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AUTHOR Trent, John H.
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ABSTRACT

This paper reports on a survey of the need for inservice metric education and for greater emphasis upon metric education in mathematics methods courses in Nevada. The report is based upon data from two types of questionnaires. One questionnaire surveyed the need for metric workshops. The second questionnaire surveyed the present knowledge of the metric system. Both questionnaires were administered to a random sample of elementary, junior high, and high school teachers in Nevada and to elementary and secondary mathematics method students at the University of Nevada, Reno. The paper contains eight tables comparing the data from these two questionnaires. Each table is followed by separate conclusions. In general, it is concluded that there is a need for metric workshops for elementary teachers of Nevada and that more amphasis should be incorporated into elementary mathematics methods courses. Furthermore, it is recommended that a relevant comprehensive questionnaire be prepared and administered to secondary mathematics and science teachers in order to verify the need for further metric education. (BW)

COMPARATIVE NEEDS OF ELEMENTARY AND SECONDARY IN-SERVICE TEACHERS AND COLLEGE PRE-SERVICE STUDENTS FOR METRIC EDUCATION

by

Dr. John H. Trent
University of Nevada
Reno, Nevada

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As far back as the time of Thomas Jefferson, it has been recommended that the United States adopt the metric system of measurement. Bills have been submitted to Congress for the past several years recommending that the metric system be adopted as the primary system of measurement in this country. The last Congress appropriated 10 million dollars for metric education in the United States, to be used for each of the next four years. It is expected that the present Congress will pass a bill recommending that the metric system be phased in over a period of ten years. If this occurs, teachers in the schools of America should be prepared to teach their students to measure and think in this system. In order to do this, teachers themselves will have to be able to measure and think metrically. Few if any studies have been conducted to determine whether or not American teachers have this ability.

A survey was conducted in January 1975[1] in order to determine the present knowledge of the metric system of Nevada elementary teachers and to determine whether or not there is a need for in-service workshops for these teachers. The findings of this study showed:

a. That a high percentage of Nevada elementary teachers had not had a course in which the metric system was taught or used.

b. Do not feel qualified to teach arithmetic or science courses in which the metric system is used or taught.

1. Trent, John H., The United States is on the Metric System, The American Technical Society, 1975, "Survey Shows Need for Metric Workshops for Elementary Teachers."

c. Do not feel that their students are adequately prepared in the metric system.

d. Do not feel that adequate guidelines, course outlines and materials on the metric system are available to them for satisfactorily teaching the metric system to their students.

e. The elementary teachers were unable to correctly respond to questions relating to meters, kilograms and liters. Only 18% correctly responded to the question relating to Celsius temperature, and 90% did not know the meaning of SI and MKS.

As this study showed a great need for metric workshops for in-service elementary teachers and no data was available regarding possible similar needs for junior high and secondary in-service teachers and pre-service elementary and secondary teachers, a comparative study of these possible needs was initiated in February 1975.

In order to obtain the desired information, two questionnaires were sent to a random sample of in-service elementary and secondary teachers in Nevada. Questionnaires were also distributed to both elementary and secondary (pre-service) methods students at the University of Nevada, Reno. These questionnaires were identical to those administered in January 1975 to Nevada elementary teachers. The data obtained from the first questionnaire is shown in Table I below.

TABLE I

NEED FOR METRIC WORKSHOP QUESTIONNAIRE
COMPARISON OF RURAL AND METROPOLITAN COUNTIES

1. Have you had a college course in which the metric system was taught or used?

Rural counties	Yes 25 (20.5%)	No 97 (79.5%)
Large population counties	Yes 38 (26.2%)	No 107 (73.8%)
Medium population counties	Yes 14 (13.7%)	No 88 (86.3%)

Chi Sqd. = 5.66463 Sign level = n.s.

2. Do you feel qualified to teach arithmetic (or science) courses in which the metric system is taught or used?

Rural counties	Yes 27 (21.1%)	No 101 (78.9%)
Large population counties	Yes 39 (27.5%)	No 103 (72.5%)
Medium population counties	Yes 19 (18.8%)	No 82 (81.2%)

Chi Sqd. = 2.86744 Sign level = n.s.

3. Did you know that in 1974 Congress passed a law stating the "education systems should be encouraged to provide metric education for students"?

Rural Counties	Yes 98 (80.3%)	No 24 (19.7%)
Large population counties	Yes 120 (85.1%)	No 21 (14.9%)
Medium population counties	Yes 89 (86.4%)	No 14 (13.2%)

Chi Sqd. = 1.782 Sign level = n.s.

4. Did you know that the Nevada State Textbook Commission has recommended that all textbooks adopted after January 1, 1976, have the metric system as the primary system of measurement?

Rural counties	Yes 69 (52.7%)	No 62 (47.3%)
Large population counties	Yes 68 (48.2%)	No 73 (51.8%)
Medium population counties	Yes 70 (69.3%)	No 31 (30.7%)

Chi Sqd. = 11.2399 Sign level = .01

5. How adequately prepared in the metric system are students when they commence the school year in your class?

	Very well Prepared	Fairly well Prepared	Inadequately Prepared	No Preparation
Rural counties	0 (0%)	2 (12.5%)	25 (29.4%)	100 (38%)
Large pop. cos.	0 (0%)	9 (56.2%)	35 (41.2%)	90 (34.2%)
Med. pop. cos.	0 (0%)	5 (31.3%)	25 (29.4%)	73 (27.8%)

Chi Sqd. = 5.79934 Sign level - n.s.

