METRIC KNOWLEDGE OF A SELECTED POPULATION OF STUDENTS ENROLLED IN HOME ECONOMICS CLASSES

by

Jan T. Collins

AN ABSTRACT

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of Master of
Science in Nutrition and Food Science at
University of Wisconsin-Stevens Point,
Stevens Point, Wisconsin

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The purpose of this study was to evaluate the metric knowledge of students enrolled in on-campus home economics classes at the University of Wisconsin-Stevens Point. The historical background of the metric controversy in the United States was also investigated along with the implementation of metrics in the food area. The metric questionnaire which was formulated was administered to 447 students. The hypothesis developed which was tested statistically was that there is no significant difference in the working knowledge of the metric system between categories of students enrolled in home economics classes at the University of Wisconsin-Stevens Point. These categories being age in years, academic major and year in college. Using F-ratio tests, it was proven that there was no significant difference in the working knowledge of the metric system of students and (a) age group, and (b) year in college. A significant difference was proven to exist in the working metric knowledge of the sample and academic majors.

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Approved by Grace Hendel Date 12/17/75

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CHAPTER I

INTRODUCTION

The United States is rapidly becoming a metric nation. Industry, education, business, and government are all studying the issue of metrication to learn how they can prepare for it. For the consumer, it will be necessary to understand metrics, since clothing, gasoline, food, and other products will be sold in metric units. A "metric America" will become a reality. An informed public is essential if this is to happen efficiently and with the least possible cost.

Weights and measures were some of the first tools invented by humans. Early civilization needed simple measures for many tasks, such as, constructing dwellings, making clothing, and trading food and raw materials. Parts of the body and natural surroundings were first used by people as measuring instruments. But as civilizations progressed, weights and measures became more complex. It became necessary not only to weigh and measure more complex things, but also to do so accurately and repeatedly all over the world. Each country invented its own measuring system, but gradually these systems became more standardized as nations began to trade with one another. The need for a single, worldwide, coordinated measurement system was recognized over 300 years ago.(6)

One of the first responsibilities of the federal legislature two centuries ago was to set the standards of weights and measurements for the United States. As our country approaches its bi-centennial, the controversy surrounding the conversion to the metric system is still prevelant in our land. This controversy has continued from the term of President Washington to the present time, with the debate still going on.

Since this issue is vital to our country and will affect all Americans, the purpose of this study was to investigate the controversy around a "metric America", the implications of a conversion to the metric system in the food area, and to evaluate the working knowledge of the metric system of University of Wisconsin-Stevens Point students enrolled in home economics classes.

Objectives to be accomplished in this study were:

1. To investigate the historical background of the controversy of the implementation of the metric system in the United States.

2. To investigate the implications of a conversion to the metric system in the food area in the United States.

3. To formulate an instrument to test the working knowledge of the metric system in the sample population.

4. To evaluate the working knowledge of the metric system of students enrolled in home economic classes at the University of Wisconsin-Stevens Point based on age, academic major, and year in college.

In undertaking this study of the metric system, one basic assumption was made: that the faculty and students will be willing to participate in the administration and completion of the survey forms.

The hypothesis developed which was to be tested statistically is as follows:

There is no significant difference in the working knowledge of the metric system between categories of students enrolled in home economics classes at the University of Wisconsin-Stevens Point. These categories were age in years, academic major and year in college.

CHAPTER II

REVIEW OF LITERATURE

"Weights and measures may be ranked among the necessaries of life to every individual of human society. They enter into the economical arrangements and daily concerns of every family."[1] One hundred and fifty years ago John Quincy Adams wrote an eloquent and comprehensive report for the Congress, which contained this quotation. His report dealt with the metric question and the modernization of our measurement system. Still today this question remains unsettled.(14)

Although each chapter of the history of the efforts to convert the United States to the metric system has ended with the words, "but no action was taken by Congress," there are strong indications that the last chapter is about to be written. Metrication is indeed "a decision whose time has come" for America.(5)

Customary System

Our customary system of measurement is part of our cultural heritage from the days when the thirteen Colonies were under British rule. The system is a confusing maze of ancient units based largely on the human body, but every body

[1]U.S. Department of Commerce. National Bureau of Standards Special Publication 345. A Metric America:A Decision Whose Time Has Come. July 1971, p. vi.

was different resulting in conflicting measures. It is a hodge-podge of Anglo-Saxon, Roman and Norman-French weights and measures. Since medieval times, commissions appointed by various English monarchs had reduced the chaos of measurement by setting specific standards for some of the most important units. For instance, early records indicate that an inch was defined as the length of three barleycorns, round and dry when laid together.(14) The foot was derived from the Romans who divided it into 12 units which were called inches. Legend tells us that an English king decreed that a yard should be the distance from the tip of the nose to the end of the thumb.

In the 16th Century a pound was established as the weight of 7,200 grains. The bushel was then added, confusing the matter further, as bushels containing different items did not all weigh the same.

The U.S. gallon is the British wine gallon, standardized at the beginning of the 18th Century. England in 1824, however, replaced this measure with the Imperial gallon, which is about 20 percent smaller than the current U.S. gallon which is now the standard measure of liquids.

Retaining our present mixture of unrelated units complicates our every act of weighing and measuring. "The relationship among length measures is inconsistent: 12 inches equal 1 foot; 3 feet equal 1 yard; 5 1/2 yards equal 1 rod; 320 rods equal 1 mile. The relationship among volume measure is equally inconsistent: 3 teaspoons equal 1 tablespoon; 16

tablespoons equal 1 cup; 4 cups equal 1 quart."[2]

In short, the customary system was a makeshift one based largely on folkways.

Origin and Development of the Metric System

By the late middle ages a complex assortment of measuring systems had been in use throughout all of Europe. Factors that influenced this diversity were intense provincialism, the pressure of tradition, and the custom to give measurements in units unique to the object to be measured. Land measured in rods, a horse's height in hands, diamonds in carats, are but a few examples. The status of trade and technology was such that society could function even with all these variations. But with the advent of scientific advances in the seventeenth and eighteenth centuries, the need for change became evident. The need for a single, worldwide, coordinated measurement system for communicating the results of research and study became apparent.(5)

The final impetus for a universal measurement system came at the time of the French Revolution. The principal result was a political conversion from a monarchy to a republic, but changes were not confined to politics. When reminders of the feudal system were being discarded, the opportunity that French scientists had long awaited for came: "to create an entirely new, rational system of weights and measures to

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[2]Batcher, Olive M., and Young, Louise A.: Metrication and the Home Economist. J. Home Econ. February 1974, p. 29.

replace the arbitrary and illogical units of the old system."[3] In 1790 a bill was passed by the French National Assembly authorizing the Academy of Sciences to develop a new system of weights and measures. The result was the metric system.

