The Development of an Industrial Arts Measurement Knowledge Test

Chester H. Gutzler

College of William & Mary - School of Education

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THE DEVELOPMENT OF AN INDUSTRIAL ARTS MEASUREMENT KNOWLEDGE TEST

A Project
Presented to
the Faculty of the Department of Education
College of William and Mary

In Partial Fulfillment
of the Requirements for the Degree
Master of Education

by
Chester H. Gutzler
August 1952
ACKNOWLEDGEMENT

For helpful suggestions and guidance during the writing of this project, the writer wishes to express his appreciation to the members of his committee: Dr. Kenneth Cleeton, Dr. Howard Holland, Dr. Luther McRae, and Mr. George Myers.

The writer also is indebted to all the industrial-arts instructors of Virginia for their aid in providing data for this project.
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CHAPTER I

THE PROBLEM AND ITS LITERATURE

This study was an attempt to discover the different levels of achievement in terms of measurable information that junior high-school pupils possess at the beginning of an industrial-arts exploratory course. The information gained from the investigation is intended for use in individual and group guidance of pupils and for improving the quality and the effectiveness of industrial-arts instruction.

Newkirk and Greene\(^1\) express the idea that the diagnosis of skill and knowledge of the individual industrial-arts pupil, as well as that of the class, is of great value in promoting instructional efficiency.

Teacher planning in industrial-arts is somewhat more complicated than in some subject matter fields. This situation is due in part to the confusion that exists in the ranks of industrial-arts education; for leading industrial-arts educators have expressed much indecision as to the principles and practices of an industrial-arts program. Thus, it is understandable that even more confusion must

exist in the minds of administrators who are trying to fit an industrial-arts program into the school curriculum. Moreover, there is a trend toward increasing the responsibility placed on the shoulders of the industrial-arts instructors; and many times this includes the development of the course of study as well as the individual course planning.

The industrial-arts movement has undergone several great changes; the most important influence, perhaps, was the Smith-Hughes Act, which clearly defined vocational education. This act resulted in emphasis being placed on vocational education and only recently has industrial-arts begun to assume importance on its own merits.

Frank C. Moore has defined industrial arts as one of the practical arts, a form of non-vocational education, which has for its purpose giving information about and experience in the use of tools, materials, and processes incident generally to the home and industry. This viewpoint


4 Myers, op. cit., pp. 317.

illustrates the great change that has taken place from the turn of the century to the present. In the late twenties industrial-arts instruction emphasised the development of skills and fundamental tool processes; the main objective being to produce a skilled worker. The present-day objectives such as: (1) interest in industry; (2) appreciation and use; (3) self-discipline and initiative; (4) cooperative attitudes; (5) health and safety; (6) interest and achievement; (7) orderly performance; (8) drawing and design; and (9) shop skills and knowledge, tend to reverse the earlier objectives. The unfortunate result of this change of motives is that not all of the industrial-arts educators have accepted the new objectives.

The investigator hopes that this study will aid the industrial-arts instructor in solving one of his many problems; namely, improving the quality and effectiveness of industrial-arts instruction on both the individual and class level. This objective can be achieved through the location of achievement levels, in terms of measurable information that junior-high school pupils possess at the beginning of an exploratory industrial-arts course. With the location of this information the industrial-arts instructor may better adjust his planning to the actual needs of his class.

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6 Supra, pp. 2-3.
I. THE PROBLEM

It was the purpose of this study to construct and use a paper and pencil test for discovering, in terms of measurement knowledge, the achievement level of junior-high school pupils at the start of an industrial-arts exploratory course.

The following definitions apply to terms frequently used in this study: Knowledge is considered as the acquaintance with facts and things; Measurement Knowledge is thought of as acquaintance with those facts and things that are capable of being computed, compared or represented by a standard, or proportioned by rule. Skill, as used by Selvidge and Fryklund, is interpreted as applied knowledge.

It was recognized that measurement knowledge was one of many industrial-arts readiness factors that were important and one that would lend itself to study, therefore, this investigation is limited to that one factor. Measurement knowledge was selected for investigation because of the investigator's belief that such knowledge is a prime factor if students are to make satisfactory progress in an industrial-arts program. Furthermore, under special abilities in the aims of education section, the Trade and Industry Education Service

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of the Division of Vocational Education lists this factor in the *Virginia Industrial Arts Handbook*. Greene, Jorgensen, and Gerberich also believe that industrial-arts instruction could be made more effective through the appraisal of pupil's measurement knowledge.

The literature of the Industrial-Arts Education field was explored for material pertinent to the problem, and no directly related information concerning the problem was discovered.

The need for an achievement test of measurement knowledge was evident throughout the fourteen years of industrial-arts teaching experience of the investigator. Actually the need for a device to measure the achievement level of the individual and class measurement knowledge at the beginning of an industrial-arts exploratory course had always seemed to exist. Measurement knowledge in industrial-arts is similar in all psychological aspects to knowledge in other school subjects that are now being measured effectively with an objective-type examination. Data

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10 Newkirk and Greene, *op. cit.* p. 14
secured through the use of a measurement knowledge objective type test is much superior to the teacher's unaided judgement and should greatly improve shop instruction.\textsuperscript{11} Selvidge and Fryklund\textsuperscript{12} also state that a program of testing is most effective when it is used for diagnosing individual learning difficulties and individual needs. The development of achievement tests designed especially for this field should encourage shop instructors to determine the readiness of their pupils for the industrial-arts course.

The measurement knowledge test was constructed for use in junior-high school exploratory industrial-arts courses in the Portsmouth, Virginia Public Schools, and pupils in the sixth, seventh, and eighth grades for the school session of 1951-52 were selected as subjects for the study. No attempt was made through the use of the test to establish achievement levels and norms other than for use in the Public School System of Portsmouth, Virginia.

II. PROCEDURE

The primary step in the construction of the industrial-arts measurement knowledge test was the collection of data from which test items could be formulated. The questionnaire method was selected as the means to secure the necessary data.

