THE ALBERTA TEACHERS' ASSOCIATION MATHEMATICS COUNCIL

delta-k

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Editorial

I have now prepared two issues of *Delta-K* and have not had an opportunity to obtain reactions on either at this time. I am most anxious to know what is superfluous, what is missing and what is valuable. I have presented some questions; I have challenged you for response to articles; I have requested your contributions. I am unable to make personal contact with many of you for obvious reasons of time and distance. But contributions and constructive criticisms will help make *Delta-K* and MCATA more valuable sources of suggestions to improve the role of mathematics in the lifelong education of everyone directly and indirectly reached through our mathematics teachers. Together, we can grow professionally and improve both our intellectual and social environments more effectively than any of us can singly.

Delta-K makes MCATA members aware of happenings and the philosophy of mathematicians and mathematics teachers collectively. For MCATA members, it can be a source of expression of individual practices and philosophy. You can be heard by all of us if you contribute practical and/or philosophical manuscripts and/or letters to the editor in reaction to published material or as original ideas. I promise to present your position without comment and/or endorsement along with the reactions of all who prepare logical defensible differences, except where a repetition of arguments may occur in several consecutive issues, necessitating a temporary closing of one topic in favor of fresh topics.

Metric or not metric?

This is no longer a question. We have reached the point where our world is too interdependent economically to have a multiplicity of physical standards of measurement that create confusion. With this issue of *Delta-K*, we have adopted the international standard of paper size.

This standard is based on paper size of one meter square, referred to as A0. All smaller paper sizes are cut from this paper in such a manner that, no matter what size, it is in the same proportion as the original, and there is no waste. The sizes are A1, A2, A3, A4, A5, A6, A7, and A8. The size we are using is A4.

In this issue

This may necessitate some adjustments in filing cabinets which is a temporary inconvenience that will easily be overcome as irregular sizes and shapes of paper will no longer be used. For our amateur photographers, darkroom work will be much easier as less cutting and waste will occur in printing paper. For others, we suggest there will be a way for you to see improvements as time passes.

Relationship between university mathematics departments and mathematics teachers

At a recent MCATA executive meeting, the ability of mathematics teachers and university mathematics departments to assist each other was questioned: "What can the university offer mathematics teachers?" The university now offers credit courses, but is this the most useful program today in light of the present minimum requirement of a degree before beginning teaching in our public schools?

Questions that arose from this meeting related to innovative courses, short courses, workshops, seminars, classroom visits and travelling courses to our more remote centers. What content and format is the most desirable and valuable in your situation? Your responses are essential if we are to assist our universities in improving their services to us. Something they *are* doing that most of us are not using is to send representatives to the classrooms to show that mathematics careers are available and that not all mathematicians are odd, and that mathematics is for students of every talent and interest. Contact Dr. Jack Macki at the University of Alberta in Edmonton for more details on this program. Contact Dr. Macki or other members of MCATA executive for improvements to the liaison and activities with the Universities.

Annual meetings forthcoming in 1974

NCTM annual meeting is April 17 - 20 at Atlantic City, New Jersey. Members of NCTM have received details of the meeting; others may contact Dr. George Cathcart, NCTM representative for MCATA. NCTM is the organization that made it possible for our Name-of-Site meeting in Edmonton last fall to have leaders in mathematics from every part of North America. NCTM assists us in other ways also, such as providing us with a wider market for our monographs and making available publications from other sources.

MCATA annual meeting is October 25-26 at Jasper. We have not abandoned our practice of rotating the meeting sites to accommodate everyone; we've just added another site not recently used. Our costs will be: registration - $5 for members and $10 for non-members with a one year membership included and a luncheon on Saturday; accommodations - $18 per person per day and $12 per day double occupancy. The "social" and keynote address will be on Friday evening; Saturday will have sessions for teachers with topics of special interest at each level. Details will be released soon. For suggestions and questions that are already in your mind and need immediate attention, contact Denis Baudin, annual meeting chairman (see last page for address).

Math kits- New format

Our math lab kits have grown in size and popularity so that a single K-XII kit is too massive to be practical. We have divided our kits into three groups: elementary, junior high and senior high, as stated in the information letter from Stu McCormick, Coordinator of Math Laboratory Kits. When you experiment with the sample materials, consider what you want added so that we can update the kit for our next circulation. One item that will not appear in the kits before next fall is material for use in teaching metric measurements.

We are gathering material and ideas for evaluation now so that what will be included will be valuable to MCATA members and other teachers at all grade levels. What is in your repertoire that is valuable for others? What do you need to evaluate before you purchase? Your participation is the only way MCATA members may truly work together to improve the teaching of mathematics in our schools. Your executive is working to make the kits worthwhile, but our success depends on your assistance and active participation.

