Broad Spectrum Mathematics Project

by *Peter Weygang* and *Alan C. Madgett*

This project is an attempt to modify mathematics curricula and methodology at the senior high school and first year university levels. We hope to create changes in mathematics education by putting into practice three fundamental ideas:

i. That a high school mathematics program should, for the majority of students, provide a wide but solid foundation.

ii. That mathematics is best developed from a consideration of the realistic and relevant mathematics which occurs in the everyday world of business, technology, and the pure and social sciences.

iii. That the products of modern technology, namely the mini-calculator and the computer, are perfectly valid mathematical tools, and should take their rightful place in mathematics education.

In considering these ideas, point by point, we find that the high school mathematics curricula have been controlled, to a large extent, by university entrance requirements. The presumption has always been that schools are preparing students for admission to the honors program in pure mathematics (which is not the intent of the average student). The majority of students are in fact proceeding to an Arts program, Life Sciences, or other similar disciplines in which the mathematics content is not of a highly theoretical or abstract nature, even though the amount of mathematics involvement and usage can be quite appreciable. These students need a program which builds confidence by using simple mathematical ideas, which builds flexibility by presenting a variety of mathematical alternatives, and which builds interest by presenting material which is relevant to the real world.

In considering the second point, it should be noted that the mathematics-user group has experienced a tremendous growth in recent years. It is difficult to find a profession, occupation or activity which does not have a mathematical component, often quite large. Even in baseball, batting averages are given to three digit accuracy! In today's world students are, from dire necessity, brought face to face with a mathematical reality. Many students are not 'turned on' by mathematics; as a result, these resentful students pose a number of problems for the teacher, ranging from discipline to methodology. Motivation has become a big issue in mathematics education because, unlike the Classics, mathematics can not be avoided by students without serious implications for later life.

Fortunately, most students are anxious to get out into the real world, to become adults and full-fledged citizens. The school environment is very artificial and, by contrast, anything which smacks of realism has an inflated appeal. By

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using real problems as a starting point in mathematics we do two things. First, we capture the interest of the student, by capitalizing on his desire for reality. Second, we provide the students with a problem and a treatment in its original context, be it agriculture or nuclear medicine. This incidental background information is of considerable value to the students, and helps to enrich their vision of the world. We feel that this approach opens the students' eyes to career opportunities, provides some new insights, and of course teaches some good solid mathematics!

In considering the third point, it is apparent that students leaving high school enter a world in which the computer is commonplace. Every major university and industry has its own computer, every office desk has its mini-calculator. The age of 'speed of light' arithmetic has arrived everywhere, except in the mathematics classroom. Mathematics teachers have, in general, an ingrained distrust of the slide rule, calculator, or any other means of easing arithmetic computation. At the same time they fail to appreciate that arithmetic difficulties are the prime hurdle to understanding mathematics. Computation is no friend of logic.

The study of fractions will illustrate this point. Historically, fractions, such as 1/2, 1/4, 1/8, were associated with the early tradesman in his day to day calculations, such as in making window sashes, doors and the like. Manipulation of these fractions had a real value since the alternative, reduction to decimals, was a tedious process. At some stage a misguided pedagogue decided that, since 1/12 + 3/4 was a useful piece of mathematics, he was justified in producing lots of practice examples such as 5/7 + 4/11. This in itself was an error since these fractions are almost impossible to conceptualize, as is the answer, 83/77. Nonetheless, this fraction cult still dominates much of junior mathematics. If for some curious reason it were necessary to do this computation, then the sensible way is to use the calculator:

$$\frac{5}{7} + \frac{4}{11} = .71428571 + 36363636 = 1.07792207$$

This answer is probably close enough, and took two seconds!

At a higher level of mathematics we should again be using numerical methods and calculator aids. For example, numerical integration is a genuine alternative to theoretical integration. In fact, the problems which arise in industry are invariably represented by ill-behaved functions or purely empirical data, for which the slick methods of theoretical mathematics are seldom of much value.

Project History

The original concepts which underly this project were formulated some five years ago by Mr. Weygang. This formulation was followed by a discussion with Ontario Ministry of Education representatives on the project's acceptability. Mr. John Milliken (now the Ministry of Education's liaison officer for this project) gave his approval in principle and the way was clear for the next stage. This was a period of consultation with the mathematics faculty at Laurentian University, who provided considerable specific guidance as to desirable course content. Professor A.C. Madgett was a member of the original advisory group, as was Dr. J. Scott-Thomas, the project director.

Following this input Mr. Weygang developed a detailed course outline and some teaching units. The course is now in the fourth year of in-class use and has surpassed its expectations in all but one area, namely, the number and variety of real life applications being too limited. A cross-Canada survey will attempt to collect these materials.