The unit of length was to be a portion of the earth's circumference. Measures for capacity/volume and mass/weight were to be based upon the unit of length, thus relating the basic units of the system to each other. Furthermore, the larger and smaller versions of each unit were to be created by multiplying or dividing the base units by 10 and its multiples. This made the system convenient to use by eliminating the need for calculations such as division by 16 to convert ounces to pounds or by 12 to convert inches to feet. Similar calculations in the metric system could be performed simply by shifting the decimal point. Thus, the metric system is a "base-10" or decimal system.(16)

The basic linear unit was called a meter, from the Greek metron, a measure. The physical standard for the meter was to be equal to one ten-millionth of the distance from the North Pole to the equator, measured along a line running through Paris, France. Modern science has made a more accurate standard of the meter defining it in terms of light wave lengths given off by the krypton-86 atom.(6)

The metric unit of mass, the gram, was defined as the mass or weight of one cubic centimeter of water at a certain

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[3]Donovan, Frank: <u>Let's Go Metric</u>. N.Y.: Weybright & Talley, 1974, p. 23.

temperature. The metric measure of fluid volume or capacity, the liter, was based on the cubic decimeter. A liter of water now weighs one kilogram.

This system was then submitted to the French National Assembly in 1795,and an act was passed creating the metric system as the only official system of weights and measures of France. The French Academy constructed the standard of length, the meter, and the weight, the kilogram. These were then deposited in the government archives in 1799 and the metric system became the only legal system of weights and measures of France.

The International Bureau of Weights and Measures, established in 1870, serves as a permanent secretary for the Metric Convention. As more accurate ways of defining the measurement units were developed, the General Conference of Weights and Measures, the organization made up of members of the Convention, meets to vote on improvements in the system and the standards.(6)

In 1960, the General Conference adopted a more modern metric system. The name Systeme International d'Unites (International System of Units), with the international abbreviation SI, was adopted for this modernized metric system. It is built upon a foundation of seven base units. These units are meter (length), kilogram (mass), second (time), kelvin (temperature), ampere (electric current), mole (amount of substance), and candela (luminous intensity). Further improvements in SI were made in 1964, 1968, and 1971.(6)

Currently almost every country of any significance in the world is either metric or in the process of converting to the metric system. The nonuse of metric units and engineering standards is an obvious hindrance overseas to the acceptance of United States products that are "measurement sensitive". Those countries not already officially changing to metric are Brunei, Burma, Liberia, Yemen and the United States.(7)

<u>History of the Metric System Controversy in the U.S.</u>

One of the first responsibilities of the federal legislature two centuries ago was to set the standards of weights and measurements for the United States.

"In his first message in 1790, President Washington reminded Congress that it was time to set our own standards of weights and measures. The matter was referred to Secretary of State Thomas Jefferson...."[4] Jefferson came up with two proposals, one of which was a decimal system based on the swing of a pendulum. However, neither plan was adopted even though Washington continued to push standardization.

In 1816, President James Madison reminded Congress of the lack of standardization of weights and measures. The matter was turned over to John Quincy Adams. Adams, who submitted his first report in 1821, was the first to consider the metric system, but it was only one of four possibilities which he presented. Adams suggested that we adopt the English Units and later to set up a uniform standard jointly

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[4]U.S. Department of Commerce. <u>A Metric America</u>, p. 8.

with France, Britain, and Spain.

In addition to the influence of John Quincy Adams' report on the arguments used in constructing pro-metric and anti-metric cases in later years, the document had other significance. First, it represents the first serious and thorough consideration of the possibility of the United States adoption of the metric system. A second point is that the majority of Adams' doubts about the practicability of the system stem from the fact that the system had been "altered" by Napoleon in 1812.(15)

Adams' recommendations were also made in the context of the existing situation in the United States. It was also to stand as the only comprehensive study of United States weights and measure laws for many years to come. His survey disclosed: (1) that most of the States had already provided for use of the English system by law; and (2) that the lack of suitable standards and official definitions for weights and measures indicated what action was most needed.(15)

In addition, he stressed international harmony of measurement. The preponderance of American trade at that time was still with Britain, and the United States was bounded on one side by British Canada and on the other by Spanish possessions. He therefore deemed it wise to consult both Britain and Spain before making any such radical change as adopting the metric system.(14) Congress took no action in response to the Adams' report.

Until the metric question was reconsidered some 40 years after Adams' report, the United States industrial society took form and grew large. A brief flurry of interest in the metric system, coinciding with its rapid spread from France to other nations, was cut short by the Civil War.

The legalization of the metric system by the United States was hastened by two international conferences in 1863 and by two Congressional moves in 1963-4. On the international scene, a postal congress and an international statistical congress adopted resolutions which further secured the position of the metric system as the internationally preferred system of measurement.(15)

By an Act of Congress in 1863 the National Academy of Sciences was founded to advise the government on all technical matters. The first committee established by the Academy was that on Weights, Measures, and Coinage. Although this committee did not complete their work before being replaced by a permanent committee in 1866, they got to the heart of the matter very quickly. They were "strongly in favor of the adoption of the French metrical system, but more strongly...in favor of...a universal system of weights, measures, and coins, available for the general acceptance of all nations."[5]

On January 21, 1864, the House of Representatives adopted a resolution creating a new standing committee, the Committee on a Uniform System of Coinage, Weights, and

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[5]U.S. Department of Commerce. National Bureau of Standards Special Publication 345-10. U.S. Metric Study Interim Report:A History of the Metric System Controversy in the United States. July 1971, p. 40.

Measures. The committee was headed by John A. Kasson.(15)

In 1866 the Kasson Committee (14) reported favorably on three metric bills that were eventually passed by Congress. The most important was legalizing the use of metric weights and measures, and it also specified English system equivalents of metric weights and measures. One of the other bills directed the Postmaster General to distribute metric postal scales to all post offices exchanging mail with foreign countries; the other directed the Secretary of the Treasury to furnish each state with one set of metric standards.

