

7-1-1999

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Recommended Citation

Lipschutz-Yevick, Miriam (1999) "A Mathematics Manifesto: Think Differently! Think Quantitatively! Quantitative Awareness as a Fresh Thinking Cap," *Humanistic Mathematics Network Journal*: Iss. 20, Article 20.
Available at: <http://scholarship.claremont.edu/hmnj/vol1/iss20/20>

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A Mathematics Manifesto: Think Differently! Think Quantitatively! Quantitative Awareness as a Fresh Thinking Cap

Miriam Lipschutz-Yevick
New York City

Quantitative literacy among a large proportion of the population could make a powerful contribution towards improving both the inner and outer environment we share as one humanity. It will enhance people's self confidence and so lower their fear to participate in informed decision making.

The dissemination and the teaching of quantitative awareness and literacy to students, to children, to adults of all ages has become a matter of increasing interest. Several sessions, one of which was sponsored by the Humanistic Mathematics Network, were devoted to this topic at the recent meeting of the American Mathematical Society in San Antonio. This awareness can be elicited in many different guises and reveals aspects of our "life environment" previously hidden or ignored. Let us mention but a few of the imaginative ideas presented at the meeting as well as a few among the numerous contributions that have been made towards the use of simple mathematical tools aimed at gaining new insights into our "life environment."

MATHEMATICS IN TRADITIONAL DESIGNS

INTEGRATING MATHEMATICS AND CULTURE IN A DEVELOPING NATION (DEAN E. AND SUSAN C. ARGANBRIGHT)

The students studied traditional patterns of design in weaving, in leathercraft, in tilings etc. from a geometrical standpoint. Their acquaintance with these ancestral creations triggered their enthusiasm in learning about abstract concepts such as linear transformations, periodicities, symmetry, etc., and stimulated them to use these to invent new designs.

MATHEMATICS ON THE PLAYGROUND

A GUIDE TO BLAZING A MATH TRAIL (MARY-MARGARET SHOAF)

A stroll with small children through a playground while observing the math all around. Thus the speed of descent on a slide translates into its steepness, the steepness into the slope and the slope into observing the relation between its length and height. The

children's conceptual vocabulary is enriched with the word "slope."

MATHEMATICS IN ART

ART AND GEOMETRY: PROPORTION AND SIMILARITY (CATHERINE A. GORINI)

The speaker projected some familiar works of art revealing similarities and repetitions of geometrical patterns in the artistic composition. She thereby opened new vistas and enhanced the audience's appreciation of the more abstract elements entering into the work.

(for more, see Gorini's article of the same title on page 36)

MATHEMATICS IN POLITICAL DECISION MAKING

INFORMATION, DATA, AND DECISIONS (DEBORAH HUGHES HALLETT)

Statistical tools were taught to and applied by a group of government bureaucrats hailing from a variety of developing countries. One of the students' projects consisted of a sharp scrutiny of the use of the weighted averages of various indices (such as the G.N.P., life expectation and literacy) as a measure of development, the so-called H.D.I. (Human Development Index). An independently undertaken collection of relevant statistics revealed that this index is highly sensitive to the weighting (and so ordering) of the components. A relatively small change in these weights produces a massive change in the H.D.I. and so in the funds allocated to these various sectors. Equally blatant was the use of positive correlation between the H.D.I. and G.N.P. revealed in a regression analysis used by governmental agencies. This provoked a violent reaction due to the students' knowledge that the latter functioned as a component of the former to begin with. The students thus became strongly alerted to the danger of manipulation of data for political purposes. At the same time the importance of quantitative knowledge and tools to counteract false conclusions was made ever more evident.

MATHEMATICS IN VOTING SYSTEMS

QUESTIONABLE RULES (DONALD SAARI)

This was a mathematical demonstration of the unreasonableness of declaring the candidate with the largest total vote as the winner in an election with more than two candidates. The sentiment of the electorate would be more accurately reflected by deciding on the winner by weighting the candidates' votes according to their rank in the voters' (combined) preference. Professor Saari explained the combinatorics and discussed these alternatives with a group of fourth-graders using, say, the vote for class president as an example. These youngsters immediately concurred with his method of choosing, maintaining that the "winner take all" outcome would be unfair.

MATHEMATICS AND COINCIDENCES

PROBABILITIES (PERSI DIACONIS)

In a lecture addressed to the general public, Diaconis applied what he labeled the "Birthday Tool" (i.e. the well-known estimate of the sizable likelihood of a coincidence of birthdays in a relatively small group of people), to the occurrence of events which we apprehend as coincidences in the course of our lives. He thus cleared away some of the confusion or obfuscation by others frequently created by such appearances. This simple mathematical technique once again offers a new thinking cap.

MATHEMATICS AND THE FEAR OF AUTHORITY

DOES THE EVIDENCE OF AUTHORITY PREVAIL OVER THE AUTHORITY OF EVIDENCE? (SHANDY HAUKE AND MARK K. DAVIS)

The teacher would acquaint her math students with some of the weaknesses in the work of authority figures in the history of mathematics such as, say, Pythagoras, with the intent of freeing them from their fear of mathematics. They were thus encouraged to not be overawed by "established truth" but to trust in their own ability to think the subject matter through independently. It was pointed out that it took nearly fifteen hundred years to the eventual overthrow by Copernicus, Kepler, Galileo and Newton of the official but erroneous cosmology of Aristotle and Ptolemy, much of this delay caused by the fear of authority.