Progress Report (As of September 30, 1974)

The collection of material started in British Columbia where it was possible to enter into productive discussions with representatives of a wide variety of occupations such as oceanography, forestry, natural gas, and fisheries. Some classroom teaching was also done, in Kamloops, and the reaction to the approach and materials was extremely encouraging.

In Alberta it has been possible to visit representatives of the plywood industry, corrosion engineers, petroleum engineers connected with the Athabasca Tar Sands, environmental specialists, and a host of others. In all areas we have been able to obtain significant contributions, both as information and examples, which relate mathematics to real world situations.

The collection stage of the project, which is funded by the Ontario Ministry of Education, will be completed in June of 1975. At that time we will begin the mammoth task of collating and re-working the material into a form which will be of maximum use to classroom teachers. The final form will probably be a set of resource books incorporating problems spanning a wide range of mathematical ability and grade levels. Each problem will be preceded by a short explanation of the technology involved, in order to 'set the scene'. The problem will be followed by a solution (sometimes several solutions of increasing refinement will be presented). The solutions will be followed by some notes and suggestions which may be of value to the teachers.

We are very fortunate to be able to undertake this project and we appreciate that most teachers do not have the time, energy or financial resources to make such a survey. The re-establishment of contacts between education and reality is one of our most pressing needs. We hope and trust that the end product of this project will be of use to all teachers of mathematics throughout Canada.

Sources of Funding

1. Ontario Ministry of Education: Grants-in-Aid of Educational Research Program $20,000.
2. P. Weygang - Ontario Secondary School Teachers' Federation Travelling Scholarship $3,000.
3. A.C. Madgett - President's Research Fund, Laurentian University $3,000.

VISITATIONS

British Columbia

1. Environment Canada, Vancouver (Commercial Fisheries Operations)
2. Environment Canada, Patricia Bay, Victoria (Marine Sciences Division)
3. Fisheries Research Board of Canada, Nanaimo
4. B.C. Forest Products Limited, Vancouver
5. Westcoast Transmission Limited, Vancouver (Natural Gas Pipe Lines)
6. B.C. Hydro, Vancouver (Hydro-electric Power Generation)
7. Seaspan International Limited, Vancouver (Shipping)
8. B.C.I.T., Industry Services Division, Vancouver

Alberta

1. Alberta Agriculture (Food Production), Edmonton
2. Alberta Environment, Edmonton (Air Management, Water Quality, Hydrology, Pesticides)

3. Zeidler Plywood Corporation, Edmonton
4. Wardair Canada Limited, Edmonton (Air Transportation)
5. Caproco Corrosion Prevention Ltd., Edmonton
6. Gainers' Ltd., Edmonton (Meat Packers)
7. Great Canadian Oil Sands, Edmonton (Athabasca Oil Sands: Oil Recovery)
   Athabasca Realty, Edmonton (Housing - Athabasca Oil Sands)
8. Numac Oil & Gas Ltd., Edmonton (Exploration)
9. Sherritt Gordon Mines Limited, Fort Saskatchewan (Nickel Processing)
10. Alberta Research Council, Edmonton
11. Imperial Oil Gas Separation Plant, Redwater
12. Fleetwood Homes of Alberta, Red Deer
13. Energy Resources Conservation Board, Calgary
14. Canadian Petroleum Association, Calgary
15. Schlumberger of Canada, Calgary
16. Dowell of Canada, Calgary
17. Water Survey of Canada, Calgary
18. City of Calgary: Transportation Department
    Management Systems Development Department
19. General Hospital, Nuclear Medicine Dept., Edmonton
20. Sicks' Lethbridge Brewery, Lethbridge
21. Catelli Ltd., Lethbridge
22. Agri-Analysis Lethbridge
23. Lilydale Poultry Sales, Lethbridge
24. Alberta Agriculture (Lethbridge): Poultry Branch

Metric Manual

As the United States prepares for conversion to the metric system, J.J. Keller & Associates, Inc., have announced the publication of the "Metric Manual," dealing with metric data relative to the conversion process.

The deluxe binder edition provides practical background information necessary to understand the full implications of metrication. The "Metric Manual" has required several years of planning and research - and parallels the announcements by several major industries and organizations to convert to the metric system.

Ideal for home and business libraries, the "Metric Manual" is published in loose-leaf, three-ring binder format and contains: History of Measurement Development of Metrology, U.S. Metric Considerations, Standards, Government Agencies, Metric Training, Personal Applications, Business Considerations, Industrial Foundation, Professional Concerns, Related Organizations, Foreign Commerce, Measurement Comparisons, Glossary and Appendix.

I have made a study of the above publication and find the review satisfactory. At the time it was introduced to the public (August, 1974) it was being offered at a special introductory price of $25, direct from the publisher: J. J. Keller & Associates, Inc., 145 W Wisconsin Avenue, Neenah, Wisconsin 54956. (Editor)