6. How much are you now teaching the metric system to your students?

	A lot	A little	None at all
Rural counties	4 (33.3%)	77 (37.4%)	47 (32.2%)
Large pop. cos.	5 (41.7%)	83 (40.3%)	54 (37%)
Med. pop. cos.	3 (25.0%)	46 (22.3%)	45 (30.8%)

Chi Sqd. = 3.35762 Sign level = n.s.

7. If a federally funded in-service course in metric education were offered by the University of Nevada, Reno, would you attend it?

A. If it were offered in your county:

Rural counties	Yes 125 (96.2%)	No 5 (3.8%)
Large population counties	Yes 122 (87.1%)	No 18 (12.9%)
Medium population counties	Yes 82 (88.2%)	No 11 (11.8%)

Chi Sqd. = 6.77112 Sign level - .05

B. If it were offered on the University of Nevada, Reno campus:

Rural counties	Yes 34 (33%)	No 69 (67%)
Large population counties	Yes 9 (7.8%)	No 106 (92.2%)
Medium population counties	Yes 75 (84.3%)	No 14 (15.7%)

Chi Sqd. = 125.83 Sign level = .001

8. How great is the need for placing more emphasis on the metric system in elementary mathematics classes?

	Needed		
	Very great	Somewhat	No need
Rural counties	75 (35.7%)	41 (30.6%)	3 (37.5%)
Large population counties	74 (35.2%)	55 (41.0%)	3 (37.5%)
Medium population counties	61 (29.1%)	38 (28.4%)	2 (25.0%)

Chi Sqd. = 1.50136 Sign level = n.s.

9. Do you feel that adequate guidelines, course outlines and materials on the metric system are available to you for satisfactorily teaching the metric system to your students?

Rural counties	Yes 13 (10.6%)	No 110 (89.4%)
Large population counties	Yes 26 (21%)	No 98 (79%)
Medium population counties	Yes 28 (29.5%)	No 67 (70.5%)

Chi Sqd. = 13.2639 Sign level = .01

The primary emphasis of the first analysis of questionnaires was to determine if the need for metric workshops for elementary teachers of Nevada was confined to a specific geographic area such as rural or metropolitan (medium and large population) counties. An analysis of the data indicated the following:

a. In rural and metropolitan counties (medium and large populations) most elementary teachers had not had a college course in the metric system. A chi squared analysis showed that there was no significant difference at the .05 level between teachers from rural and metropolitan counties.

b. Most of the elementary teachers of Nevada participating in this survey did not feel qualified to teach an arithmetic or science course in which the metric system was taught or used. A chi squared analysis showed that there was no significant difference at the .05 level between teachers from rural and metropolitan (large and medium population) counties.

c. Rural counties indicated students were inadequately prepared in the metric system. However, a chi squared analysis showed that there was no significant difference at the .05 level between teachers from rural and metropolitan counties with respect to teacher perception of student preparation.

d. Rural and metropolitan elementary teachers agreed they would attend an in-service metric workshop if offered in their county. However, a chi squared analysis indicated a significant difference at the .05 level in favor of in-service metric workshops being offered in their own counties.

e. A majority of both rural and metropolitan elementary teachers did not feel adequate guidelines, course outlines and materials were available to them for teaching the metric system in their classroom.

An inference which may be drawn from this study is that there is a need for in-service workshops on the metric system by both rural and metropolitan (medium and large population) elementary teachers of Nevada, as almost all teachers indicated they would attend an in-service metric workshop if offered in their home county.

A second questionnaire was administered simultaneously with the first questionnaire. This was administered to determine the present knowledge and ability of these elementary teachers from rural and metropolitan areas of Nevada on the metric system. The questions and responses to this questionnaire are in Table II.

TABLE II

KNOWLEDGE OF METRIC SYSTEM QUESTIONNAIRE
COMPARISON OF RURAL AND METROPOLITAN COUNTIES

1. The average lineman in the National Football League weighs:

____A. 15 kilograms
____B. 115 kilograms
____C. 225 kilograms
____D. 325 kilograms
____E. 425 kilograms

	Correct Response	Incorrect Response
Rural counties	53 (39.5%)	81 (60.5%)
Large population counties	63 (44.4%)	79 (55.6%)
Medium population counties	52 (51.5%)	49 (48.5%)

Chi Sqd. = 3.32309 Sign level = n.s.

2. The height of the average American male is:

____A. 1.85 centimeters
____B. .185 meters
____C. 1.85 meters
____D. 18.5 meters
____E. 18.5 centimeters

	Correct Response	Incorrect Response
Rural counties	70 (52.2%)	64 (47.8%)
Large population counties	81 (57%)	61 (43%)
Medium population counties	57 (56.4%)	44 (43.1%)

Chi Sqd. = .732178 Sign level = n.s.

3. The average American car gasoline tank holds:

____A. 80 liters
____B. 180 liters
____C. 8 liters
____D. .8 liters
____E. 1800 liters

	Correct Response	Incorrect Response
Rural counties	69 (51.1%)	66 (48.9%)
Large population counties	80 (56.3%)	62 (43.7%)
Medium population counties	57 (56.4%)	44 (43.1%)

Chi Sqd. = 1.22589 Sign level = n.s.

4. Match the below numbers to the letters:

____A.	meter	1. .001 meter
____B.	centimeter	2. .01 meter
____C.	Millimeter	3. 39.37 inches
____D.	kilometer	4. .1 meter
____E.	decimeter	5. 1000 meters

	Correct Response	Incorrect Response
Rural counties	68 (54.7%)	56 (45.2%)
Large population counties	83 (58.5%)	59 (41.5%)
Medium population counties	63 (62.4%)	38 (37.6%)

Chi Sqd. = 1.30277 Sign level = n.s.

