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A Study to Determine Virginia Industrial Arts Teacher's Knowledge of Terms Associated with the Metric System of Measurement

Samuel P. Bowers
Old Dominion University

A STUDY TO DETERMINE VIRGINIA INDUSTRIAL ARTS TEACHER'S KNOWLEDGE OF TERMS ASSOCIATED WITH THE METRIC SYSTEM OF MEASUREMENT

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Samuel P. Bowers

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John M. Ritz

John M. Ritz, Ed.D.
Graduate Advisor

E. Murray Rudisill, Ph.D.
Graduate Program Director
Secondary Education

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Chapter 1

INTRODUCTION

The metric system of measurement will become the system of measure for the United States in the very near future. Over the next decade, inch, ounce, and pound will gradually be replaced by meter, liter, and gram. Although these units of measurement are common to most sectors of the world, for the majority of persons living in this country the INTERNATIONAL SYSTEM OF UNITS (S.I.) is not familiar (Koble, 1976, p. 113).

When the United States converts to the metric system of measurement, educational systems will play an important role in this metrification. These systems will be held responsible for the education of the youth, since they will need to know how to work within this new system of measurement.

The areas of education most affected by metrication will be the math, sciences, and industrial arts as well as vocational areas. Since measurements are essential in these areas, the metric system will have to be heavily emphasized, so upon graduation, the student who enters an industry or field that might have converted to the metric system will be able to use the new system of measurement without hesitation or extra training. Before a teacher can instruct students in the use of the metric system, he or she must understand and be able to use the metric system and the tools involved. The question that arises is: Will more emphasis be needed on the understanding of the metric system in teacher preparatory colleges?

This study hopes to answer this question by determining how many new and existing Industrial Arts teachers in Virginia understand the basic metric terminology and how to use the metric system of measurement.

STATEMENT OF THE PROBLEM

The problem of this study was to determine Virginia industrial arts teacher's knowledge of terms associated with the metric system of measurement.

RESEARCH QUESTIONS

This problem was answered by focusing on the following questions:

1. Are Industrial Arts teachers in the state of Virginia ready to teach the metric system of measurement in their shops?
2. Do the Industrial Arts teachers in Virginia understand the common terms, their conversion to English, and prefixes associated with the metric system of measurement?

LIMITATIONS

This study was to determine how many Virginia Industrial Arts teachers understood the terminology and how to use the metric system of measurement. It was not meant to measure the general math ability of the teachers, but to determine if the teachers knew what the metric terms, prefixes, and conversions were. The data collected from the survey only relates to Virginia Industrial Arts teachers and not to any other area in the United States.

BASIC ASSUMPTIONS

The following assumptions were made before the data was collected and tabulated:

1. That the teachers who were to be surveyed did not look up the answers that they did not know at the time they completed the survey.
2. That the teachers did answer all the questions to the best of their ability.
3. That all Industrial Arts teachers surveyed taught in an area that will be affected by the conversion to the metric system.

BACKGROUND

Although legislation has been enacted to provide a planned, voluntary schedule for metric conversion in the United States, the United States is still way behind other countries in converting. According to a national metric contigency study concerning problems in vocational education planning for metric conversion, 96% of those surveyed said that it would take ten years or more to convert to the metric system in education (Duffenderfer, 1974, p. 85).

In 1973, the House of Representatives made a bill providing a span of ten years after which the metric system would be predominant, but not the sole system of weights and measures in the United States (Esch, 1974, p.54). This bill was later changed to the Metric Conversion Act of 1975, which called for voluntary changeover to the metric system. This legislation created the U.S. Metric Board to develop and carry out a program of gradual conversion. This program was expected to promote the increased use of metric usage in business, industry, and education (Simone, 1977, p. 363).

In relation to this act, educators must become aware of their role in preparing students of today to become leaders of tomorrow.

> Full awareness of the metric system will occur in schools and it will be far easier for a child to adapt to the new system than it will be for an adult. It would not take much to teach metrics, providing we as educators, learn the system first.
> (Baillargeon, 1974, p. 83)

The important point to remember concerning the above mentioned statements is that teacher educators must prepare teachers who are competent enough to teach students in the terminology and usage of the metric system of measurement. As evidence will be given, this has not been done in the past.

For instance, in 1969, a Gallup Poll (1970, p. 59) was made in which people were asked the question, "Do you know what the metric system is?" and only 67% of the college graduates polled answered in the affirmative. The author suggests that it is hard to believe that one out of three people go through a four year college without learning what the metric system is. It also must be assumed that many of those polled, who said that they knew what the metric system is, merely knew its name, without knowing how it worked.

As stated by Feirer (1972, p. 19), every teacher education institute should evaluate its courses and make changes where needed to make teachers "think metric". If this is not done, grave problems will develop in converting to the metric system. He states that in-service classes are needed to help prepare the experienced teacher for the change.

Instructors of vocational and technical education will be among the first to face the challenge of metric conversion. Drafting equipment, tool graduation, and machine settings will have to be converted or replaced.

Nelson (1972, p. 22) surveyed the senior Industrial Education majors at Stout State University and learned that most had received limited training in the metric system, but 40% had some difficulty interpreting prefixes of the metric units and could not convert from one system to another.

According to another survey made of Industrial Arts teachers by Nelson (1972, p. 22) almost 40% of the teachers have no formal training related to the metric system. As can be seen, there is a need for additional training in the metric system. It is apparent that educational programs will have to develop programs for these teachers. Nelson states that the educational consultants to the United States Metric Study estimated that it would take from eight to fifteen hours of in-service training to prepare most Industrial Arts teachers in the use of the metric system.