\textsuperscript{11} Newkirk and Greene, \textit{op. cit.}, pp. 43-45.
\textsuperscript{12} Selvidge and Fryklund, \textit{op. cit.}, p. 360.
In the construction of the questionnaire, suggestions revealed in the Research Bulletin, "The Questionnaire," developed by the National Educational Association, were closely followed by the investigator. The measurement knowledge items selected for inclusion in the questionnaire check lists were selected from the official Virginia elementary state course of study, elementary text books, and elementary source books. The items selected represented the measurement knowledge that should have been acquired by the pupils in previous elementary experiences.

Analogous measurement knowledge items were classified into fifteen different sections. The questionnaire recipients, all the white industrial-arts teachers in Virginia, were given instructions to place check marks by each item showing the amount of measurement skill and knowledge they believed a junior-high school pupil should possess as he enters an industrial-arts exploratory course. Check marks were placed in the columns labeled None, Little, Much, and Mastery. The terms "skill" and "knowledge" were defined on the questionnaire for ease of interpretation. Spaces were provided in which additional items could be added by the industrial-arts instructors who answered the questionnaire.

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14 See Questionnaire, pp. 12-14
A preliminary try-out of the questionnaire was made using five industrial-arts instructors in the Portsmouth, Virginia city school system. Revision of the instrument was made in line with suggestions offered during this try-out. One major change was made in the form of the column lay-out to facilitate easier reading and checking of items. A letter of transmittal was developed explaining the purpose and stating sponsorship by the Virginia State Supervisor of Trade and Industry. Several questions were added to the general information section of the questionnaire at the request of the Department of Trade and Industry. This general information section was included to secure background information about the recipients of the questionnaire.

The questionnaire was mailed to all white industrial-arts teachers in Virginia. The mailing list was supplied by the State Department of Trade and Industry and included the names of 187 white industrial-arts instructors. Two follow-up cards were sent out; the first, ten days after the questionnaire was mailed; and the second, twenty days later. Replies were received from 127 of the 187 instructors, a 68 per cent return. The returns included four question-

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15 See Appendix A. p. 55
16 See Appendix A. p. 56
17 See Appendix A. p. 57
naires which were marked unclaimed, three which were not completed because the addressees were in military service, and five which were marked incorrectly; therefore, a total of twelve returns could not be used. The remaining 115 replies were employed in identifying which measurement knowledge items were to be included in the test.
CHAPTER II

THE DEVELOPMENT OF THE INDUSTRIAL-ARTS MEASUREMENT KNOWLEDGE TEST

The measurement knowledge items checked by the industrial-arts instructors on the questionnaire were to serve as the basis for construction of the measurement knowledge test. After the test was constructed and following two revisions, the final form of the instrument was given to 221 junior-high school pupils taking exploratory industrial-arts courses. The reliability of the test was checked statistically and norms for Portsmouth, Virginia school system were established.

I. QUESTIONNAIRE DATA

The industrial-arts measurement knowledge test was designed as a pencil and paper type test, so the skill (performance) factor was not included; only the knowledge (of measurement) factor was considered in this study. Inclusion or rejection of measurement knowledge items for test items was determined by classifying the items checked by the respondents into columns labeled "much" and "mastery" as one category, and columns "little" and "none" as another category. The

18 Supra, p. 5.
measurement knowledge items checked by a majority or over 50 per cent of the respondents in the columns "much" and "mastery" were selected for inclusion in the test. 19

Common practice and experience in teaching are factors which may be relied upon to help define judgment concerning areas of knowledge about which pupils should know. The investigator selected the industrial-arts instructors of the state to help judge which measurement knowledge the test should be concerned with.

The general information section of the questionnaire showed that the average Virginia industrial-arts instructor had approximately ten years teaching experience in his field and represented twenty-six different fields of industrial-arts instruction, ranging from the fourth grade through college level. The heaviest concentration of experience was in the eighth grade through the eleventh grade; and furthermore, the school year 1950-51 found the majority of the industrial-arts instructors also teaching in those grades. Another interesting fact disclosed that a major number of the school systems represented by the 115 shop instructors began industrial-arts programs in the seventh or eight grades. Therefore, the investigator believes that the opinions expressed by the industrial-arts instructors who represent such a wide range of

19 See Questionnaire. p. 12-14.
### Degree of skill (s) a junior high pupil should possess.

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#### Degree of skill (s) a student (e) in measurement and knowledge should possess.

#### Instructions:

Place a 'V' mark in the columns showing the amount of measurement skill or knowledge that you believe a junior high school pupil should possess. Please check both the (applied knowledge) and knowledge (acquaintance with facts and things) section of each idea.

#### Blank spaces are for any additions you may wish to add.

#### MEASUREMENT QUESTIONNAIRE
### Degree of skill (s) and knowledge (k) a junior high pupil should possess

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<td>k</td>
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<td>k</td>
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<td>k</td>
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<td>k</td>
<td>s</td>
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</tr>
<tr>
<td>Degree of skill(s) and knowledge (k) a junior high pupil should possess</td>
<td>Master</td>
<td>Much</td>
<td>Little</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>------------------------------------------------------------------------</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cubic Measure</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Cubic Inch</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
experience and training, afford a valid basis for the construction of questions in the junior-high school measurement knowledge test. The questionnaire tabulation indicated that forty-nine items in thirteen sections should be included in the measurement knowledge test. The sections labeled Metric Measure, Cubic Measure, and Formulas, were checked "little" or "none" by a large percentage of the industrial-arts instructors on the questionnaire. Therefore, test items "cup" and "ounce" in the Liquid Measure Section, as well as "degree" in the Symbol Section were also excluded as the basis for test. Inch, foot, yard, and dozen were the only items, out of over a hundred choices that the industrial-arts instructors selected for inclusion by nearly unanimous opinion. All items in the Linear Measure Section were checked as important enough to be used as bases for test questions.

