Colorado Mathematics Teacher

Colorado Council of Teachers of Mathematics

May 1985 Volume 17 No. 4

THE PLACE OF TECHNOLOGY IN THE TEACHING OF SCHOOL MATHEMATICS

The COLORADO MATHEMATICS TEACHER
A publication of the Colorado Council of Teachers of Mathematics

Volume 17, Number 4 May, 1985

Single topic issue:
THE ROLE OF TECHNOLOGY IN THE TEACHING OF SCHOOL MATHEMATICS

Marc Swadener, Editor

TABLE OF CONTENTS

The COLORADO MATHEMATICS TEACHER is a publication for members of the Colorado Council of Teachers of Mathematics. It is published four times yearly (September, November, February, and May). For information on membership contact Ms. Margilee Sauer, CCTM Sec/Treas., 510 Inca Parkway, Boulder, Colorado 80303.

USING THE COMPUTER TO DELIVER INSTRUCTION IN MATHEMATICS

Irwin J. Hoffman
George Washington High School
Denver, Colorado

The philosophical viewpoint in some recent articles contributed by Dean's of the Engineering Colleges of Colorado (ECC), professors of mathematics (reflected in positions taken by the Naional Council of Teachers of Mathematics) (NCTM), and the Mathematics Task Force of the Colorado Department of Education (CDE) seems to ignore the magnificent opportunity the computer has given us. These articles generally have two suggestions:

1. High school computer instruction should be withdrawn as a mathematics credit. (It should be placed in a Computer Science Department which may or may not have mathematically trained instructors.)

2. High school mathematics classes could stress word problems and problem solving skills; however they should do so only within the context of historically pristine and pure mathematics courses.

The NEWSLETTER of the ECC (#6, November, 1983) notes that students at the universities have difficulty with "the solution of word problems, or mathematics modeling . . . (and) solving problems that involve several steps . . . (they) have difficulty developing a plan for the solution." The NEWSLETTER goes on to endorse the recommendation of the CDE Mathematics Task Force (August 1983) that "Computer Science courses are important . . . but should not count as satisfying mathematics requirements for high school graduation."

The CDE Math Task Force also recommended that "emphasis be placed on reasoning and problem solving skills. Of . . . importance is the ability to organize complicated strategies to reach decisions, designs, and solutions. Students must gain experience with . . . mathematical modeling . . . students must state the problem, recognize the assumptions and constraints, formulate mathematical expressions, find solutions and interpret results."

The implications, of course, are that programming computers (while important) is not good mathematics and that problem solving (i.e., pure mathematics) is not appropriately taught in a computer mathematics class.

Maybe it is time to take a broader view of what constitutes mathematics. No one addresses this issue better than B. A. Fusaro in the newsletter of the Mathematical Association of America (MAA) (FOCUS, Vol. 4, No. 1).

> "To understand the reception given the computer by established mathematics, it is necessary to journey back in time. The current dangerously xx period of mathematics, which is showing signs of drawing to a close, began with G. Cantor's fascinating creations (1897). Presumably mathematics could be seen as a pure creation of human thought, completely independent of the world of nature. This budding humanistic conceit was bolstered by the work of G. Frege (1884) and G. Peano (1897). The three "G's" laid the foundation for a new mathematics that came to full power after World War II, as exemplified by Bourbaki & Co. The ground floor was laid by the epic "Principia Mathematica" (1910-1913) of Whitehead and Russell, who purported to show [that] all of mathematics was reducible to an abstract, severe logic, devoid of content. Ironically, the superstructure was erected by D. Hilbert (1904, 1927), known to applied mathematicians for his 'Mathematical Physics.' The workmen were urged on by G. H. Hardy, who believed that mathematics was creative, beautiful and valuable in some sort of inverse relation to its

utility."

"Statistics rapped on the door in the 1920's, but found no WELCOME sign. In fact, it was clearly a case of DO NOT DISTURB. It went out to find a new home where it could, usually in schools of agriculture or forestry. The field of operations research, developed during World War II, also found itself unwelcome and went to departments of engineering or business and management. Step by step, mathematics alienated itself from its scientific and engineering cognates. Even classical applied mathematics came to be viewed as an aberrant or interloper. Boubaki-itis was epidemic, infecting even the pre college levels via the New Math."

"This is the situation the computer bantling faced in the 1950's. Could an electronic apparatus breach the walls of abstract formalism? The message to the babe was predictable: Go away. And so it did, to engineering and business departments, and to administrative data processing centers. Thus an extraordinary tool for numerical or constructive mathematics became only remotely or indirectly accessible to departments that could have had mainframes for the asking."