Kasson made clear the intentions of his committee. The metric system was not being made compulsory. Rather, Congress was to permit the use of metric, while stimulating interest in reform. And this was to remain the goal of metric advocates for several more decades.(14)

In 1873 the American Metrological Society was founded and headed by Frederick A. P. Barnard. In addition to its interest in advancing the metric system, the Society was concerned with internationally uniform coinage, standardized time zones, and several other reforms. Because of the groups diversified interests, the American Metric Bureau was founded in 1976. Even though it only remained active for a few years, its most ambitious project was the purchase of metric hardware, such as, scales, rulers, and capacity measures, for resale to educational institutions. After Barnard's death in 1889, the Bureau's influence dwindled rapidly.(14)

The American Metrological Society and the American Metric Bureau did, however, manage to spark some interest in

Measurement. Between 1877 and 1886, Congress considered several pieces of legislation dealing with increased use of the metric system. For the most part, the bills proposed were along the lines advocated by the Metrological Society and were designed to effect the partial adoption of the metric system by the U. S. Government, especially in its international dealings.(14)

In 1875 the United States, along with sixteen other nations, signed the Treaty of the Meter. It accomplished several objectives. It reformulated the metric system and refined the accuracy of its standards. It provided for the construction of new measurement standards and distirbution of accurate copies to participating countries. It established permanent machinery for further international action on weights and measures. And it set up a world repository and laboratory, the International Bureau of Weights and Measures near Paris.(14)

After the new measurement standards were finished in 1889, the Secretary of the Treasury declared the new metric standards to be the nation's "fundamental standards" of length and mass. Thus, the United States became an officially metric nation. Other customary units are defined as fractions of the standard metric units.(14)

In the Treaty of the Meter, the United States had joined with every other major nation in the world in endorsing the metric system as the internationally preferred system of weights and measures and through which measurements are made internationally compatible at the highest level of accuracy.(14)

Between 1866 to 1890, a major legislative push to secure adoption of the metric system in the United States had come and gone. Through the efforts of Barnard, two pro-metric interest groups had been formed and carried on the fight to bring about metrological reform in the interests of international uniformity. But with this came the appearance of an active anti-metric organization which succeeded in casting unfavorable light on the conversion to the metric system. It also prevented any attempts to pass legislation on the proposed reforms of weights and measurements since the metric system was not based on Anglo-Saxon weights and measures.(15)

One of the most significant events in the entire history of the metric system in the United States occurred in 1896. In that year Congress came within a hair of approving a measure to adopt the metric system, first for government affairs and later for the nation as a whole. Although the House of Representatives first granted and then immediately rescinded its approval of the bill, supporters of the metric system were aroused to further efforts and became even more convinced that the success they had worked so long to attain was near at hand. But the bill was sent back to committee, and there it died.(14)

Over the next ten years, more than a dozen bills dealing with the metric system were proposed and many were defeated. Support for the metric system continued to come from scientists, educators, and some government officials. Members of the Committee on Coinage, Weights and Measures kept the subject alive in Congress.(14)

Until about 1900 America's involvement with science had been principally on an individual basis. Many foresaw that the nation was not prepared to fully meet the technical needs of a new industrial world. The country especially lacked a central institution responsible for measurement standards, precision instrument development, and materials research. Following the example of other countries, a new governmental institution was created that would be "a complete laboratory, fitted for undertaking the most refined measurements known to modern science."[6] The National Bureau of Standards, NBS, was established on July 1, 1901. The history of the metric system in the United States has been linked to the NBS by the very act of its creation.(15)

Most of the metric legislation proposed between 1896 and 1907 would have required the Government to adopt the metric system first, with the rest of the country following within a few years. At first, the pro-metric factions had the momentum, but the tide turned about 1902, when Halsey and Dale managed to stir up such an outcry from a few manufacturers and influential engineers that further proposals were bottled up in a committee. They were, in fact, so successful that advocates gave up trying and decided to wait

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[6]U.S. Department of Commerce. History of Metric System Controversy in the U.S., p. 115.

for a more opportune time.(14)

The next phase of the metric controversy, which began before the United States became involved in World War I and lasted until the Great Depression set in, took place mostly outside Congress. From 1914 to 1933, the nation experienced what has been called the "Great Metric Crusade." Public debate and campaigns reached their highest level on both sides. But again, nothing of significance emerged from Congress. The anti-metric forces continued with additional backing from the American Institute of Weights and Measures.(15)

With financial and political backing from a large portion of the nation's major manufacturers and manufacturing associations, the Institute was able to overwhelm each pro-metric proposal with organized protests and adverse publicity. It published its own journals, bulletins, and pamphlets, plus having the support of some leading professional and trade journals.

In the face of a continuing barrage of opinion, two newly-founded, pro-metric organizations began speaking out. The only one which still remains today was established in 1919, the American Metric Association. It drew most of its support from groups that were pro-metric in the past. A few companies were also represented, but did not have the pull as those in the anti-metric groups did.(14)

In the post-war, pre-depression years, only two Congressional hearings were held on the subject, although forty bills were introduced. Then, with the onset of the prolonged financial crisis, the metric question was shoved into the background. When times got better, the United States was in an isolationist mood and not disposed to considering a change to the metric system, although the time would come when metric advocates would propose a crash metric changeover as a tonic for a sluggish economy.(14)

In fact, the metric controversy remained dormant for almost three decades. The nation was too busy to consider the question during World War II, and at its end, the United States so dominated the world's production and exchange of foods that there seemed to be no need for a change.(14)

With the launching of the Soviet Union's first Sputnik satellite in 1957, America's attention was suddenly focused on science and technology. In that same year a U. S. Army regulation established the metric system as the basis for weaponry and related equipment. A committee of the Organization of American States proposed that the metric system be adopted throughout the Western Hemisphere. The following year the major nations still using the Customary system, including the United States and Britain, agreed to use the same metric equivalents to define their inch-pound units.(14)

In 1960, the metric system was itself refined by a General Conference of Weights and Measures. Although the metric system had been the common measurement language of the 43 nations that adhered to the Treaty of the Meter, like other languages, it was spoken in various dialects. Prior to 1960 there were subtle differences in the use of metric; none caused confusion in everyday use, but where the highest levels of scientific and engineering precision were required, the metric system was not really standard and there was room for misunderstanding and error.(14)

The General Conference of Weights and Measures cleared these differences by agreeing on a standard metric system. The result was the International Metric System, known as, International System of Units, or SI.

