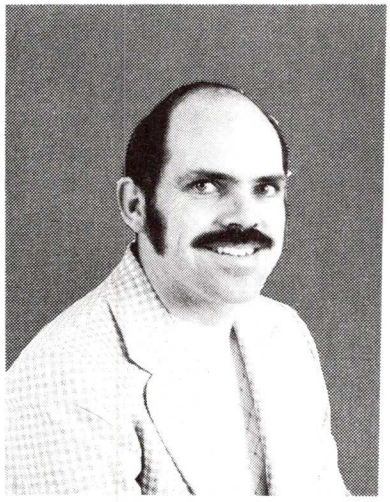
Metric Interest Centres in Secondary Mathematics



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Canada is in the process of officially converting to the metric system of units known as the International System of Units (Système International d'Unités), or SI. While this has many implications for all sectors of our country, it has special implications for mathematics teachers. It has direct implications as we teach measurement in the junior high school. It has indirect implications as other teachers look to us to educate students who can discuss and apply this new system in their classes and courses. It has vivid implications for our secondary school students. They are persons who are already naturally familiar with the "imperial" system of measures. Yet, as they reach adulthood in a few years, they will have to function in a metric society.

The Metric Commission of Canada is providing a great deal of literature on the change. Our provincial Department of Education is providing both in-service leadership and organization as are other educational agencies in the province and indeed across Canada. Our professional organizations, the MCATA and the NCTM are providing ideas and guidelines. Last, but certainly not least, commercial publishers and school equipment suppliers are providing a vast array of material and devices to help us "go metric" and "think metric" in our mathematics classrooms.

Thinking seriously about the learning problem facing secondary school students, we can see that learning the "SI" is not a short term proposition meant to satisfy the requirements of a school examination. Students must have sufficient time and experience to grow in personal familiarity with -

- the basic units of SI, what they look and feel like,
- the derived units of area, volume and capacity so useful in our junior high school curriculum,
- the system itself based on 10,
- the nominal system of prefixes,
- the symbolic system tied up in the numerous correct abbreviations.

How can we, as teachers, best use the growing myriad of metric materials and metric ideas to provide the range of experiences needed by our students in meeting the objectives stated above? It is the purpose of what follows to describe what I have termed a Metric Interest Centre which is an instructional plan to allow a mathematics teacher to provide the needed time and metric experiences for our students.

What is a Metric Interest Centre (MIC)? Physically, a MIC is a collection of materials, most of which can be made or collected by your students, appropriate SI measuring devices, and a large number of projects involving their use. These projects are the heart of the centre and should be designed so that students can work on them individually, in small groups, or as classes.

The pedagogical basis for using a MIC has been alluded to above. It is based on the premise that learning, especially that which is to be lastingly useful, takes *time*. It is also based upon a second premise which has two components. The first is that secondary students, particularly those at the junior high school level (perhaps ages 12-14), need *personal experiences* upon which to base the many generalizations necessary in gaining personal mastery over SI ideas. By personal experience is meant being faced with a situation, interpreting it for yourself and then working successfully within it. The second component of this premise is that secondary students need to be faced with situations which are *motivating*. Combining these three notions, it can be said that the pedagogical aim of an MIC is to provide *motivating personal experiences* with metric measuring situations over an extended period of *time*. Hopefully these will constitute the *practice* so necessary for learning which lasts.

Professionally the MIC allows a mathematics teacher the opportunity to interpret both the curriculum and the SI learning objectives noted above in a way that is most relevant to the students. The teacher can make use of the environment in which the school exists, the occupations of the parents, and the stores in the areas in making up projects on which students can work. Students can and should be expected to provide extensions to the MIC and indeed to come up with projects on their own.

The Metric Interest Centre examples which follow will include measures of length, area, volume, mass, and capacity. In addition, they will focus on comparative problems and all of the aspects of SI. The teacher must be sensitive to the mathematical prerequisites and corequisites of the various projects. These

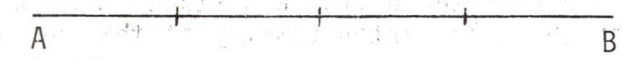
mainly involve the notions of ratio and proportion, as well as measurement concepts. However, the following projects attempt to develop a situation in as open a way as possible, allowing any student to try any project.