"Even today, the mathematical world seems largely unaware of this missed opportunity. So it is indeed a blessing that the mathematical maiden (to switch metaphors), through no virtue of her own, has a second chance. The second chance is the microcomputer."

Our inheritance of academic disciplines as mutually exclusive subjects is an anachronism. If mathematics can be construed as including the study of symbol manipulation according to certain rules derived from assumptions, and the application of these rules to model problems, then the syntax of a programming language and the resultant algorithms are mathematics. In fact the "emphases" recommended by the CDE Math Task Force are more easily implemented by the strategies used in teaching computer programming that in the current mathematical offerings.

Computer problems are "de facto" word problems. In fact, taken out of context, the CDE Math Task Force (with is beautiful goals) describes a computer class. A good computer assignment forces the students not only to be thorough in their analysis of a problem, but, through the uses of procedures, requires them to reduce the task to a combination of smaller tasks. The nature of the environment of the solution requires a thoughtful analysis, a requirement sometimes elusive in the "pure" mathematical approach.

In the instruction given in Knuth's text, <u>THE ART OF COMPUTER PROGRAMMING</u>, Volume 3, one finds the definition of a "heap."

"A file of keys, K_1, K_2, . . ., K_n is a 'heap' if $K_{j/2} > K_j$ for $1 < (j/2) < j <= N$."

<u>How can this not be mathematics?"</u>

At George Washington High School the Computer Mathematics class among many other things, teaches solutions to polynomials of degree n, the Simplex Tableau, Gaussian reduction techniques to solutions of n equations in n unknowns, determinants, and matrix inversions. Students build models of series and examine the concepts of convergence and divergence. They analyze data with statistics and build regression lines. Prior to the computer solutions students are shown how to reduce "big" problems into "smaller" parts [Procedures and Functions]. They are required to produce certain solutions manually, certainly an enhancement to "more normal mathematical skills." In effect they are mirroring the recommendations in the ECC <u>NEWSLETTER</u>.

If we take the computer out of the mathematics offerings, we loose the most magnificent motivational device mathematics has ever found. Many students are studying mathematics with determination in order to better program the computer.

Programs students write involve functions, logic, symbol manipulation, analysis of exceptional cases, precision, documentation, generalizations, significant figures, modeling, problem solving, reading word descriptions, interpretation of results, recognition of assumptions and constraints. and the formulation of algebraically related expressions. The "emphases" paragraph, taken out of context, seems to be a call for computer programming as a mathematics course.

The reason so many mathematics teachers have started teaching programming skills is that they recognize the motivational and mathematics skills fostered by programming. It is a grass roots movement, one of Naisbitt's "megatrends."

Perhaps those professors calling for an end to computer mathematics offerings are disturbed that so many computer classes do not emphasize problem solving skills as described above. The solution to this situation is not to dismiss computer programming out of hand, but to work with high school mathematics teachers to use the computer as a vehicle that enhances these skills.

Students should be counseled to that computer mathematics is a concurrent offering with the more traditional mathematics curriculum. Students often take two humanities courses. Why not take two mathematics courses? A student who is heading for a major in engineering should never be counseled to substitute trigonometry for computer programming or vice versa. However, a budding barrister might find algorithms more beneficial than analytic geometry.

I would never argue that writing algorithms for random disk access and other less obvious mathematics is, by the description in the "emphases" quote, pure mathematics.

This micro megatrend cannot be stopped. Those who are describing a different position must join the battle lines and see what we see; a method of motivating our students to be more thorough in all aspects of their approach to a problem. The dissenters should help us use this tool more effectively, not to take it away altogether. The culture lag between the theorists and the "implementors" must end. Curricula of programs that are successful in using computers to teach mathematics should be promulgated. Effective speakers on the subject should be invited to present at conferences and school district meetings. The "good" should be emulated rather than usurping energy by haranguing the bad programs with the inevitable results reported in my opening remarks.

The designers of the new mathematics curriculum should heed the warnings of Dr. Fusaro. Include the computer. Do not dismiss it to another discipline that may not use it to enhance mathematics.

REFERENCES:

Colorado Department of Education, REPORT OF THE COLORADO DEPARTMENT OF MATHEMATICS TASK FORCE, Denver, Colorado, 1983.

Engineering Colleges of Colorado, NEWSLETTER, Volume 6, November 1983.

Knuth, THE ART OF PROGRAMMING, Volume 3.

Mathematical Association of America, FOCUS, Volume 4, Number 1, 1983, page 3.

* *