Mathematics Canada

As announced in the August issue of *Science Forum,* the Science Council of Canada has agreed to finance a one-year study of the mathematical sciences in Canada. In addition to the traditional disciplines of pure and applied mathematics, the mathematical sciences include such fields as mathematical statistics, computer science, actuarial science, and operations research. The initiative for the study comes from the Canadian Mathematical Congress, and the study itself will be supervised by a joint committee whose members have been appointed by: The Canadian Mathematical Congress, The Canadian Information Processing Society, The Canadian Operational Research Society, The Canadian Institute of Actuaries, The Statistical Science Association of Canada, The American Statistical Association (District 11).

Surprisingly little attention has been given to the mathematical sciences in Canada. Although the need for long-range policy planning in this area seems obvious, the Lamontagne Report (entitled "A Science Policy for Canada") scarcely mentions mathematics at all. The present study will be breaking new ground in attempting to provide an overall view of the role of mathematics in Canadian science, education, government, and industry. The specific objectives of the study are:

1. To establish what kinds of mathematics are currently used in Canada and to what extent. Also to suggest areas of mathematics which are not being studied or used to the extent which would be desirable.

2. To describe and evaluate the various possible types of research in the mathematical sciences.

3. To estimate present and future manpower supplies and needs at various levels of mathematical competence.

4. To examine current objectives and methods of training in mathematical activities and to suggest possible improvements at the undergraduate and graduate levels.

5. To recommend methods by which significant real problem areas amenable to mathematical treatment can be identified and publicized on a systematic and continuing basis.

The Impact of Mathematics on Society

Mathematics has always played an important part in human civilization and in human thought, but its influence has never been so pervasive as it is today. Until the 20th century, the impact of mathematics on everyday life was immediate and easily understandable, involving down-to-earth applications of arithmetic, algebra, and geometry. Now, however, increasingly abstract and powerful mathematical techniques have come to be used in many subtle and indirect ways. Modern engineering developments, based on sophisticated mathematical theories, have led to the creation of present-day communications networks, nuclear weapons, aerospace technology, and electronic computers. Within the last 30 years, statistical procedures have come to play a dominant role in quality control, government planning, psychological testing, agricultural research, and in all of the experimental sciences. During the same period of time, advanced mathematical methods - which were once the exclusive domain of the physical sciences - have become increasingly important in economics, sociology, the biological and medical sciences, business, and even linguistics. More recently, mathematical modelling and computer simulation techniques have become major tools for decision making.

Problems in Communications

This remarkable expansion in the range of mathematical applications has created many problems in communication and coordination. For the most part, students are not acquiring an adequate understanding of how mathematics is being used in the modern world, and as a result their mathematical education seems curiously irrelevant to many of them. Users of mathematics in science, government, and industry often feel that professional mathematicians are unable or unwilling to respond to their needs. Meanwhile, mathematicians have all they can do to keep abreast of developments in their own field. The astonishing rate at which the mathematical literature is growing makes it increasingly difficult to assimilate and retrieve new information. Indeed, it is often difficult for mathematical researchers to grasp the motivation or significance of some of the problems being dealt with in the literature. Thus, the explosion of mathematical knowledge has created a serious communication problem within the mathematical community itself, particularly since it has given rise to a large number of more or less independent mathematical disciplines.

There is widespread recognition that all is not well. Recent budgetary cuts, declining student enrollments, and the so-called "Ph.D. crisis" have brought the situation in the universities close to the crisis point. Obviously something will have to be done soon, for better or for worse. Many mathematicians fear that the cultural values of mathematics are in danger of being sacrificed for the sake of short-range utilitarian goals. Many see a need too for greater diversification of mathematical activities, with more emphasis on the interfaces between mathematics and other fields of human endeavor. This would involve new attitudes and approaches in teaching mathematics, more cooperation with mathematicians in government and industry, and greater opportunities for interdisciplinary studies. At present there is little incentive to pursue such goals, since they are not encouraged or rewarded on a systematic basis.

Participation in the Study

The mathematics study will investigate possible mechanisms for dealing with these and similar problems. In fact, the actual process of the study may be of greater importance than any written report which will result, according to the study director, Prof. John Coleman, who is also Head of Mathematics at Queen's University. He and his assistant, Dr. Gordon Edwards, are urging practitioners and users of mathematics to participate actively in the study - not only by formulating their views in briefs and letter, but by engaging in a genuine dialogue with their colleagues on the present and future state of the mathematical sciences in Canada. Study groups are being set up for this purpose within universities and colleges, professional mathematical societies, and teachers' associations. These study groups will provide a unique opportunity for people of different professional backgrounds to exchange information and ideas on a wide variety of specific topics related to the aims of the study. For example:

A. Undergraduate mathematical education:

- changing needs: the purpose of a mathematical education
- student involvement: active vs. passive learning
- specialization and fragmentation of subject matter
- the question of "relevance" in mathematics

B. The role of the professional societies:

- who speaks for the mathematical community?
- the need for public education
- the question of social responsibility
- a national voice for mathematicians?

