways to approach it and by suggesting – explicitly or implicitly – questions for needed research and development in this domain.

The contributions focus on
1. mathematics, philosophy and ethics
2. history of mathematics as related to world history
3. the use of mathematics in order to contribute to peace
4. mathematics education and peace education.

1. Mathematics, philosophy and ethics
One of the questions addressed in the contributions belonging to this issue is whether and why mathematics and mathematics education can be or should be subject to ethical considerations (D'Ambrosio, Fasheh, Rottoli, Skovsmose).

Ole Skovsmose in *Aporism: uncertainty about mathematics* argues for a critique of mathematics including ethical considerations. He introduces the notion of "aporism", a philosophical strand which addresses the question of the social functions of mathematical knowledge by discussing the formatting power of mathematics.

Ubiratan D'Ambrosio in *Mathematics and peace: our responsibilities* discusses the "professional" responsibility of mathematicians and mathematics educators for achieving peace and dignity for mankind via mathematics (research and development) and mathematics education. One aspect in his contribution is the relationship between mathematics, mathematics education and especially mathematical thinking on the one side, and human behavior, models of society and political power on the other side – an aspect which has not yet been treated with sufficient intensity and which should be investigated for different cultures and for different times.

Ernesto Rottoli in *Ethics in mathematical education* outlines how awareness of the plurality of truth, as one – not yet well understood – feature of modern mathematics can provide a basis for the discovery of values (among them values which are preconditions for peace) and the shaping of interpretative frames for them.

2. History of mathematics as related to world history
Reasons for investigating the development of mathematics in relation to world history (in particular to military history[1]) in this context are given by D'Ambrosio.

Anna Rosa Scarafiotti and Annarosa Giannetti in *Can mathematics educate for peace?* provide such a historical outline. They present some examples of mathematical topics initially developed for war purposes and later applied to "peaceful" ones.

3. The use of mathematics in order to contribute to peace
The following possibilities to use mathematics in order to contribute to peace can be identified in the contributions:
– mathematical topics can be taught in such a way that they contribute to values education (for example Bayes' law and tolerance, Rottoli)
– mathematical modeling or analyses of peace or conflict situations[2] can
  * lead to a better understanding of situations and their

dynamics – and thus to insight into chances or the impossibility to avoid escalation
* demonstrate that, in some cases, a mathematical model can lead to wrong or morally unacceptable conclusions – making students aware that there are situations where decisions must not be based on mathematical considerations alone (Emmer, Scarafiotti/Giannetti)
– mathematics can be used to expose dangerous trends – thus leading to the insight that counter-measures are badly needed (Fasheh)
– mathematics itself can be part of the basis on which to build a "better" world (Fasheh).

Michele Emmer in *The mathematics of war* starts from the – rather negative – image of mathematics drawn in newspaper reports on war as well as in a novel also dealing with war and contrasts this with a teacher manual where mathematics is seen as one means to offer several paths to peace education.

Anna Rosa Scarafiotti and Annarosa Giannetti – identifying "positive" peace with the mathematical concept of balance – suggest the study of dynamical systems and of fractals. Students thus may recognize the need for punctilious attention to maintain a balance situation and for careful analysis and continuous check of those parameters which control the system and keep it in a state of "peace".

4. Mathematics education and peace education

An integration of mathematics education in peace education[3] touches[4]
– the goals of mathematics education
– the manner of how mathematics is presented to the students
– the selection of contents as related to mathematics *and* real-world contexts
– teaching methods and organization
– social interaction in the classroom and in schools
(D'Ambrosio, Emmer, Fasheh, Rottoli).

Munir Fasheh in *Which is more fundamental: outward peace or being true to our humanity?* stresses the importance of discussing concepts and meanings only in context. "Peace" and "mathematics" are used as examples: "What do we mean by peace, whose peace, and at what human and environmental cost?" "What do we include in the math curriculum and what do we exclude, and why?" One of the roles of mathematics in mathematics education is seen as to expose dangers, to provide a basis for creating a saner and more just world and for a human response to disastrous trends. His examples of topics to be dealt with in mathematics teaching relate to aspects of war and peace other than only military ones.

