The Development of Validated Metric Teaching Materials: Basics

Barbara Vanhove Hoff

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THE DEVELOPMENT OF VALIDATED METRIC TEACHING
MATERIALS: BASICS

BY
BARBARA VANHOVE HOFF

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Home Economics, South Dakota
State University

1975
THE DEVELOPMENT OF VALIDATED METRIC TEACHING MATERIALS: BASICS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirement for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

/Thesis Adviser

Head, Home Economics Department

Date
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Chapter 1

INTRODUCTION

The change from English to metric measurement in the United States is an issue of long standing. Since 1790 Congress has proposed many mandatory metric bills, but passage of these bills failed because of political and industrial pressures. In 1968 President Johnson signed a bill to study the feasibility of metric measurement in the United States. This study took three years to complete, and the committee recommendations were presented to Congress in 1971. Legislators were left no alternative but to seriously consider passage of a mandatory metric bill.

Learning about the metric system of measurement is receiving increased emphasis in today's society. The public is being exposed to basic metric terms in various media, the terms frequently being placed side by side with English measurements. Weather predictions may be given in degrees Celsius, canned goods weighed in grams, pattern measurements reported in centimeters and distance on road signs given in kilometers.

BACKGROUND FOR THE STUDY

Learning the metric measurements will not be a difficult problem for young children because the system is now used from the beginning in mathematic classes. It will be more of a problem for older consumers
who have had no opportunities in school to learn to use the metric system. It will also be a problem for upper level high school students who have been using English measurements all of their lives and feel it is not necessary to learn to use a second system.

People in industry are now developing metric teaching materials for their employees. To compete in international trade, it is necessary to use the system of measurement common to European and Asian countries.

In the spring of 1974 a small group of home economics graduate students at South Dakota State University became interested in meeting the needs of consumers to learn to use the metric system. Various group and individual teaching methods were explored such as multi-media materials for group use and several types of individualized materials. They also thought in terms of where adults would find it convenient to learn: in the home, in adult classes, through extension clubs or in informal groups. To fit the various learning situations, a variety of learning material might be needed.

Self-instructional programming was considered as one appropriate approach to individualized learning. Materials developed with this approach would be convenient for use in the home by individuals or by small groups who might wish to do some of the activities together.

Since the above mentioned graduate students had no preliminary experience in types of programming and principles used in this method of learning, a series of seminars was held Saturday mornings for a
semester. The students discussed a variety of techniques used in programming and had experience in frame writing. Students critiqued each other's efforts. A suitable method for the consumer to use to meet mastery level of basic metric measurements was desired. A first step in developing the desired new teaching materials, the present study was undertaken.

PURPOSE OF THE STUDY

The purpose of this study was to develop a "Basic Metric" self-instructional program for use by female adult consumers who wish to learn to use metric measurements. Such a study was not conceived as an experimental or descriptive type of research but rather as a creative project in which innovative teaching materials are developed. Although the creative element is of major importance, the use of programming required a scientific procedure for developing the teaching materials. The sequence of steps in programming is similar to the steps advocated by systems designers.

Field testing of teaching materials was a second purpose. Plans were made to secure data which would indicate the extent to which objectives of the self-instructional program had been met.
DEFINITIONS OF TERMS USED

The need for common definition of terms in this area is apparent. In cases where several terms have been used synonymously, the writer has defined the following technical terms.

**Criterion examination:** a test or examination given to the student at the completion of a program or during the development of the program to test how much the student has learned.

**Error rate:** average percentage of items of responses to program missed by subjects.

**Self-instructional program:** the sequence of carefully constructed frames leading the student to mastery of a subject with a minimum number of errors.

**Target population:** the population of persons for whom the program is prepared.

**Terminal behavior:** the behavior that a program is designed to produce.
Chapter 2

REVIEW OF LITERATURE

This review of literature will trace the history of the movement toward adoption of the metric system in the United States. It will include the origin of weights and measures, movement toward standardizing weights and measures, the origin of the metric system and the reasons for adoption of the metric system.

ORIGIN OF WEIGHTS AND MEASURES

When primitive men learned to speak and communicate, there was a need for a way of expressing quantities. Early man became a measuring man. He could only calculate in simple form and then communicate his findings to his fellow men.

Treat (1971) stated that ancient units of linear measurement were descriptive of what was to serve as standards and that the measurement system exhibited a naturally-ordered ratio between multiples and subdivisions.

The most important measuring unit was the basic unit of length. A wide variety of units was suggested by persons living in different geographical areas. During the Middle Ages European kings, queens and men of trade often referred to a part of the human body as one of the fixed units of length (Treat, 1971).

Kirsch (1973) described how arms, hands and fingers were used to
measure such items as cloth. There were several ways of measuring such as the distance between the fingertips of the two hands when the arms were outstretched. A measure half this distance was frequently used. This unit was secured by measuring from the tip of the nose to the fingertips of an outstretched arm. A smaller length called the "ell", the distance from fingertips to elbow, was also used.

According to Hallock and Wade (1906) other units of measurement used were the distance from the end of the thumb to the end of the little finger when the fingers were spread, finger length from tip to each joint and finger width.

When distance was to be measured, men would pace off the distance and count the number of times the right foot swung forward. This distance was reported as so many "paces". This resulted in the use of the "pace" as a unit of length. The Romans measured long distances as so many thousands of paces of a marching army. From this came our unit of length, a mile.

Rooms were measured by putting one foot before the other, heel to toe. The distance was reported as so many feet.

Kirsch (1973) stated that the rod was based on the total length of the shoeless right feet of the first sixteen men who came out of a church.

Treat (1971) traced the origin of the inch to the length of three barleycorns, round and dry, laid together. A penny-weight was the weight of thirty-two wheatcorns taken from the middle of the ear.
According to legends the foot used by the French was the length of Charlemagne's foot. The yard used today was supposed to have been the distance from the nose of King Henry I of England to the fingertips of his outstretched arm. Queen Anne's wine gallon established the measure for most liquids.

People found that when parts of the human body were used as measuring units, length varied because of differences in body size. A buyer might want it measured with long arms whereas the seller would obviously want it measured with short arms.

Confusion in units of weights and in techniques of measuring hindered trade and commerce among the colonies in America. It also hindered relationships between America and countries in Europe. People became easy prey for dishonest traders and swindlers.

Kirsch (1973) described the variations in many containers that became units of capacity. Goods were sold by the box, barrel, the bag, the basket or the bucket. There was no uniformity in sizes of these containers.

Scientists questioned the old theories and began to find fallacies in the measuring systems. There was need for an orderly, exact and reasonable system of measuring. Ways of measuring were, however, habits and would be hard to change.
EARLY MOVEMENT TO STANDARDIZE WEIGHTS AND MEASURES IN THE UNITED STATES

People who settled on the North American continent brought with them the commercial tools and practices of their homelands. For this reason there was no uniformity of weights and measures in the colonies. The founders of America began to realize that the systems based on customs passed down from previous generations were inadequate.

Smith (1958, p. 1-2) stated that when the colonies gained independence, they made provisions for a uniform standard in their Articles of Confederation as follows: "The Congress shall have Power... To regulate Commerce.... among the several states,... To... fix the Standard of Weights and Measures".

President Washington stated in his message to Congress in 1790 "uniformity in currency, weights and measures of the United States, is an object of great importance, and will, I am persuaded, be duly attended to" (Judson, 1963, p. 3). He then delegated his Secretary of State, Thomas Jefferson, to prepare a suitable plan for establishing uniformity in the weights and measures for the United States. The report would then be brought back to the House of Representatives.

Jefferson made his report to the House of Representatives in July 1790. His proposal had two plans:

The first plan was based on the supposition that the present Weights and Measures are to be retained, but to be rendered uniform and invariable, by bringing them to the same invariable standard.
The second plan proposed reducing every branch to the same decimal ratio already established in their coins, and thus bringing the calculation of the principal affairs of life within the arithmetic of every man who can multiply and divide plain numbers... (Judson, 1963, p. 3)

Treat (1971, p. 18) stated that Jefferson preferred basing the standard on the motion of the earth on its axis, which "though not absolutely uniform and invariable, may be considered as such for every human purpose."

The report was accepted by the House but no action was taken. President Washington again addressed his Congress in 1791 on the same subject, and the matter was referred to committees. In April, 1792, a senate committee recommended that Jefferson's second plan be adopted, which was entirely a decimal system of weights and measures. Again no action by Congress took place.

After Jefferson's attempt to secure passage of a bill standardizing weights and measures, the Congress of the United States showed no concern until 1816.

Smith (1958) pointed out that it was President James Madison, in December 1816, who again reminded Congress about the unfinished business concerning standardizing weights and measures. A year later the Senate authorized the Secretary of State, John Quincy Adams, to reinvestigate the standardization of weights and measures.

Adam's report took four years to complete, and Judson (1963) stated that the report was an elaborated review of the history of
weights and measures in England, on the continent of Europe, and in the United States. He considered in detail the history of the metric system and told of its pros and cons.

DeSimone (1971, p. 10) stated that Adams called attention to five features of the metric system that could be considered distinct advantages: the "invariable" standard of length taken from nature; the single unit for weight and the single unit of volume; the decimal basis; the relation of weights to French coinage; and its uniform and precise terminology.

Adams presented Congress with four possible courses of action, based on his analysis of advantages and disadvantages of the metric system:

To adopt, in all its essential parts, the new system of weights and measures...
To restore and perfect the old English system of weights, measures, moneys, and silver coins...
To devise and establish a (combined) system... by adaptation of parts of each system to the principles of the other...
To adhere, without any innovation whatever, to our existing weights and measures, merely fixing the standard (DeSimone, 1971, p. 10).

Judson (1963, p. 5) stated that Adams made two final recommendations, "to fix the standard, with the partial uniformity of which it is susceptible, for the present, excluding all innovations", and "to consult with foreign nations, for the future and ultimate establishment of universal and permanent uniformity."

Again Congress took no action because in England people were
objecting to change, and France was using the metric system side by side with the ancient weights and measures, causing much confusion.

Problems still kept arising especially along the coastline of America. The customhouses were using a variety of weights and measures, causing loss of revenue.

The Senate in 1830 directed the Secretary of Treasury to make an examination of weights and measures in the customhouses (Smith, 1958). This authority to investigate was then given to Ferdinand Rudolph Hassler.

After Hassler surveyed the customhouses, he recommended basic units of length, mass and capacity to be adopted and constructed by the Treasury Department (Smith, 1958). This recommendation by Hassler led Congress in June 14, 1836, to adopt a resolution of standard weights and measures. Congress directed the Treasury Department to furnish each state with weights and measures adopted as standards by the customhouses.

Smith (1958, p. 10) stated that "the adoption of the Joint Resolution of June 14, 1836, marked the end of the six-decade era of initial national uncertainty regarding standards of weights and measures...."

The urgent needs in the weights and measures field had been met by a combination of temporary actions (Treat, 1971). These needs were the setting of a standard for coins, correcting the deficiencies in customhouse operations and providing for uniform State standards.
There was no pressing demand for further action on weights and measures by the Congress for several years to come.

CHANGE TO THE METRIC SYSTEM IN EUROPEAN COUNTRIES

A committee of French, Dutch, Italian and Swiss scientists made speeches on the metric system in Paris as early as December 10, 1799 (Kirsch, 1973). These scientists defined the meter as a fixed portion of the earth's circumference.

The meter was selected as the chief building block of a complete system of measurement. The system was to be based on decimals and was to be arranged in clear, orderly steps which were all multiples or subdivisions of the meter.

At this time the French also tried to change the calendar year and daily time to the base ten but had difficulty in making it work. Kirsch (1973) stated it took ten years for revolutionary France to learn it was not necessary to overthrow everything that was old.

Kirsch (1973, p. 48) pointed out that in Paris, the metric committee, composed of scientists, made vigorous and repeated appeals to all nations to adopt the metric system. They believed mankind had not made a significant advance in the search for better methods of weights and measures. They also viewed the metric system as "capable of becoming a new link of universal brotherhood among all peoples who adopt it."
In France the metric system became compulsory in 1840 (Treat, 1971). Napoleon's conquests forced several of France's immediate neighbors to recognize early the effectiveness of keeping in step with France to facilitate trade. The metric system proved to be ideal for scientific work, and the acute need for a universal language of science was beginning to be felt by 1850.

Treat (1971) stated that in the United States there were conflicting opinions concerning the metric system between 1821 and 1863.

In 1851 the first international exhibition was held in London, and in 1855 another took place in Paris. At both of these events the diversity of weights and measures used from country to country was evident, and this diversity caused inconvenience to the judges. As a result, in 1855 at the Paris exhibition, about 150 delegates banded together to form the International Association for Obtaining a Uniform Decimal System of Measures, Weights and Coins. Fifteen countries were represented, among them the United States. Thorough investigations of various alternative decimal systems soon led the group to settle on the metric system. The International Association for Obtaining a Uniform Decimal System of Measures, Weights and Coins thus became the first pro-metric organization.

**MOVEMENT TO AUTHORIZE USE OF METRIC SYSTEM IN AMERICA**

Between 1855 and 1863, the United States had diplomatic problems
which were associated with wars. This made uniformity of weights and measures a low priority item on the agenda of Congress. Two international conferences in 1863, the postal and statistical congresses, however, hastened the legalization of the metric system in the United States. Both of these took the position that the metric system was to be preferred over other measuring systems. Two Congressional moves were made in 1863-1864, led by a metric advocate, John A. Kasson, a former First Assistant Postmaster General (Cox, 1956).

Another event in 1863 had a profound impact on the decision to authorize the use of the metric system in the United States. It was the founding of the National Academy of Sciences. Authorization was given "to investigate, examine, experiment and report upon any question of science and art" which might naturally be inclined to favor the metric system reform (Treat, 1971, p. 39).

The first committee established by the National Academy of Sciences was the Weights, Measures and Coinage Committee. Alexander D. Bache was the first president of the Academy, and his first report states:

The discussions in the body of this committee were strongly in favor of the adoption of the French metrical system, but more strongly, in fact unanimously, in favor of the effort to arrive at a thorough international system - a universal system of weights, measures, and coins, available for the general acceptance of all nations. (Cox, 1956, p. 440)

Congress again gave formal recognition to the importance of
uniform weights and measures by adoption of a resolution in the House of Representatives on January 21, 1864. The resolution created the Committee on a Uniform System of Coinage, Weights and Measures. The committee accepted as its role the bringing about of weights and measures reform. It also served as the main battleground on which metric contests were fought and as the final resting place for most metric bills (DeSimone, 1971).

In January, 1866, the National Academy of Sciences' Committee on Weights, Measures, and Coinage submitted its report to the Secretary of the Treasury. The report emphasized as opinions of the minority:

The subject is one of much perplexity....
The entire adoption of the French metrical system involved the necessity of discarding our present standard of weights and measures....
Such a change, in my opinion, can only be, in a government like ours, the work of time and through education of the rising generation.... (Cox, 1956, p. 444).

The full report by the committee was far more favorable toward positive action with regard to the metric system. The majority of the members were in favor of adopting a decimal system and stated that the metric system was the best in use. The committee also recommended that the Congress provide for construction of metric standards; that the standards be distributed to the States and customhouses and that the metric system be introduced into the post offices of the United States (Cox, 1956, p. 448).

Discussion of weight and measure problems in the National
Academy's committee were more elaborate and their recommendations more definite. The committee reviewed previous work undertaken on weights and measures: Thomas Jefferson's plan, John Quincy Adam's arguments and recommendations, the history of weights and measures in the United States, and the status of the metric system in other nations of the world (Treat, 1971).

After presentation to Congress of the report of the National Academy's committee, a Joint Resolution of July 27, 1866, and the law of July 28, 1866, made legal throughout the United States the employment of weights and measures of the metric system. The text of the law was as follows:

It shall be lawful throughout the United States of America to employ weights and measures of the metric system; and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection because referred to therein are weights and measures of the metric system.

The tables in the schedule hereto annexed shall be recognized in the construction of contracts and in all legal proceedings as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and said tables may be lawfully used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system (Smith, 1958, p. 12).

Treat (1971) stated that the demand for adoption of the metric system was only coming from a small segment of the population, the scientists and the government officials. The Act of 1866 did not change people's daily lives. The law was not mandatory, and it did not
stir interest; people were free to ignore it if they chose to do so. The Act did not pave the way for a significant program of education about the metric system.

The first phase of metric investigation in the United States had ended. The final goal of general adoption had been established, and arguments for the system had been set. The advocates felt that it was simply a matter of time and proper influence through the educational process before popular acceptance of the metric system was to be gained.

John A. Kasson, Chairman in 1866 of the Committee on Coinage, Weights and Measures, was the first person to promote education of the people concerning the metric law and use of the metric system. He addressed a group of educators in New York State, urging them to teach the coming generations the advantages of the metric system (DeSimone, 1971).

John Kasson's efforts soon became somewhat popular. It was not long before the promotional campaign had a counter movement. As a result of earnest opposition, things began to "go sour" for those favoring the introduction of the metric system in this country (DeSimone, 1971).

The metric controversy started at Columbia University between 1866-71 with Charles Davies and Frederick A. P. Barnard, the president, opposing each other. Their arguments were the principal points of controversy in the metric debate for 40 years. Davies opposition was
based on five factors which have become the classical arguments against adoption of the metric system:

1. The basic unit of the system, the meter, he considered to be inherently defective. He also felt that the meter was too large a base unit.

2. The decimal multiples and subdivisions, while being for the purpose of calculation, were not the ones best suited for use in practical application.

3. The metric system's nomenclature, while perhaps suitable for scholars, would not be easy for school children to comprehend.

4. ..., that if the system were introduced it would be necessary to exclude all other systems. He also felt another serious impediment to its introduction would be man's basic reluctance to cast aside old and familiar things in exchange for something unknown and untested.

5. The remaining objections to the adoption of the system...and his strongest language was reserved for this particular set of assertions:

1. It would strike out from the English language every word and phrase and sentence used in connection with our present units of weights and measures, and would impose the necessity of learning a new language for the one now in use:

2. It would blot out from the knowledge of the nation all apprehensions of distance, and area, and volume, acquired through the present units, and would render necessary the acquirement of similar knowledge by less convenient units, have different relations to each other, and expressed in a new and unknown language:

3. It would extinguish all knowledge of money values, now so familiar to the entire population in their daily purchases, and sales, and barters, for those values are all adjusted with reference to the units of weights and measures:

4. It would change the records of our entire landed property, requiring them all to be translated into a new and foreign language (Davies, 1871, p. 41-46).

Treat (1971) stated that Davies report was the first to give extensive consideration to the question from an educational point of view. Davies was one of the very few highly educated people to give unfavorable recommendations concerning the metric system.
Reaction to Davies report was quick. President Frederick Barnard of Columbia gave an oral address to a convocation in 1872. He was concerned with the unfounded objections and the impressions Davies report left on the people.

Frederick Barnard gave formal arguments against Davies' five points of opposition. He then outlined a five point program of action for properly introducing the metric system to the people of the United States. The plan called for:

1. Teaching the metric system in the schools so as to educate the young to a thorough understanding of the system and a familiarity with its practical application;
2. Putting the system into use in the customhouses and making it the basis on which tariffs were to be levied;
3. Adopting the metric weights and measures for public surveys, such as the coast survey;
4. Requiring military and naval establishments to use the system; and

As a result of the Davies-Barnard debate, the advocates for the adoption of the metric system had two tasks to accomplish; first they had to disprove Davies' arguments and then convince people that what they were proposing was desirable.

The subject of the metric system lay dormant in the United States Congress until 1875 when the Treaty of the Meter was signed in Paris by seventeen nations, including the United States. The treaty provided for the manufacture of new and improved standards for metric weights and measures. It also established and maintained a permanent
International Bureau of Weights and Measures, and it established the creation of a general conference as a permanent deliberative body to pass upon international weights and measures matters. The United States gave its final approval of the Treaty in 1878 (Judson, 1963).

Now that the metric system was the official international system of weights and measures, its future was not in doubt. The extent to which it would be used universally was, however, uncertain.

One possible reason for the failure of metric supporters to reach their desired objectives in the legislature in the 1870's and 1880's was the founding in 1879 of the first anti-metric society. The society was called The International Institute for Preserving and Perfecting Weights and Measures and was led by Charles Latimer. The society's objectives were to defeat any proposed legislation designed to further the use of the metric system and to preserve the English customary system of weights and measures and work for its improvement (Cox, 1956).

Treat (1971) stated that the only legislation passed in the 1880's concerning weights and measures was a Joint Resolution in 1881 requiring the Secretary of State to supply state land grant colleges with sets of weights and measures standards.

The activities of the American Metric Bureau and the International Institute for Preserving and Perfecting Weights and Measures began to dwindle and die with the deaths of Charles Latimer and F.A.P. Barnard in 1888 and 1889 (Cox, 1956).

In the next twenty-five years supporters of the metric system
began a strategy which called for rapid adoption of the system by the Government, followed by universal transition to the metric system on the part of the rest of the United States after a brief introductory period.

Metric supporters assumed that the eventual acceptance of the metric system was going to happen and that the people of the nations would not fail to appreciate the advantages of the metric system. They also felt that the best way to get people acquainted with the metric system was to have the government adopt it for all its work.

Movement Toward Government Adoption

The movement toward government adoption of the metric system began with some outstanding events occurring between 1890 and 1914. The first of these occurred in 1893 with the issuing of a Treasury Department Bulletin by Thomas C. Mendenhall, the Superintendent of Weights and Measures. He announced that the United States prototype meter and kilogram would from this time on be considered the nation's "fundamental standards of length and mass" (Judson, 1963, p. 26). Units of the English system were defined not by their own standards but by carefully specifying what fraction of a meter would constitute a yard and what fraction of a kilogram would make up a pound.

The next year 1894, Congress appointed a commission to study the practicability of the metric system. Hearings were held during the next two years, and in 1896 the House of Representatives passed a bill
requiring government adoption of the metric system but then voted to reconsider its action, and the bill was sent back to committee for further consideration. There were several attempts to have it revived, but no action was taken by the House of Representatives (Smith, 1958).

An Act of Congress established the National Bureau of Standards in 1901. The bureau held extensive hearings on the proposed government adoption of the metric system. These hearings brought serious opposition, leading the legislature to decline approval of the adoption of the metric system (Cochrane, 1966).

Papers and books containing arguments against the metric system were written in 1904. A well known book by Halsey and Dale was given the title *The Metric Fallacy*. Much of this book consisted of arguments against the adoption of the metric system and prediction of how the metric system would affect the people of the United States.

Arguments opposing adoption of the metric system were forceful with the Committee of Coinage, Weights, and Measures refusal to report favorably in 1907 on a metric bill. Metric system promotional efforts died down until the arrival of World War I (Cox, 1956).

**The Great Metric Propaganda War**

From 1908 to 1930 the pro-metric movement became a different kind of campaign. The metric proponents and the opposition became almost

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totally institutionalized in that the battles were fought by organizations and interest groups rather than by individuals. The main objective of the pro-metric organizations was still to secure passage of legislation designed to increase United States use of the metric system. Advocates hoped to get public opinion to influence the legislators.

The organizations involved in the pro-metric campaign were the American Metric Association, founded in 1916, and the World Trade Club, founded in 1920. The American Institute of Weights and Measures was the main anti-metric organization that existed between 1916-1931 (DeSimone, 1971).

The publicity and tactics these organizations used did not result in any action on the part of Congress. More legislation was proposed during this period, but only twice were major hearings conducted, and not once did the metric issue get on the floor of either the House of Representatives or the Senate (DeSimone, 1971).

The onset of the depression made money needed to support a legislative campaign unavailable. The metric issue was laid to rest for another quarter of a century.

The Comprehensive Study Phase

After the great metric propaganda war fell to pieces in the 1930's, interest in adopting the metric system in the United States was not rekindled until 1955. Kirsch (1973) stated that two reasons for not
mentioning the metric system were the health of the American economy and the isolationist political mood of the people of the United States.

In 1945 Ingalls, the tentative president of the American Institute of Weights and Measures, published a collection of anti-metric arguments and comments about past events. After this, the American Institute of Weights and Measures went out of existence. In 1946 the House Committee on Coinage, Weights and Measures was abolished by a Legislative Reorganization Act (Treat, 1971).

In the next ten years mathematic teachers, the U.S. Army and the Committee on Service and Astronautics adopted and urged the use of the metric system. Meanwhile the world's balance was shifting. Kirsch (1973) stated that the Soviet Union and China had changed to the metric system. Later in the year 1962, the metric system would also be in use in Asia and Japan.

In 1959, Secretary of Commerce Lewis Strauss urged the use of the metric system. This stimulated several Senators and Representative to introduce bills concerning the metric system in Congress. The result was several hearings on metric proposals, but the bills were not passed by the Congress.

The British Board of Trade, with the approval of the government, announced plans in 1965 for conversion to the metric system in Great Britain. The plan would take ten years to complete. This announcement meant that the United States would be the only major power using non-metric units (Kirsch, 1973).
Legislative activities were again initiated in Congress but failed to pass the House on September 20, 1965. In the next session the bill was again introduced, but it died in committee. Then in the ninetieth Congress, efforts to secure the passage of a metric study bill were renewed by Senator Pell and Senator Robert P. Griffen (DeSimone, 1971).

On November 15, 1967, the Senate Committee on Commerce held hearings on both Senator Pell's and Senator Griffen's bills. A bill providing for a metric study was passed by the Senate but was held up by the House Committee on Rules. The hearings led to spirited debates. A number of amendments were attached, and the bill was finally passed and signed, Public Law 90-472 on August 14, 1968, by President Lyndon B. Johnson. This bill provided for:

A program of investigation, research, and survey to determine the impact of increasing use of the metric system on the United States: to approve the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting by international use of dimensional and other engineering standards based on the customary measurements units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States (Treat, 1971, p. 252).

The Congress then instructed the Department of Commerce to have the National Bureau of Standards conduct a three-year study to probe every aspect of the question: advantages and disadvantages and the views of consumers, business people, workers and educators. On the
basis of the findings and conclusions, Secretary of Commerce Maurice H. Stans would then make "such recommendations as he considers to be appropriate and in the best interest of the United States" (DeSimone, 1971, p. 1).

As a result of the study Secretary Stans recommended the following on July, 1971:

-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, and anticipating the kinds of special problems described in the report, to a central coordinating body responsive to all sectors of our society;
-That within this guiding framework, detailed plans and timetables be worked out by these sectors themselves;
-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, after deciding on a plan for the nation, establish a target date ten years 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 (DeSimone, 1971, p. 1).

SUMMARY OF REVIEW OF LITERATURE

This review of the literature about the history of the metric
system revealed the continual push for adoption in the United States. Several people and organizations from 1790 to 1968 recommended but failed to persuade Congress to pass a law for a mandatory metric system of measurement.

During these years other countries have one by one adopted the metric system, putting the United States in the position of being the only major world power to cling to an outmoded system of weights and measures.
Chapter 3

PROCEDURE FOR DEVELOPING THE PROGRAM
AND FIELD TESTING

The purpose of this study was to develop a self-instructional program on basic metric terms for the average consumer. The measure of effectiveness of the program was specified as the percentage of consumers who pass the final criterion-referenced test with 90 percent accuracy, thus demonstrating that they had reached the mastery level of basic metric knowledge.

A field test was necessary to evaluate how well the objectives of the program were achieved and how the average consumers would react to this method of instruction.

PREPARATION OF THE PROGRAM

Definition of the Target Population

The target population was defined as average female consumers, members of the group being restricted to:

1. housewives, working adults or high school juniors and seniors,
2. women between the ages of 16 and 60 years,
3. women who have reached sixth grade reading level.
Statement of Objectives

Bloom edited the book *Taxonomy of Educational Objectives* for a group of college and university examiners. He classified educational objectives according to different levels of behavior. The writer of the self-instructional program used the three levels: knowledge, comprehension and application in the development of behavioral objectives for the basic metric program.

The following behavioral objectives were formulated. After completion of the self-instructional program, the consumer should be able to:

1. decide which of the metric terms to use in specific situations: grams, meters, liters or celsius;
2. distinguish between the metric prefixes kilo, deci, centi and milli;
3. use basic measurement terms appropriately;
4. change basic metric units to an approximate English measurement;
5. change English units to approximate metric units;
6. express metric quantities in different units by moving the decimal point.

The objectives served as guides in developing the program and pre- and post-tests.
Development of Tests and Attitude Scale

The researcher's first concern was the development of criterion-referenced pre- and post-tests. These tests were based on the objectives of the program and were in parallel form.

The pre-test (Form A)\(^1\) was developed for use in determining the consumer's level of knowledge prior to taking the program. Consumers who had already achieved the objectives of the program, as measured by a score of 90 percent or higher on the pre-test, were advised not to take the program since it would be repetitive or boring.

The post-test (Form B)\(^2\) measured whether or not consumers responding to the program had reached mastery level of learning of concepts in the program.

A consumer's attitude sheet was developed to be given at the end of the post-test. This would give the researcher feedback from the consumers as to reaction to the metric system and to the type of teaching used.

Description of Program

Once a clear idea had been reached of what was expected of the consumer at the completion of the self-instructional program, the researcher was ready to determine the technique of programming to be used.

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1. See appendix page 77
2. See appendix page 82
A series of sessions on programming was conducted for a small group of graduate students as a special problems course. Extensive study of the literature led to the decision to use a linear program produced in booklet form.

Try-out Revision Cycle

During the first writing of the self-instructional program, the writer had individual students from her high school and two graduate students from South Dakota State University respond to frames in the program. The students were asked to tell the writer what frames were hard to understand or vague. This gave ideas for improving the frames and a basis for deciding whether additional frames were needed to achieve the objectives.

As the next step in the try-out revision cycle, the writer gave the program to a group of home economics teachers who were attending the "Trends in Home Economics Education" workshop at South Dakota State University, July 1, 1974. Using their feedback and their post-test results, the writer further revised the program. Frames were added and two supplementary panels were constructed to accompany the program. These were the "Metric Slide Rule" and a "Metric Cone" card.

Supplementary Materials for Field Testing

An answer sheet consisting of frame numbers and blanks corresponding to frames in the program was developed to accompany the self-instructional program. This answer sheet stimulated students to record
their responses on every frame and was later to be used to determine error rate. Answer sheets for the pre-test and post-test were developed to facilitate correcting the tests and to make it possible to reuse the copies of the tests.

The first section of the consumer attitude sheet was designed to consist of four items to be checked on a seven point scale, thus expressing reaction to this particular set of teaching materials. In the second section the consumer was asked to rank seven methods of learning about the metric system according to their preferences. An open-ended question at the end gave opportunity to record feelings about the teaching material and about the metric system.

The "Metric Slide Rule" was developed to aid the consumer in visualizing the result of moving the decimal point. The "Metric Cone" was used by the consumer to see the size relationship of the metric prefixes.

TESTING HIGH SCHOOL CONSUMERS

After preliminary trial of the frames with individuals and with a group of teachers, the self-instructional program was ready to be administered to a group of high school students.

Two high school teachers volunteered their students for the field

1. See appendix page 90
2. See appendix page 87 and 88
3. See appendix page 89
testing. These teachers taught in Milbank, a school in northeastern South Dakota which has an enrollment of 500 students from urban and rural communities. The 50 students who participated in the study were juniors and seniors enrolled in home economics classes and therefore were qualified as members of the target population.

The teachers administered the pre- and post-test, the basic metric self-instructional program and the consumer attitude sheet to their students. No special training was given to the teachers to prepare them to perform these duties.

After the program was administered in the high school, the attitude sheets were scanned. It was recognized that many of the students did not see the need for a change to the metric system and had a negative attitude toward such a change. Obviously some motivational device was needed to acquaint consumers with the certainty of the coming change to the metric system and the need to be ready for it. The J. C. Penney filmstrip "Metric Song" was chosen as a motivation technique to precede the program.

**TESTING ADULT CONSUMERS**

Children and young people will have an opportunity to learn in school about the metric system. The out-of-school consumers will have less opportunity to receive this training. For this reason it was important to include adult consumers in the field testing program.

Subjects were 50 consumers who belonged to Lake County Home
Extension clubs in South Dakota. They were consumers who were either housewives, working adults or both. The club presidents were contacted personally by the researcher to see if they were willing to participate in the field testing. At this time the procedure to be followed was explained.

Each extension club met in the home of a member. Those attending were given the pre-test and it was scored immediately by the researcher. Eight club members who scored 90 percent or more were advised not to take the program. Remaining members were given a set of materials to be taken home. They met again after one week to fill out the post-test and attitude sheet.

ANALYSIS OF DATA

Pre- and Post-Tests

The test was divided into two subtests of equal length using alternate responses. Two scoring keys were constructed, and each test was hand scored. Each correct reaction to a response was given a value of one. The total score for an individual was the sum of the correct responses on the two subtests.

The coefficient of reliability was determined by correlating the scores on the two subtests and applying the Spearman-Brown modified formula. The mean scores were computed, and the frequency distributions plotted.

Content validity was achieved by basing the pre- and post-test
items on the objectives set up at the beginning of the research.

**Description of Data**

The data were described by preparing frequency distributions of scores on the pre-test and scores on the post-test. Means and standard deviations of the distributions were computed. Information was summarized item by item on the consumer attitude sheet. For the ranking items, an average ranking for each of the seven teaching techniques was computed.

**Hypotheses Tested**

Means of the two sub-groups, high school and adult consumers, were compared using the "t" test. The hypothesis tested was: there is no difference between high school and adult consumers in their scores on the post-test.

The following correlations were computed: pre-test and post-test scores; post-test scores and errors on the program; post-test scores and scores on attitude toward the program.
Chapter 4

FINDINGS

The data obtained from the field test of the Basic Metric Program will be discussed in this chapter. High school and adult consumer reactions to the program will be summarized.

Data are discussed with respect to (1) reliability of the criterion referenced tests; (2) frequency distributions on the criterion referenced tests; (3) errors on the program and (4) attitudes of the consumers toward this method of teaching. High school consumers are compared with adult consumers with respect to scores on the criterion referenced pre-test, errors on the program, scores on the criterion referenced post-test, and attitude toward this method of teaching.

Description of Test

Criterion referenced tests1 were based on the seven objectives2 stated for the self-instructional program. The tests were divided into seven parts, each part containing several items based on one objective.

The criterion referenced tests were developed in two equivalent forms which are referred to as pre- and post-tests. The maximum score for each of these tests was 76.

The test items were all completion type questions. An effort was made to design questions that measured the understanding of concepts

1. See appendix p. 77 and 82
2. See page 29 in this thesis
used in the metric system rather than memorization of facts.

As a basis for calculating reliability of pre- and post-tests, each test was divided into two sub-tests; one consisted of the odd numbered items and the other of the even numbered items. Each subject was thus given three scores on each test; an odd score, even score and a total score. A coefficient of correlation between scores on odd numbered and scores on even numbered items was computed for each test. This coefficient of correlation expressed the reliability of a test half the length of the test. To estimate the reliability of the entire test, the Spearman-Brown modified formula was applied. The reliability of the pre-test was .98. This is an exceedingly high reliability. The exceedingly high reliability of the post-test was .96, similar to the pre-test.