5. The termperature on a hot day in central Nevada is about:

____A. 27° Celsius
____B. 212° Celsius
____C. 37° Celsius
____D. 100° Celsius
____E. 47° Celsius

	Correct Response	Incorrect Response
Rural counties	24 (17.9%)	110 (82.1%)
Large population counties	22 (15.5%)	120 (84.5%)
Medium population counties	20 (19.8%)	81 (80.2%)

Chi Sqd. = .782295 Sign level = n.s.

6. What does MKS stand for?

	Correct Response	Incorrect Response
Rural counties	5 (3.8%)	128 (96.2%)
Large population counties	4 (2.8%)	138 (97.2%)
Medium population counties	3 (3%)	98 (97%)

Chi Sqd. = .0046316 Sign level = n.s.

7. What does SI stand for?

	Correct Response	Incorrect Response
Rural counties	5 (3.8%)	128 (96.2%)
Large population counties	0 (0%)	142 (100%)
Medium population counties	6 (5.9%)	95 (94.1%)

Chi Sqd. = 5.73148 Sign level = n.s.

The responses to these questions indicated:

a. Even though teachers from metropolitan areas did somewhat better, there was no significant difference indicated at the .05 level between the rural and metropolitan (medium and large population) county elementary teachers in their knowledge and ability on the questions related to meters, kilograms and liters.

b. Most of the rural and metropolitan (medium and large population) county elementary teachers were unable to respond correctly to the questions related to Celsius temperature and the meaning of MKS and SI. However, there was no significant difference in the chi squared analysis of the .05 level in the responses of the rural and metropolitan (medium and large population) county elementary teachers on the questions related to Celsius termperature, SI and MKS.

The inferences to be drawn from this data concur with the previous conclusion that there is a need for in-service metric workshops for Nevada elementary teachers from both rural and metropolitan counties, even though the teachers from the metropolitan areas showed a somewhat greater knowledge of the metric system.

At the same time, the same set of questionnaires was sent to elementary, junior high and secondary teachers of Nevada. This set of questionnaires was to determine the comparative needs of elementary, junior high and high school teachers of Nevada in relation to their knowledge of the metric system. A comparison of the responses received from elementary, junior high and senior high school teachers is shown in Table III below.

TABLE III

NEED FOR METRIC WORKSHOP QUESTIONNAIRE
COMPARISON BETWEEN ELEMENTARY, JUNIOR HIGH, AND HIGH SCHOOLS

1. Have you had a college course in which the metric system was taught or used?

Elementary	Yes 77 (20.9%)	No 292 (79.1%)	
Junior high	Yes 33 (51.5%)	No 31 (48.5%)	
High school	Yes 49 (66.2%)	No 25 (33.8%)	
Chi Sqd. = 72.7749	Sign level = .01		

2. Do you feel qualified to teach arithmetic (or science) courses in which the metric system is taught or used?

Elementary	Yes 85 (22.9%)	No 286 (77.1%)	
Junior high	Yes 33 (58.9%)	No 23 (41.1%)	
High school	Yes 54 (74%)	No 19 (26%)	
Chi Sqd. = 87.2892	Sign level = .01		

3. Did you know that in 1974 Congress passed a law stating that "education systems should be encouraged to provide metric education for students"?

Elementary	Yes 307 (83.9%)	No 59 (16.1%)	
Junior high	Yes 50 (80.6%)	No 12 (19.4%)	
High school	Yes 58 (77.3%)	No 17 (22.7%)	
Chi Sqd. = 2.01754	Sign level = n.s.		

4. Did you know that the Nevada State Textbook Commission has recommended that all textbooks adopted after January 1, 1976, have the metric system as the primary system of measurment?

Elementary	Yes 207 (55.5%)	No 166 (45.5%)	
Junior high	Yes 23 (37.1%)	No 39 (62.9%)	
High school	Yes 37 (49.3%)	No 38 (50.7%)	
Chi Sqd. = 7.53635	Sign level = .05		

5. How adequately prepared in the metric system are students when they commence the school year in your class?

	Very well prepared	Fairly well prepared	Inadequately prepared	No preparation
Elementary	0 (0%)	16 (4.4%)	85 (23.3%)	263 (72.3%)
Junior high	0 (0%)	6 (9.5%)	34 (47.2%)	23 (36.5%)
High school	0 (0%)	6 (8.1%)	39 (52.5%)	29 (39.2%)
Chi Sqd. = 49.4464		Sign level = .001		

6. How much are you now teaching the metric system to your students?

	A lot	A little	None at all
Elementary	12 (3.3%)	206 (56.6%)	146 (40.1%)
Junior high	10 (16.1%)	41 (66%)	11 (17.8%)
High school	25 (33.3%)	39 (52%)	11 (14.7%)
Chi Sqd. = 97.0263	Sign level = .001		

7. If a federally funded in-service course in metric education were offered by the University of Nevada, Reno, would you attend it?

A. If it were offered in your county:

Elementary	Yes 329 (90.6%)	No 34 (9.4%)
Junior high	Yes 51 (85%)	No 8 (15%)
High school	Yes 62 (87.3%)	No 8 (12.7%)
Chi Sqd. = .738574	Sign level = n.s.	

B. If it were offered on the University of Nevada, Reno campus:

Elementary	Yes 118 (38.4%)	No 189 (61.6%)
Junior high	Yes 26 (49.1%)	No 27 (50.9%)
High school	Yes 29 (55.8%)	No 23 (44.2%)
Chi Sqd. = 6.7313	Sign level = .05	

8. How great is the need for placing more emphasis on the metric system in high school mathematics classes? (or science classes)

	Needed		
	Very great	Somewhat	No need
Elementary	210 (59.6%)	134 (38.1%)	8 (2.3%)
Junior high	36 (60%)	22 (36.7%)	2 (3.3%)
High school	45 (62.59%)	26 (36.1%)	1 (1.4%)
Chi Sqd. = .213524	Sign level = n.s.		