C. Elementary and secondary school mathematics:

- education for life or for university?
- the new math: victory or catastrophe?
- math as an aspect of human culture
- must math always be taught as a skill?

D. The future of mathematical research:

- new directions in fundamental and applied research
- funding of mathematical research
- rationalization of mathematical research
- alternatives to research

E. The role of the technical schools and community colleges:

- mathematical training or mathematical education?
- adult and continuing education
- mathematicians for industry and government?
- liaison with the universities

F. The mathematical Ph.D.:

- must research be "original" to be valuable?
- the mathematical scholar: "breadth" vs. "depth"
- "teacher training" for the Ph. D.?
- the effects of formula financing

G. The mathematician in industry and government:

- solving unformulated problems
- communicating with non-mathematicians
- narrow technician or versatile performer
- "selling" mathematical ideas

Coleman and Edwards feel that the kind of interaction that may take place in these local study groups will do more to help shape policy decisions in the mathematical sciences than any written report could possibly do.

Data Collection

But policies cannot be formulated in a vacuum. The mathematics study will have to provide reasonably accurate information on how the mathematical sciences are being used (or abused) in Canada, what the distribution of the mathematical labor force is and how it is changing, what the strengths and weaknesses of Canadian educational policies in the mathematical sciences are, and - most elusive of all - what the future holds. A variety of techniques are being employed to assemble the required information:

1. Questionnaires are being distributed to all those who graduated in the mathematical sciences from Canadian universities in 1960, 1965, 1970, 1971, 1972, and 1973, to find out where they are now, what kind of work they are doing, and how relevant their mathematical education has proven to be.

2. A number of mathematically intensive industries and government departments are being asked to provide detailed information on what use they are currently making of the mathematical sciences and what their manpower needs are in this area. Because of limitations of time and resources, this estimate of manpower needs cannot be regarded as definitive. However, it will provide a useful framework in which to interpret the statistics resulting from the very ambitious study of Highly Qualified Manpower currently being undertaken by Statistics Canada for the Ministry of State for Science and Technology. Data from the HQM Study should be available by Fall 1974.

3. In order to have some basis for speculation about possible changes in manpower needs for the mathematical sciences, estimates are being sought from various levels of management in industry and government regarding the extent to which the mathematical sciences are likely to be used in their organizations in the future.

4. All members of university mathematics departments and professional mathematical societies are being asked to provide information on their current activities and attitudes in relation to their own mathematical education. It is hoped that this exercise will arouse them to a more probing assessment of current university courses in the mathematical sciences, in addition to providing some useful information on professional characteristics.

5. In order to round out the picture and add some flesh and blood to the cold statistics, Coleman and Edwards are visiting universities, trade schools, and community colleges, faculties and departments of education, government offices, industries, and professional societies, in order to gain some first-hand impressions of the changing role of the mathematical sciences in each of these kinds of institutions.

Different Perspectives

If a problem is viewed from several different perspectives, a more realistic and balanced overview will likely result. For this reason, it is hoped that each study group will go out of its way to solicit the views of others who have a professional interest in mathematics. For example, any study on undergraduate mathematical education should involve some contact with users of mathematics in other university departments as well as employers of mathematicians outside the university.

Consensus not Necessary

It is always satisfying to arrive at a consensus. In most cases, however, a consensus cannot be expected to emerge from the kind of study group envisaged here. It will be far more valuable at this stage if the various conflicting views are given full and complete exposure, so that the range of possible alternatives is clearly appreciated by everyone. A great deal of time can be wasted in trying to force a consensus which simply isn't there.

On The Teaching Of Mathematics In Schools

1. Are students learning how to use mathematics effectively in their everyday life, for example, managing finances wisely, understanding graphs, recognizing extortionate interest rates, spotting fallacious numerical arguments, following simple mathematical explanations, and such?
2. Are students acquiring an understanding of the role that mathematics plays in contemporary society, such as uses and abuses of statistics, computers, mathematical modelling, simulation techniques?
3. To what extent is mathematics presented as an enriching aspect of human culture in such areas as an historically evolving discipline, as one of the great languages of man, as it relates to philosophy, art, and science?
4. Are students becoming "mathematically literate" in the sense that they recognize the utility of abstraction and are not afraid of symbols? In other words, are they able and/or willing to pick up a well-written math book and learn the contents themselves?
5. What have been the effects (positive and negative) of the "New Math"? Are students more self-confident, are they less competent in basic skills, do they regard math as "abstraction for the sake of abstraction"?
6. Is teacher training (including in-service training) adequate to the needs of mathematics teachers? Some comments on the relevance or irrelevance of various aspects of university math education would be welcome here.
7. Is there sufficient communication and cooperation between primary school, secondary school, and university teachers? Specific suggestions for improving the situation would be appreciated.
8. What are the chief obstacles (administrative, pedagogical, financial) to improving the quality of mathematics education at the pre-university level?
9. Should mathematics always be taught as a skill to be mastered, or should certain topics be presented in a more descriptive way in order to acquaint students with important mathematical aspects of modern thought and modern society? (Refer to questions 2 and 3 above.)