Thirty-four items out of the forty-nine selected by the shop instructors for inclusion were chosen by more than a 2 to 1 majority, while thirty-four of the fifty-two items were excluded by the same ratio. The selection and rejection of items to be included in the measurement knowledge test by the industrial-arts teachers indicated a close agreement in a majority of cases.

---

20 Newkirk and Greene, op. cit., p. 32.
21 See Table I. pp. 16-18.
### TABLE I

**INDUSTRIAL-ARTS TEACHERS’ CHOICES OF ITEMS FOR INCLUSION IN A MEASUREMENT KNOWLEDGE TEST**

<table>
<thead>
<tr>
<th>Linear Measure</th>
<th>Liquid Measure</th>
<th>Decimal Measure</th>
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<tbody>
<tr>
<td>Yard</td>
<td>20 95</td>
<td>1. Whole Number</td>
</tr>
<tr>
<td>Foot</td>
<td>9 106</td>
<td>.1 Tenth</td>
</tr>
<tr>
<td>Inch</td>
<td>7 106</td>
<td>.01 Hundredth</td>
</tr>
<tr>
<td>Half Inch</td>
<td>10 105</td>
<td>.001 Thousandth</td>
</tr>
<tr>
<td>Quarter Inch</td>
<td>20 95</td>
<td>.0001 Ten Thousandth</td>
</tr>
<tr>
<td>Eighth Inch</td>
<td>31 84</td>
<td>.00001 Hundredth</td>
</tr>
<tr>
<td>Sixteenth Inch</td>
<td>46 69</td>
<td>.000001 Millionth</td>
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</table>

<table>
<thead>
<tr>
<th>Metric Measure</th>
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<tbody>
<tr>
<td>Meter</td>
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<td>35 80</td>
</tr>
<tr>
<td>Decimeter</td>
<td>109 6</td>
<td>51 64</td>
</tr>
<tr>
<td>Centimeter</td>
<td>103 7</td>
<td>72 43</td>
</tr>
<tr>
<td>Millimeter</td>
<td>109 6</td>
<td>89 26</td>
</tr>
<tr>
<td>Kilometer</td>
<td>109 6</td>
<td>98 17</td>
</tr>
<tr>
<td>Kilowatt</td>
<td>101 14</td>
<td>100 15</td>
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<td>Kilocycle</td>
<td>106 10</td>
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<table>
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<th>Symbols</th>
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<th>Angles</th>
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<tbody>
<tr>
<td>( \pi )</td>
<td>76 39</td>
<td>350° Circle</td>
</tr>
<tr>
<td>( \angle )</td>
<td>68 47</td>
<td>180° Straight Line</td>
</tr>
<tr>
<td>Degree</td>
<td>58 57</td>
<td>90° Right Angle</td>
</tr>
<tr>
<td>&quot; Inch</td>
<td>28 87</td>
<td>60° Angle</td>
</tr>
<tr>
<td>( ^{\circ} ) Foot</td>
<td>23 86</td>
<td>45° Angle</td>
</tr>
<tr>
<td>( \triangle )</td>
<td>67 48</td>
<td>30° Angle</td>
</tr>
<tr>
<td>% Per Cent</td>
<td>47 68</td>
<td>Acute Angle</td>
</tr>
<tr>
<td>( \sqrt{\text{ }} ) Square Root</td>
<td>86 29</td>
<td>Obtuse Angle</td>
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<table>
<thead>
<tr>
<th>Value</th>
<th>Value</th>
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<tbody>
<tr>
<td>NO LITTLE</td>
<td>NO LITTLE</td>
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<tr>
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### TABLE I (continued)

**INDUSTRIAL-ARTS TEACHERS CHOICES OF ITEMS FOR INCLUSION IN A MEASUREMENT KNOWLEDGE TEST**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Value</th>
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<td>Scale</td>
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<tr>
<td>Protractor</td>
<td>80 55</td>
</tr>
<tr>
<td>Compass</td>
<td>47 66</td>
</tr>
<tr>
<td>Caliper</td>
<td>86 29</td>
</tr>
<tr>
<td>Micrometer</td>
<td>103 12</td>
</tr>
<tr>
<td>Voltmeter</td>
<td>104 11</td>
</tr>
<tr>
<td>Ammeter</td>
<td>103 12</td>
</tr>
<tr>
<td>Divider</td>
<td>86 29</td>
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<td>Fractions</td>
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<tr>
<td>Whole Numbers</td>
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<tr>
<td>Mixed Numbers</td>
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</tr>
<tr>
<td>Multiplication</td>
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</tr>
<tr>
<td>Subtraction</td>
<td>6 109</td>
</tr>
<tr>
<td>Addition</td>
<td>4 111</td>
</tr>
<tr>
<td>Division</td>
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<tr>
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<td>Cone</td>
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<td>76 39</td>
</tr>
<tr>
<td>Hexagon</td>
<td>93 72</td>
</tr>
<tr>
<td>Octagon</td>
<td>93 72</td>
</tr>
<tr>
<td>Parallelogram</td>
<td>93 72</td>
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<table>
<thead>
<tr>
<th>Terms</th>
<th>Value</th>
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<td>Edge</td>
<td>44 71</td>
</tr>
<tr>
<td>Face</td>
<td>43 73</td>
</tr>
<tr>
<td>Thickness</td>
<td>51 64</td>
</tr>
<tr>
<td>Width</td>
<td>33 82</td>
</tr>
<tr>
<td>Length</td>
<td>33 82</td>
</tr>
<tr>
<td>Board Feet</td>
<td>74 41</td>
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<tr>
<td>Formulas</td>
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</tr>
<tr>
<td>A = S</td>
<td>86 29</td>
</tr>
<tr>
<td>A = WL</td>
<td>78 37</td>
</tr>
<tr>
<td>V = W LH</td>
<td>89 26</td>
</tr>
<tr>
<td>C = W D</td>
<td>90 25</td>
</tr>
<tr>
<td>D = 2 R</td>
<td>83 32</td>
</tr>
<tr>
<td>A = ½ bh</td>
<td>93 22</td>
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<table>
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<tr>
<th>Square Measure</th>
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<tbody>
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<td>Square Foot</td>
<td>52 63</td>
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<td>Square Inch</td>
<td>53 62</td>
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</table>
## TABLE I (continued)