As can be seen by the preceding research, the metric conversion of the United States is in the very near future. According to past surveys, there is a need for more emphasis to be placed upon the understanding of the metric system of measurement. Especially true is the case for Industrial Arts teachers, both old and new to the system in Virginia. Since education is to play such an important role in the metric conversion process, teachers must be well versed in the use of the metric system. Colleges are going to have to re-vamp their curriculums to incorporate the new language that will be found on campus, Metrics.

DEFINITIONS OF TERMS

The following is a list of terms related to the following research. A basic knowledge of these terms will help in understanding this research problem.

(1). Teacher Preparatory Colleges - are schools of higher learning, offering specialized instruction in teaching techniques.

(2). Curriculum - as defined by Webster's Dictionary (1966, p. 338), to be a complete progressive series of studies in a certain field necessary for graduation or to receive a degree.

(3). Industrial Arts Teachers - as defined by Bonser and Mossman (1963, p. 70), is one who instructs students in understanding the changes made by man in forms of materials to increase their values and the problems and processes related to these changes.

(4). Public School System - as defined by Webster's Dictionary (1966, p. 1177), is a group of institutions supervised by municipal, county, or state authorities and that are maintained by public taxes, thus they are free to children in the district.

(5). Student - is one who attends an institution of learning.

(6). Metric System - as defined by Webster's Dictionary (1966, p. 927), is a decimal system of weight and measures that commonly uses the meter for length, the gram for mass, the second for time, and the degree Celcius for temperature, and units derived from these.

(7). Existing Teacher - ones who have taught in their particular field for two or more years.

(8). Likert Scale - as defined by Ary, Jacobs, and Razavieh (1972, p. 179), presents a number of positive and negative statements regarding an attitude object.

(9). Stratified Sampling - as defined by Ary, Jacobs, and Razavieh (1972, p. 164), is when the population consists of a number of subgroups or strata that may differ in the characteristics being studied.

(10). Pearson r Formula - as defined by Ary, Jacobs, and Razavieh (1972, p. 116), is also known as the product moment coefficient of correlation. It is used when the scale of measurement is either of the interval or the ratio type. It is defined as the mean of the z-score products, that is, each individual's score on one variable (X) is multiplied by his z-score on the other variable (Y).

SUMMARY

This study was justified since the United States is already in the process of converting to the metric system of measurement. As can be seen from the related studies much needs to be done in teacher preparatory colleges in order to meet the needs of students who will become leaders in a metric oriented world.

The following four chapters hopes to enlighten this problem by giving a review of related literature on the conversion to metrics, outlining a research procedure, explaining the working of the research procedure, and then compiling and tabulating the data related to the research questionnaire. At the summary, conclusion and recommendation part of the research paper (Chapter 5), it is hoped to enlighten you on the necessity for colleges to strengthen their use of the metric system in their teaching of new and old teachers as a part of their requirements to educate the teacher who in turn can educate the students.

Chapter 2

REVIEW OF LITERATURE

Man has always measured his surroundings in one way or another. Ancient man judged distances by guessing which was based on his various experiences - sighting, pacing, and the like. This type of measurement was adequate at that time since his world demanded no accuracy. However, as the requirements for greater accuracy increased, man began to use various parts of his body, along with barley corns, wheat, rice, and poppyseed for a measurement base. This lacked any semblance of standardization, obviously, due to variance in sizes.

Finally, followed by much confusion, even death penalties, and on-and-off enforcement, France in 1837 established by law the metric-decimal system. Others followed, including such countries as Italy, Portugal, and Germany until the metric system spread throughout the world. (Lundy, 1974 - 24)

The world is constantly becoming smaller, but the United States is still just an island in the world of measurement. America has, of yet, converted to the metric system of measurement. America will convert to metrics; we cannot remain as the only significant world power not using metrics. No matter what our government does or does not do about metrication, law or no law, American industry is going metric. (Turner, 1974 - 13)

Our American industry moves at a terrific rate of progress, caused by competition, economics, and market demands created by an ever-changing society. Industrial Arts teachers must stay abreast of this movement in the classroom in order to fulfill the demands placed on them by industry. Modern industrial concepts must be included in any and all acceptable industrial arts programs.

Industrial Arts teachers must not wait to be pushed by anyone - they must move with industry with the metric conversion.

METRIC GROWTH

The move toward metric systems is not new. The United States Government has debated the issue since 1821. In that year, John Quincy Adams stated that the metric measure was the closest system to uniformity applied to weights and measures. (Martin, 1974 - 16)

The United States legalized metric weights and measures by an act of Congress in 1866... (Turner, 1974 - 13)

Since 1866, numerous bills, 36 from 1900 to 1930, have been introduced in Congress. Each time the bills aroused interest and thought, but very little action.

In 1968, Congress passed the U.S. Metric Study Act. This act directed the Secretary of Commerce to arrange an inquiry and evaluation into a system of fixed standards of weights and measures. The Secretary then charged the National Bureau of Standards with the task. Public hearings and debates were represented by people and groups from all walks of life - business, labor, education, industry, medicine, real estate, wholesalers, agriculture, to name a few. These hearings, debates, and investigations, and subsequent writings became known as the U.S. Metric Study.

The findings and conclusions of the Metric Study were reported in 1972. The results are too numerous to list. Some of the major results are the following:

1. The United States is increasingly moving in a haphazard manner toward a metric system. Physicians, pharmacists, and scientists currently use the metric system as a measurement language. Manufacturing and non-manufacturing industries

are gradually adopting the system. Math and science education currently include metric as part of the instructional program.