Conclusion

Individuals or groups concerned with the future of the mathematical sciences in Canada are urged to make their views known by writing letters, submitting briefs, or participating in study groups. For further information, contact Dr. A.J. Coleman (Study Director) or Dr. G. Edwards (Assistant Study Director) at the following address:

The Mathematics Study
c/o Science Council of Canada
150 Kent Street
Ottawa, Ontario
K1P 5P4

The preceding material is printed for information primarily. However, you may react by corresponding with The Math Study. I am sure late reactions will be useful, although MCATA cannot now act as a group.

Is new 'New Math' next?

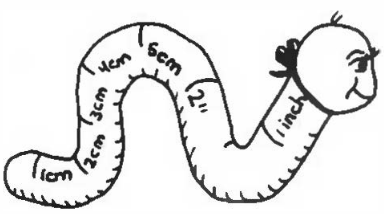
Reprinted from *EDUCATION U.S.A.*, September 24, 1973

Does the "newest math" equal the new math plus the old math minus the rote? There is no doubt that the teaching of math has become a major concern - again - and educators are hopeful that a new reform movement will produce a compromise along these lines rather than a swing back to traditional math. The new math, which began as a reform in 1958, is now being strongly criticized for its emphasis on learning concepts rather than on computation or application of math principles. It was recently panned severely in a new book, *Why Johnny Can't Add,* by New York University math professor Morris Kline. It lost its biggest supporter with the phasing out of the School Mathematics Study Group last year. And it hasn't fared at all well in standard acheivement tests.

Educators and mathematicians, however, refuse to describe the current concern as a duel between the "old" and the "new". There is no groundswell against the new math, says Gorden Cawelti, executive secretary of the Association for Supervision and Curriculum Development, "just an examination of its excesses". The objective of the new math, in his opinion, "was to get the roteness out of math teaching and try to remove the blocks that kept students from liking it". James Gates, executive secretary of the National Council of Teachers of Mathematics, predicts that math teaching in the future will emphasize the application of math to everyday problems, "but I hope we don't go too far with the application and overdo it". California, where the new math is used in all grades, now has a legislative committee investigating why its students' math achievement test scores have dropped over the past four years. The legislature has mandated that additional emphasis be given to computation skills in the next textbook adoptions. However, Jack Price, a former math teacher and now assistant superintendent for curriculum in the San Diego, Calif., schools, hopes the pendulum doesn't swing back too far, "although it probably is good that it's moving back a little." His district, as well as many others in the state, has produced supplemental units to improve computational skills, which the achievement tests emphasize.

Increasing the application of math to "real world problems" was the central discussion point at four workshops held this summer by the National Science Foundation (NSF). There was a consensus at the meetings to apply math to real situations, not just in the physical world, but also in other sciences, such as geography, biology, population studies, and statistics, says Lauren Woodby, NSF precollege math specialist. This shouldn't be presented through "phony problems", he says, but should involve students in solving problems about their world. He also believes that the new math concern for stimulating more capable students is now being replaced by a goal of math literacy for all students. All of those who commented on math teaching for *EDUCATION U.S.A.* agree that teacher training is a high priority for introducing any changes.

Emphasis on the application of math will get a natural boost from the conversion to a metric system, according to Gates. "Learning the metric system is a more practical exercise than worrying about base and sets," he says, and he predicts that the metric conversion will go ahead even if Congress is slow to approve it. Only three states have moved to introduce the metric system into education, but Ohio is now using road signs with both the metric and English systems, and National Instructional Television is preparing film materials for schools on the metric system.



Inching our way toward the metric system

Reprinted from *The Mathematics Teacher*, April 1973, Volume 66, Number 4.

"What is heavier, a pound of gold or a pound of feathers?"

"They both weigh the same," answers the bright child in whom we have carefully nurtured logical thinking.

"Wrong!" we reply. "A pound of feathers is determined by avoirdupois weight and measures 7,000 grains. A pound of gold is determined by troy weight and measures 5,760 grains. Thus a pound of feathers is heavier. Clear? Let us try once more. What is heavier, an ounce of gold or an ounce of feathers?"

"An ounce of feathers?"