Congress still did not feel an urgence to convert to metrics. However, on May 24, 1965, the President of the British Board of Trade announced in Parliament the United Kingdom's intention to adopt the metric system over the course of the next ten years. Britain's action made it clear that the United States would soon be one of the very few nations that still adhered to the customary system of measurement. An acceptable bill was drafted by the U. S. Congress which became Public Law 90-472, the Metric Study Act, and was signed into law in 1968.(14)

<u>Public Law 90-472, The Metric Study Act</u>

The congressional debate leading to the passage of Public Law 90-472, the Metric Study Act, reflected a far more practical understanding of the nature of the metric problem than did earlier and more turbulent congressional debates on the subject. Many times in the last hundred years passions had been inflamed on both sides of this issue, and rarely did the debate rise above a purely emotional level. This time the Congress did not request a plam for conversion to metric usage. Instead the Congress asked the Department of Commerce to "determine the impact of increasing worldwide use of the metric system on the United States."[7] They were to also consider "the desirability and practicability of increasing use of metric weights and measures and to study the feasibility of retaining and promoting...engineering standards based on the customary measurement units...."[8] Finally they were to "evaluate the costs and benefits of alternative courses of action which may be feasible for the United States."[9]

The law also required that special attention be given to the "advantages, disadvantages and problems associated with the possible changes in either the system of measurement units or the related dimensional and engineering standards currently in use in the United States."[10]

The final U. S. Metric Study report was published in July, 1971. The Secretary of Commerce summed up the recommendations;

> That the United States change to the International Metric System deliberately and carefully; that this be done through a coordinated national program; that the Congress assign the responsibility for guiding the change...to a central coordinating body responsive to all sectors of our society...;that early priority be given to educating every American school child and the public at large to think in metric terms; that immediate steps be taken by the Congress to foster U.S. participation in international standards activities; that in order to encourage efficiency and minimize the overall costs to society, the general rule should be that any changeover costs shall "lie where they fall"; that the Congress...establish a target date ten years

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[7]Branscomb, Lewis M.: The U.S. Metric Study. Sci. Teach. 38: 59, 1971.

[8]Ibid.

[9]Ibid.

[10]Ibid.

ahead, by which time the U.S. will have become predominantly, though not exclusively, metric; that there be a firm government commitment to this goal.[11]

Current Metric Legislation

The most current legislative action took place on September 5, 1975, when the House of Representatives approved metric legislation by a vote of 300 to 63. The legislation, H.R. 8674, was a bill to declare a national policy of converting to the metric system in the United States, and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system. This legislation then moved to the Senate for consideration. The Senate Commerce Committee has indicated it may wish to hold brief hearings. Favorable action in the Senate is considered likely by the end of 1975.(7)

Now after centuries of debate, the United States is on its way to becoming a unified metric nation for the first time.

Implications in the Food Area

Amid early signs that many Americans will resist changing pounds to kilograms, quarts to liters and miles to kilometers, the federal government is about to commit the United States to going metric. The United States is dedicated to a position of world leadership. It cannot maintain this position and stand alone clinging to a measuring system built upon the length of barley corns and the girdles of

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[11]Stover, Allan C.: You and the Metric System. N.Y.: Dodd, Mead & Co., 1974, p. 36-7.

Saxon kings.

With the changeover the consumer will be the last to feel the impact of the metric system, and the home economist will need to be ready to help consumers make the change smoothly and easily.

When talking about going metric, one really has to consider two kinds of changes, "soft" and "hard". A soft change, for example, occurs when the weather announcer begins reporting the temperature in degrees Celsius instead of degrees Fahrenheit. For the consumer the change over is mainly a "soft" or mental change. One problem source is the natural tendency of resisting change, especially since the customary system of measurement is so engrained in the United States population, and the need to switch to the metric system is not apparent. Therefore, a well defined program for the conversion of systems is necessary so that people will begin to "think metric, not conversion".(14)

"Hard" changes involve altering size, weights, and other dimensions of physical objects. An example of a hard change would be if the dairy industry starts selling milk by the liter. The milk distributor has to modify his machinery to fill a slightly larger container. At some point consumers will be faced with a hardware change, but it is almost always preceded by a soft change.(14)

Metric Terms

The use of metric terms will be the "soft" change that will affect consumers first.

The metric system is a base-10 or decimal system of weights and measures. Our currency is an example of the base-10 or decimal system. Most Americans will have to learn only one base unit each for length (the meter), mass or weight (the gram), capacity or volume (the liter), and temperature (°Celsius). Another term, the joule, will be discussed later. One will also need to learn three prefixes that will affect one in every day living: milli- (0.001 or 1/1000), centi- (0.01 or 1/100). and kilo- (1,000 times). Seldom used prefixes are deka- (10 times), deci- (0.1 or 1/10), and hecto- (100 times). Therefore, to convert the units from one size to another it is simply a matter of moving the decimal point. An example would be 4,590 millimeters = 459 centimeters = 4.59 meters = 0.00459 kilometers.(2)

With a very few exceptions, all the symbols for metric units are not capitalized or are not followed by a period. The symbols for the base units are meter (m), gram (g), liter (ℓ), and temperature (°C). The correct symbol for the liter is a script letter not a printed letter. The various prefixes' symbols are milli- (m-), centi- (c-), kilo- (k-), deka- (dam-), deci- (d-), and hecto- (h-). The above example can also be written as 4,590 mm = 459 cm = 4.59 m = 0.00459 km.

The units that Americans will soon be using everyday are: the millimeter, centimeter, meter, and kilometer for describing length and distance; the milliliter and liter for capacity or volume; the gram, kilogram, and tonne for weight; the kilometer per hour for highway speed; and the degree Celsius for temperature.(13)

One advantage that would be realized with this change in terminology is that liter will replace fluid ounce, pint, quart, and gallon, and gram will be used in place of pound and ounce. The confusion that exists between the ounce and fluid ounce, and the liquid and dry pint or quart would be eliminated. (8)

Food Packaging and Labeling

The metric system has already inched itself onto the supermarket shelves. Many items are already being labeled in metric as well as in customary measures. Volume measures are given in milliliters and fluid ounces, weights in grams and pounds/ounces. According to U. S. Department of Commerce figures, in 1960 only pound and ounce measures were used on food packages. By 1970, half of the packages showed dual measurements, ounces, grams, and liters. This evidenced the growing use of the metric system by the food industry. It is estimated that the percentage has increased even more since 1970. (6)

Eventually, only metric measures will be given on packages. Milk will be sold in one liter containers instead of quarts. A 500 gram package will replace the current pound package of butter. Fresh foods such as meat and produce will be weighed in grams and kilograms.

Since standard measures in the metric system are slightly larger than in the customary system, most container sizes will be changed to the metric size. Because the metric containers will hold a larger quantity than the customary size, prices will be correspondingly higher. (6)

Metrication should help standardize food packaging and eliminate the confusing number of sizes. It will also be useful in comparison shopping, since determining unit prices will be easier.(9)

Nutrition labeling utilizes the metric system by stating various nutrients in gram and milligram units. The Food and Drug Administration decided to use the metric system on nutrition labels because the ounce is too large a measuring unit to describe the amounts of nutrients in a serving of food.