2. The United States should adopt the metric system through a highly coordinated and national planned procedure. The transition period should be ten years. This time period would allow industry, business, education, etc., ample time to make the changeover. There would be a minimum of dual inventories, dual production, and dual education.

3. An International Metric System is currently being developed. The U.S. should participate fully in developing these standards. Full-scale participation allows an international system to be adaptable to American technology. Since only about 10% of these standards have been developed, U.S. influence in establishing further standards depends on our willingness to adopt the standards.

4. The costs and benefits of metric use are impossible to evaluate. Its effect on world trade is important, but immeasurable. Foreign countries are more willing to import products which are measured in metric units. International communication would improve. New jobs would result in the U.S.

5. The rule of reason will govern any metric conversion. For example, a football field will always be 100 yards long. A runner will still gain 10 yards, not 9.144 meters. (Martin, 1974 - 16 & 17)

In 1972, a bill in Congress declared that it was National policy that the country convert to the metric system voluntarily and it would create a twenty-one member National Metric Conversion Board to make a plan for the changeover. The bill would not force anyone to change measuring systems, but it would have an impact on the progress of the changeover. In 1974 the bill was defeated, due to opposition of labor organizations who claim the changeover would be costly members of the country's labor force and small businesses in terms of both tools and training.

Finally, on December 23, 1975, President Gerald R. Ford signed the Metric Conversion Act of 1975 calling for voluntary conversion to the metric system and establishing a U.S. Metric Board to coordinate that conversion. (Weaver, 1977 - 294)

The President's signing the Metric Conversion Act of 1975 is a milestone in the history of the U.S. measurement policy. The United States is ~~new~~ committed to providing a national program that will make the International Metric System the predominant but not exculsive system of measurement throughout the country. Metric conversion remains a voluntary activity for the next ten years.

In 1975, at the Office of Education of the Department of Health, Education, and Welfare, $2 million was appropriated to establish a metric education program to support model projects for improving metric education throughout the country.

Various metric education programs are under way in all 50 states. In many schools steps have been taken to incorporate the metric system, especially through the new science and mathematics curriculums of the past decade. Professional associations have also been concerned with metric education. A recent questionnaire to 100 scientific societies affiliated with the AAAS showed that science and mathematics education associations have been producing metric education materials.

Public awareness of the metric system has increased steadily, according to Gallup pools conducted in 1965, 1971, and 1973. More than half of the adults polled in 1973 were aware of the metric system, nearly twice as many as in 1965. However, only 30 percent of the sample gave an accurate description and, of this group, 60 percent favored adoption of the metric system.

Until now metrication in the United States has been voluntary and uncoordinated. The Metric Conversion Act of 1975 is the congressional response to this absence of coordination and direction. The new law establishes a U.S. Metric Board to coordinate voluntary conversion to the metric system within the next ten years.

The composition and method of selection of the members of the board is a recognition of the importance of metric conversion and its diffuse impacts upon American society. The chairperson and 16 members of the board are to be appointed by the President with the advice and consent of the Senate. Twelve members are to be chosen from lists of individuals submitted by organizations and groups with the following interests: engineering, science, and technology, manufacturing (including retailing and commerce), labor, state and local governments, small business, building construction, standards making, and education. Four members are to be selected at large to represent consumers and other concerned groups.

The board will have three functions: to prepare and implement a comprehensive program of planning and coordinating metric conversion; to carry out a program of public information and education at all levels of society; and to conduct related research and submit recommendations to Congress and the President.

The great barrier to the public acceptance of metric measurement appears to be anxiety - the fear of the unknown, the dread that learning to use metric will be difficult. Scientists and other educators can help smooth the transition to metric by:

A. Continue participation in the discussions and planning of metric conversion.

B. Initiating and assisting in formal and informal public education activities.

C. Contributing to research on any unresolved problems or questions associated with metric conversion.

D. By scrupulously using the metric system themselves. (Rees, 1976 - 141)

WHY METRICS NOW?

One message is clear. We can delay metric usage but we cannot stop it. "Granted it will be costly in some, but not all instances. But will the delay be less costly or more costly? Granted we will have to replace some 6,000 standards now used in our customary system. But we will eventually have to write metric standards anyhow: let's begin to educate the public now." This is what the proponents of "metrication now" are saying, but many are not listening.

So far, most of the constructive planning has been in the private sector. Some educators, some industries, and some "nonadvocate" nonprofit organizations are leading the effort. (Smith, 1975 - 10)

PROS AND CONS FOR ADOPTING THE METRIC SYSTEM

One reason Americans accept their illogical system of weights and measures is that they do not know that a better system exists. This was confirmed by a Gallup pole in which people were asked the question, "Do you know what the metric system is?" Over 9 out of 10 grade school graduates (93%) replied in the negative; almost 3 out of 4 (71%) high school graduates said no. Only among the college graduates did a majority of the respondents (67%) answer in the affirmative. (Donovan, 1971 - 59)

Regardless of the obvious ignorance on the part of most Americans, there are some very logical and sound reasons why adoption and implementation of the metric system is desirable:

1. It would assist in maintaining a position of world leadership, since many foreign countries look to the United States for assistance.

2. It would be politically beneficial, as it would allow better communication between the United States and other countries.

3. It is easier to learn than the standard system - smaller number of related units.

4. Because the metric system is simplier, it therefore leaves less room for error - based on the decimal system.

5. The educational system would benefit. It makes a person more skillful with numbers, quantities, and calculations. Students should be more interested or less bored with a simplier number system.

6. Greater interchangeability would be gained among all countries. Parts and the like produced in different countries of the world would be the same.

7. It would put the United States in step with the rest of the world.

8. Since the metric system is so much simplier, time and money could be saved because of less sophisticated calculations.