"Wrong!"

"They both weigh the same?"

"Wrong again! A pound of gold consists of 12 ounces because it is determined by troy weight. Therefore an ounce of gold is equal to 480 grains. But there are 16 ounces in an avoirdupois pound. Therefore an ounce of feathers equals 437.5 grains."

It should come as no surprise that many people in North America have ceased all critical thinking with respect to measurement. A full-page advertisement for a certain small car in the 18 October 1971 issue of *Newsweek* boldly proclaimed a 57-inch overall outside width while it is a full five feet across on the inside! How many readers noticed the discrepancy?

Anyone who feels smug and confident regarding his knowledge of the North American system of weights and measures is invited to test his mettle on the following questions:

1. How many cubic inches are there in a gallon?
2. What is the difference between a liquid quart and a dry one?
3. How many square feet are there in an acre?
4. A common aspirin tablet is five grains. How many scruples does that represent?
5. What is the number of pennyweights in a troy ounce?

There will be a few who can answer all the above correctly. Yet the list could have been made much longer and more difficult by including references to rods, furlongs, square perches, poles, chains, cord feet, fathoms, cables, nautical miles, leagues, pecks, gills, drams, hogsheads, and barley corns. And it must not be overlooked that though a bushel generally represents 60 lb. avoirdupois, it is equal to only 48 lb. of barley, 32 lb. of oats, 56 lb. of rye or Indian corn. And do not forget the regional differences. In Massachusetts a bushel of potatoes is 60 lb. but only 56 lb. in North Carolina or West Virginia.

Is it any wonder that 14 countries are presently preparing to "go metric" and join the 114 countries and territories that have adopted the metric system already? Increasing world trade and the fact that Britain is in an advanced stage of change-over from the inch-pound to the meter-gram system make a similar change mandatory for the economic survival of the few remaining nonmetric countries (see Appendix A). Most think as Canada (*White Paper*, 1970, p.5):

> The government believes that adoption of the metric system of measurement is ultimately inevitable - and desirable - for Canada. It would view with concern North America remaining as an inch-pound island in an otherwise metric world - a position which would be in conflict with Canadian industrial and trade interests and commercial policy objectives. The Government believes that the goal is clear, the problem lies in determining how to reach this goal so as to ensure the benefits with a minimum of cost.

If such governments are correct in their assessments, then the need to begin this process of change as quickly as possible is obvious. The longer the decision is delayed, the more the eventual cost of the change will be increased.

The implications for the educational system are clear. The children presently in school will be in their early 30s in the year 2000. Presumably the whole world will be metric by that time. Inches, pounds, and yards will have gone the way of the fountain pen, the kerosene lamp, and the log cabin: picturesque memories of the past, surviving in a few standard expressions and in museum exhibits, but otherwise of historical interest only.

In preparation for that time, there is an immediate need for greater emphasis on teaching the metric system and a consequent need for retraining teachers and revising books. This is urgent already because of the years that elapse between the introduction of new texts and the graduation of the students who have used them.

As soon as primitive men learned to speak and communicate, a need for expressing quantities must have arisen. No doubt the first expressions were vague and inexact, but they served a purpose, just as similar statements of measurement serve a purpose today. We are still told to gather an "armful" of wood for the fire and to add a "handful" of flour or a "pinch" of salt to a certain cooking recipe. The grocery store may advertise that a "truckload" of watermelons has arrived just in time for the weekly special. The term "truckload" serves a purpose because no one except the storekeeper cares whether that means 600 watermelons or 1000. All these measurements are easy to visualize and often directly relate to physical experiences. A nomadic Eskimo reckons distances by so many "sleeps". A German farmer may explain that he owns six "mornings" of land, meaning the land area that can be plowed by a man in six mornings. We do comparable things in North America when we measure distance by stating that it is a "three-hour drive" or when we measure areas by "city blocks". Sometimes such measurements survive in our language even though they can no longer be easily visualized. Electoral districts are called "ridings" from the distance a man could cover on horseback. And just as primitive man developed new measures as the need arose, so do we: we talk about a "pack" of cigarettes and a "roll" of paper towels.

But such inexact measures were hardly sufficient for trade or barter; they left too much room for disagreement because they meant different things to different people. Even where agreement existed, it still could be very confusing. For example, a last (load) of herring was 12 kegs, but a last of gunpowder was 24 kegs. A last of brick was 500 bricks, but a last of tile was only 144 tiles. A last of wool was 12 sacks.

If one goes to a marketplace in Europe, one can still buy goods by the "ell". An ell of cloth is a length of cloth stretched between the hand and the shoulder. This measure survives in our word elbow. But when purchasing by the ell, watch the salesman closely to see that he indeed stretches his hand and arm completely while measuring your purchase. Preferably buy from people with long arms and under no circumstances buy elastic that way.