9. Do you feel that adequate guidelines, course outlines and materials on the metric system are available to you for satisfactorily teaching the metric system to your students?

Elementary	Yes 67 (19.6%)	No 275 (80.4%)
Junior high	Yes 16 (27.6%)	No 42 (72.4%)
High school	Yes 26 (36.1%)	No 46 (63.9%)
Chi Sqd. = 9.89177	Sign level = .05	

An analysis of the data showed:

a. Most elementary teachers of Nevada had not taken a college course in the metric system. However, a majority of both the junior high and senior high teachers had taken such a course. This difference was significant at the .01 level.

b. In comparison to junior and secondary teachers of Nevada, most elementary teachers of Nevada felt less qualified to teach the metric system. There was a significant difference in the perceived ability at the .01 level.

c. Nevada elementary teachers were more aware that the Nevada State Textbook Commission had recommended that all textbooks adopted after January 1, 1976, have the metric system as the primary system of measurement. However, there was no significant difference at the .05 level.

d. A majority of Nevada teachers on all levels (elementary, junior high and high school) felt that students were inadequately prepared in the metric system. The X^2 analysis was significant at the .001 level, showing that more teachers felt this inadequacy on the part of their students.

e. Approximately 80% of the elementary teachers felt there were not adequate guidelines, course outlines and materials on the metric system available to them to adequately teach their students the metric system, whereas only 40% of the junior high and high school teachers believed that there were not sufficient guidelines, course outlines and materials available to them. There was a significant difference between the elementary and junior high and high school teachers of Nevada at the .05 level.

f. Over 85% of Nevada teachers would attend an in-service metric workshop if held in their county. There was no significant difference in the responses of elementary and secondary teachers. However, only about half of the teachers said they would attend a metric workshop if held on the University of Nevada, Reno campus. Thus, significantly more teachers at all levels would attend a metric workshop if it were held in their own county.

From this questionnaire, the following inference may be drawn: while there is definitely a need for in-service metric workshops for elementary teachers of Nevada, the need is not nearly as great at the junior and senior high school levels.

The second questionnaire administered was to determine the comparative knowledge and ability of the elementary, junior high and high school teachers of Nevada, see Table IV below.

TABLE IV

KNOWLEDGE OF METRIC SYSTEM QUESTIONNAIRE
COMPARISON BETWEEN ELEMENTARY, JUNIOR HIGH, AND HIGH SCHOOLS

Without reference to conversion tables, please check the appropriate (nearest) answer with an X.

1. The average lineman in the National Football League weighs:
   ____A. 15 kilograms
   ____B. 115 kilograms
   ____C. 225 kilograms
   ____D. 325 kilograms
   ____E. 425 kilograms

	Correct response	Incorrect response
Elementary	168 (44.6%)	209 (55.4%)
Junior high	46 (76.7%)	14 (23.3%)
High school	61 (81.3%)	14 (18.7%)

Chi Sqd. = 48.4253 Sign level = .001

2. The height of the average American male is:
   ____A. 1.85 centimeters
   ____B. .185 meters
   ____C. 1.85 meters
   ____D. 18.5 meters
   ____E. 18.5 centimeters

	Correct response	Incorrect response
Elementary	208 (55.2%)	169 (44.8%)
Junior high	54 (90%)	6 (10%)
High school	72 (97.3%)	2 (2.7%)

Chi Sqd. = 65.0997 Sign level = .001

3. The average American car gasoline tank holds:
   ____A. 80 liters
   ____B. 180 liters
   ____C. 8 liters
   ____D. .8 liters
   ____E. 1800 liters

	Correct response	Incorrect response
Elementary	207 (54.6%)	172 (45.4%)
Junior high	47 (78.3%)	13 (21.7%)
High school	69 (90.8%)	7 (9.2%)

Chi Sqd. = 41.7616 Sign level = .001

4. Match the below numbers to the letters:

____A.	meter	1. .001 meter
____B.	centimeter	2. .01 meter
____C.	millimeter	3. 39.37 inches
____D.	kilometer	4. .1 meter
____E.	decimeter	5. 1000 meters

	Correct response	Incorrect response
Elementary	214 (58.3%)	153 (41.7%)
Junior high	53 (88.3%)	7 (11.7%)
High school	68 (90.7%)	7 (9.3%)

Chi Sqd. = 42.3427 Sign level = .001

5. The temperature on a hot day in central Nevada is about:
   ____A. 27° Celsius
   ____B. 212° Celsius
   ____C. 37° Celsius
   ____D. 100° Celsius
   ____E. 47° Celsius

	Correct response	Incorrect response
Elementary	96 (23.6%)	311 (76.4%)
Junior high	26 (43.3%)	34 (56.7%)
High school	37 (50%)	37 (50%)

Chi Sqd. = 27.3718 Sign level = .001

6. What does MKS stand for?

	Correct response	Incorrect response
Elementary	12 (3.2%)	364 (96.8%)
Junior high	9 (15%)	51 (85%)
High school	34 (46.6%)	39 (53.4%)
Chi Sqd. = 120.623	Sign level = .001	

7. What does SI stand for?

	Correct response	Incorrect response
Elementary	11 (2.9%)	365 (97.1%)
Junior high	6 (10%)	54 (90%)
High school	21 (28%)	54 (72%)
Chi Sqd. = 57.4731	Sign level = .001	