**INDUSTRIAL-ARTS TEACHERS CHOICES OF ITEMS FOR INCLUSION IN A MEASUREMENT KNOWLEDGE TEST**

<table>
<thead>
<tr>
<th></th>
<th>VALUE</th>
<th>VALUE</th>
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<tbody>
<tr>
<td></td>
<td>LITTLE</td>
<td>MUCH</td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dozen</td>
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</tr>
<tr>
<td>Ounce</td>
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<td>Pound</td>
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<td>Quire</td>
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<td>22</td>
</tr>
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<td>38</td>
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<tr>
<td><strong>Cubic Measure</strong></td>
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<td></td>
</tr>
<tr>
<td>Cubic Yard</td>
<td>62</td>
<td>33</td>
</tr>
<tr>
<td>Cubic Foot</td>
<td>74</td>
<td>41</td>
</tr>
<tr>
<td>Cubic Inch</td>
<td>75</td>
<td>42</td>
</tr>
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<td><strong>Parts of Circle</strong></td>
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</tr>
<tr>
<td>Circumference</td>
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<td>69</td>
</tr>
<tr>
<td>Diameter</td>
<td>51</td>
<td>64</td>
</tr>
<tr>
<td>Radius</td>
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<td>48</td>
</tr>
<tr>
<td>Degree</td>
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<td>54</td>
</tr>
</tbody>
</table>

Miscellaneous

<p>| | | |</p>
<table>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following formula was used to approximate the number of test items that should be allotted to each section of the questionnaire:

\[
\text{Number of questionnaire items in each section} \times \frac{75}{49} = \text{(The number of test items)}. \\
\text{(The number of questionnaire items to be included from all sections).}
\]

The number of test items representing each selected questionnaire item was developed by the use of the above formula. The test originally included more than seventy-five items, which incidently seemed suitable for a forty-five to fifty minute time limit. This number (seventy-five) was arrived at experimentally by giving a longer test to forty-nine junior-high school pupils and computing the average completion time.

One of the most satisfactory and reliable objective-test exercises in the measurement of industrial-education information is the multiple-response. After study of authorities in the field of test construction, Lindquist in particular, it was decided to use a consistent type of item, namely multiple-response, throughout the test. An attempt was also made to use as much non-verbal material as possible

---

22 Ibid., p. 109.

in the development of the multiple-response items. The general suggestions for construction of objective test items listed in Greene, Jorgensen, and Gerberich24 were closely followed in constructing the test.

The plan suggested by Remmers and Gage25 was adhered to in the development of the directions for administering and scoring the test.26 A separate answer sheet was devised on which the pupil recorded his answers.27 A manual scoring key was also developed.28

II. TEST TRIALS AND REVISIONS

The test was given to a group of fifteen pupils—five from each of the sixth, seventh, and eighth grades respectively. After study of the results, the test was revised and changes were made to eliminate items that were too difficult, too easy, and poorly stated. A record of all questions asked by pupils during administering of trial test, aided in making necessary revisions. The revised test had a total of eighty-five test items.

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26 See Appendix B, p. 58.
27 See Appendix B, pp. 60-61.
28 See Appendix B, pp. 60-61.
The number of items in Part A, the Numbers Section, was doubled in order to reduce error. It was felt by the investigator that in this section, which involved arithmetic computation, that chance error might be introduced in single item presentation; thus, the number of items was doubled and in the scoring credit for the Numbers Section was halved to keep the total possible score at seventy-five. The arrangement of items in the test booklet was changed to conform to the organization of items in the questionnaire. The decision to use the timed method for giving the test was also made at this time. These changes necessitated a new set of directions and a new answer sheet with a new scoring key.

The revised test was given to thirty-four sixth, seventh, and eighth grade pupils. The maximum time allotment for the individual sections of the test was established at the point where 90 per cent of the pupils completed the test. This suggested time schedule is included in the instructions for administering the test. Again the results were checked and minor revisions were made.

Following the second revision, the test was given,
during the fall term of the school year 1951-52, to 21 sixth
grade pupils, 55 seventh grade pupils, and 145 eighth grade
pupils for a total of 221 pupils enrolled in exploratory in-
dustrial-arts courses. 31

III. STATISTICAL PROCEDURE

The Pearson product-moment formula was used to compute
the reliability coefficient of the two halves of the test by
the split-half method using the odd and even numbered items.
The reliability of one-half of the test was established, and
following this, the Spearman-Brown prophecy formula was used
in estimating the reliability for the whole test. The standard
error of the coefficient of correlation was computed for all
grades. Table No. II reveals the Numbers, Half Test Coefficients
of Correlations, Whole Test Coefficients of Correlations, and
The Standard Error of the Coefficients of Correlations.

TABLE NO. II

COEFFICIENTS OF CORRELATIONS AND THE STANDARD ERROR OF
THE COEFFICIENTS FOR THE MEASUREMENT KNOWLEDGE TEST
GIVEN TO THE SIXTH, SEVENTH, AND EIGHTH GRADE PUPILS

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of Pupils</th>
<th>Coefficients of Correlations</th>
<th>Standard Error of Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Half Test</td>
<td>Whole Test</td>
</tr>
<tr>
<td>Sixth</td>
<td>21</td>
<td>.7269</td>
<td>.8807</td>
</tr>
<tr>
<td>Seventh</td>
<td>55</td>
<td>.8012</td>
<td>.8395</td>
</tr>
<tr>
<td>Eighth</td>
<td>145</td>
<td>.9477</td>
<td>.9176</td>
</tr>
</tbody>
</table>

31 See Test. pp. 25-47
Norms for Portsmouth, Virginia school system were developed for the investigator's own use. The percentile curves show that the eighth grade runs rather consistently above the other two grades; however, about 13 per cent of the eighth grade fall below the medium of the sixth grade. The medium of the sixth and seventh grades vary but two points while the difference in medium of the seventh and eighth grades is four points. The Q₁ of the eighth grade is approximately the same as Q₃ of the seventh grade. Also the spread between the sixth and seventh grade in Q₁ is six points while between the seventh and eighth grade it is only four points. In regards to Q₃ all three grades show approximately the same four point spread. The coefficient of variation between the sixth and seventh grade shows a variability of nearly 80 per cent on measurement knowledge. Between the seventh and eighth grade this coefficient is nearly 90 per cent. Also between the sixth and eighth grade the coefficient of variability runs nearly 91 per cent.