It is estimated that the U.S. aero-space industry alone would save about $65 million a year in engineers' time by converting entirely to metric.

Conversely, opponents of the switch from present measurement to the metric see the following as some of the reasons the U.S. should not change:

1. The U.S. has achieved its status as a world leader through the use of inches and pounds.

2. With the advent of the computer, it is unnecessary to change over.

3. Changing would cause confusion.

4. People would have to be retrained.

5. It would be very costly, especially to small industry and business.

6. During changeover, the nation would be part metric and part customary.

There may be opposition and controversy, but the question of whether the United States is going metric is largely resolved. (Sherwood, 1972 - 16)

GOING METRICS IN INDUSTRIAL ARTS

There can be little doubt in the mind of any industrial arts teacher educator that the USA is going metric. The hundreds of articles dealing with the subject which have appeared in newspapers and magazines attest to this fact. So does the availability of hundreds of differend kinds of metric teaching materials from textbooks and instruments to films, workbooks, and charts. The questions in the mind of the industrial arts teacher educator are several, perhaps the most important of which is, "Exactly what am I supposed to be doing?" A number of agencies and organizations are dealing with his topic at present, and it might be well to review some of their findings and recommendations which could provide the basis for an action program for industrial arts teacher education.

The American Industrial Arts Association is involved in this area of activity in that it sits as a member of the Coordinating Committee for Education and Industrial Training of the American National Metric Council. Their executive secretary has attended several meetings dealing with this matter of metrics in teacher education, and now the American Industrial Arts Association has a committee actively engaged in program work.

The following is a review of a series of recommendations relative to metrics in industrial arts teacher education programs.

1. Of first priority is the matter of identifying some one faculty member in each department of industrial arts teacher education to assume a leadership role. This individual should become, in so far as possible, a metric expert in his field. He should be well versed in SI metrics. This means he should fully understand what the modernized metric system is, what its advantages are, what are

some of the metric practice problems which have emerged, and what base and derived units are going to be most used in industrial arts teacher education programs. This person also should be the recipient of all metric information that reaches the department. He should become responsible for collecting metric resource materials for use by himself and the faculty. Provision should be made for him to attend appropriate metric conferences which are sponsored by metric bodies throughout the country. He should provide leadership in his department for helping other faculty members become metrically qualified. He should further assist the faculty members in such areas as woodworking, drafting, and metal working to examine their programs carefully, to discover what specific kinds of metric information, tools, and instrumentation is required in this curriculum. An industrial arts teacher education department cannot hope to become actively involved in metric education without proper leadership.

2. The teacher education department must determine its role in metric education and establish a system of priorities.

3. The faculty must decide what kinds of metric in-service programs can and should be planned to meet the needs of the teachers in the field.

4. Following the decision as to kinds of workshops or in-service programs to be planned, the teacher educator should provide in-service workshops or in-service courses for teachers. These can be summer session courses, programs, seminars, workshops, or routine course offerings occuring throughout the year.

5. Teacher education departments must also recognize the need for help where needed. They should secure the services of qualified consultants to spend one or two days working with the faculty, helping them to learn metrics and to learn how to use them.

Teacher educators must work together to insure that their industrial arts teacher educators and others become aware of the importance of the metric conversion movement now taking place in the United States. (Lindbeck, 1974 - 9)

GOING METRICS IN-INDUSTRIAL EDUCATION

A major and somewhat drastic change will occur in our measurement system, involving a well-planned national effort. To accomplish this task, a ten-year transition period has been recommended. Educators from the elementary grades to the college level will be requested to make major contributions. Every school curriculum will be affected. Industrial education and its many areas provide a most opportune setting to perform a major role during this transition.

There are numerous problems in converting from the customary units to a metric system. Some of these are only superficial. Many are very realistic. All of the problems involve education in one form or another. Many of the problems "hit" at the heart of industrial education. Because of this, industrial education teachers in all areas of instruction are in a most opportune position to stand up and be counted. The growth and even existence of industrial education in the future will depend upon improving curricula, teacher competency, and instructional facilities. The introduction of the metric system seems to provide this opportunity for professional growth.

It would be impossible to list all the problems encountered in a metric conversion. However, there are some identifiable problems that have a direct bearing on all areas of industrial education such as the following:

1. Textbooks. Textbooks will be outdated. Some textbooks will need to be completely rewritten, while others will need only updating. The impact of this is rewarding. First, many of the outdated textbooks in the laboratory would now be automatically replaced. Second, curricular material would be updated. Third, courses of study would need revising and further development. Fourth, tremendous opportunities would exist for classroom teachers at all levels to contribute to professional publications. Fifth, textbooks not heretofore written would be in demand. Classroom teachers with special interest in metrics would have new avenues to become authors of textbooks.

2. Equipment. The thought of the cost of an equipment changeover is frightening to the taxpayer, administrator, and teacher. A planned transition period from obsolete equipment to updated equipment could be developed. New existing equipment could be phased out, if necessary, over a period of time. This would probably mean several years. Older equipment would need to be replaced immediately, or as soon as it wore out. Instead of ordering wooden and steel rulers in inches, you would be purchasing metric rulers, meter sticks, and meter tapes.

3. Teachers. An often-cited problem in converting to a metric system is the retraining of classroom teachers and teacher educators. This is not an easy task. In some cases, certain restraints will surely make it nearly impossible.

The classroom teacher and teacher educator are very similar to the industrial laborer. First, in-service education programs need to be established. The cost of these programs will be borne by the participants. Since most industrial education teachers are involved in some form of continuing education, this should not necessarily be an added expense. For those teachers not currently involved in continuing education, this gives them the opportunity to do so. The universities and colleges have an important role to play in providing metric workshops.