To make trade possible, a local baron or chieftain often established certain standards of measurement. His foot was always a popular standard. So was his thumb. A certain Anglo-Saxon king defined the yard as the length of his girth. Picture the foot-, the thumb-, and waist-measuring ceremonies. Imagine all the resulting confusion. Not only did these measures differ from place to place, but also they changed with the advent of any new ruler. And life expectancy was rather short in those days.

Charlemagne was among the first national rulers in the western world who attempted to create order from this confusion of weights and measurements. Tradition has it that the French foot of 12.79 inches was the exact measurement of Charlemagne's extremity. He failed, as did many governments after him, until the 18th century came around. As long as trade occurred primarily at the local level, the situation was not disastrous. People did not question why cloth should be measured by the ell, land by rods, and a horse's height by hands. Converting from one measure of length to another was difficult because our number system with Indian-Arabic numerals had not yet spread over Europe.

With the growing acceptance of the decimal system, the beginning of science and industry, and the development of more powerful national governments that were extremely interested in the flow of goods for purposes of taxation, the situation changed. Voices became adamant in favor of a more rational system of measurement, a system that would be universal and that would have the various units of length, area, and capacity related in a simple manner. If the new system was to be truly universal, with all measures related as much as possible, then the selection of a basic unit was important. Several possibilities were considered. The time of the swing of a pendulum is directly related to its length. The length of a pendulum that would describe one complete swing per second was suggested as the fundamental unit of the new linear measure. But that would hardly be universal, critics pointed out. A pendulum swings faster at the north and south poles than it does at the equator. Moreover a measure defined in that way would presuppose a definition of a second, which was in itself a questionable measure.

A second suggestion for a unit was a sector of the equator. But the length of the equator would be difficult to measure. Besides, few countries touch the equator, and thus the new measure would not be truly universal.

Finally, a third proposal was agreed upon. *A portion of a meridian would be used as a general standard.* Although few countries were on the equator, every nation was on some meridian. (It was generally accepted at that time that every meridian was of exactly the same length as any other meridian, a belief that was later proved wrong.) But what portion of the meridian should be used? One millionth, a ten-millionth, a hundred-millionth? Practical aspects of daily life as well as trade and commerce had to be taken into consideration. Since the approximate circumference of the earth along a meridian was already known from astronomical calculations and since dividing that length by 40 million would yield a length of about one yard, that was the unit decided on for the basic measure. An intermediate standard based on the astronomical calculations was accepted for the time being.

Meanwhile a committee of scientists was appointed to determine the exact distance from Dunkirk to Barcelona. It was known that both cities were on the same meridian and both were at sea level. Therefore multiplication of that distance by a proper constant would yield the figure for the circumference of the earth. It took seven years for the scientists to accomplish their mission, and it involved many dangers and hardships. This was a time of revolution and turmoil. But when all calcualtions had been completed, it turned out that the astronomical observations had been surprisingly accurate. The intermediate measure of length that was based on it differed less than one-half of one per cent from what the surveyors found. Nevertheless, the new standard was quickly made into law, and the intermediate one abolished. The new measure was called the meter (in French metre from the Greek metron, measure). In turn the basic measure was multiplied or divided by powers of ten to establish other linear measures. Greek prefixes to the term meter were used to denote multiples of the unit, while Latin prefixes indicated subdivisions.

The result was as follows:

1 kilometer	=	1000 meters
1 hectometer	=	100 meters
1 dekameter	=	10 meters
1 meter	=	1 meter
1 decimeter	=	0.1 meter
1 centimeter	=	0.01 meter
1 millimeter	=	0.001 meter

For a unit of area the square dekameter was decided on. A square meter would have been too small for practical purposes, a square hectometer too big for this land where fields were small. A square 10 meters by 10 meters roughly equaled the size of a woman's herb and vegetable garden, thus making it easy to visualize. The new unit of area was called an are.

At first glance one would expect an extension of this new measure by the proper prefixes to create the whole increasing and decreasing sequence. But a square equal in area to 10 are would have the length of $10\sqrt{10}$ meters (approximately 31.6 meters), thus upsetting the simplicity of the system. Hence acceptable extensions of this measure are the following:

1 hectare	=	100 are
1 are	=	1 are
1 centiare	=	0.01 are

Of course one can always speak of a square kilometer or a square meter if the needs require it.