WRITING ABOUT THE MATHEMATICS

Writing things down as in a personal journal sifts one's thoughts, consolidates one's inner life and fits one's experiences into the pattern of one's life story. Similarly expressing the chain of reasoning developed in an attempt to solve a math problem or understand a math argument adds coherence to one's thinking and

consolidates one's reasoning powers.

MATHEMATICS FOR LIFE AND SOCIETY

A COURSE IN QUANTITATIVE LITERACY (MIRIAM L. YEVICK)

This course was developed and taught at Rutgers University to students with a defective mathematics background in lieu of the standard remedial one. Basic quantitative skills were extracted from applications relevant to the students' life environment: using powers of ten to estimate the total intake by the Port Authority during rush hour (and comparing the total accumulated net revenues to the original cost of construction); developing a "feel" of magnitudes by fitting items such as the number of hours worked in a lifetime, the number of pounds of meat consumed in one year in developed as against developing countries, the number of millionaires in the world, etc. into powers-of-ten slots; using trees to evaluate the number of individuals on which one's actions may leave a mark in a lifetime; using permutations to calculate the number of orderings of priorities in a national budget, etc. An adaptation of this course is currently being taught successfully to a group of seniors at The Windrows, a Princeton retirement community. They are encouraged to transmit this way of viewing the world to their grandchild as a token of their own concern and as a bridge to the future for both generations.

For both young and old the fear of mathematics was greatly reduced after they recognized their ability to acquire a quantitative thinking cap. They were also alerted to the potential of using math as therapy when encouraged to think about a math problem while engaged in daily tedious work, when overwhelmed by the stress of personal problems, or when experiencing insomnia or when suffering from physical pain.

SUMMARIZING SOME OF THE POTENTIAL POSITIVE CONSEQUENCES OF QUANTITATIVE AWARENESS:

1. An appreciation of a new dimension of experiencing the world.
2. The development of a sense of abstraction, generalization and precision of thought, hence an ability to think in larger units and so recognize patterns of personal and social problems in a global context.
3. Gaining an enhanced inner confidence by the mastery of a new tool with which to evaluate the "established truth," be it in politics, economics,

education...with a more critical stance.

- 4. Conquering the fear of math spills over in a lowering of fear in general and a potential to refashion one's habits of mind. It opens up the possibility of basic changes in one's "cosmology" on a personal and communal level.
- 5. It allows all to share in relishing the joy and beauties of mathematics.

A CALL TO ACTION

I listened to Public Radio while in San Antonio, and after hearing the news I was regaled several times a day by an instructive and exciting little astronomy lesson originating in the university's observatory. It occurred to me that we could do the same with a "Think Math!" lesson.

My suggestion is that we establish a website devoted to disseminating Quantitative Awareness. We would both teach and solicit comments and contributions of a kind similar to the type of examples we discussed previously, i.e. quantitative techniques to view such things as budgets, national and local priorities, election expenditures, environmental problems, etc.

A clear and humane vision is sorely lacking in most of the world's governing bodies (beholden mainly to moneyed moguls, corporate or individual) in the face of the numerous difficult problems facing our world . Thus all kinds of things have gone out of kilter even in the most advanced countries, such as health care, education, legal and political arrangements, environmental balance, demographics, distribution of wealth, let alone the allocation of resources. Many of us, as teachers, have seen the spark of understanding light up in the eyes of our students when they grasped a concept, then realized its use and that they themselves could apply it. It is becoming more necessary than ever that people at large be enabled to search for and advance solutions from below and figure things out at the local and global level. This requires a critical stance towards what one is "told from above," be it by the media or the politicians, coupled with a confidence in one's ability to think clearly, rationally and freely. Let's go for it!



Math is really great
It teaches you how to calculate.
You can learn stuff about math
Even when you take a bath.
Sometimes math can be strange
Like when learning about range.
Math can be real mean
When you are a teen.
You need to do multiplication
For analyzation.
a future with math is near
Please do not fear.
The things you learn about math today
Will bring you all the way.
I think math is really great
It teaches you how to calculate.

Eric Rasyidi

Adding is as easy as one, two, three.
Just add ten plus ten to reach twenty.
But as you really begin to try,
Addition becomes fun as can be.
Subtraction isn't much harder.
You don't have to be any smarter.
Instead of adding you take away.
You can subtract any day,
If you remember my simple starter.
Multiplying is like adding many times.
For example, let's use three dimes.
Instead of adding ten plus ten plus ten,
Just multiply three times ten.
Multiplication can be great sometimes.
Division is just shrinking numbers down.
When you divide there's no reason to frown.
You can divide in the rain.
You can divide on a noisy train.
Don't try dividing in a pool because you just might
drown.

Marshall Sachs