However, consumers need to understand metric weights in order to make good use of nutriiton labeling. For instance, consumers can use the labels to help them plan more nutritious meals, but they need to relate the gram content of the nutrients shown on the label to the total grams needed for a day. They can buy better nutrition for the money they spend by comparing the nutrients on different brand labels with the price of the items. By evaluating the labels, they can find foods which are especially good sources of certain nutrients they may want. Nutrition labeling is a valuable service to consumers, but only if they understand it and use it.(6)

Non-food items that will be affected by a change to metrication include wrapping materials such as waxed paper and foil. These will be measured in meters, decimeters and centimeters rather than yards, feet and inches.(9)

Metrics in the Kitchen

Metrication in food preparation has concerned many home economists and consumers. It will not mean throwing out old recipes, cookbooks, or utensils, but it will mean some adjustments.(2)

Before changes in food preparation can be made, some metric measuring device standards need to be developed. The American Standards Association has the responsibility for developing these.(10) A subcommittee has been working on these standards and has made recommendations using the liter, the basic metric unit for capacity or volume as a starting point.

For liquid ingredients, recommendations indicate measures shall be one liter (1,000 milliliters), 500 milliliters, and 250 milliliters with the capacity mark near the top but below the pouring lip. Graduations and markings for the 250 milliliters measure, the substitute for the present day standard measuring cup, will be in units of 25 milliliters; for the 500 and 1,000 milliliter measures, in units of 50 milliliters.(10)

For dry ingredients the measures shall be in 500 ml, 250 ml, 125 ml and 50 ml. The capacity shall be to the top levle.(10)

A set of small household measures shall consist of a minimum of five individual measures in the following capacities: 25 ml, 15 ml, 5 ml, 2 ml, 1 ml when leveled with a straight edge of a knife or spatula.(10)

In order that one does not confuse the present day customary measures with the new metric measures it is recommended that the words <u>cup</u> and <u>spoon</u> <u>not</u> <u>be</u> <u>used</u>. The terms one-half, one-fourth, one-third will not be used since it is desirable that one follow the units of ten (decimal) system as much as possible. The term mils, shortened form for milliliters, will be used. Canada has approved this system and people there find the use of the term mils very easy to adjust to.(10)

The basic recommendation is that one uses present day measures with existing recipes and when the standards are approved and new standard measures are available, use them with newly developed metric recipes.(10)

Since there is not a great deal of difference in the present day standard cup, 237 ml, and the new 250 ml measure, a difference of less than one tablespoon, the two could be confused if both were called cups. The present day tablespoon contains 14.8 ml and the teaspoon 4.7 ml, so there would not be that much difference between these measures and the current recommended small household measures. For many present-day recipes, one could probably use these recommended metric measures, but for critical recipes such as souffles and rich white cakes the product may not be as good a product as when using measures which were used in developing the recipe. For these types of critical recipes, new metric recipes will need to be developed.(10)

Thus, in cooking, consumers can continue to measure ingredients by volume for recipes. However, the metric cup measures will be in liters and milliliters instead of ounces.

Pan sizes will probably be stated in millimeters. In soft conversion the 8-inch round or square pan will be refered to as a 203 mm round or square pan and the 13 x 9-inch oblong pan will be called a 330 mm x 229 pan. Once metrication is completed, the numbers will probably be rounded out to more convenient figures, with corresponding changes in pan sizes. This would be the hard conversion.(6)

Besides volume and mass, adjustments in temperature will be required. The dial or temperature scale of an oven will need to be replaced or dual marked with Celsius or Fahrenheit units. Water will freeze at 0°C and boil at 100°C. A cake will bake at 180°C.

For counting calories, consumers will be counting kilojoules (kJ) instead of calories. The joule is the unit of energy in the metric system and will, therefore, replace calories when the metric system is adopted. It is one of the derived units in the metric system or Systemes International, SI. The joule is the basis for energy measurements in all branches of science on which nutritional science depends and is defined in terms of the basic units of mass, length, and time.(1) It is both a measure of mechanical energy and heat. One kilocalorie is equivalent to 4,180 kilojoules, or 1 calorie to 4.180 joules.(17)

The equivalents for the energy producing nutrients are:

1 g carbohydrate	provides 4 calories or 17 joules.
1 g protein	provides 4 calories or 17 joules.
1 g fat	provides 9 calories or 38 joules.(17)

The following are examples of energy allowances(17):

Body Weight kg	Women kcal	Women kjoules	Men kcal	Men kjoules
40	1,550	6,500		
50	1,800	7,500	2,200	9,200
60	2,000	8,400	2,500	10,500
70	2,220	9,200	2,800	11,700
80			3,050	12,800

It is being proposed that the transition be gradual and that initially publications start using both terms and then gradually using only joules.

Metrics in Food Service

In many foreign countries, recipe ingredients are often measured by weight, not by volume. While consumers in the United States do not use this method, it is an accepted practice in food service, where measuring mistakes can mean lower profits or even a loss. Since weighing ingredients is the most accurate way of measuring, many commercial restaurants and instituion kitchens prefer this method in food service.(6)

In 1968, the Department of Dietetics and Nutrition at the University of Kansas Medical Center started to convert food preparation to the metric system. Conversion was accomplished through mathematical computation of recipes, changeover to metric equipment and utensils, and training employees to use the converted recipes and metric measuring devices. Initially, the smallest quantity listed on the recipe was prepared and the product compared with one produced with the customary system. Since the products were comparable, the testing phase was eliminated and products were prepared to meet menu needs.(11)

Stages of Change

When the metric system finally becomes the official system of weights and measures for the United States, home economists will need to know and teach it to others. Since there is a difference between being familiar with a system and being able to use it for everything without translating, the goal is to think in metric terms rather than in the customary system.

Researchers in sociology at Iowa State University found that people advance through five stages before they can use a new product or system with ease of habit.(16) These stages are:

The first stage in learning to "think metric" begins when one hears that the United States will probably change over to the metric system in the near future; this is the awareness stage. An information-gathering stage follows awareness. During this stage the aware person begins to ask questions about the metric units, prefixes, advantages and disadvantages, etc. Next is the application stage. One begins to apply metric knowledge. Different objects are measured using metric dimensions and units. Gradually this practice leads to the next stage. During the trial stage use of the metric system is more and more frequent. One tends to forget the old measurement system in favor of the metric system. In the adoption stage one has begun to think in metric terms.(16)

Since the rest of the world is already geared to metric, the United States can scarcely hope to stand alone for long. The time to "think metric" has come to this country.