The responses to the questions asked showed:

a. Most of the elementary teachers of Nevada responded correctly to questions related to meters, kilograms and liters. The majority of the secondary and junior high teachers of Nevada responded correctly to these same questions related to meters, kilograms and liters. The significant difference was at the .001 level in favor of the secondary and junior high teachers of Nevada responding more correctly than elementary teachers on questions related to meters, kilograms and liters.

b. On the question related to Celsius temperature, 76.4% of the elementary teachers of Nevada responded incorrectly, as compared to 50% of the secondary and junior high teachers. Difference was significant at the .001 level.

c. The majority of elementary, junior high and senior high school teachers responded incorrectly to questions related to SI and MKS. However, significantly more of the elementary teachers were unable to correctly answer these questions. These differences strengthen the conclusion that elementary teachers of Nevada need in-service metric workshops. In addition, they show that there is some need for an in-service metric workshop for junior high and secondary teachers.

In order to compare the relative needs and knowledge of elementary in-service teachers of Nevada and the elementary math methods (pre-service) students for in-service metric workshops, questionnaires identical to those used in other parts of this study were sent to a random sample of elementary math methods (pre-service) students at the University of Nevada, Reno.

TABLE V

NEED FOR METRIC WORKSHOP QUESTIONNAIRE
COMPARISON BETWEEN ELEMENTARY TEACHERS AND ELEMENTARY MATH METHODS STUDENTS

1. Have you had a college course in which the metric system was taught or used?

Elementary teachers	Yes	77 (20.9%)	No	292 (79.1%)
Elem. math methods students	Yes	7 (16.3%)	No	36 (83.7%)

Chi Sqd. = .256797 Sign level = n.s.

2. Do you feel qualified to teach arithmetic (science) courses in which the metric system is taught or used?

Elementary teachers	Yes	85 (22.9%)	No	286 (77.1%)
Elem. math meth. students	Yes	2 (4.5%)	No	42 (95.4%)

Chi Sqd. = 6.93733 Sign level = .01

3. Did you know that in 1974 Congress passed a law stating that "education systems should be encouraged to provide metric education for students"?

Elementary teachers	Yes	307 (83.9%)	No	59 (16.1%)
Elem. math meth. students	Yes	26 (17.2%)	No	18 (41%)

Chi Sqd. = 14.2399 Sign level = .001

4. Did you know that the Nevada State Textbook Commission has recommended that all textbooks adopted after January 1, 1976, have the metric system as the primary system of measurement?

Elementary teachers	Yes	207 (55.5%)	No	166 (45.5%)
Elem. math meth. students	Yes	8 (17.2%)	No	36 (71.8%)

Chi Sqd. = 20.4723 Sign level = .001

5. How adequately prepared in the metric system are the students when they commence the school year in your class?

	Very well prepared	Fairly well prepared	Inadequately prepared	No preparation
Elem. teachers	0 (0%)	6 (5.5%)	85 (23.3%)	263 (72.3%)
Elem. students	2 (6.7%)	3 (10%)	12 (40%)	13 (43.3%)

Chi Sqd. = 24.0039 Sign level = .001

6. How much are you now teaching the metric system to your students?

	A lot	A little	None at all
Elementary teachers	12 (3.3%)	206 (56.6%)	146 (40.1%)
Elem. math meth. students	2 (6.7%)	4 (13.3%)	24 (80%)

Chi Sqd. = 19.4627 Sign level = .001

7. If a federally funded inservice course in metric education were offered by the University of Nevada, Reno, would you attend it?

A. If it were offered in your county:

Elementary teachers	Yes	329 (90.6%)	No	34 (9.4%)
Elem. math meth. students	Yes	31 (75.6%)	No	10 (24.3%)

Chi Sqd. = 7.08986 Sign level = .01

B. If it were offered on the University of Nevada, Reno campus:

Elem. teachers	Yes	118 (38.4%)	No	189 (61.6%)
Elem. math meth. students	Yes	35 (83.3%)	No	7 (16.7%)

Chi Sqd. = 28.452 Sign level = .001

8. How great is the need for placing more emphasis on the metric system in high school mathematics (or science) classes?

	Very great	Needed somewhat	No need
Elementary teachers	210 (59.6%)	134 (38.1%)	8 (2.3%)
Elem. math meth. students	28 (77.8%)	8 (22.2%)	0 (0%)

Chi Sqd. = 3.70201 Sign level = n.s.

9. Do you feel that adequate guidelines, course outlines and materials on the metric system are available to you for satisfactorily teaching the metric system to your students?

Elementary teachers	Yes	67 (19.6%)	No	275 (80.4%)
Elem. math meth. students	Yes	7 (21.2%)	No	26 (78.8%)

Chi Sqd. = .0003 Sign level = n.s.

A comparison of the data obtained from elementary math methods (pre-service) students and the elementary in-service teachers of Nevada showed:

a. The majority of the elementary math methods (pre-service) students of the University of Nevada, Reno had never had a college course in the metric system. This compared to 79.1% of the elementary teachers of Nevada, who indicated they had not had a college course in the metric system. The chi squared analysis did not show a significant difference even at the .05 level.

b. A majority of the elementary math methods (pre-service) students of the University of Nevada, Reno as compared to 77.9% of the elementary teachers of Nevada did not feel qualified to teach a course in arithmetic or science in which the metric system was used. The difference was significant at the .01 level.

c. Over three-fourths of the elementary inservice teachers and pre-service methods students did not feel adequate guidelines, course outlines and materials on the metric system were available to them to satisfactorily teach the metric system in their classrooms. The chi squared analysis was not significant at the .05 level.

d. Most of the elementary math methods (pre-service) students of the University of Nevada, Reno and the majority of elementary teachers of Nevada agreed that they would attend an in-service metric workshop if offered in their own county.