The impace of metric conversion on the teacher is relative to his professional readiness. It enhances him as a teacher in several ways. First, it gives him the opportunity to better himself professionally. Second, the occasion exists to develop new and/or revive curricular materials. Third, it allows him to show his leadership qualities during the metric conversion period. Fourth, through in-service education, it allows him to reestablish himself with a nearby university or college.

4. Students. It will probably be easier for students to convert to a metric measure than it will be for teachers, teacher educators, labors, etc.

However, the development of good textbooks, adequate laboratories, and retraining of teachers will make the task even easier.

There are several factors to be considered. First, the National Education Association is on record as recommending the teaching of the metric system as the primary measurement language. Second, it is reported that as much as 25% of class time could be saved in teaching math involving metric units. This extra time would provide the student the opportunity to pursue other interests. Third, a change to a metric system does not only mean that the students will be able to convert inches to meters, Fahrenheit to Celsius, pounds to kilograms, etc.; it also means that the student is to think metrically. Fourth, metric education involves students at all levels - elementary to adults.

The predicted impact on student development is phenominal. First, the base 10 units of the metric system allow slower children to learn the system more readily than the customary units. Second, many students are currently engaged in science curricula developed in metric measurements. Third, a student of the metric system will be better able to cope not only with future industrial problems, but with other problems related to the future of mankind. (Martin, 1974 - 16)

<u>GOING METRICS IN-VOCATIONAL EDUCATION</u>

No single change in educational content is going to affect all vocational curriculum more profoundly than conversion from the customary system of measurement to the SI international system.

Vocational educators constantly tell each other and the public that they are preparing young people to enter the world of business and industry, and today's world of business and industry is rapidly changing from customary to metric.

Regardless of the vocational curricular area concerned, all students will need to know and be able to use the metric system of measurement and understand the metric standards involved in their chosen field.

What are the challenges for vocational educators as they convert to metric education? Certainly the teacher, the administrator, the curriculum specialist and the state departments of vocational education each have a role to play in this endeavor.

Let's look at the problems vocational educators will face.

1. The classroom teacher. The first thing is to learn the SI metric system, the "modernized" system. Classroom teachers must also know and understand the national and international standards as they apply to their particular area. Today only a few metric standards are currently available. In the years ahead it is estimated that there will be about 11,000 metric standards covering everything. The classroom teacher must also be able to select good instructional material for use in metric conversion and learn how to use the necessary metric tools and equipment.

2. The administrator. Administrators have different but very definite responsibilities in metric conversion. They must first assess the cost of implementing the metric system and plan the budgets that will include enough funds to convert the equipment and provide for the necessary tools and other measuring devices. Administrators also have the responsibility of providing for in-service metric training for their staff, making sure that every instructor has an opportunity to work with a qualified metric expert in learning the system. Administrators must also coordinate with advisory committees the conversion to metric as it relates to each trade or occupation. It may also be the responsibility of vocational schools to provide input to industry, particularly the small and medium-sized industries that cannot afford a metric expert in their

own organization. Schools must be prepared to offer short courses for various industrial groups on metric conversion.

3. The curriculum specialist. The curriculum specialist in vocational education is responsible for evaluating current curriculums and courses of study to make sure that the metric system and metric standards are integrated in every curriculum. An analysis of current courses will certainly indicate that measurement is an important and an essential part of every phase of vocational education.

4. State Department of Education. Many state directors of vocational education currently look upon metrics as a low-priority item. They consider metric conversion to be primarily the responsibility of some other individual in the state department. This is a sad situation because metric conversion should be given far higher priority than almost any other aspect of the vocational program at this time. Before a state department spends money on developing performance objectives the conversion to metric measurement should be made.

It is time that vocational educator-from classroom to those with the state department of education-realize that metric conversion is here to stay and is the most pressing educational problem to be faced by all. (Feirer, 1977 - 23)

SUMMARY

Civilization has come a long way from seed and body member measurement to present impending use of the metric system for determining volume, weights, lengths, widths, and thickness. We may as well be resolved to the fact that change in this case will in all probability benefit mankind.

These changes or proposed changes to standardization are the prospects we in the U.S. will face soon. Other countries are concerned with them now, so it seems that our transition may be eased by their efforts. The climate for change in other countries has become favorable, but some costly adjustments may be ahead.

We should not shirk or be afraid of these differences as educators, for we may be called upon to work with industry, trade associations, and worker organizations to assist in the planning which leads to a universal standard. We could even be asked to teach or prepare industrial personnel, so it is imperative that we know about metric conversion.

The Chairman of the British Metrication Board, Lord Ritchie-Colder, pointed out that educators were essential to the metric changeover. They not only engaged students to think metric terms, but provided a second numerical language. Should metric conversion occur in the U.S., whether planned or unplanned, we as educators must prepare for metrication now.

As can be seen by the related review of literature, the metric conversion of the United States is NOW. We, as Industrial Arts teachers, must take a good hard look at what is facing us in the very near future. There is a need for more emphasis to be placed upon the understanding of the metric system of measurement. This is especially true for new and existing Industrial Arts teachers in the stat of Virginia.

Colleges are going to have to re-vamp their curriculums to incorporate the new language that will be found on campus, Metrics.

It was through this study that the author hoped to determine if, indeed, more emphasis must be, at the college level, placed upon the understanding of the metric terminology and the metric tools.

Chapter 3

METHODS AND PROCEDURES

Chapter 3 is devoted to the type of research design that was used in collecting the data, scale used, and how the data was analyzed.