CHAPTER III

ORGANIZATION OF THE STUDY

Since it is inevitable that the metric system will someday become the official system of weights and measures for the United States, the pressure will be on all of us to learn and adapt to the new measurement system. Many groups, especially home economists, will find themselves in the positions of teaching it to others. The need will be to first become familiar with the system and then be able to use it in everyday life without translating back to our customary system. Since the goal is now to "think metric" rather than in the customary measurement system, this study was concerned with the working knowledge of the metric system of students enrolled in home economics classes at the University of Wisconsin-Stevens Point.

Design of the Study

A descriptive survey research technique was used to gather information concerning the working knowledge of the metric system from the chosen population sample of students currently enrolled in on-campus home economics classes at the University of Wisconsin-Stevens Point.

The variables that were given statistical treatment are as follows: (1) the independent variables were the age group, academic major, and the year in college, and (2) the dependent variable was the student's knowledge of the metric system.

Population Sample

The metric questionnaire that was developed was given to almost all students that were in attendance in home economic classes at the University of Wisconsin-Stevens Point during the two week period of October 27th thru November 7th of the fall semester of 1975. All of the home economics classes were surveyed with a few exceptions. The investigator was unable to administer the questionnaire form in three class sections due to individualized projects. Three seven-week block classes were also omitted because of the time period in which the questionnaire was presented. These classes were for students who would be student teaching the last part of the fall semester. Students in off-campus home economics classes were not included in the study.

Development of the Instrument

A questionnaire (Appendix A) was formulated to encompass the basic metric units, their prefixes and symbols, and conversions to and from metric measures. Additional items were included to gain necessary background information concerning the individual's age group, academic major, year in college and any previous metric instruction. Some written instructions for filling out the questionnaire were also included. A pilot test involved five University of Wisconsin-Stevens Point students who were not currently enrolled in any home economics classes. No changes in the questionnaire were made after the pilot test.

The instrument was administered by the investigator to each class with the same oral instructions to each section. This information reinforced the written instructions already on the form. A maximum of twenty minutes was allowed to complete the survey form. Answers were placed on an optican scanning computer answer sheet to aid in the tabulation and analysis of the data. Clearance to administer the survey was obtained from the dean of the School of Home Economics and from each individual professor.

Procedures for Analysis of Data

Upon completion of the survey, the answer sheets were taken to the Instructional Data Processing Center at the University of Wisconsin-Stevens Point. There the optican scanning answer sheets were punched to cards. An IBM 1130 computer was used for processing. The scoring program that was used was SABCA which was originally written at the University of Iowa and then adapted at the University of Wisconsin-Stevens Pont. An item analysis was first run on the total sample. The mean and standard deviation for the entire sample was determined along with the reliability of the test.

The scoring program was coded to include the following categories: age group, academic major, and year in college. The cards were sorted into the three categories and run on the SABCA program. The computer printout included cell means and standard deviations, degrees of freedom and f-ratios. An additional test scoring was used on selected matched questions to determine the ability of the sample population to apply metric conversion factors to practical application problems. (Appendix A-5) Conclusions were drawn from these results.

CHAPTER IV

RESULTS AND DISCUSSION

The responses obtained from the metric survey, which incorporated an understanding of the base measurement units of the metric system, their prefixes and symbols, conversion factors and practical applications, are presented as the dependent variable in this chapter. Also included are the independent variables, age, academic major, and year in college.

Population Sample

The sample size was 447 students enrolled in home economics classes at the University of Wisconsin-Stevens Point. An additional twenty-eight students had filled out the questionnaire form but these forms were not used in the study because of insufficient information on them.

A distribution of sampled students by age was made. There were 130 persons 19 years of age or under, 288 between 20 to 24 years of age, and 29 who were 25 years of age or older.

The distribution of students in the sample by academic majors is pressented in Table 1. This sample population corresponds closely to the actual percentage of majors in the various areas of study in the School of Home Economics.

Table 1. Distribution of Sample Population by Academic Majors, by Total Sample and Home Economics Only Sample

		Total Sample		Home Economics Only Sampled
Academic Majors		Number	Percentage	Percentage
Home Economics Education		117	26	30
Early Childhood Education (H.E.)		40	9	10
Food and Nutrition:				
Dietetics	82			
Experimental Foods	5			
Food Service Mgt.	10			
General	2			
Graduate	4			
Total		103	23	27
Home Economics in Business:				
Fashion Merchandising	58			
Housing and Interiors	56			
Communications	8			
Food and Equipment	4			
Total		126	28	33
Non-Home Economics Majors		61	14	
Total			100	100

In Table 2 the distribution of students in the sample by year in college is shown. Graduate students made up only 3 percent of the sample because only on-campus classes were used in the study.

Table 2. Distribution of Students in Sample by Year in College, by Number and Percentage

Year in College	Frequency	
	Number	Percentage
Freshmen	88	20
Sophmore	101	22
Junior	124	28
Senior	121	27
Graduate	13	3
Total	447	100

Metric Knowledge

Thirty-nine questions that sought an understanding of metric knowledge were included in the original questionnaire. One question was discarded due to a calculation error. The remaining thirty-eight questions were divided into five major groups of metric knowledge: base measurement units, prefixes, symbols, conversion factors and practical applications. (Appendix A-5)

The number of correct responses to questions on base measurement units, prefixes and symbols of the metric system by the students sampled is shown in Table 3. An understanding of the base measurement units and the symbols used in the metric system were each understood by about 80 percent of the students in the study. However, less than 50 percent of the students displayed an understanding of the prefixes. Since these three groups of knowledge are so very basic to an understanding and utilization of the metric system, knowledge of these areas, especially metric prefixes, needs to be stressed.

Table 3. Distribution of Correct Responses to Questions on Base Measurement Units, Prefixes and Symbols, By Number and Percentage

Description of Question	Correct Responses		
	Number	Percentage	
Base measurement units			
Length	436	98	
Mass/weight	420	94	
Capacity/volume	413	92	
Temperature scale	256	57	
Calorie	229	51	
Number base of system	367	82	
Mean			79
Prefixes			
deci-	198	44	
hecto-	136	30	
milli-	235	53	
mega-	145	32	
kilo-	262	59	
deka-	180	40	
centi-	203	45	
micro-	272	61	
Mean			46
Symbols			
kilometer	352	79	
centimeter	433	97	
millimeter	366	82	
gram	395	88	
milligram	396	89	
kilogram	263	59	
milliliter	407	91	
liter	241	54	
deciliter	393	88	
Mean			81

More important than knowledge of metric base measurement units and their prefixes and symbols is the knowledge of conversion factors and the ability to apply metric knowledge to practical applications. The sampled student's

Table 4. Distribution of Correct Responses to Questions on Conversion Factors and Practical Applications for the Metric System, by Number and Percentage

Description of Question	Correct Responses Number	Percentage
Conversion factors		
Meter to inches	309	69
Kilogram to pounds	238	53
Fluid ounces to milliliters	138	31
Mile to kilometers	252	56
Gallon to liters	98	22
Inch to centimeters	315	70
Mean		50
Practical applications		
Pound to gram	103	23
M.P.H. to kilometers	183	41
Inches to centimeters	158	35
Kilometer to mile	132	30
Meter to yard	271	61
Inches to centimeters	148	33
Inches to centimeters	202	45
Fluid ounce to liter	97	22
Temperature scale	136	30
Mean		36

ability to make this transfer of metric information is shown in Table 4. Only one-half of the students sampled were able to complete conversion factors between the metric and the customary systems of measurement. The ability to utilize these conversion factors on practical application problems was demonstrated by only 36 percent of the students sampled.