Inferences drawn from these responses indicate that: (1) The elementary math methods (pre-service) students are not adequately prepared in the metric system. (2) There is a possible need to upgrade the elementary methods curriculum at the University of Nevada, Reno to provide a better basic foundation in the metric system. (3) This lack of adequate metric preparation supports the belief that there is a great need for in-service metric workshops for Nevada elementary teachers.

A second questionnaire was administered simultaneously to determine the comparative knowledge and abilities between elementary math methods (pre-service) students of the University of Nevada, Reno and elementary teachers of Nevada. This comparison is shown in Table VI.

TABLE VI

KNOWLEDGE OF METRIC SYSTEM QUESTIONNAIRE
COMPARISON BETWEEN ELEMENTARY TEACHERS AND ELEMENTARY MATH METHODS STUDENTS

Without reference to conversion tables, please check the appropriate (nearest) answer with an X.

1. The average lineman in the National Football League weighs:
   ____A. 15 kilograms
   ____B. 115 kilograms
   ____C. 225 kilograms
   ____D. 325 kilograms
   ____E. 425 kilograms

	Correct response	Incorrect response
Elementary teachers	168 (44.6%)	209 (55.4%)
Elem. math meth. students	10 (22.7%)	34 (77.3%)
Chi Sqd. = 109.519	Sign level = n.s.	

2. The height of the average American male is:
   ____A. 1.85 centimeters
   ____B. .185 meters
   ____C. 1.85 meters
   ____D. 18.5 meters
   ____E. 18.5 centimeters

	Correct response	Incorrect response
Elementary teachers	208 (55.2%)	169 (44.8%)
Elem. math meth. students	23 (52.3%)	21 (47.7%)
Chi Sqd. = .04231	Sign level = n.s.	

3. The average American car gasoline tank holds:
   ____A. 80 liters
   ____B. 180 liters
   ____C. 8 liters
   ____D. .8 liters
   ____E. 1800 liters

	Correct response	Incorrect response
Elementary teachers	207 (54.6%)	172 (45.4%)
Elem. math meth. students	11 (25%)	33 (75%)
Chi Sqd. = 12.6853	Sign level = .001	

4. Match the below numbers to the letters.

____A.	meter	1. .001 meter
____B.	centimeter	2. .01 meter
____C.	millimeter	3. 39.37 inches
____D.	kilometer	4. .1 meter
____E.	decimeter	5. 1000 meters

	Correct response	Incorrect response
Elementary teachers	214 (58.3%)	153 (41.7%)
Elem. math meth. students	15 (34%)	29 (66%)
Chi Sqd. = 8.38513	Sign level = .01	

5. The temperature on a hot day in central Nevada is about:
   ____A. 27° Celsius
   ____B. 212° Celsius
   ____C. 37° Celsius
   ____D. 100° Celsius
   ____E. 47° Celsius

	Correct response	Incorrect response
Elementary teachers	96 (23.6%)	311 (76.4%)
Elem. math meth. students	4 (9%)	40 (91%)
Chi Sqd. = 4.03183	Sign level = n.s.	

6. What does MKS stand for?

	Correct response	Incorrect response
Elementary teachers	12 (3.2%)	364 (96.8%)
Elem. math meth. students	0 (0%)	44 (100%)
Chi Sqd. = .524535	Sign level = n.s.	

7. What does SI stand for?

	Correct response	Incorrect response
Elementary teachers	11 (2.9%)	365 (97.1%)
Elem. math meth. students	0 (0%)	44 (100%)
Chi Sqd. = .423637	Sign level = n.s.	

The responses to these questions showed:

a. There was no significant difference (.05 level) in the responses given by elementary teachers and elementary methods students with respect to the questions relating to knowledge of the metric lengths and weights. However, significantly more (.001 level) of the elementary teachers correctly responded to the question related to volume. Further, significantly more (.01) of the

elementary teachers correctly answered the matching question relating to metric units.

b. The majority of the elementary math methods students and elementary teachers responded incorrectly to the question related to Celsius temperature. The chi squared analysis showed no significant difference at the .05 level.

c. 100% of the elementary math methods students of the University of Nevada, Reno responded incorrectly to the questions related to SI and MKS. The majority of elementary teachers of Nevada responded incorrectly to these same questions related to SI and MKS. The chi squared analysis was not significant at the .05 level.

From these responses, the inferences below might be drawn:

a. The elementary math methods students did not have adequate knowledge of the metric system.

b. In comparison, elementary teachers of Nevada demonstrated a knowledge of meters, liters and kilograms, basic metric knowledge; however, both elementary teachers of Nevada and elementary math methods students of the University of Nevada, Reno were unable to respond correctly to questions related to Celsius temperature, SI and MKS. Therefore, elementary teachers of Nevada and elementary math methods students of the University of Nevada were not able to think in "metric terms."

c. The responses further substantiate the great need for in-service metric workshops for elementary teachers of Nevada and possibly the great need for in-service workshops for elementary math methods students of the University of Nevada, Reno.

A final study was made to determine the needs of junior high and secondary teachers of Nevada as compared to the needs of the secondary math methods students of the University of Nevada, Reno. See Table VII. Ultimately, this was a comparison of the needs of elementary teachers of Nevada and the elementary math methods students of the University of Nevada, Reno.