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32 See Figure 1. p.24
FIGURE 1

PERCENTILE CURVE REPRESENTING THE DISTRIBUTION OF SCORES OF SIXTH, SEVENTH, AND EIGHTH GRADE PUPILS, ON THE INDUSTRIAL ARTS MEASUREMENT KNOWLEDGE TEST.
INDUSTRIAL ARTS TEST
MEASUREMENT KNOWLEDGE

DIRECTIONS:

This is a test of your achievement, in the elementary grades, of Measurement Knowledge.

The test is made up of 12 parts. Each part will be timed.

There are 85 questions in the test.

You are to start and stop working at Teacher's Command.

Try to answer all questions.

There are several answers suggested for these questions. Select the answer which you think is correct. Place an X through the letter of that answer on the answer sheet.

Do not mark Test Booklet. All answers must be on the answer sheet.

Following is a sample question to show you how to mark your answers.

Sample

1. Gasoline is sold in what way? Answer

   a. pound
   b. gallon
   c. cup
   d. ounce

   1. a. X, c. d.

Fill in the space provided for name, school, age, and grade, at the top of the answer sheet.

DO NOT TURN PAGE UNTIL COMMAND IS GIVEN:
1. The picture below represents which one of the following measures?

   - a. rod
   - b. inch
   - c. foot
   - d. yard
   - e. meter

2. The picture below represents which one of the following measures?

   - a. yard
   - b. foot
   - c. meter
   - d. rod
   - e. inch

3. The picture below represents which one of the following measures?

   - a. eighth inches
   - b. sixteenth inches
   - c. half inches
   - d. quarter inches
   - e. inch

4. The picture below represents which one of the following measures?

   - a. sixteenth inches
   - b. eighth inches
   - c. quarter inches
   - d. half inches
   - e. inch

5. The picture below represents which one of the following measures?

   - a. quarter inches
   - b. half inches
   - c. sixteenth inches
   - d. inch
   - e. eighth inches

(TURN PAGE)
6. The picture below represents which one of the following measures?
   a. eighth inches
   b. sixteenth inches
   c. quarter inches
   d. half inches
   e. inch

7. The picture below represents which one of the following measures?
   a. sixteenth inches
   b. quarter inches
   c. half inches
   d. inch
   e. eighth inches

8. If an inch is divided into halves which one of the answers below would be the correct number of parts in the inch?
   a. four
   b. sixteen
   c. two
   d. eight

9. Which answer listed below would be the smallest part of an inch?
   a. half
   b. sixteenth
   c. quarter
   d. eighth

10. Which answer listed below would be the largest part of an inch?
    a. sixteenth
    b. half
    c. eighth
    d. quarter

( DO NOT TURN PAGE)
INDUSTRIAL ARTS TEST

PART II

1. The sign (”) is the same as which one of the following answers?
   a. foot sign
   b. dollar sign
   c. per cent sign
   d. inch sign
   e. degree sign

2. This sign (\%) is the same as which one of the following answers?
   a. dollar sign
   b. foot sign
   c. inch sign
   d. degree sign
   e. per cent sign

3. This sign (‘) is the same as which one of the following answers?
   a. foot sign
   b. degree sign
   c. inch sign
   d. per cent sign
   e. dollar sign

4. If John wishes to order a 28 inch bike from a catalogue, which answer below shows the correct way to write this?
   a. 28'
   b. 28''
   c. 28%
   d. 28°

5. John also wishes to order a 12 foot boat, which measure below shows the correct way to write this?
   a. 12°
   b. 12''
   c. 12%
   d. 12'
1. Which answer below is the correct name for bottle Z in the above picture?
   a. quart
   b. pint
   c. gallon
   d. half pint

2. Which answer below is the correct name for bottle X in the picture?
   a. pint
   b. gallon
   c. quart
   d. half pint

3. Which answer below is correct for bottle Y in the picture?
   a. gallon
   b. quart
   c. half pint
   d. pint

4. Eight boys buy a gallon of ice cream and divide it evenly, which answer below shows the amount each would receive?
   a. quart
   b. pint
   c. half pint
   d. half gallon
5. If each boy receives a half pint of milk, how many boys will a gallon serve?
   a. 8
   b. 4
   c. 16
   d. 32

6. Four boys wish to drink a quart of chocolate milk, if each receives the same amount which answer below is correct?
   a. gallon
   b. pint
   c. half pint
   d. half quart

( DO NOT TURN PAGE)
1. This number (75.) is the same as which one of the following answers?
   a. tenth
   b. whole number
   c. hundredth
   d. thousandth

2. This number (.9) is the same as which one of the following answers?
   a. whole number
   b. thousandth
   c. hundredth
   d. tenth

3. This number (.53) is the same as which one of the following answers?
   a. thousandth
   b. hundredth
   c. whole number
   d. tenth

4. Which answer below is a tenth?
   a. .742
   b. .05
   c. 7.
   d. .8

5. Which answer below is a hundredth?
   a. 9.
   b. .74
   c. .894
   d. .7
1. The picture below represents which one of the following answers?

   a. 45 degree angle
   b. 90 degree angle
   c. 180 degree angle
   d. 360 degree angle
   e. 75 degree angle