5. Annotations
These annotations provide some references to literature in addition to those listed in the authors' contributions.

Annotation 1
Booss, B.; Høyrup, J.: Von Mathematik und Krieg. Über die Bedeutung von Rüstung und militärischen Anforderungen für die Entwicklung der Mathematik in Geschichte und Gegenwart. – Marburg: Bund Demokratischer Wissenschaftler e.V., 1984 (Schriftenreihe Wissenschaft und Frieden; 1). English edition: Mathematics and War: An Essay on the Implications, Past and Present, of the Military Involvement of the Mathematical Sciences for Their Development and Potentials. In: J. Høyrup (Ed.), In measure, number, and weight. Studies in mathematics and culture. Albany, NY: State University of New York Press, 1994, p. 225–278, 343–349
Davis, P. J.; Hersh, R.: The mathematical experience. Chapter "Mathematics and war". – Basel: Birkhäuser, 1981, p. 93–96. Deutsche Fassung: Erfahrung Mathematik. Kapitel "Mathematik und Krieg". Basel: Birkhäuser, 1994, p. 94–97
Hilton, P.: Cryptanalysis in World War II and mathematics education. – In: Mathematics Teacher 77(1984)No.7, p. 548–552

For the relationship of mathematics education and military education see:

Cernoch, F.: Podil matematiky na vychove k brannosti (Role of mathematics in military training). – In: Matematika a Fyzika v Skole 13(1982)No.3, p. 150–154
Langins, J.: The Ecole Polytechnique and the French Revolution: Merit, militarization and mathematics. – In: LLULL. 13(1990)No.24, p. 91–105 (ISSN: 0210-8615)

Annotation 2
Caspary, W. R.: Richardson's model of arms race: Description, critique, and an alternative model. – In: Int. Studies Quarterly XI(1967), p. 63–88. Deutsche Fassung: Das Richardson-Modell des Wettrüstens: Beschreibung, Kritik und ein Alternativmodell. In: M. E. A. Schmutzer (Ed.), Mathematische Methoden in der Politikwissenschaft. München: Oldenbourg, 1977, p. 267–293
[The alternative model presented here also considers economic constraints.]
Chatterjee, Manas: Use of quantitative and statistical techniques in conflict and peace analysis. – In: S. P. Mukherjee (Ed.) et al., Essays on probability and statistics. Festschrift in honour of Professor Anil Kumar Bhattacharyya. Calcutta: Presidency College, Dept. of Statistics, 1994, p. 59–68
Epstein, J. M.: On the mathematical biology of arms races, wars, and revolutions. – In: L. Nadel (Ed.) et al., 1992 lectures in complex systems. Papers from the summer school held in Santa Fe, NM, USA, 1992. Reading, MA: Addison-Wesley, 1993, p. 425–436
King, J. P.; Joynt, C. B.: The raindrop theory and arms growth. – In: International Journal of Mathematical Education in Science and Technology 26(1995)No.6, p. 821–834
[A deterministic model for a given nation's arms growth is presented. It is compared with the classical model of L. F. Richardson (which assumes a country's arms production to be motivated solely by the production of arms by its clearly defined enemies). The new model predicts arms production in terms of the country's perceived fear. The model is fitted to appropriate data and relevant constants are determined. Then it is tested by comparing its determinations with some known past values.]
Koller, D. (Ed.): Simulation dynamischer Vorgänge. Ein Arbeitsbuch. Kap. 4.3.4 Revolution (Simulation of dynamic processes. A workbook. Chapter 4.3.4 Revolution). – Stuttgart: Klett, 1995, p. 162–165
Martynyuk, A. A.: On a generalization of Richardson's model of the arms race. – In: Russ. Acad. Sci., Dokl., Math. 50(1995)No.3, p. 366–369; translation from Dokl. Akad. Nauk, Ross. Akad. Nauk 339(1994)No.1, p. 15–17
Ploeg, F. van der; Zeeuw, A. J. de: Perfect equilibrium in a model of competitive arms accumulation. – In: Int. Econ. Rev. 31(1990)No.1, p. 131–146