TABLE VII

NEED FOR METRIC WORKSHOP QUESTIONNAIRE
COMPARISON BETWEEN JUNIOR HIGH AND HIGH SCHOOL TEACHERS AND SECONDARY METHODS STUDENTS

1. Have you had a college course in which the metric system was taught or used?

Junior high	Yes	33 (51.5%)	No	31 (48.5%)
High school	Yes	49 (66.2%)	No	22 (33.8%)
Sec. methods students	Yes	13 (76.5%)	No	4 (23.5%)

Chi Sqd. = 4.60654 Sign level = n.s.

2. Do you feel qualified to teach arithmetic (or science) courses in which the metric system is taught or used?

Junior high	Yes	33 (58.9%)	No	23 (41.1%)
High school	Yes	54 (74%)	No	19 (26%)
Sec. methods students	Yes	9 (52.9%)	No	8 (47.1%)

Chi Sqd. = 4.25644 Sign level = n.s.

3. Did you know that in 1974 Congress passed a law stating that "education systems should be encouraged to provide metric education for students"?

Junior high	Yes	50 (80.6%)	No	12 (19.4%)
High school	Yes	58 (77.3%)	No	17 (22.7%)
Sec. methods students	Yes	12 (70.6%)	No	5 (29.4%)

Chi Sqd. = .548264 Sign level = n.s.

4. Did you know that the Nevada State Textbook Commission has recommended that all textbooks adopted after January 1, 1976, have the metric system as the primary system of measurement?

Junior high	Yes	23 (37.1%)	No	39 (62.9%)
High school	Yes	37 (49.3%)	No	38 (50.7%)
Sec. methods students	Yes	3 (16.7%)	No	15 (83.3%)

Chi Sqd. = 6.40443 Sign level = .05

5. How adequately prepared in the metric system are students when they commence the school year in your class?

	Very well prepared	Fairly well prepared	Inadequately prepared	No preparation
Junior high	0 (0%)	6 (9.5%)	34 (54%)	23 (47.2%)
High school	0 (0%)	5 (8.1%)	39 (52.5%)	29 (39.2%)
Sec. meth. stu.	0 (0%)	1 (8.3%)	9 (75%)	2 (16.7%)

Chi Sqd. = 2.2122 Sign level = n.s.

6. How much are you now teaching the metric system to your students?

	A lot	A little	None at all
Junior high	10 (16.1%)	41 (66.1%)	11 (17.8%)
High school	16 (33.3%)	39 (52%)	9 (14.7%)
Sec. methods students	5 (29.4%)	9 (52.9%)	3 (17.7%)

Chi Sqd. = 2.07949 Sign level = n.s.

7. If a federally funded in-service course in metric education were offered by the University of Nevada, Reno, would you attend it?

A. If it were offered in your county:

Junior high	Yes	51 (85%)	No	9 (15%)
High school	Yes	62 (87.3%)	No	9 (12.7%)
Sec. methods students	Yes	10 (62.5%)	No	6 (37.5%)

Chi Sqd. = 4.81947 Sign level = n.s.

B. If it were offered on the University of Nevada, Reno campus:

Junior high	Yes	26 (49.1%)	No	27 (50.9%)
High school	Yes	29 (55.8%)	No	23 (44.2%)
Sec. methods studetns	Yes	15 (100%)	No	0 (0%)

Chi Sqd. = 11.7715 Sign level = .01

8. How great is the need for placing more emphasis on the metric system in high school mathematics (or science) classes?

	Very great	Needed somewhat	No need
Junior high	36 (60%)	27 (36.7%)	2 (3.3%)
High school	45 (62.5%)	26 (36.1%)	1 (1.4%)
Sec. meth. stu.	14 (82.4%)	3 (17.6%)	0 (0%)

Chi Sqd. = 2.10036 Sign level = n.s.

9. Do you feel that adequate guidelines, course outlines and materials on the metric system are available to you for satisfactorily teaching the metric system to your students?

Junior high	Yes	16 (27.6%)	No	42 (72.4%)
High school	Yes	26 (36.1%)	No	46 (63.9%)
Sec. methods students	Yes	8 (66.7%)	No	4 (33.3%)

Chi Sqd. = 5.42088 Sign level = n.s.

The findings showed:

a. Some of the junior high and secondary teachers of Nevada did not have a college course in the metric system. Only 23.5% of secondary math methods students of the University of Nevada, Reno did not have a significant college course in the metric system. The chi squared analysis showed no significant difference at the .05 level.

b. Approximately two-thirds of the junior high and secondary teachers of Nevada and secondary math methods students did not feel qualified to teach an arithmetic or science course in which the metric system was taught or used. The chi squared analysis was not significant at the .05 level.

c. The majority of the secondary and junior high teachers of Nevada and most of the secondary math methods students of the University of Nevada, Reno did not feel adequate guidelines, course outlines or materials on the metric system were available to satisfactorily teach the metric system in their classrooms. The chi squared analysis showed no significant difference at the .05 level.

d. The majority of the secondary math methods students of the University of Nevada, Reno and of junior high and secondary teachers of Nevada agreed they would attend an in-service metric workshop if offered in their counties. The chi squared analysis was not significant at the .05 level.

Inferences drawn from these responses are that secondary math methods students of the University of Nevada, Reno and junior high and secondary teachers of Nevada are possibly more adequately prepared in the metric system. There is possibly a need for an in-service metric workshop for the junior high and secondary teachers of Nevada as the majority indicated they would attend a metric workshop if offered.

A second questionnaire was administered to the same sample to determine the present knowledge and ability of these teachers and the secondary math methods students. See Table VIII.