The basic measure for volume (capacity) posed no great difficulty. Reason demanded that it be defined in terms of the meter. One cubic meter was clearly much too big (approximately 250 gallons); a cubic centimeter too small. Hence the only reasonable choice was the cubic decimeter, which is equal in capacity to about one quart. The new measure was called a liter (French: litre). Again the derived measures followed the same pattern as for the meter:

1 kiloliter	=	1000 liter
1 hectoliter	=	100 liter
1 dekaliter	=	10 liter
1 liter	=	1 liter
1 deciliter	=	0.1 liter
1 centiliter	=	0.01 liter
1 milliliter	=	0.001 liter

Convenient though the liter was for purposes of measuring liquids, it was not satisfactory in all cases. For firewood, for instance, a cubic meter would appear much more reasonable. It was adopted as such and called the stere (from Greek stereo: solid). The stere was used nearly exclusively for wood, and as a result no names for powers of the stere were ever adopted because there existed little need for them.

To us, living in the second half of the twentieth century, the unit of weight (more properly, mass) agreed on is surprising because it is so small. But at the time the unit was selected relatively few goods were sold by weight. Notable exceptions were precious metals and spices, which were sold in small quantities, of course, but which played a very important part in the economic structure of the country. And the scientists themselves often dealt in very small quantities in their laboratories. At any rate, the unit of mass selected was the mass of one cubic centimeter of water at its greatest density. This was called the gram (French gramme). Again the usual derivations were agreed on:

1 kilogram	=	1000 grams
1 hectogram	=	100 grams
1 dekagram	=	10 grams
1 gram	=	1 gram
1 decigram	=	0.1 gram
1 centigram	=	0.01 gram
1 milligram	=	0.001 gram

For the measure of angles the traditional 90-degree angle, called a grade, was divided into decigrades, centigrades, and milligrades. (It is for that reason that the term "centigrade", as applied to temperature, is incorrect. It is more properly called Celsius, after the Swedish scientist Anders Celsius, who created that particular temperature scale.) The renaming of angles never caught on, however, because of the cumbersome fractions involved. For instance, the traditional 60-degree angle became 66 2/3 centigrades. It is clear that this change was no improvement. (See Appendix B for a list of some people and dates associated with the development of the metric system.)

What most hampered the acceptance of the metric system in non-French countries, however, was the excessive zeal displayed by the metric creators in other areas. They fashioned a new "week" of ten days' duration, thus doing away with the Sabbath. They began an entirely new calendar starting with the year one. As a result the whole metric system came to be associated in the eyes of many with a "godless atheism", a system "conceived in sin and born in iniquity", as some put it. Combine this with a common veneration for matters old and familiar as well as the distaste of the English-speaking world for anything French that resulted from the Napoleonic wars.

Now Great Britain has discarded the inch-pound system, and Canada has declared its intention to go the same way. The time for decision in the United States has come. On August 6, 1971 Senator Pell of Rhode Island introduced a bill (S.2483) "to provide a national program in order to make the international metric system the official and standard system of measurement in the United States and to provide for converting to the general use of such system within 10 years after the date of enactment of this Act." The bill has been passed by the Senate.

The ultimate decision to GO METRIC appears inevitable. Teachers would do well to start acquainting their students with the system more thoroughly than in the past. THINK METRIC should be the only slogan in the teaching of measurement for the child who will spend most of his adult life in the 21st century.

APPENDIX A

The only countries in the world not committed to the metric system are: (De Simone, *A Metric America,* 1971):

Barbados	Jamaica	Naura	Trinidad
Burma	Liberia	Sierra Leone	United States
Gambia	Muscat and Oman	Southern Yemen	
Ghana		Tonga	

APPENDIX B

Some People and Dates Associated with the Development of the Metric System

1586 - Simon Stevin (1548-1620) - Dutch mathematician publishes a pamphlet *Thiende* which deals with decimal fractions. He advocates decimal coinage and decimal weights and measures.

1670 - Gabriel Mouton (1618-1694) - Vicar in Lyon generalizes some of Stevin's proposals and proposes a comprehensive decimal system that uses as a basic measure the length of an arc of one minute of a great circle.

1789 - Charles Maurice Talleyrand (1754-1838) sponsors the original draft to the French National Assembly for introducing a uniform system of measures.

1790 - Antoine Laurent Lavoisier (1743-1794) is appointed secretary and treasurer of the committee to secure uniformity of weights and measures. As such he has a great influence on its acceptance. He dies under the guillotine in 1794.

1792-1799 - Jean Baptiste Delambre (1749-1822) - French astronomer measures the arc of the meridian from Dunkirk to Barcelona. This becomes the basis for calculating the meter.

1793 - Joseph Louis Lagrange (1736-1813) French-Italian mathematician becomes president of the commission for the reform of weight and measures. This committee later introduced the metric system to France and other countries.

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A graphic experience

If all the equations below are graphed on the same set of coordinates, the result is a picture. Students enjoy the exercise, and it is especially easy to check the accuracy of the work.