2. The picture below represents which one of the following answers?

   a. 75 degree angle
   b. 90 degree angle
   c. 180 degree angle
   d. 360 degree angle
   e. 45 degree angle

3. The picture below represents which one of the following answers?

   a. 180 degree angle
   b. 45 degree angle
   c. 90 degree angle
   d. 360 degree angle
   e. 75 degree angle

4. The picture below represents which one of the following answers?

   a. 360 degree angle
   b. 180 degree angle
   c. 45 degree angle
   d. 75 degree angle
   e. 90 degree angle

5. A 90 degree angle is the same as which one of the answers below?

   a. circle
   b. straight line
   c. half a right angle
   d. right angle

(TURN PAGE)
6. A 45 degree angle is the same as which one of the answers below?

   a. right angle
   b. half a right angle
   c. circle
   d. straight line

(Do not turn page)
1. The picture below represents which one of the following answers?

   a. scale (rule)
   b. compass
   c. yard stick
   d. divider

2. The picture below represents which one of the following answers?

   a. yard stick
   b. divider
   c. compass
   d. scale (rule)

3. Which one of the instruments below would you need to draw a straight line?

   a. compass
   b. scale (rule)
   c. divider
   d. protractor

(DO NOT TURN PAGE)
INDUSTRIAL ARTS TEST

PART VII

1. This picture represents which one of the answers below?
   
   ![Circle]
   
   a. square
   b. triangle
   c. circle
   d. rectangle
   e. octagon

2. This picture represents which one of the answers below?
   
   ![Square]
   
   a. rectangle
   b. cone
   c. square
   d. triangle
   e. circle

3. This picture represents which one of the answers below?
   
   ![Rectangle]
   
   a. square
   b. cube
   c. triangle
   d. circle
   e. rectangle

4. This picture represents which one of the answers below?
   
   ![Cube]
   
   a. rectangle
   b. cube
   c. circle
   d. triangle
   e. hexagon

5. Which figure in the list below is most like a pancake?
   
   a. square
   b. rectangle
   c. circle
   d. triangle
6. Which figure in the list below is most like a pat of butter?
   
   a. rectangle  
   b. circle  
   c. square  
   d. triangle

7. Which figure in the list below is most like a dollar bill?
   
   a. circle  
   b. square  
   c. rectangle  
   d. triangle

8. This picture represents which one of the answers below?
   
   a. square  
   b. rectangle  
   c. triangle  
   d. circle  
   e. trapezoid

(DO NOT TURN PAGE)
1. A dozen apples could be evenly divided among how many boys?
   a. 8
   b. 6
   c. 15
   d. 18

2. Eggs are usually sold by which one of the following ways?
   a. bushel
   b. ounce
   c. pound
   d. dozen

3. John's mother brought home 24 oranges, how many dozen was this?
   a. 6
   b. 8
   c. 4
   d. 2

4. A pound of candy was divided between 8 boys, how many ounces did each receive?
   a. 8
   b. 2
   c. 6
   d. 4

5. Mary's mother spilled half of a pound of sugar, how many ounces remained?
   a. 32
   b. 8
   c. 16
   d. 4

(DO NOT TURN PAGE)
INDUSTRIAL ARTS TEST

PART IX

1. Which one of the answers below describe this number \( \frac{1}{2} \)?
   a. decimal
   b. whole number
   c. mixed number
   d. fraction

2. Which one of the answers below describe this number \( \frac{4}{3} \)?
   a. fraction
   b. decimal
   c. whole number
   d. mixed number

3. Which one of the answers below describe this example \((7 \times 10)\)?
   a. division
   b. subtraction
   c. addition
   d. multiplication

4. Which of the answers below describe this example \((8 \times 2)\)?
   a. addition
   b. division
   c. subtraction
   d. multiplication

5. Add (Work on scratch paper, mark answer on answer sheet)
   
   \[
   \begin{array}{c|c}
   397 & 47188 \\
   42715 & 49189 \\
   86 & 43188 \\
   \hline
   \end{array}
   \]

   a. 47188
   b. 49189
   c. 43188
   d. 43178

6. Add
   
   \[
   \begin{array}{c|c}
   4\frac{1}{2} & 15\frac{1}{2} \\
   5\frac{1}{2} & 15\frac{1}{4} \\
   \hline
   3\frac{1}{2} & 16 \\
   \end{array}
   \]

   a. 15\frac{1}{2}
   b. 15\frac{1}{4}
   c. 16
   d. 16\frac{1}{2}
INDUSTRIAL ARTS TEST

PART IX

7. Add

\[
\begin{array}{c}
5 \frac{3}{8} \\
7 \frac{4}{5}
\end{array}
\]

a. 13 \frac{7}{8} \\
b. 14 \frac{7}{40} \\
c. 15 \frac{7}{5} \\
d. 13 \frac{7}{40}
\]

8. Add

\[
\begin{array}{c}
2 \text{ ft.}, 3 \text{ in.} \\
4 \text{ ft.}, 9 \text{ in.}
\end{array}
\]

a. 6 \text{ ft.}, 11 \text{ in.} \\
b. 7 \text{ ft.}, 1 \text{ in.} \\
c. 7 \text{ ft.} \\
d. 6 \text{ ft.}, 6 \text{ in.}
\]

9. Add

\[
\begin{array}{c}
4 \text{ lb.}, 9 \text{ oz.} \\
1 \text{ lb.}, 8 \text{ oz.}
\end{array}
\]

a. 5 \text{ lb.}, 1 \text{ oz.} \\
b. 6 \text{ lb.}, 3 \text{ oz.} \\
c. 6 \text{ lb.}, 1 \text{ oz.} \\
d. 3 \text{ lb.}, 1 \text{ oz.}
\]

10. Subtract

\[
\begin{array}{c}
5945 \\
4672
\end{array}
\]

a. 1264 \\
b. 1273 \\
c. 1274 \\
d. 1275
\]