PROJECT I

Materials: Twine, marking pens, half-gallon milk cartons, material to put in cartons. In a convenient location in your classroom, mark 2 points (A and B), 4 metres apart on the floor of your classroom.

Card A

From the ball of twine, cut off a piece exactly the length from A to B.



Find and mark with a pen the exact middle of your twine. (How can you do this?) Find and mark the exact middle of the other two segments of your twine. (What is an easy way to do this?) You now have a measuring instrument with 4 parts of equal length. How tall are you? More than 1 unit? _____ More than 2 units? _____ Take a metre stick and measure the segments and total length of your twine: Segment _____, Total _____ . With another person, use your measuring twine to find the approximate perimeter of your classroom, or room at home, in metres.

Card B

Cut another piece of twine exactly as long as one segment of your measuring twine. Without using a metre stick or any other kind of standard measure, figure out a way of dividing this piece of twine into 10 equal parts. (Hint - you will have to use something with parallel lines on it, for example, boards on a floor.)

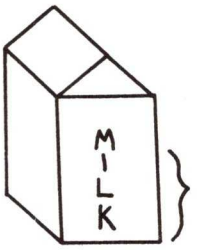
Each of these small segments represents a tenth of a metre (0.1 m) and is called a decimetre (dm).

Using your measuring twines, work with another person to find the following in decimetres and metres.

	decimetres dm	*metres* m
height		
length of arm		
length of foot		

Card C

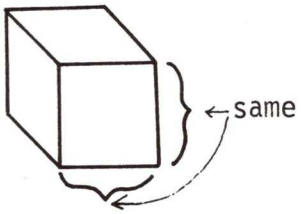
Take a half-gallon milk carton. Use your twine to measure the length of the side of its bottom in decimetres.



measure and cut

How long? _____

Carefully measure up from the bottom a distance the same as the length of the bottom side. Cut off the milk carton exactly at this height.



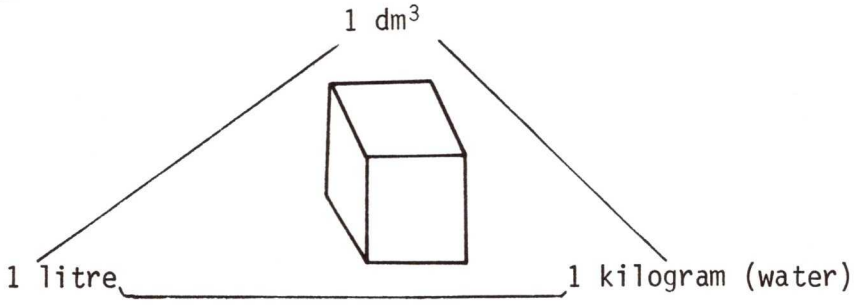
What shape is your container? _____

What are its dimensions? _____ by _____ by _____.

Its volume is found by multiplying its length, width and height (which are the same).

Volume = _____ dm x _____ dm x _____ dm = _____ dm^3.

Fill your container with rice or sand or other material. You now have a litre of material.
Empty your container and exactly fill it with water. The mass of this water is about 1 kilogram.



You might think of your container as showing the "magic metric triangle."
Use your container to estimate capacity of these containers in litres.

10 oz. pop bottle	_____	*litres*
26 oz. pop bottle	_____	ℓ
40 oz. pop bottle	_____	ℓ
soup can	_____	ℓ
48 oz. juice can	_____	ℓ
half-gallon milk carton	_____	ℓ

Card D

In Canada's change to metric units, new measures of common objects will likely be adopted. For example, a chair seat measuring 42.3 centimetres high, in the future may be set at 40 or 45 or 42 centimetres; a pencil now 14.3 cm long, set at 14 cm. Put your mind to work and see if you can think up good dimensions for these and other objects. Filling in the table following should help. To help you learn to "think metric," make an estimate of the distance in centimetres (cm) or metres (m) before you measure. See how close your guesstimate can be! Use a metre stick marked off in centimetres in your measuring.