Rapoport, A.: Fights, games and rebates. – University of Michigan Press, 1974

Rapoport, A.: Mathematische Methoden in den Sozialwissenschaften. – Würzburg: Physica-Verlag, 1980. English edition: Mathematical models in the social and behavioral sciences. New York: John Wiley & Sons, 1983

Rapoport, A.: Decision theory and decision behaviour. Normative and descriptive approaches. – Dordrecht: Kluwer, 1989
[A principle theme is the relationship between normative and descriptive decision theory. Normative decision theory addresses itself to the question of how people ought to make decisions in various types of situations, if they wish to be regarded as "rational". Descriptive decision theory purports to describe how people actually make decisions in a variety of situations. Among the topics dealt with are: decision under uncertainty, decisions under risk, subjective aspects of risk, theory of social choice, individual psychology of decision making as cognitive dissonance, conflict decision theory as an extension of cognitive dissonance theory, limitations of freedom of choice, psychological pressures in non-cooperative games.]

Smith, T. C.: Math applications: A case study of the Soviet-American arms race. – In: UMAP J. 3(1982)No.1, p. 15–30

Smith, H. A.: Nuclear deterrence. Applications of elementary probability to international relations. – In: UMAP J. 1(1980)No.3, p. 73–89

Starkermann, R.: The model of a peace conference – Quot homines tot sententiae. – In: Syst. Anal. Modelling Simulation 12(1993)No.2, p. 167–183
[The mathematical model renders insight into the emotional labyrinth and, therefore, the enormous difficulty for reaching a consensus of attitudes in a conglomerate of diverse conference partners.]

Starr, H.: Coalitions and future war: A dyadic study of cooperation and conflict. - Beverly Hills, CA: Sage Publications, 1975

Stein, G.: Krieg und Frieden im Mathematikunterricht (War and peace in mathematics teaching). – Technische Hochschule, FB Mathematik, Schloßgartenstr. 7, D-64289 Darmstadt (Preprint No. 765/June 1983)
[This booklet demonstrates the effect of instinct and tradition, i.e. human behaviour and social acting, in a discrete mathematical model for armament development.]

Wendroff, B.: Cooperation in a three-way arms race. – In: Appl. Math. Lett. 3(1990)No.3, p. 127–129

Zou, Heng-fu : A dynamic model of capital and arms accumulation. – In: J. Econ. Dyn. Control 19(1995)No.1-2, p. 371–393

But see also for the problematics of mathematical modelling:

Booss-Bavnbek, B.; Pate, G.: Information technology and mathematical modelling, the software crisis, risk and educational consequences. – In: ZDM Zentralblatt für Didaktik der Mathematik 21(1989)No.5, p. 167–175

Stein, G.: Das logistische Wachstum als problematisches Beispiel mathematischer Modellbildung (Logistic growth as a problematic example of mathematical model building). – In: ZDM Zentralblatt für Didaktik der Mathematik 27(1995)No.1, p.1–5

Annotation 3
Aitkin, M.: The background of a textbook example: a short history of a Vietnam War attitude survey. – In: Stats. The magazine for students of statistics (Fall 1996)No.17, p. 3–11

Hudson, B.: Peace education and mathematics. – In: World Studies Journal 5(1985)No.4, p. 10–12

Hudson, B.: Global perspectives in the mathematics classroom. – In: Educational Studies in Mathematics 21(1990)No.2, p. 129–136

Wilson, N. H.: A primer on approaches to peace education. – In: Social Science Record 9(1972)No.2, p. 42–48

Annotation 4
The need to develop appropriate educational media (like textbooks or computer software for example) is not addressed explicitly – is this self-evident and articles like the following two outdated?

Hudson, B.: Social division or adding up to equality? Militarist, sexist and ethnocentric bias in mathematics textbooks and computer software. – In: World Studies Journal 5(1985)No.4, p. 24–29

Hudson, B.: Please don't shoot rabbits. Is bombing hospitals any way to learn mathematics? – In: Micromath 1 (1985) No. 1, p. 64

Two ZDM-issues "Mathematics and democracy" (to appear 1998 / 1999) could also be of interest in the context of these ZDM-analyses.

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