The inability of students to make this transfer of knowledge is further illustrated in Table 5. An analysis of sets of conversion factor questions and practical application questions was made of the five pairings of question sets. (Appendix A-5) The set testing the meter and yard knowledge

Table 5. Percentage Distribution of Responses for Conversion-Application Problem Sets

Conversion-Application Sets	Percentage		
	Neither	One	Both
Dual Sets			
Meter & yard	18		48
Meter(#26)		21	
Yard(#36)		13	
Kilogram & pound	40		17
Kilogram(#27)		37	
Pound(#32)		6	
Fluid ounces & milliliters	56		9
Fluid ounces(#28)		22	
Milliliters(#40)		13	
Mile & speed in kilometers	27		25
Mile(#29)		32	
Speed limit km.p.h.		16	

Quad Set	Neither	One	Two	Three	Four
Inches & centimeters	12				11
Inches(#31)					
Centimeters(#34)		29			
Centimeters(#37)			32		
Centimeters(#39)				16	

= Question number in questionnaire form (Appendix A)

showed that almost 50 percent of the sample population was able to both convert and apply the metric information. About one-fourth of the students could convert and apply the mile and speed in kilometers knowledge set, something not necessarily expected with a sample of home economics students. Only seventeen percent of the students could make the conversion-to-application transfer for the kilogram and pound set, a rather low figure for this sample population. The remaining two sets showed very low ability on the part of the students sampled to convert and apply metric knowledge.

When the conversion factor question was compared with its matching application question, the conversion factor had a higher percentage of correct responses than the application problem. This would indicate either an inability to transfer the necessary conversion factor to a practical application, or that the student did not know the answer and simply guessed. For the "quad" set, the ability to carry the conversion factor to all three application problems was demonstrated by only 11 percent of the sample. A breakdown of which questions were answered correctly for the remaining responses in the "quad" set was not available.

A question pertaining to any previous metric instruction or exposure had been included in the questionnaire form. Seventy-eight percent of the sample had indicated some type of previous contact with the metric system. The reliability of the questions used in the study was tested with a resulting reliability coefficient of 0.76, by Kuder-Richardson Formula.

Analysis of Categories Studied

The independent variables studied were broken into three categories: age, academic major, and year in college. F-ratio tests were used to determine if there was a significant differences of mean score on metric knowledge between students in these categories. The results are presented in

Table 6. Relationship of Mean Score on Metric Knowledge by Categories Studied

Categories	Mean Score (0-38 Score)	Significant Differences* Between Mean Score on Metric Knowledge
All categories	21.87	
Age groups		
19 years of age & under	21.35	
20 to 24 years of age	22.67	n.s.
25 years of age & older	20.10	
Academic Majors		
Home Economics Education	22.54	
Early Childhood Education (H.E.)	19.95	
Dietetics	25.15	
Experimental Foods	24.60	
Food Service Management	24.50	
General Food & Nutrition	19.00	$p<0.01$
Fashion Merchandising	20.72	
Housing & Interiors	19.46	
Communications	19.75	
Food & Equipment	30.75	
Non-Home Economics Majors	21.54	
Year in college		
Freshmen	21.38	
Sophmore	20.98	
Junior	22.45	n.s.
Senior	23.19	
Graduate	22.22	

*n.s. (non-significant) means $p>0.01$

Table 6.

There was no significant difference between the mean score on metric knowledge in two of the categories, age and year in college. However, there was a significant difference between mean score on metric knowledge and academic major, at $p<0.01$ level. In a more extensive study, a t-test would be used to determine which groups in this category are unequal in their knowledge of the metric system. Although this test was not used in this study, some general observations can be made.

The group that scored the highest out of all the majors was Food and Equipment. However, there were only four students in that major that were in the study. Dietetics, Experimental Foods and Food Service Management majors were the next highest scoring groups. Home Economics Education majors ranked fifth on the metric knowledge questionnaire. The need for this group to have metric knowledge is of special importance since they will be closely involved in consumer education for the understanding and use of the metric system. The five remaining majors scored below the mean for the total sample.

CHAPTER V

CONCLUSIONS

Since a "metric America" will soon become a reality, it will be necessary to begin to "think metric." With the impending changeover in measurement systems in the United States, the purpose of this study was to evaluate the metric knowledge of students enrolled in on-campus home economics classes at the University of Wisconsin-Stevens Point.

The following two objectives were accomplished through a review of literature. The historical background of the metric controversy in the United States was investigated. Implications of a metric changeover in the food industry were also discussed.

The metric questionnaire that was developed was administered to 447 students. The data that was collected was used to evaluate the metric knowledge between categories of students.

The hypothesis developed which was tested statistically was:

There is no significant difference in the working knowledge of the metric system between categories of students enrolled in home economics classes at the University of Wisconsin-Stevens Point, these being:

a) There is no significant difference in the working knowledge of the metric system of students sampled and age group.

b) There is no significant difference in the working knowledge of the metric system of students sampled and academic majors.

c) There is no significant difference in the working knowledge of the metric system of students sampled and year in college.

The hypothesis stating that (a) there is no significant difference in the working knowledge of the metric system of students sampled and age group was accepted as was the hypothesis (c) there is no significant difference in the working knowledge of the metric system of students sampled and year in college. One of the hypothesis, (b) there is no significant difference in the working knowledge of the metric system of students sampled and their academic majors, was rejected at a $p<0.01$ level of statistical significance; there was a difference in metric knowledge between students in different academic majors.

Results seem to indicate a need for futher education and understanding of all aspects of the metric system but especially in conversion factors and application. Although there is exposure to metrics in many food, clothing and education classes, this exposure could be made more extensive. The results of this study could be made available to all home economics teachers here at the University of Wisconsin-Stevens Point to indicate the need for more metric education and application situations.