	Guesstimate dimensions (centimetres or metres)	*Actual measure dimensions*	*Your proposed metric measure for the object*
Mathematics book			
Ball point length			
Writing paper dimensions			
Chair seat height			
Book shelf width			
Wall panelling panel			
Doorway width and height			

PROJECT II

Materials: A variety of commercial and homemade measuring devices.

Card E

One of the facilities for the Commonwealth Games in Edmonton will be a pool for swimming competitions. Make an accurate drawing of such a pool and find the following information about it in metric units: length, width, depth, volume, water in pool, width of lanes.

List the Commonwealth records for the various events and then calculate them in kilometres per hour. Visit a swimming pool in your neighborhood. Find out, or, better yet, measure and calculate the above measures for your pool.

Card F

Visit your community hockey rink. Find the following measures in metric units: length, width, distance from end boards to blue line, distance between blue lines, distance from back of net to boards, diameter of face-off circle, number of litres of water needed to originally flood ice, number of litres used in maintaining ice, volume of ice on rink.

Card G

Get a score-card from a nearby golf course. Rewrite the card using metric units. Extra for experts: How many square metres of grass are there on the largest green? Write a report on how you figured this out.

Card H

Look over cards E, F and G. Find the relevant measures or change the wording of the rules of other games which interest you so that they use SI.

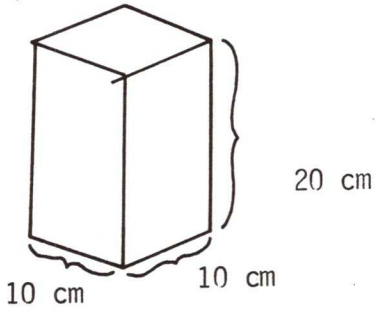
Card I

Organize a metric sports day for your school. Set up all the events in metric units. The day could involve various running, jumping, throwing, and target events. It could also involve some "fun and think" events such as a relay race carrying pails of water to fill a larger container where each contestant would have to calculate the amount he or she adds in litres. Think up your own events which will help all the kids in your school to "think metric." Have your classmates and teacher help you organize and carry out the sports day.

PROJECT III

Materials: Metric measurement devices, tagboard, tape.

Card J



This carton can contain up to two litres. What is its volume? _____ Can you find other shaped cartons which would hold 2 litres? Sketch them and give their dimensions. Build them out of tagboard.

Card K

Get a half-pint milk carton. On it you will find its metric capacity 227.8 millilitres (ml). As we change to SI, the contents of milk cartons will likely change to 250 or 200 ml. What portion of a litre would each of these measures be?

250 ml = _____ℓ

200 ml = _____ℓ

Design various milk cartons which would hold 200 ml. You may wish to get your teacher, the industrial arts teacher, or a carpenter to help you with this. Sketch and build cartons you think will work. What shapes do you think would be most practical? Why?

Extra for a smart shopper:

What is the price of milk now (½ pint)? What would be fair prices for 250 ml cartons? _____, 200 ml cartons? _____. Why? What do you think milk machine prices would be for these cartons: 250 ml? _____, 200 ml? _____. Why?

Card L

Collect containers for various products and complete the table following.

	Current measure in grams	*Better SI measure*
Soap		
Soup		
Soda Biscuits		
Ice Cream		
Bread		

Measure the containers used above. What would be the metric measures for your new container?

PROJECT IV

Materials: A road map of Alberta, topographical maps of various parts of Alberta, map of Canada, rulers marked in centimetres.

Card M

Find the shortest road distances in kilometres (km) between your home and the following cities: Calgary, Peace River, High Level, Fort McMurray, Banff, Pincher Creek, Coronation, Lloydminster, Vegreville, Edson, Grande Cache, Medicine Hat, Red Deer, Brooks, Grande Prairie, Rocky Mountain House. Check the laws of Alberta and convert the following signs to appropriate or equivalent metric measures: speed limit signs (on highways, in towns and cities), load limit, clearance signs, junction signs.