Also, included in Chapter 3, is a description of how the subjects were selected; predictions as to what to expect from the outcome; conditions of testing; data analysis; and a summary.

RESEARCH DESIGN

This research study was of a descriptive nature. A questionnaire was used in collecting the required data for the analysis of the study. The Likert Scale was used in constructing the questionnaire and in determining the results of the data collected.

SUBJECT SELECTION

The study was concerned with 920 industrial arts teachers in the state of Virginia. A list of first year teachers and one of existing teachers was obtained from the Department of Education, Richmond, Virginia. Stratified sampling was used, from which the researcher randomly selected 90 teachers, by using the table of random numbers, from each group to make a total of 180 teachers in the sample.

OUTCOME MEASURES

The instrument used was a questionnaire consisting of statements about the metric units of measurements. The subject, who was surveyed, had three responses in which to choose from concerning each statement; if the statement was correct, incorrect, or if they were unsure. The statements dealt with three different phases of the metric system; (1) major metric units, (2) prefixes used with the major units, and (3) with the relation of metric units to the English units.

The validity of the questionnaire was determined by my advisor, Dr. John Ritz, Director of Graduate Programs, Old Dominion University, Department of Vocational and Industrial Arts Education.

The reliability was determined by the test-retest method. As explained by Ary, Jacobs, and Razavieh (1972 - 118), the scores of the tests were inserted into the Pearson r formula so that the coefficient of stability could be comput...

CONDITIONS OF TESTING

The questionnaire was mailed to all 180 industrial arts teachers in the state of Virginia. Included in the mailing was: (1) a letter explaining the purpose of the questionnaire and instructions for responding to the statements, (2) the questionnarie, and (3) a self-addressed, stamped envelope for returning the survey. The letter explained that the questionnaire was to be completed and returned as quickly as possible and that reference materials were not to be used while responding to the questionnaire statements.

If the return of the questionnaire for each group was less than 85%, the researcher would employ a follow-up program to reach a random number of those nonresponding subjects from each group. Another questionnaire was sent to those subjects with a different letter urging them to complete and return the questionnaire.

DATA ANALYSIS

After the questionnaires were returned, those filled out correctly were separated into two groups, according to first year or existing teachers. This was done in order to obtain the data sample. Using the Likert Scale, values of 3, 2, and 1 were assigned to each possible response, reversing the procedure for incorrectly stated statements. The score for each individual's test in each group was then computed. The sum of all the scores in each group were computed and compared to the highest possible score summation for each group of teachers. From this data, it was considered that these groups understand the basic elements in the use of the metric system, if their score summation will be greater than 90% of the highest possible score summation for their group.

The sum of the scores for each of the three phases of the metric system was computed for each group and compared to the highest possible score summation for each phase, in each group. This was to determine if each group was strong or weak in the three phases of the metric system (major metric units, prefixes of measurements). If the score summation for each phase was higher than 90% of the highest possible phase score summation, then the particular group was considered to be strong in that area.

SUMMARY OF CHAPTER 3

A questionnaire, mailed out to 180 industrial arts teachers in the state of Virginia, was used in collecting the data for the study. A test-retest-method of collecting the data was employed. The Likert Scale was used to determine the scores, which were computed to the highest possible score summation for each group. The three phases of the metric system were considered separately for each group and scores for each were handled in the same manner as described above.

Chapter 4

RESULTS OF THE STUDY

This chapter presents the results of the data collected in the survey of new and existing Industrial Arts teachers concerning metric terminology. There were 180 Industrial Arts teachers surveyed and 180 questionnaires were returned (After a follow-up letter was sent to 25 new teachers not responding to the first letter). Each survey was graded on a 28 point scale and the mean score was calculated for each group. The mean score for the first year teachers group was 25.1 and the mean score for the existing teachers group was 25.04. Table 1 gives you the necessary data for computing the mean score for each group.

Table 1

MEAN SCORE

Group	Σ Raw data	Number of Cases	Mean Score
X	2259	90	25.1
Y	2254	90	25.04

Computations are as follows:

$$\bar{X} = \frac{\Sigma X}{N} = \frac{2259}{90} = 25.1; \quad \bar{Y} = \frac{\Sigma Y}{N} = \frac{2254}{90} = 25.04.$$

Explanation of symbols:

$\bar{Y}$ - Mean Score for the existing teachers.
$\bar{X}$ - Mean Score for the new teachers.
ΣX - Sum of the data collected for new teachers.
ΣY - Sum of the data collected for the existing teachers.
N - Number of cases surveyed.

The interpretation of the data is that the mean score for each group was calculated by taking the sum or total score accumulated for each group on the survey and dividing it by the number of subjects in that particular group. The results of the survey, at this point, indicated that the groups surveyed (existing teachers and new teachers) were pretty much the same as far as an average of each group was concerned.

The survey was then broken down into the three phases (major metric units, prefixes of major metric units, and relation of the English to metric). This was done in order to determine how each group did according to the three phases. Table 2 (A, B, & C) provides the necessary data for comparing the new teachers in industrial arts with that of the existing teachers in industrial arts, as to their performance on each of the three phases of the survey.

Table 2 (A,B,&C)

Table 2 (A) - MAJOR METRIC UNITS

Group	Σ Raw Score	Σ Highest Possible Score	%
X	1355	1440	94
Y	1385	1440	96

Table 2 (B) - PREFIXES OF MAJOR METRIC UNITS

Group	Σ Raw Score	Σ Highest Possible Score	%
X	465	540	86.1
Y	411	540	76.1

Table 2 (C) - ENGLISH TO METRIC CONVERSION

Group	Σ Raw Score	Σ Highest Possible Score	%
X	442	540	82
Y	459	540	85

* Each Group, if they scored 85% of highest possible score, they were considered strong in that area.