11. Subtract

\[
\begin{array}{c}
5 \frac{1}{2} \\
3 \frac{1}{7}
\end{array}
\]

a. 2 \frac{1}{7} \\
b. 2 \frac{5}{4} \\
c. 2 \frac{1}{5} \\
d. 2 \frac{1}{2}
\]

12. Subtract

\[
\begin{array}{c}
91 \frac{1}{4} \\
50 \frac{5}{8}
\end{array}
\]

a. 39 \frac{1}{2} \\
b. 40 \frac{5}{8} \\
c. 41 \frac{5}{2} \\
d. 40 \frac{1}{2}
\]

(TURN PAGE)
13. Subtract

\[
\begin{array}{c}
7 \text{ lb. 7 oz.} \\
5 \text{ lb. 12 oz.}
\end{array}
\]

a. 2 lb. 5 oz. \\
b. 1 lb. 11 oz. \\
c. 13 lb. 6 oz. \\
d. 1 lb. 19 oz.

14. Multiplication

\[
\frac{2}{5} \times \frac{3}{5}
\]

a. \(\frac{6}{25}\) \\
b. \(\frac{6}{25}\) \\
c. 5 \\
d. 5/10

15. Multiplication

\[
4 \frac{1}{2} \times 8 \frac{3}{4}
\]

a. 12 \(\frac{3}{4}\) \\
b. 39 \(\frac{3}{4}\) \\
c. 32 \(\frac{3}{4}\) \\
d. 37 \(\frac{1}{4}\)

16. Multiplication

\[
9 \frac{3}{8} \times \frac{1}{5}
\]

a. 9 \(\frac{3}{40}\) \\
b. 1 \(\frac{7}{8}\) \\
c. 9 \(\frac{2}{3}\) \\
d. 9 \(\frac{8}{15}\)

17. Division

\[
\frac{92}{1564}
\]

a. 25 \\
b. 17 \\
c. 15 \\
d. 19

18. Division

\[
\frac{1}{2} \div \frac{1}{4}
\]

a. \(\frac{1}{2}\) \\
b. 8 \\
c. 2 \\
d. \(\frac{1}{2}\)

(TURN PAGE)
INDUSTRIAL ARTS TEST
PART IX

19. Division

\[ \frac{144}{1584} \]

a. 110
b. 11
c. 10
d. 12

20. Division

\[ \frac{1}{8} \div \frac{1}{2} \]

a. \( \frac{1}{2} \)
b. 1 \( \frac{3}{4} \)
c. \( \frac{1}{16} \)
d. \( \frac{8}{16} \)

(DO NOT TURN PAGE)
1. Which answer below is the same as part X in the picture?
   a. end
   b. edge
   c. face
   d. side

2. Which answer below is the same as part Y in the picture?
   a. end
   b. top
   c. edge
   d. bottom

3. Which answer below is the same as part Z in the picture?
   a. top
   b. end
   c. edge
   d. face
4. Which answer below is the same as part U in the picture?
   a. width
   b. thickness
   c. length
   d. heighth

5. Which of the answers below is the same as part V in the picture?
   a. length
   b. thickness
   c. depth
   d. width

6. Which of the answers below is the same as part W in the picture?
   a. thickness
   b. width
   c. length
   d. depth

7. A block of wood similar to the above picture, would have how many surfaces?
   a. 3
   b. 4
   c. 5
   d. 6

8. A block of wood similar to the above picture, would have how many edges?
   a. 1
   b. 2
   c. 4
   d. 6

(TURN PAGE)
INDUSTRIAL ARTS TEST

PART X

9. A block of wood similar to the above picture, would have how many ends?

a. 6
b. 4
c. 2
d. 1

(Do not turn page)
1. Which answer below is the name of part X in the above picture?
   a. circumference
   b. radius
   c. diameter
   d. degree

2. Which answer below is the name of part Y in the above picture?
   a. diameter
   b. radius
   c. arc
   d. circumference

3. Which answer below is the name of part Z in the above picture?
   a. circumference
   b. diameter
   c. degree
   d. radius

4. The diameter of a circle is the same as how many radii?
   a. 4
   b. 6
   c. 2
   d. 8
5. Which of the parts below is the longest part of a circle?
   a. diameter
   b. radius
   c. arc
   d. circumference

   (DO NOT TURN PAGE)
INDUSTRIAL ARTS TEST

PART XII

1. Mrs. Jones' kitchen measures 12 ft. by 15 ft., how many square feet of linoleum would she need to completely cover the floor?
   a. 27 sq. ft.
   b. 45 sq. ft.
   c. 180 sq. ft.
   d. 90 sq. ft.

2. Mr. Brown wishes to paint his bedroom floor which measures 15 ft. by 20 ft. If a gallon of paint will cover 200 sq. ft., which answer shows the correct amount of paint needed?
   a. 1 gal.
   b. 1½ gal.
   c. 2 gal.
   d. 2½ gal.

3. A square foot is made up of how many square inches?
   a. 12 sq. in.
   b. 36 sq. in.
   c. 72 sq. in.
   d. 144 sq. in.

(DO NOT TURN PAGE)
CHAPTER III

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

This study accomplished its avowed purpose to construct a pencil and paper test for discovering, in terms of measurement knowledge, the achievement level of junior-high school pupils at the start of an industrial-arts exploratory course. Using such sources as elementary text books, elementary source books, and the official Virginia elementary state course of study, items were identified for inclusion in a questionnaire which was designed to reveal what should be asked on a measurement knowledge test. The questionnaire was distributed to all white industrial-arts instructors in Virginia.

Of the 101 items listed in the questionnaire forty-nine were selected for inclusion in the test. The forty-nine items were classified in the following categories: Linear Measure, Symbols, Angles, Decimal Measure, Liquid Measure, Instruments, Numbers, Figures, Terms, Parts of Circle, Square Measure, and Miscellaneous. Metric Measure, Cubic Measure, and Formulas were not selected as suitable for test items.