Card N

Find a lake on a map of Alberta. Give its approximate measurements in

metres: length, width. Make the smallest rectangle you can around the lake. What is its area in square metres? _____ What is the area of the lake (approximately)? _____

Card O

On a map of Canada use metric measures to find:

- the area of the smallest rectangle in square kilometres (km^2) which will enclose the country,
- the approximate length of our none island coastline in kilometres,
- the air distance in kilometres from Edmonton to: Victoria, Regina, Winnipeg, Toronto, Quebec City, Fredericton, Halifax, St. Johns, Charlottetown, Whitehorse, Yellowknife.

PROJECT V

Card P

Metric Hunt 1

Find, using metric units, the following information (give the measure in at least two equivalent forms):

Examples -

Dad's height	180 cm	1.8 m
Cream carton	227.8 ml	0.2278 ℓ
Your height	_____	_____
Amount of natural gas Alberta exports daily	_____	_____
Area of a page of your local newspaper	_____	_____
Highest elevation in Alberta	_____	_____
Capacity of the gasoline tank on your car	_____	_____
Height of your school building	_____	_____
Volume of your math classroom	_____	_____

Card Q

There are many prefixes in the metric system which are not commonly used. Find things which are usually measured using the following prefixes. Find as many

things as you can for each category. If you wish, get pictures of each and, with a classmate, make a display of your findings: nanno, micro, milli, centi, deci, deca, hecta, kilo, mega.

PROJECT VI

CARD R

Obtain a copy of your local newspaper. Change all of the "ads" so that they would be appropriate in a metric society. Remember to change the prices where necessary.

Example: 3 lb. margarine -- $1.79

A convenient metric amount might be 1 kilogram or 2 kilograms so our new ad might be: 1 kg margarine -- $1.31, 2 kg margarine -- $2.62.

CARD S

In that same newspaper, go through the sports page and change it using appropriate metric values.

Example: "In Montreal, Steve Smith vaulted 18'2½." "In Montreal, Steve Smith vaulted 5.55 metres."

DEVELOPMENT AND USES OF A METRIC INTEREST CENTRE

The projects and cards are but a few of the many possible directions such a Metric Interest Centre could take. The basic units, the system and applications have been stressed; review games have not but are easy to develop.

M	E	T	R	I
100 cm	10 g	30 m	250 ml	1 dm^3
0.2 mm	2 kg	5.54 m	6 ℓ	600 cm^3
150 km	350 mg	ST FREE	3 kl	0.01 m^3
10 dam	0.3 kg	382 cm	170 ml	1 m^2
1 000 m	110 g	12 dm	0.85 ℓ	10 000 cm^2

In the game METRI, a call of "under T, 1.2 m" would be marked as shown. Games such as this are useful in stressing within unit conversions the abbreviation system and the prefix system.

In developing other projects on cards, a good source is your imagination and that of your colleagues. But, as mentioned earlier, there is a wealth of material available. A major task is to take a piece of material - for example the Metric Commission's "Metric Conversion in Agriculture," - and transform it into a project. This could be done by attaching a 5 x 8 card with student directions on it. For example -

Card Agr.

Read "Metric Conversion in Agriculture."

What is the area of your farm in hectares ? _____
How many hectares of wheat did Canada plant last year? _____
What is the mass in kilograms of your largest beef animal? _____

Another important source of cards and projects is the students themselves. They could be required to contribute at least two cards a year to the Centre. This would be a source of over 300 potential cards for the average junior high teacher.

There are many ways to use a MIC in your teaching. Organizing your classes into small groups and assigning them to complete a certain set of projects or cards could well form the basis for a unit on the SI. A better use would be to spread these assignments over the course of a semester or year, allowing sufficient student time to simply grow in familiarity with the system. An even more open use would simply require each student to complete a report on a contracted number of cards or projects of the student's choice over the course of a year or semester.

However you choose to use such a centre, the idea is to provide a junior high student with the time and experience base for SI learning and the motivational impetus to do something with it.