TABLE VIII

KNOWLEDGE OF METRIC SYSTEM QUESTIONNAIRE
COMPARISON BETWEEN JUNIOR HIGH AND HIGH SCHOOL TEACHERS
AND SECONDARY METHODS STUDENTS

Without reference to conversion tables, please check the appropriate (nearest) answer with an X.

1. The average lineman in the National Football League weighs:
   ____A. 15 kilograms
   ____B. 115 kilograms
   ____C. 225 kilograms
   ____D. 324 kilograms
   ____E. 425 kilograms

	Correct response	Incorrect response
Sec. methods students	10 (55.6%)	8 (44.4%)
Junior high teachers	46 (76.7%)	14 (23.3%)
High school teachers	61 (81.3%)	14 (18.7%)

Chi Sqd. = 4.53313 Sign level = n.s.

2. The height of the average American male is:

____A. 1.85 centimeters
____B. .185 meters
____C. 1.85 meters
____D. 18.5 meters
____E. 18.5 centimeters

	Correct response	Incorrect response
Sec. methods students	17 (94.4%)	1 (5.6%)
Junior high teachers	54 (90%)	6 (10%)
High school teachers	72 (97.3%)	2 (2.7%)
Chi Sqd. = 2.24019	Sign level = n.s.	

3. The average American car gasoline tank holds:

____A. 80 liters
____B. 180 liters
____C. 8 liters
____D. .8 liters
____E. 1800 liters

	Correct response	Incorrect response
Sec. methods students	10 (55.6%)	8 (44.4%)
Junior high teachers	47 (78.3%)	13 (21.7%)
High school teachers	69 (90.8%)	7 (9.2%)
Chi Sqd. = 11.104	Sign level - .01	

4. Match the below numbers to the letters:

____A. meter — 1. .001 meter
____B. centimeter — 2. .01 meter
____C. millimeter — 3. 39.37 inches
____D. kilometer — 4. .1 meter
____E. decimeter — 5. 1000 meters

	Correct response	Incorrect response
Sec. methods students	14 (77.8%)	4 (22.2%)
Junior high teachers	53 (88.3%)	7 (11.7%)
High school teachers	68 (90.7%)	7 (9.3%)
Chi Sqd. 1.40188	Sign level - n.s.	

5. The temperature on a hot day in central Nevada is about:

____A. 27° Celsius
____B. 212° Celsius
____C. 37° Celsius
____D. 100° Celsius
____E. 47° Celsius

	Correct response	Incorrect response
Sec. methods students	8 (44.4%)	10 (55.6%)
Junior high teachers	26 (43.3%)	34 (56.7%)
High school teachers	37 (50%)	37 (50%)
Chi Sqd. = .614958	Sign level = n.s.	

6. What does MKS stand for?

	Correct response	Incorrect response
Sec. methods students	4 (22.2%)	14 (77.8%)
Junior high teachers	9 (14%)	51 (85%)
High school teachers	34 (42.1%)	39 (53.4%)
Chi Sqd. = 15.8301	Sign level = .001	

7. What does SI stand for?

	Correct response	Incorrect response
Sec. methods students	2 (11.1%)	16 (88.9%)
Junior high teachers	6 (10%)	54 (90.0%)
High school teachers	21 (27.1%)	54 (72.0%)
Chi Sqd. = 7.05647	Sign level = .05	

Responses to the questions asked showed:

a. The majority of secondary math methods students of the University of Nevada, Reno and a majority of junior high and secondary teachers of Nevada responded correctly to questions related to meters, kilograms and liters. Chi squared analysis showed no significant difference at the .05 level.

b. Most of the secondary math methods students of the University of Nevada, Reno and most of the junior and secondary teachers of Nevada responded correctly to the question related to Celsius temperature. The chi squared analysis was not significant at the .05 level.

c. There was a significant difference at the .001 level between junior high teachers and secondary math methods students responding incorrectly as compared to secondary teachers on questions relating to SI and MKS.

The inferences drawn from these responses are that secondary math methods students of the University of Nevada, Reno and junior high and secondary teachers of Nevada had a knowledge of the metric concepts of liters, kilograms and meters; however, each sample group was unable to respond to the questions on SI and MKS and were therefore unable to think in "metric terms." This study further substantiates that there is a need for metric workshops for secondary math methods students of the University of Nevada, Reno and for junior high and secondary teachers of Nevada; however, this need was probably not as great as the need for in-service metric workshops for the elementary teachers of Nevada and elementary math methods students of the University of Nevada, Reno. The data further indicates that secondary math

methods students of the University of Nevada, Reno and junior high and secondary teachers of Nevada were more adequately prepared in the metric system as there was a 40% higher correct response level than recorded for the elementary teachers of Nevada and elementary math methods students of the University of Nevada, Reno.

In general, one may conclude from the comparative studies that there is a great need for metric workshops for elementary teachers of Nevada and groups of elementary teachers who have similar characteristics. Thus more emphasis on metric education should be incorporated into the elementary math methods programs. Even though the greatest need is for metric in-service workshops for elementary teachers of Nevada located in rural counties, there is a need for metric education for all elementary teachers. The surveys showed that Nevada junior high and secondary math teachers have a better knowledge of the metric system. However, it is felt that because the questions asked were quite basic and not even 75% of the secondary teachers could answer most of these simple questions, they could profit from a metric workshop. It is recommended that a relevant comprehensive questionnaire be prepared and administered to secondary math and science teachers in order to verify this suspected need. A further implication of this survey may be that teachers feel unqualified to use metric materials that are already available to them. If they were able to attend metric workshops, they might better be able not only to utilize metric materials that are already available to them, but to wisely select from the wide variety of metric materials which will become available to them in the future.