Explanation of Symbols:

X - New Teacher in Industrial
Y - Existing Teacher in Industrial Arts

Raw Score - Total Score accumulated on each phase of the survey
% - Percent of score accumulated compared to highest possible score

A similar method was used to compare the over-all performance of new and existing teachers. The results of that comparison is contained in Table 2 (D).

Table 2 (D) - BASIC ELEMENTS OF METRIC SYSTEM

Group	Σ Raw Score	Σ Highest Possible Score	%
X	2259	2520	89.6
Y	2254	2520	89.4

** Overall performance - if each group scored 85% of total overall score (highest possible score), they understood the metric terminology and the basic elements of the metric system.

The interpretation of the data for the % (percent) for each group, as compared to the highest possible score summation, are as follows:

$$\% = \frac{\Sigma \text{Raw Score}}{\text{Highest Possible Score}}$$

(NOTE: The same symbols were used as were used in previous tests).

This reads as follows: If the group surveyed scored 85% of the total alotted percentage allowed, then they were considered to be strong in that particular area. Also, to compare the performance of each group surveyed to each other, the same held true for the percentage. That is, if the group surveyed, scored 85% of the total score as compared to the highest possible score, then they were considered to know the basic metric terminology and the basic units of the metric system.

Once the % (percentage) was calculated, it was then necessary to calculate whether or not the survey was, indeed, significant. To do this the use of the Person r formula for raw data was used to find the product moment correlation coefficient. See Table 3 for the data.

Table 3

PRODUCT MOMENT CORRELATION COEFFICIENT

X	Y	X^2	Y^2	XY
2259	2254	57,759	57,120	56,358

Pearson r formula, $r = \dfrac{XY - \dfrac{(\ X)\ (\ Y)}{N}}{X^2 - \dfrac{(\ X)^2}{N}\ Y^2 - \dfrac{(\ Y)^2}{N}}$

$r = .33$

Explanation of symbols:
X = Total raw score for New Teachers
Y = Total raw score for Existing Teachers
X^2 = Sum of the square of the raw scores for New Teachers
Y^2 = Sum of the square of the raw scores for Existing Teachers
XY = Product total of the New and Existing Teachers raw scores.

Once the correlation was determined, a test of the correlation was performed to see whether or not it deviated sufficiently from zero so that it cannot be regarded as a chance fluctuation from no relationship. In other words, does the correlation show a real or chance relationship? Assuming the null hypothesis that the values of the two variables (new teachers and existing teachers) are unrelated, the following test of significance was applied:

$$t = \frac{r\ \ N-2}{1-r^2}$$

$$= \frac{.33\ \ 90-2}{1-.33^2}$$

$$= \frac{3.10}{.94}$$

$$= 3.3$$

Explanation of symbols:
r = Pearson r product
t = t-test for stability significance
N = Number fo cases surveyed

Refering to Fisher's t-table in Introduction to Research in Education, by Ary, Jacobs, and Razavieh, page 360, with degrees of freedom = N - 2 or 88, it was found that at the .05 level of probability to be between 2.660 and 2.617. Since the observed value of t was 3.3 is greater than the .05 level of probability, it can be concluded that the correlation of .33 shows a real or significant relationship, and not a chance relationship, since there is only 5 chances out of 100 the relationship could be due to chance. Therefore, the null hypothesis must be rejected concerning no relationship between the two variables.

SUMMARY

This chapter as illustrated in Tables 1, 2 (A,B,C,&D), and 3, presented the results of the Survey Questionnaire. It analyzed the data gathered in categories including total raw scores, major metric units, prefixes of major metric units, the relation of English to metric, and a test of significance was performed to determine if, indeed, the data collected was significant. This information can be found in tables and problems in this chapter.

The following chapter summarizes the research of this paper, analyses the results of Tables 1, 2, and 3, draws conclusions, and makes recommendations.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

This study was undertaken to determine how many new and existing Industrial Arts teachers in the state of Virginia understand the metric terminology. To acocmplish this task, the researcher asnwered the following questions: (1) Are Industrial Arts teachers ready to teach the metric system of measurement in their shops? (2) Do the Industrial Arts teachers understand the common terms, their conversion to English, and prefixes associated with the metric system of measurement?

The study was concerned with 920 Industrial Arts teachers in the State of Virginia. A list of first year teachers and one of existing teachers was obtained from the Department of Education, Richmond, Virginia. Stratified sampling was used, from which the researcher randomly selected 90 teachers, by using the table of random numbers, from each group to make a total of 180 teachers in the sample.

A questionnaire was used in collecting the required data. One hundred percent of those surveyed responded to the survey. The data collected was analyzed and arranged in tabular form. This information revealed the knowledge of new and existing Industrial Arts teachers in the state of Virginia concerning metric terminology. Analysis of this information served as the basis for the conclusions and recommendations of this study.

CONCLUSIONS

The results of this study revealed that there was little difference, as far as knowledge of metric terminology was concerned, of new and existing Industrial Arts teachers in Virginia.

In conclusion, the following information pertaining to Virginia Industrial Arts teachers knowledge of terms associated with the metric system of measurement was formulated:

1. The Industrial Arts teachers, new and existing, understand the basic metric system as far as terminology.
2. Both groups, new and existing teachers, were bothered or weak with the prefixes of the major metric units. That is, this was the area where the largest incorrect answers were recorded for both groups.
3. Both groups are weak in the conversion of the English unit to metric unit. This was the second highest incorrections.