The program was developed with a goal in mind that subjects would attain mastery level learning. Mastery level of basic metric knowledge was defined as attainment of a score at or beyond 90 percent level on the criterion referenced post-test. Since the maximum score was 76, a score at the 90 percentile was 67. Thus a score of 67 or higher was necessary for persons who met the mastery level criterion.

Test-Retest Development Cycle

The development cycle began with three average students at Ramona High School. These students were given the pre-test to determine whether they needed to go through the program. They scored below 67
and therefore continued to participate in the project. As the individual students went through the program, they responded verbally to frames, commenting to the researcher about reasons for their responses and difficulties they were having in responding. Frames with which they had problems were reworded. After completion of the program, the students responded to the post-test. Their responses to certain post-test items indicated that additional frames were needed because these students could not correctly respond to these items. An effort was made to revise the program sufficiently for the next students who participated in the project to correctly respond to post-test items.

The next step in the test-retest development cycle was to give the test to 34 home economics teachers at South Dakota State University. It was recognized that these graduate students were superior to average consumers in educational level. This was, however, a convenient group of people to use as subjects. They were interested and willing to cooperate in the project. Summary of the pre-test data showed that 12 of the 34 teachers scored 90 percent and above. These teachers were dropped from the project, and the remaining 22 teachers went through the program and post-test. The distribution of post-test scores of these teachers is diagrammed in Figure 1. The criterion for mastery of the program was a score of 67 or higher. Since a score of 67 is the midpoint of a bar on the histogram, half of the frequency in this interval, or two students, might be counted with those attaining the specified criterion level. A total of 10 teachers attained mastery level, and 12
scored below 90 percent. These results showed that the program did not reach the mastery level of proficiency even when subjects were a select group. The program did not successfully guide 90 percent of subjects to mastery level of learning. Some frames of the program were then reworded, and 16 additional frames and two supplementary panels were added.

![Histogram of Post-test Scores](image)

**Figure 1. Histogram of Post-test Scores of Home Economics teachers**

The program was then considered to be at the stage where average consumers might be expected to attain mastery level. The decision was made to accept the program for field testing.

**Field Test Data**

Frequency distributions of post-test scores of students are shown pictorially in Figure 2. The range of scores was from 34 to 74, and the mean was 59.86. The distribution is assymmetrical, as anticipated for a criterion referenced test. There were 18 students, 36 percent,
who scored beyond 67, the 90 percent cut-off point arbitrarily set for
mastery level learning. Thirty-two students, 64 percent, scored below
67.

The fact that a large number of students failed to reach mastery
at the level set in this study may be due to lack of motivation to
learn to use the metric system rather than inadequacy of the self
instructional program. The decision was made to attempt to motivate
adult consumers by introducing the study with an audio-filmstrip
produced by J. C. Penney Company called "The Metric Song"\(^1\). This was
developed for the purpose of helping people to see the need for
learning to use the metric system.

The post-test results for the adults are shown in Figure 3. The
range of scores was from 22 to 76, the mean being 63.87. The frequency
distribution was the type expected for criterion referenced tests.
Twenty-nine adults, 58 percent, scored 67 or above, and 21 adults,
42 percent, did not attain this specified mastery level of learning.

It is clear that adults did considerably better than students in
the post-test, 58 percent scoring beyond the 90 percentile, whereas
36 percent of students scored beyond this point. The difference
between students and adults might be due to added motivation given to
adults. In addition to this, adults did the task voluntarily.

Adulst also had the freedom to choose when and where to complete the

\(^1\)Audio-filmstrip, The Metric Song. J. C. Penney Company, Inc., 1301
Avenue of the America, New York, N. Y.
Figure 2. Histogram of Post-test Scores of Students
Figure 3. Histogram of Post-test Scores of Adults
task.

Portions of the post-test in which consumers made many errors were observed. There is a relationship between frames in the program and items in tests since both were keyed to the same objectives. Therefore, errors on the post-test may be related to specific frames in the program. Revision of frames and addition of lead-up frames is recommended for certain sections of the program which are keyed to items in the post-test in which many errors are made. The section of the program which caused greatest difficulty was the section where consumers were taught to change from one unit to another by moving the decimal point in one direction or another. It is recommended that frames 41, 42, 44, 45, 46 and 53 be revised and that frames be added to this section.

Each consumer indicated her reaction to this method of instruction on the Consumer Attitude Sheet1 after completing the program and the post-test. The reaction sheet was divided into two parts, the first of which contained four items on a seven point scale and the second, a series of methods of learning which were to be ranked.

Eighty-nine consumers responded to the four items on the Consumer Attitude Sheet. Frequencies are shown in Table 1. The students differed significantly from adult consumers as indicated by a "t" test of 4.13 which is significant beyond the 1 percent level. The attitude of

1See appendix p. 90
Table 1

Number Selecting Each Level of Response for Feelings Toward Program

<table>
<thead>
<tr>
<th>Feelings</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boring - Interesting</td>
<td>11</td>
<td>4</td>
<td>9</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>3.490</td>
</tr>
<tr>
<td>Difficult - Easy</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>4.388</td>
</tr>
<tr>
<td>Frustrating - Satisfying</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>15</td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>3.776</td>
</tr>
<tr>
<td>I will forget rapidly -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probably will remember</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>12</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>3.306</td>
</tr>
<tr>
<td>Mean of total score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15.16</td>
</tr>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boring - Interesting</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>16</td>
<td>5.675</td>
</tr>
<tr>
<td>Difficult - Easy</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>13</td>
<td>14</td>
<td>0</td>
<td>5</td>
<td>3.975</td>
</tr>
<tr>
<td>Frustrating - Satisfying</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>4.425</td>
</tr>
<tr>
<td>I will forget rapidly -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probably will remember</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>7</td>
<td>5.200</td>
</tr>
<tr>
<td>Mean of total score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.43</td>
</tr>
</tbody>
</table>


adults was considerably higher than the attitude of students, the means being 19.44 and 15.16, respectively.

The students' highest mean was on the "difficult-easy" continuum, 4.39, and the lowest was on the "I will forget rapidly-probably will remember" continuum, 3.31. Students tend to feel that the program is slightly too easy, but the scores on the post-test do not indicate this.

The adults, however, found the program to be interesting, felt that they would probably remember the material but believed it to be slightly difficult. The difference between the two groups might be attributed to this being a new type of learning experience for the adults whereas the newness and novelty of programmed learning has worn off with students. It is also possible that the introductory audio-filmstrip used with adults set the stage for positive attitudes toward learning the metric system and thus to this particular program.

The ranking of methods of learning, the second part of the attitude sheet, is shown in Tables 2 and 3. These two tables should be considered together. Both students and adults chose programmed learning as the preferred method of learning this type of material as indicated by the numbers who ranked this method high in comparison with other methods. Twenty-one, almost half of the students, chose "doing the exercises in a program like this" as the most preferred method of learning. An additional 16 of them chose it as their second or third preferred method. Thus, more than three-fourths of the students ranked
Table 2
Number of Students Selecting each Rank for Method of Learning

<table>
<thead>
<tr>
<th>Methods of Learning</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Watching a movie</td>
<td>3</td>
</tr>
<tr>
<td>Listening to a teacher</td>
<td>4</td>
</tr>
<tr>
<td>Reading a book</td>
<td>1</td>
</tr>
<tr>
<td>Working in a lab under guidance of a teacher</td>
<td>14 16 5 5 2 2 1</td>
</tr>
<tr>
<td>Doing the exercise in a program like this</td>
<td>21 8 8 1 2 2 3</td>
</tr>
<tr>
<td>Listening to tapes</td>
<td>1</td>
</tr>
<tr>
<td>Reading things available in newspapers and magazines</td>
<td>1 5 6 10 5 7 11</td>
</tr>
</tbody>
</table>
Table 3

Number of Adults Selecting each Rank for Method of Learning

<table>
<thead>
<tr>
<th>Methods of Learning</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watching a movie</td>
<td>1</td>
</tr>
<tr>
<td>Listening to a teacher</td>
<td>2</td>
</tr>
<tr>
<td>Reading a book</td>
<td>3</td>
</tr>
<tr>
<td>Working in a lab under guidance of a teacher</td>
<td>4</td>
</tr>
<tr>
<td>Doing the exercise in a program like this</td>
<td>5</td>
</tr>
<tr>
<td>Listening to tapes</td>
<td>6</td>
</tr>
<tr>
<td>Reading things available in newspapers and magazines</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
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<tr>
<td>Watching a movie</td>
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<td>2</td>
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<td>3</td>
<td>4</td>
<td>6</td>
<td>16</td>
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<td>4</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>1</td>
<td>1</td>
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<td>Reading a book</td>
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<td>2</td>
<td>4</td>
<td>13</td>
<td>10</td>
<td>5</td>
<td>3</td>
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<td>Working in a lab under guidance of a teacher</td>
<td>12</td>
<td>8</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
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<td>Doing the exercise in a program like this</td>
<td>21</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Listening to tapes</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Reading things available in newspapers and magazines</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>
this type of learning as first, second or third. In the case of adults all except one chose this method as first, second or third.

"Working in a lab under guidance of a teacher" is obviously the second choice of method of learning for the students, whereas, "listening to tapes", and "reading a book" are the least preferred. The least preferred methods of learning for the adults was "watching a movie" and "listening to tapes".

The three teaching methods on which consumers differed were: "watching a movie", "reading things available in newspapers and magazines" and "reading a book". The students ranked these methods three, four and five, and the adults ranked them in the opposite direction.

The hypotheses tested in this study were: there is no difference between high school and adult consumers in their scores (1) on the pre-test, (2) on the post-test, and (3) on the attitude scale. Data were analyzed by using "t" tests to test the hypotheses.

There was a significant difference at the 5 percent level between the two groups on the pre-test. The mean of students was higher than the mean of adults, 41.94 and 33.82, respectively. It might be anticipated that use of the metric system in science courses would result in the students having some knowledge in the metric system.

The "t" test for the post-test showed a significant difference at the 5 percent level with the adult mean, 63.87, being higher than the student mean, 59.86. It is interesting that whereas students scored higher than adults on the pre-test, adults scored higher than students
on the post-test.

The difference significant at the 1 percent level between students and adults on the attitude scale has been previously discussed\(^1\). It is possible that the more positive attitude of adults affected their learning and their scores on the post-test.

\(^1\)See page 43 in this thesis
Chapter 5

SUMMARY AND RECOMMENDATIONS

SUMMARY

This study had two purposes; first, the development of a "Basic Metric" self-instructional program for use by adult consumers who wish to learn to use metric measurements and second, the evaluation of the program by means of field testing.

The development of the program followed the sequence advocated by many current programmers. The target population was defined as average consumers between the ages of 17 and 60 years who have reached sixth grade reading level. Six objectives were stated as guides for the development of the program, pre- and post-tests. The linear technique was used in the development of the program. A set of frames was written in the form of partially completed statements requiring student responses. The program was tried on individual students and adult consumers who were not familiar with the metric system. Continuous revisions were made on the program based on individual feedback. The major revision was the addition of two supplementary panels to accompany the final program, the "Metric Cone and the "Metric Slide Chart".

Criterion pre- and post-tests, a program answer sheet and a consumer attitude sheet were developed to use during the field test.

To participate in the field testing of the basic metric program,
two classes of high school seniors at Milbank, South Dakota, and 50 female adult consumers in Lake County were used. The pre- and post-test and program were administered by the two teachers at the high school and by the researcher for the adult consumers. The answer sheets were returned to the researcher for scoring.

Reliability of the test was determined by dividing it into two subtests of equal length, alternate responses being assigned to the subtests, and correlating the scores on the subtests. After applying the Spearman-Brown modified formula, the coefficient of reliability were found to be .98 for the pre-test and .96 for the post-test. Since these were criterion referenced tests, an arbitrary level of 90 percent was set as a mastery level score. As anticipated, the distribution was negatively skewed, a large proportion of the respondents scoring high. Thirty-six percent of students and 58 percent of adults scored beyond this level. The superior learning of the adults may possibly be attributed to the use of an audio-filmsstrip as a motivating device prior to introducing the program.

The student and adult reactions to programmed instruction differed in that the adults reacted somewhat more favorably toward programmed learning. This difference may be due to the fact that programmed learning was a new and novel experience for adults and a repeat experience for high school students. The adult and student consumers agreed on their preferred teaching methods. They both ranked first, "doing exercises in a program like this" and last, "listening to tapes".
RECOMMENDATIONS

The following revisions or suggestions are recommended for further improvement of the Basic Metric self instructional program:

1) Use a film or other motivating device to prepare people to want to learn to use the metric system,

2) Improve the wording and write lead-up frames for sections of the program related to post-test items missed by a large number of participants,

3) Improve the metric slide chart panel.

The investigator recommends the following research in which the basic metric program might be used:

1) Develop and try out methods of teaching a divided class, part of whom are working on a self-instructional program and part of whom are taught by some other method.

2) Compare consumers who completed the Basic Metric program with consumers who received traditional classroom teaching in the use of basic metric knowledge with respect to:
   a) scores on the criterion post-test;
   b) scores six months after completion of the criterion post-test;
   c) scores on an attitude reaction sheet
3) Develop self instructional programs on metric length, mass, volume and temperature,

4) Suggest experiences in which learnings from the self instructional program will be transferred to a new task or used to achieve objectives at the analysis, synthesis or judgment level,

5) Develop a self-instructional program on basic metrics for educable mentally retarded consumers.
BIBLIOGRAPHY


Basic Metric
Bills have been promoted in Congress requiring conversion to the metric system. Beyond doubt, America will be on the metric system in the near future. The average American consumer, thinking about this, is tempted to throw up his hands and wonder, "How is it going to help me? It will cost more money. I am too old to learn something new. Besides, I am not good in math!"

Through the use of this Metric Basics program, "Josha" will show you how easy the metric system of measurement will be. He will help you gain experience in its use.

DIRECTIONS TO THE STUDENT

The book you are using is a Self Teaching program.

This book is different from most of the books you have used because you will teach yourself with a small amount of help from the teacher.

The program uses small steps to teach you.

This program will not make sense if you skip around. You must read and write on the answer sheet each page before going on to the next page.

After writing your answer, look on the back of the frame to see if your answer is correct. If it is incorrect, reread the frame using the correct answer.
The following symbols before answer blanks indicate the types of responses to make:

# _____ a number
___ one word
* _____ more than one word
** _____ in your own words

You are now ready to begin the program. Please do not write in this program book. Write your answers on a piece of paper.

Josha is trying to convince "Minnie the Consumer" that the metric system of measurement is going to be a help to her.

What do you suppose they are saying to each other?

On your answer sheet write what you think they are saying.

Josha is now going to tell you about the metric system of measurement and how to use it.

Josha says, "There are four basic terms that the consumer will use in metric measurements. They are meter, gram, liter and Celsius. Remember the following ways to pronounce these terms: meter and liter rhyme with Peter, gram rhymes with Sam and Celsius sounds like "Cell see us." Pronounce them out loud.

The four basic metric terms a consumer will use are: _____, _____, _____, and _____.
Josha says, "Let's take the first metric term, 'meter.' It is the base unit of length. You as a consumer will use the abbreviation 'm' for meter."

The term used when measuring length is _____. The symbol is a small _____.

The measurement most like the meter is the yard.

Which is longer, a meter or a yard? ____

There is a family of measures of length: millimeter, centimeter, decimeter, meter, and kilometer.

What do all members of the family have in common?
These distances will be expressed in so-many meters or units which are a part of the meter family.

Place a check beside other item(s) that will be measured in units containing the meters.

1. race track
2. weight of butter
3. height of Judy

Meter's big sister is the "kilometer." She is used to measure long distances and is about 5/8ths of a mile.

Long distances are measured in ______. A kilometer is (longer/shorter) ______ than a mile?

It is ten miles from Chicago to a suburb.

The distance in kilometers is (more/less) ______ than ten miles.
Josha says,
"The second metric term is 'gram.' It is the base unit of mass or weight. The symbol for gram is a small 'g.'"

The term used when measuring weight is ____. The symbol consumers will use is "g".

Gram's big brother is the "kilogram." He weighs a little more than twice our pound.

A kilogram is (lighter/heavier) ____ than a pound?

Some of the things weighed as mass expressed in grams are pictured below:

Put a check by the example(s) that we will express in grams. 1. your weight 2. distance from where you are now to Chicago 3. a bar of soap.
Which would you express in meter and grams? Answer each example by using the correct abbreviation.

_____ 1. wallpaper
_____ 2. can of peas
_____ 3. carpet
_____ 4. house
_____ 5. hamburger

Josha says, "The third metric term, 'liter,' is the derived unit of volume. The symbol used by the consumer will be a little 'l.'"

"Liter rhymes with ______. The unit of volume is the _____ and its abbreviation is _____.

The liter is used for measuring liquids such as milk, paint and oils.

Which is larger, the quart or the liter? _____

Think of a food that would be measured in liters _____.
Write the abbreviation for the unit (meter, gram or liter) used to measure each of the following:

1. soda pop  
2. cheese  
3. lemonade  
4. bread  
5. table top size  
6. door size

Josha says, 'The last metric term is 'Celsius,' the unit of temperature. Pronounce it this way: cell see us. The symbol will be °C' (degree sign with capital C).'

The unit of temperature used in the metric system is ____. The symbol that will be used to express Celsius is ____.

In Celsius the temperature at which water freezes is _____. Water boils at _____. 
Josha wants you to tell him what unit to use to measure each of the following. Use the symbol.

1. distance to your house
2. salt in a shaker
3. oven temperature
4. fuel in a car
5. room dimensions
6. pitcher of milk
7. sugar in a sugar bowl
8. warmth of a room

Josha wants to know,
"What do you measure when each of the following terms are used?"

1. meter ______
2. liter ______
3. gram ______
4. Celsius ______

Josha says,
"Many prefixes are used in the metric system. A prefix is a syllable added to the beginning of a word to change its meaning such as 'sub' in 'subway' and 'submarine'."

What are the prefixes in each of these three words: unnecessary repay dislike
METRIC CONE OF PREFIXES

kilo
hecto
deka
meter, liter, gram
deci
centi
milli

more than 1
Base units
less than 1

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NUMERICAL VALUE OF PREFIXES

kilo 1000
hecto 100.0
deka 10.00
meter liter gram
deci .100
centi .010
milli .001

Base units

25

NUMERICAL VALUES OF PREFIXES AND FRACTIONS

kilo 1000
hecto 100.0
deka 10.00
meter liter gram
deci .1
centi .01
milli .001

26
Makes sense, doesn't it?

Look at the card labeled "Metric Cone"

From the base units line-

1. How many steps down the cone is a deciliter?
2. How many steps down the cone is a centigram?
3. How many steps down the cone is a milligram?
4. How many steps up the cone is a kilometer?

Metric prefixes are specific multiples or divisors of ten. A good example of a system based on tens is our money system: pennies, dimes, dollars, ten dollars, hundred dollars....

The basic units, (meter, gram, liter) in the metric system have prefixes attached to them based on multiples or divisors of _____.
The metric base units, (meter, liter, gram) can be changed by adding the prefixes. Celsius is different because it doesn't take one of these prefixes.

Which metric base units are combined with a prefix? ______

Josha says, "Let's take each one of these prefixes and use it to change the base unit. The prefix that stands for 1/10 or .1 of a base unit is 'deci.' The abbreviation for deci is a little 'd'.'"

The prefix that stands for .1 of a base unit is ______. You will use the symbol ______.

Just as a dime is 1/10 (.10) of a dollar, a decimeter is ____ of a meter.
Josha says,
"The prefix that stands for 1/100 or .01 of a base unit is 'centi'. Its abbreviation is a little 'c'."

A hundredth of a liter is expressed by the prefix ___. Its symbol is ___. 1/100 of a liter is called a ___.

Just as a hundredth of a dollar is one cent, 1/100 of a gram is one ___.

decimeter

centi
"c"
centimeter
centiliter

centigram
Just as there are 100 cents in one dollar there are _____ centimeters in 1 meter.

(____ cm. = 1 m.)

Just as there are 10 cents in one dime there are _____ centiliters in 1 deciliter.

(____ cl. = 1 dl.)

When changing size of units, sometimes we multiply by 10 and sometimes we divide by 10.

One dime is 1/10 of a dollar, one dollar is 10 dimes.

Fill in the blanks.

1. 1 dg. = ____ cg.

2. 1 cm. = ____ dm.

Moving to the smaller end of the cone we divide by 10 or use fractions. Moving to the upper part of the cone we multiply by 10.
Josha says, "The smallest prefix is the 'milli,' which is 1/1000 of a base unit. The abbreviation for milli is a little 'm'."

Place a check beside the word that stands for a thousandth of a gram.

1. decigram
2. milligram
3. centigram

It takes 1000 millimeters to make one meter.

1000 milligrams = ____ gram(s)

(number)

What is this larger unit called? ____

1 centimeter

What is this smallest unit called? ____

1 millimeter
How many times smaller is a deciliter than a liter?  10  
How many times smaller is a centiliter than a deciliter?  10  
How many times smaller is a centiliter than a base unit?  100  
What part of a liter is a deciliter?  1/10  
What part of a deciliter is a centiliter?  1/100  
What part of a liter is a centiliter?  42  

Up to this point we have been working with fractions, perhaps an easier way to think of it is to move the decimal point. All it takes to change from one size unit to another is to move the decimal to the right or to the left.

The metric prefixes are based on the _____ system.

When you are going from a larger unit to a smaller unit, it takes more of the smaller units, therefore move the decimal to the (right/left) _____.

An object weighs (more/fewer) _____ centigrams than a decigram.

To express the weight in centigrams rather than decigrams, move the decimal to the (right/left) _____.
Now use SIDE A of the metric slide chart which accompanies this program.

Put it in the START position.

Use the slide to go from the base unit to the next smaller unit.

Did you move the decimal to the right or to the left?

All numbers on SIDE A are equivalents of 1 gram or 1 meter or 1 liter. These equivalents are computed by moving the decimal to the right.

You must pull the slide chart to move the decimal one place to the right.

Read the number and window to complete the equations.

1. \(1 \text{ m.} = \frac{\text{number}}{\text{symbol}}\)
2. \(1 \text{ g.} = \frac{\text{number}}{\text{symbol}}\)
3. \(1 \text{ l.} = \frac{\text{number}}{\text{symbol}}\)

Use SIDE A and pull the slide chart 2 places to the right from START.

Read the number and window and complete the equations.

1. \(1 \text{ l.} = \frac{\text{number}}{\text{symbol}}\)
2. \(1 \text{ g.} = \frac{\text{number}}{\text{symbol}}\)
3. \(1 \text{ m.} = \frac{\text{number}}{\text{symbol}}\)
Use SIDE A and pull the slide chart 3 places to the right from START.

Read the number and window and complete the equations.

1. 1 g. = \[ \frac{\text{number}}{\text{symbol}} \]
2. 1 l. = \[ \frac{\text{number}}{\text{symbol}} \]
3. 1 m. = \[ \frac{\text{number}}{\text{symbol}} \]

When going from a smaller unit to a larger unit, it takes fewer of the larger units, therefore move the decimal to the \( \text{(right/left)} \).

Starting with 1000 mm move the slide two places to the left.

1000 millimeters = \( \frac{\text{number}}{\text{symbol}} \) decimeters

Use SIDE B and set the slide chart on START position.

Pull the slide chart to move the decimal one place to the left.

Read the number and complete the equation.

1. 1 dm = \[ \frac{\text{number}}{\text{symbol}} \] m
2. 1 dl = \[ \frac{\text{number}}{\text{symbol}} \] 1
3. 1 dg = \[ \frac{\text{number}}{\text{symbol}} \] g
Use SIDE B and pull the slide chart 2 places to the left from START.

Read the number and complete the equation.

1. \( 1 \text{ cm} = \frac{\text{m}}{\text{(number)}} \)
2. \( 1 \text{ cl} = \frac{1}{\text{(number)}} \)
3. \( 1 \text{ cg} = \frac{\text{g}}{\text{(number)}} \)

Use SIDE B and pull the slide chart 3 places to the left from START.

Read the number and complete the equations.

1. \( 1 \text{ mm} = \frac{\text{m}}{\text{(number)}} \)
2. \( 1 \text{ ml} = \frac{1}{\text{(number)}} \)
3. \( 1 \text{ mg} = \frac{\text{g}}{\text{(number)}} \)

Complete the following equations.

1. \( 4 \text{ l.} = \text{______ ml.} \)
2. \( 10 \text{ dm.} = \text{______ cm.} \)
3. \( 30 \text{ mg.} = \text{______ dg.} \)
4. \( 40 \text{ cm.} = \text{______ m.} \)
5. \( 1 \text{ g.} = \text{______ mg.} \)
The consumer will be concerned with only one multiple prefix, which will make a larger unit. This is a 'kilo' which stands for 1000 times a particular base unit. Its abbreviation is a small 'k'."

The prefix that stands for 1000 times a base unit is _____. Its symbol is _____.

A "grand" in money means $1000. It is 1000 times larger as large as one dollar. Just as 'kilo' means 1000 times a particular base unit.

A kilogram is (larger/smaller)_____ than a gram.

Fill in the blanks by writing the prefix word for the following numerical values.

1. 1000 x _____
2. 1/100 _____
3. 1/1000 _____
4. 1/10 _____
Josha says, "Let's see how much we remembered by putting in your own words the meaning of the following prefixes:

1. kilo -- **
2. centi -- **
3. milli -- **
4. deci -- **

1. 1000 times a base unit
2. 1/100 of a base unit
3. 1/1000 of a base unit
4. 1/10 of a base unit
BASIC METRIC

I. DIRECTIONS: This is a story about the three metric brothers and their first cousin. Fill in the blanks with the correct word or words, writing your answer on the answer sheet.

Mr. Metric is introducing his family to a consumer who wants to know him better.

"My first brother, the basic unit of length, is named 1. He is a little more than 3 inches longer than his English friend the 2. Long distances are measured in 3. Each of these is 4 of a mile.

Let me introduce my second brother, the basic unit of mass. His name is 5. If my brother and 999 of his friends stood on a scale they would weigh a little more than twice a(an) 6.

Our first cousin, a unit of volume, goes by the name of 7. She is used for measuring liquids and is slightly more than a(an) 8.