With the high reliability of the questionnaire, it could possibly be used as a pre-post test for all students enrolled in home economics classes. With the use of social security numbers, information on this sample population could be kept and checked over a period of three to four years. Since home economicsts will be directly involved with consumer education in the metric system, it may even be necessary to move toward a proficiency test in metrics with students needing a certain score to graduate.

It now appears inevitable that the metric system will become the United States official system of weights and measures and it will be necessary for all Americans to learn and adapt to this system. The time has come for the United States to "think metric!"

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APPENDIX A

ARE YOU THINKING METRIC?

Please do not write on this sheet. Please place all answers on answer sheet only. Do NOT place your name or ID# on the answer sheet.

1. Indicate in which age group you are in.
   A. Under 19
   B. 20-24
   C. 25 & older

2. Indicate the type of instruction you have had in the use of the metric system.
   A. An entire class devoted to the metric system.
   B. as part of a class instruction, such as in a science or foods class
   C. through the media
   D. a combination of the above
   E. no instruction at all

3. The basic unit of metric length/distance is
   A. gram
   B. meter
   C. Calvin
   D. liter

4. The basic unit of metric weight is
   A. gram
   B. meter
   C. Calvin
   D. liter

5. The basic unit of metric capacity/volume is
   A. gram
   B. meter
   C. Calvin
   D. liter

6. The metric measure for temperature is
   A. Calvin
   B. Fahrenheit
   C. Centimeter
   D. Celsius

7. The metric unit which is equivalent to the calorie is the
   A. watt
   B. ampere
   C. joule
   D. coulomb

8. The metric system is based on the number
   A. 2
   B. 8
   C. 10
   D. 12

MATCH THE FOLLOWING METRIC PREFIXES TO ITS CORRECT EQUIVALENT:

9. deci-
10. hecto-
11. milli-

A. 10
B. 100
C. 1/10
D. 1/100
E. None of the above

---

12. mega-
13. kilo-
14. deka-

A. 1/1000
B. 10
C. 1,000
D. 1,000,000
E. None of the above

---

15. centi-
16. micro-

A. 100
B. 1,000
C. 1/1,000,000
D. 1/100
E. None of the above

MATCH THE FOLLOWING UNITS OF MEASURE WITH THEIR CORRECT SYMBOL:

17. kilometer
18. centimeter
19. millimeter

A. cm
B. Mm
C. Km
D. km
E. None of the above

---

20. gram
21. milligram
22. kilogram

A. Kg
B. mg
C. Mg
D. g
E. None of the above

---

23. milliliter
24. liter
25. deciliter

A. Ml
B. L
C. dl
D. ml
E. None of the above

COMPLETE THE FOLLOWING CONVERSIONS:

26. 1 meter =
   A. 28.2 inches
   B. 42.6 inches
   C. 39.4 inches
   D. 24.8 inches

27. 1 kilogram =
   A. 2.2 pounds
   B. 1.8 pounds
   C. 3.6 pounds
   D. 1.5 pounds

28. 8 fluid ounces =
    A. 310 milliliters
    B. 280 milliliters
    C. 160 milliliters
    D. 240 milliliters

29. 1 mile =
    A. 0.5 kilometers
    B. 1.1 kilometers
    C. 2.2 kilometers
    D. 1.6 kilometers

30. 1 gallon =
    A. 4.24 liters
    B. 3.76 liters
    C. 4.48 liters
    D. 3.25 liters

31. 1 inch =
    A. 25.4 centimeters
    B. 12.7 centimeters
    C. 2.54 centimeters
    D. 7.82 centimeters

COMPLETE THE FOLLOWING APPLICATIONS OF THE METRIC SYSTEM:

32. Butter may soon be sold in
    A. 50 gram packages
    B. 100 gram packages
    C. 250 gram packages
    D. 500 gram packages

33. A typical speed limit for city driving will be
    A. 45 kilometers per hour
    B. 85 kilometers per hour
    C. 60 kilometers per hour
    D. 25 kilometers per hour

34. 44/45 inch wide fabric will soon be sold in
    A. 90 centimeter widths
    B. 110 centimeter widths
    C. 130 centimeter widths
    D. 150 centimeter widths

35. A kilometer is approximately
    A. one & one-half miles
    B. one mile
    C. six tenths of a mile
    D. two miles

36. The difference between a meter and the customary yard is
    A. less than 3 inches
    B. 3 inches
    C. more than 3 inches
    D. No difference

37. A five-foot ten-inch man would measure
   A. 158 centimeters
   B. 146 centimeters
   C. 190 centimeters
   D. 178 centimeters

38. How many 2-ounce hamburger patties can you make from one kilogram of hamburger?
   A. 1
   B. 3
   C. 10
   D. 22

39. Once we are metric, Miss America contestants, instead of measuring 36-24-36 inches, will be
   A. 72-48-72 centimeters
   B. 91-61-91 centimeters
   C. 118-72-118 centimeters
   D. 130-94-130 centimeters

40. The difference between the metric cup and the customary one-cup measure is
   A. less than 1 T.
   B. 1 T.
   C. more than 1 T.
   D. No difference between the two

41. On the metric temperature scale, 25 degrees would be a good temperature for
   A. water skiing
   B. a cup of hot tea
   C. snow skiing
   D. a healthy human body

ACADEMIC CLASSIFICATION:

42. Indicate your year in school.
   A. Freshman
   B. Sophmore
   C. Junior
   D. Senior
   E. Other (Check E and also respond to specifics in number 46.)

43. Indicate your major.
   A. Home Ec Education
   B. Early Childhood Education H. E.
   C. Food & Nutrition (Also answer number 44)
   D. Home Ec in Business (Also answer number 45)
   E. Not a Home Economics major

44. Food & Nutrition majors please indicate specific area of study:
   A. Dietetics
   B. Experimental Foods
   C. Food Service Management
   D. General
   E. Graduate

45. Answer only if reponded to number 43 E.
   A. Graduate student
   B. Special student
   C. Other

45. Home Ec in Business majors please indicate specific area of study;
   A. Fashion Merchandising
   B. Housing & Interiors
   C. Communications
   D. Food & Equipment

Five Major Groups of Metric Knowledge

Base measurement units
3-8

Prefixes
9-16

Symbols
17-25

Conversion factors
26-31

Practical applications
32-41

Conversion-Application Problem Sets

Meter & yard
26 & # 36

Kilogram & pound
27 & # 32

Fluid ounce and milliliters
28 & # 40

Mile & speed limit in kilometers
29 & # 33

Inches & centimeters
31, # 34, 3 37 & # 39