Since the items for the questionnaire were identified from standard text books, courses of study and the like, and since 115 industrial-arts instructors selected particular items
from the list, it is believed that the test had curricular validity.

After the test was given to 221 sixth, seventh, and eighth grade pupils the reliability of the test was computed using the split-half method. The "whole test" coefficient of correlation for each grade was .98, .99, .92, respectively. It was also discovered that certain specific items such as, item number 6, Part VII, item numbers 2, 3, 4, and 5, Part IV, and item 1, Part I show the need for revision in order to make the test more effective.

The percentile curves for the three grades show each to be approximately the same variability in measurement knowledge.

IV. CONCLUSIONS

On the basis of the foregoing data, the following conclusions seem to be justified:

1. The test was reliable statistically.
2. The test was valid. The test seemingly had curricular validity.
3. On the basis of the results it is concluded that the test has value, when used as an achievement test, in locating individual differences on the individual as well as the class level in industrial-arts measurement knowledge.
4. The test needs revision before it may be given effectively to additional groups.

II. RECOMMENDATIONS

In view of the above conclusions the following recommendations are made:

1. A further study of industrial-arts readiness to determine the factors necessary for inclusion in an industrial-arts test should materially aid in the development of this type of testing.

2. The development of a skill factor test of measurement would be another worthwhile addition to supplement the measurement knowledge test.
BIBLIOGRAPHY

A. BOOKS


Arithmetic We Use, Grade Seven, Philadelphia:

Arithmetic We Use, Grade Six, Philadelphia:

Arithmetic We Use, Grade Five, Philadelphia:

Arithmetic We Use, Grade Four, Philadelphia:

Arithmetic We Use, Grade Three, Philadelphia:


Arithmetic for Young America, Grade Seven, New York: World Book Company, 1944. 307 pp.

Arithmetic for Young America, Grade Six, New York: World Book Company, 1944. 297 pp.

Arithmetic for Young America, Grade Five, New York: World Book Company, 1944. 314 pp.

Arithmetic for Young America, Grade Four, New York: World Book Company, 1944. 307 pp.

Arithmetic for Young America, Grade Three, New York: World Book Company, 1944. 314 pp.


Selvidge, R. W., and Verne C. Fryklund, Principles of Trade and Industrial Teaching. Peoria; Chas A. Bennett Company, 1940. 395 pp.

B. PERIODICAL ARTICLES


E. PUBLICATIONS OF LEARNED ORGANIZATIONS


APPENDIX A.
Dear Sir:

Dr. B. H. Van Oot, State Supervisor of Trade and Industrial Education in Virginia, has given me permission to send questionnaires to the Industrial Arts Instructors of the State, in order that I may secure information for use in the construction of a diagnostic industrial arts test of measurement skill and knowledge. This test to be designed for use on the junior high level.

It is hoped that the study, of which the test is to be a part, will be of value to industrial arts instructors as an aid in improving course planning in the light of individual differences of pupils.

All information you submit will be treated confidentially and impersonally. Names and places will not be used in the study.

Your immediate attention will be greatly appreciated, a copy of the completed test will be sent on request.

Sincerely yours,

Chester H. Gutzler
GENERAL INFORMATION

NAME ________________________________________________

ADDRESS ________________________________________________

SCHOOL ADDRESS ____________________________________________

TOTAL YEARS TEACHING EXPERIENCE IN INDUSTRIAL ARTS _______________

CIRCLE THE GRADE OR GRADES YOU ARE NOW TEACHING INDUSTRIAL ARTS

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, adult

CIRCLE THE GRADE OR GRADES YOU HAVE TAUGHT INDUSTRIAL ARTS

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, adult

CIRCLE THE STARTING GRADE FOR INDUSTRIAL ARTS IN YOUR SCHOOL

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,

CHECK TYPE OF SHOP ORGANIZATION IN YOUR SCHOOL

Comprehensive General Shop ______
Unit Shop ______
Other (explain) ____________________________

PLEASE LIST THE INDUSTRIAL ARTS FIELDS IN WHICH YOU ARE TEACHING, OR HAVE TAUGHT

1. ____________ 5. ____________ 9. ____________
2. ____________ 6. ____________ 10. ____________
3. ____________ 7. ____________ 11. ____________
4. ____________ 8. ____________ 12. ____________

IF YOU WOULD LIKE A COPY OF TEST, PLEASE CHECK _____

PLEASE FEEL FREE TO COMMENT ON ANY PHASE OF THIS QUESTIONNAIRE, OR ON INDUSTRIAL ARTS MEASUREMENT. ANY EXPRESSION OF OPINION WILL BE AP- PRECIATED.
5/23/51

Dear Sir:

Thank you for your prompt response to my questionnaire. If you have so requested, a copy of test will be sent you upon its completion.

In case you have not, as yet, completed the questionnaire, please do so at your earliest convenience, as your reply is necessary for the construction of this test.

Sincerely,

Chester H. Gutzler
APPENDIX B
DIRECTIONS FOR ADMINISTERING
AND
SCORING TEST

There is a total of seventy five possible points on this test. The arithmetic section (Part IX) is scored one half point for each correct answer. Provide scrap paper for working this section. Apply rules of good testing when administering this test. When scoring count only correct answers.

SUGGESTED TIME SCHEDULE

<table>
<thead>
<tr>
<th>Part</th>
<th>Time</th>
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<tbody>
<tr>
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<td>Part II</td>
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<td>Part XI</td>
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<tr>
<td>Part XII</td>
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TOTAL TIME 45 MINUTES
# Measurement Knowledge Test Answer Sheet Key

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<thead>
<tr>
<th>NAME</th>
<th>SCORE</th>
<th>AGE</th>
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<tr>
<td>SCHOOL</td>
<td>GRADE LEVEL</td>
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**Directions:** Place an X through the letter corresponding to the choice of correct answer.

## PART I

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### MEASUREMENT KNOWLEDGE TEST

**Answer Sheet**

**KEY (continued)**

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