My youngest brother, the unit of temperature is 9. The boiling and freezing points of water on his scale are 10 and 11 respectively."
II. DIRECTIONS: Write the appropriate unit of measure (gram, liter or meter) by each description. (Ex. weight of candy bar gram)

1. length of football field
2. weight of a sack of potatoes
3. lemonade in a pitcher
4. water in a swimming pool
5. your weight
6. length of a kitchen floor

III. DIRECTIONS: The following are metric prefixes that are attached to the basic units: meter, liter and gram. Write the corresponding numerical value of each prefix. (Ex. deca 10 )

1. milli
2. deci
3. kilo
4. centi

IV. DIRECTIONS: To save time in the use of the metric system, consumers use symbols. Record the unit the symbol represents and vice versa. (Ex. dg. = decigram)

1. liter
2. decigram
3. cm.
4. millimeter
5. kl.
6. cg.
7. milligram
8. meter
9. ml.
10. kg.
11. kilometer
12. gram

V. DIRECTIONS: Fill in the space under the headings; unit, symbols and value; with the proper term and number.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>SYMBOL</th>
<th>VALUE</th>
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</thead>
<tbody>
<tr>
<td>1. liter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>dm.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>1 meter</td>
</tr>
<tr>
<td>4. centiliter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>1/1000 meters</td>
</tr>
<tr>
<td>6. millimeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>cm.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>1000 liters</td>
</tr>
<tr>
<td>9.</td>
<td>g.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>1/100 grams</td>
</tr>
</tbody>
</table>

VI. DIRECTIONS: The following is a list of metric abbreviations preceded by a 1. Write the equivalent which completes the equation. (Ex. 1 dl. = 1/10 1.)

1. 1 cm. = _____ mm.
2. 1 l. = _____ m.
3. 1 dm. = ____ cm.
4. 1 km. = ____ m.
5. 1 ml. = ____ l.
6. 1 cl. = ____ l.
7. 1 kg. = ____ g.
8. 1 g. = ____ kg.
9. 1 mm. = ____ m.
10. 1 g. = ____ mg.

VII. DIRECTIONS: Below you will find a list of common expressions that contain various customary units of measure. Convert the customary unit that is underlined into metric units. Use only meter, Celsius, liter and gram for your answer.

1. An ounce of practice is worth a pound of preaching.
2. Give them an inch, and they will take a mile.
3. It is better to buy a quart of milk by the penny than keep a cow.
4. An ounce of prevention is worth a pound of cure.
5. He's all wool and a yard wide.
6. A miss is as good as a mile.
7. 101°F in the shade.
8. My cup runneth over.
9. I wouldn't touch that with a ten-foot pole.
10. To put a quart into a pint-pot.
11. The texan was wearing a ten-gallon hat.
12. Don't hide your light under a bushel basket.
13. Five foot-two, eyes of blue.
I. DIRECTIONS: This is a story about three metric brothers and their first cousin. Fill in the blanks with the correct word or respond to the directions, writing your answer on the Answer Sheet.

Mr. Metric is introducing his family to the consumer who wanted to know him better.

My first brother, the basic unit of length, is named 1. He is a little more than 3 inches longer than his English friend the 2. Long distances are measured in 3. They are about 4 of a mile.

Let me introduce my second brother, the basic unit of mass. His name is 5. If my brother and 999 of his friends stood on a scale they would weigh a little more than twice a(an) 6.

Our first cousin, a unit of volume, goes by the name of 7. She is used for measuring liquids and is slightly more than a(an) 8.

Mr. Metric introduced his youngest brother, the unit of temperature, as 9. The boiling and freezing points of water on his scale are 10 and 11 respectively.
II. DIRECTIONS: Write the appropriate unit of measure (gram, liter or meter) by each description. (Ex. weight of candy bar gram)

1. length of a block
2. weight of cookies
3. gas in a car
4. weight of a baby
5. how far you can throw a ball
6. water in a fish bowl

III. DIRECTIONS: The following are metric prefixes that are attached to the basic units: meter, liter and gram. Write the corresponding numerical value beside each prefix. (Ex. deka 10)

1. milli
2. kilo
3. deci
4. centi

IV. DIRECTIONS: To save time in the use of the metric system, consumers use symbols. Fill in each blank with the unit the symbol represents and vice versa. (Ex. dg. = decigram)

1. g.
2. dm.
3. centimeter
4. mm.
5. kiloliter
6. centigram
7. mg.
8. m.
9. milliliter
10. kilogram
11. km.
12. l.

V. DIRECTIONS: Fill in the space under the headings: unit, symbols and value; with the proper term and number.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>SYMBOLS</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
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<td>1. ________</td>
<td>________</td>
<td>.01 grams</td>
</tr>
<tr>
<td>2. millimeter</td>
<td>________</td>
<td></td>
</tr>
<tr>
<td>3. ________</td>
<td>________</td>
<td>.1 grams</td>
</tr>
<tr>
<td>4. kilometer</td>
<td>________</td>
<td></td>
</tr>
<tr>
<td>5. ________</td>
<td>________</td>
<td>.001 grams</td>
</tr>
<tr>
<td>6. ________</td>
<td>kg.</td>
<td></td>
</tr>
<tr>
<td>7. ________</td>
<td>________</td>
<td>.01 liters</td>
</tr>
<tr>
<td>8. ________</td>
<td>________</td>
<td>.001 liters</td>
</tr>
<tr>
<td>9. centimeter</td>
<td>________</td>
<td></td>
</tr>
<tr>
<td>10. ________</td>
<td>________</td>
<td>.1 liters</td>
</tr>
</tbody>
</table>

VI. DIRECTIONS: The following is a list of metric abbreviations preceded by a l. Write the equivalent which completes the equation. (Ex. 1 dl. = 1/10 l.)

1. 1 mm. = ______ cm.
2. 1 ml. = ______ l.
3. \(1 \text{ cm.} = \underline{\_\_\_\_} \text{ dm.}\)

4. \(1 \text{ m.} = \underline{\_\_\_\_} \text{ km.}\)

5. \(1 \text{ l.} = \underline{\_\_\_\_} \text{ ml.}\)

6. \(1 \text{ g.} = \underline{\_\_\_\_} \text{ kg.}\)

7. \(1 \text{ l.} = \underline{\_\_\_\_} \text{ cl.}\)

8. \(1 \text{ kg.} = \underline{\_\_\_\_} \text{ g.}\)

9. \(1 \text{ m.} = \underline{\_\_\_\_} \text{ mm.}\)

10. \(1 \text{ mg.} = \underline{\_\_\_\_} \text{ g.}\)

VII. DIRECTIONS: Below you will find a list of common expressions that contain various customary units of measure. Convert the customary unit that is underlined into metric units. Use only meter, liter, Celsius and gram for your answer.

1. You give 'em an \underline{inch} and they'll take a mile.

2. \(101^\circ\text{F}\) in the shade.

3. Peter Piper picked a \underline{peck}.

4. There was a crooked man, and he walked a crooked \underline{mile}.

5. My \underline{cup} runneth over.

6. I'll not budge an \underline{inch}.

7. It is better to buy a \underline{quart} of milk by the penny than keep a cow.

8. I walked a Lonely \underline{Mile}.

9. An ounce of prevention is worth a \underline{pound} of cure.

10. Bake cookies at \underline{350^\circ\text{F}}.

11. To put a quart into a \underline{pint-pot}.

12. When weighing meat by the \underline{pound}, you use the term that rhymes with ham.
13. When it's springtime in Alaska it's 40 below.
Metric Slide Chart Panel A

SIDE A

1 liter = 1000 gram

Open Ended Envelope Index Card

SIDE A INSERT

ml cl dl l mm cm dm m mg cg dg g

START
Metric Slide Chart Panel B

SIDE B

10000 = 0.001 gram liter meter

Open Ended Envelope Index Card

SIDE B INSERT

g dg cg mg m dm cm mm l dl cl ml

START
METRIC CONE PANEL

Metric Cone

- kilo: 1000
- hecto: 100
- deka: 10
- meter: 1
- liter: 1
- gram: 1

Decimals:
- deci: 0.1
- centi: 0.01
- milli: 0.001

Base units:
IT'S ALL OVER
(Your reacting to steps in this program)

NOW HOW DO YOU FEEL ABOUT IT?

Face reality first. Metric measurements are coming and we must learn to use them.

Would you recommend this particular set of teaching materials for your best friend? _____

Tell us why by checking a point that represents how you feel about this program. Each line represents a scale from one extreme to the other. For example this program was boring or interesting or somewhere in between.

- Boring
- Difficult
- Frustrating
- I will forget rapidly
- Interesting
- Easy
- Satisfying
- Probably will remember

It's one thing to learn about something and its another thing to use it.

Number these methods in the order you think they would help you to become a master user of the metric system. Number 1 is your first choice and number 7 your last. We are now talking about how you think you would be helped to remember and use the learning, not how well you like the method.

- watching a movie
- listening to a teacher
- reading a book
- working in lab under guidance of a teacher
- doing the exercise in a program like this
- listening to tapes
- reading things available in newspapers and magazines

On the back side of this sheet write anything else you would like to tell us about how you felt about the teaching materials.