1. $(x + 3)^2 + (y - 3)^2 = 1$
2. $(x + 3)^2 + (y - 3)^2 = 0$
3. $y = 0$ for $\frac{2}{3}\sqrt{5} \le |x| \le 9$ or $|x| \ge 13$
4. $(x - 3)^2 + (y - 3)^2 = 1$
5. $(x - 3)^2 + (y - 3)^2 = 0$
6. $(x + 11)^2 + y^2 = 4 \quad (y \ge 0)$
7. $(x + 12)^2 + y^2 = 1 \quad (y \le 0)$
8. $(x + 10)^2 + y^2 = 1 \quad (y \le 0)$
9. $(x - 10)^2 + y^2 = 1 \quad (y \le 0)$
10. $(x - 12)^2 + y^2 = 1 \quad (y \le 0)$
11. $(x - 11)^2 + y^2 = 4 \quad (y \ge 0)$
12. $x^2 + y^2 = 49 \quad (y \ge 0)$
13. $9x^2 + 4(y + 2)^2 = 36 \quad (y \le 0)$

A collection of such graphing exercises would be useful and enjoyable, and the writer would be most interested in hearing of others that anyone might discover or devise.

Robert G. Stein
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Book Reviews

J.J. Del Grande, P.J. Jones, I. Lowe and L. Morrow. *Math Book 2*. Calgary: 1972. 342 pp. $4.75.

Math Book 2 is the second to be published in a series of mathematics books for the junior and senior high school years. *Math Book 2* is one of the most attractively arranged and presented books which I have seen. The authors make excellent use of diagrams and pictures which are contemporary in order to get and maintain the interest of the students. Extensive use of colors adds considerably to the appeal and attractiveness of the book. The size of print makes for easy reading. References made in the book are to things of interest to students this age. I don't expect students would be bored with an arrangement and format of this nature.

The vocabulary is kept to a minimum and is at a level which the average Grade VIII student can read and comprehend. Explanations are systematic step-by-step procedures, mostly self-explanatory. (A good example is the instructions on the use of the protractor. Usually this information is not even included with an introduction to geometric constructions.)

The book is very cleverly arranged so that a topic is adequately covered yet not overdone. It makes good use of review exercises and computation practice. Included is an especially comprehensive explanation of positive and negative integers with many practical examples.

Most of the topics outlined in the *Junior High School Course Outlines* for Alberta are adequately covered in the book. The text is geared to the large group of students in the middle, which has often been neglected in the past, but also challenges above-average students with recreational enrichment activities, puzzle problems, and so on.

One of the best recommendations for the book is that students who have had an opportunity to look at it, almost refuse to put it down, and will pick it up to study at every opportunity.

H.A. Elliott *et al.* *Project Mathematics*. Toronto: Holt, Rinehart and Winston, 1972. Books 8, 9, and 10 are bound together in hardback for $5.95. The others are singly bound in paperback for $1.75 (Book 13) and $2.10 (Books 14, 15, and 16).

The mathematics books entitled *Project Mathematics* are an attractive and well-illustrated series. Excellent use of a variety of interesting algorithms is made for the purpose of introducing and reintroducing the basic operations of addition, subtraction, multiplication and division as they relate to integers, fractions and decimals. As students proceed through the books, the material is graduated so as to not leave gaps.

At each project level, the skills necessary for problem solving are developed by using problems that are relevant to the mathematical concepts and to real-life situations of the students.

In line with the thinking of such a noted author as Piaget, good use of concrete and semi-concrete materials is used to develop concepts. The use of these types of materials is emphasized throughout the entire series, but as one would expect, becomes somewhat less at the upper levels.

Good use is made of color in presenting the concepts of charts and graphs at all levels. Project machines are used to introduce linear functions, circumference, and so on in order to add a bit of intrigue. Operations involving the basic concepts are introduced at various levels using a variety of eye-catching techniques. Games are used at all levels to develop numerous concepts.

An excellent teacher's guide has been developed for Books 8, 9 and 10. For each chapter it outlines the concepts and skills to be taught, recommended teaching procedures, activities to precede the use of the textbook and ideas for extra and follow-up activities. Also provided in the guide is a comprehensive index for all concepts and a complete answer key.

Emphasis is placed on individualizing the program, and not rigidly following any textbook or guidebook. Students are to be actively involved in all phases of the learning program.

In total I am very pleased with this series of books. At all levels they are particularly relevant to our time and place. Although the major placement for material in these books would be in the elementary grades, books 14-16 in particular would prove of great value for reintroducing the basic operatives, sets, geometry, graphing and problem-solving at the junior-high school level. So often the reintroduction of these topics proves to be very unimaginative and deadly. The use of the techniques outlined in the *Project Mathematics* series should make the reintroduction of these topics challenging and interesting.

I would recommend the individualizing of all of the "Project Books", which would promote their use and versatility.

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