RECOMMENDATIONS

Based on the results of this survey as reported through Chapter 4 (Tables 1, 2, & 3), the following recommendations are made by the researcher:

1. It is recommended that, even though those Industrial Arts teachers surveyed, knew the basic metric terminology,

in-service workshops be offered on a yearly basis so that these teachers can keep abreast of new legislature, teaching techniques, tools, materials, and tools associated with the metric measurement system.

2. It is recommended that local schools utilize their Industrial Arts teachers, who are competent in metric terminology, so that their whole school system can convert to the new metric measurement system.
3. Colleges should offer courses or workshops, whether in-service or regular classes, in the implementation and use of the metric system in the classroom.

SELECTED BIBLIOGRAPHY

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BOOKS

Ary, Donald, Lucy Jacobs, and Asghar Razavieh, Introduction to Research in Education, Holt, Rinehart and Winston, Inc., New York, 1972.

Bonser, Frederick and Lois Mossman, The Meaning and Purpose of Industrial Arts, McKnight and McKnight Publishing Co., New York, 1963.

Donovan, Frank, Prepare Now For A Metric Future, Weybright and Tally, New York, 1971, p. 59.

Guralnik, David and Joseph Friend, eds., Webster's New World Dictionary of the American Language, The World Publishing Co., New York, 1966.

Simone, Daniel V., METRICS: The World Book Encyclopedia, Field Enterprises Educational Co., 1977, pp. 350-363.

PERIODICALS

Baillargeon, Jarvis, "Making the Change in Industrial Arts", School Shop, XXXIII, April, 1974, p. 83.

Diffenderfer, Richard, "Metric Conversion as a Planning Problem", School Shop, XXXIII, April, 1974, p. 86.

Esch, Marvin, "The Metric Conversion Act of 1973", School Shop, XXXIII, April, 1974, p. 54.

Feirer, John, "Metric Measure in Your Future", Industrial Education, February, 1972, p. 19.

Feirer, John, "Metrics in Vocational Education", Industrial Education, January, 1977, p. 23.

Koble, Ronald L., "METRICS: Are We Ready to Teach This System", Man/Society/Technology, January, 1976, p. 113.

Lindbeck, John R., "Going Metric in Teacher Education", Man/Society/Technology, September/October, 1974, pp. 9-11.

Lundy, Lyndall L., "Metric-Now-For Industrial Education", Man/Society/Technology, September/October, 1974, pp. 24-25.

Martin, Gordon E., "Going Metric-What Does It Mean for Industrial Education", Man/Society/Technology, September/October, 1974, pp. 16-18.

Nelson, Orville, "Is Metric a Measure of Pain?", Industrial Education, LXI, February, 1972, p. 22.

Rees, Mina and Arthur H. Livermore, "Milestone Legislation for a Metric United States", Science, Vol. 191, No. 4223, January 16, 1976, p. 141.

Smith, Howard S., "Musings on Metrics, Expressway Communications and Just Meaning What We Say", Industrial Education, January, 1975, pp. 7, 10, and 57.

Turner, Gerald E., "Is Modern Industry a Part of Your Industrial Arts Program?", Man/Society/Technology, September/October, 1974, pp. 12-13.

Weaver, Kenneth F., "How Soon Will We Measure In Metric?", National Geographic Vol. 152, No. 2, August, 1977, pp. 287-294.

APPENDICES

Appendix A- A copy of the Cover Letter

Appendix B - A copy of the Survey Questionnaire

APPENDIX A

A copy of the Cover Letter

Samuel P. Bowers
Star Rt.#1, Box 11-A
West Point, Virginia 23181

Dear Sir,

The following questionnaire is part of a research project, being done through a course offered at Old Dominion University, to determine if more emphasis is needed in the understanding of the metric system, as part of the Industrial Arts curriculum, in teacher preparatory colleges.

Please fill out the information requested on the questionnaire, by checking the appropriate response to each statement. Please, do not use any references, while responding to the questionnaire.

Return the completed questionnaire as soon as possible, by using the enclosed, self-addressed, stamped envelope.

Thank you.

Yours truly,

Samuel P. Bowers
IAEd Teacher

APPENDIX B

A copy of the Survey Questionnaire

METRIC SYSTEM QUESTIONNAIRE

Name ______________________________

Name of School ______________________________

Total number of years in teaching Industrial Arts ______

Year graduated from college _____ ____

Do you presently use the metric system in your classroom?

yes ____ No ____

The following statements are concerned with the use of the metric system. Using your present knowledge of the metric system, check the appropriate answer to each statement.

	True	False
a metric unit for length is the centimeter		
a metric unit for time is the second		
a English unit for mass is the gram		
a metric unit for electric current is the ampere		
a metric unit for temperature is degree celcius		
a metric unit for liquid measurement is the liter		
a metric unit for area is the square meter		
a English unit for volume is the cubic meter		
a metric unit for horsepower is the hectowatt		

	True	False
metric unit for velocity is centimeter/second		
One mile is longer than a kilometer		
One liter is less than one quart		
One yard is longer than one meter		
One inch is shorter than one centimeter		
One gram is less than one ounce		
One degree Fahrenheit is less than one degree Celcius		
The prefix "hecto" means .01		
The prefix "deci" means .01		
The prefix "kilo" means .001		
The prefix "centi" means 10		
The prefix "milli" means .001		
The prefix "deka" means 10		
10 centimeters = 100 millimeters		
100 centimeters = 1 decimeter		
1 kilometer $\doteq 10^4$ decimeters		
1000 millimeters = 1 meter		
10 decimeters = 10^{-1} dekameters		
1 inch = 25.4 millimeters		

Comments: