MATHEMATICAL ABILITIES INVOLVED IN CERTAIN NINTH GRADE GENERAL SCIENCE TEXTBOOKS

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PREFACE

The purpose of this survey was to determine the mathematical abilities involved in certain ninth grade general science textbooks. An analysis of these textbooks was made and the different mathematical concepts and mathematical abilities were counted, averaged, and tabulated. It is hoped that this information which has been compiled will be of assistance to interested teachers.

The writer wishes to express her appreciation to the following people for their guidance and assistance:

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S. G. McC.

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CHAPTER I

INTRODUCTION

Junior high school science today is almost universally centered around environmental problems. Before studying general science, it would be well if the students could be acquainted with the different mathematical concepts and the different mathematical processes and principles required in handling the formulas and problems in ninth grade general science. It is charged that the opportunities for a closer correlation and integration of mathematics with "more vital" subjects, such as the social studies and general science, are almost completely ignored.

Dissatisfaction has been expressed by some teachers of general science in regard to the lack of mathematical ability on the part of the students to cope with the mathematical situations required in general science. Since mathematics is a tool for all sciences, it is well that some heed should be given to these.

According to Morton:[1]

> There are many situations of life in which order, magnitude, and quality are essential elements. Arithmetic is a systematic pattern of thinking about such situations. It is also a series of modes of attack upon them. It is thus more than a tool which one may use in the interpretation of personal, business, social, or civic affairs. It grows out of a productive study of such affairs and is applicable to them.

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[1] R. L. Morton, "The National Council Committee on Arithmetic," The Mathematics Teacher, Oct., 1938: Vol. XXXI, #6, p. 267.

There is no doubt that much of the difficulty confronted by ninth grade general science students is due to their inability to interpret the situations which are expressed, due to a lack of previous training in some other field, such as mathematics or general reading ability. For this reason, science is having difficulty in establishing itself in the present program of studies. Judd[2] states that some phases of science, such as psychology, geography, and physiology, have been discontinued ahd have been replaced by new subjects, such as agriculture, home economics, and general science which have a great deal of practical material in them. He attributes these fluctuations to psychological causes. He also contends that there is a natural interest on the part of everyone to be attracted by science, but that due to the teaching of science by specialists in other fields who have emphasized their fields at the expense of science, interest in science has suffered. If the school is to help pupils master science, it must arrange the science work in conformity with their abilities.

There is no doubt that science is dependent to quite an extent upon mathematics for its success. Likewise, it is true that the study of nature was one of the factors

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[2] Charles H. Judd, Psychology of Secondary Education, p. 325.

that promoted the development of mathematics. This close relationship is very ably expressed by Young[3] when he expresses the idea that although mathematics as a type of thought seems to inhere in the human mind, it was the study of nature that prompted and stimulated mathematical thought in the beginning because the phenomena of nature could not be understood without mathematics.

According to Judd[4] : "Science developes only when problems are understood." "In short it is the unfamiliar which presents obvious problems."[5]

It has been said[6] that mathematics throws light on many questions that have troubled philosophers for centuries. The questions of time, space, motion, and truth confronted in science are puzzling, and it is only through the concepts of mathematics that we have been able to comprehend them.

In order to determine just what mathematical concepts and abilities are essential for the successful handling of the various scientific subjects several surveys and studies have been made.

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[3] J. W. A. Young, The Teaching of Mathematics, p. 46.

[4] Charles H. Judd, Psychology of High School Subjects, p. 329.

[5] Ibid., p. 331.

[6] Cooley, Sans, Kline, and Wahlert, Introduction to Mathematics, p. 10.

Williams[7] made a detailed analysis of the mathematical abilities assential for freshman chemistry as revealed by a survey of a chemistry textbook written by W. A. Noyes. All mathematical concepts were listed and frequencies noted. All problems were solved and the principles involved with frequencies were tabulated. He found that practically all of the concepts and mathematical principles were those that occur in arithmetic.

Congdon[8] made a survey to attempt to determine the mathematics essential for success in first-year college physics and first-year college chemistry. He used textbooks for this survey. His research revealed that in both subjects the algebraic equations involved were not difficult, and that there were few geometric facts involved.

Rendahl[9] made a detailed analysis of three high school chemistry textbooks and found that multiplication occurred more frequently than any of the other processes. The algebra was of the simplest form and the geometry was negligible.

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7 L. W. Williams, "The Mathematics Needed in Freshman Chemistry," School Science and Mathematics, Vol. XXI, October, 1921, pp. 654.65.

8 Allan Ray Congdon, The Training in High School Mathematics Essential for Success in Certain College Subjects.

9 J. L. Rendahl, "The Mathematics Needed in Solving Problems in High School Chemistry," School Science and Mathematics, Vol. XXX, June, 1930.

Lamb[10] in his survey of ten hygiene books used in Grade 5, found that very little arithmetical knowledge was necessary.

Shoptaugh[11] made a survey of the adopted textbooks used in the state of Louisiana for high school in physics, chemistry, biology, and general science. He found that the mathematical concepts essential for chemistry, biology, and general science were rather numerous and pertained to denominate numbers. The mathematical abilities for biology and general science were negligible while those for chemistry were chiefly arithmetical. The mathematical concepts essential for physics were rather numerout pertaining largely to geometry, algebra, and denominate numbers. The mathematical principles in physics were chiefly algebraic.

In order to ascertain the amount of mathematics involved in general science according to present texts used, five modern general science books have been surveyed to determine just which mathematical principles and concepts appear in order that interested teachers may have some sort of a guide to assist them in determining just what

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10 Theldon N. Lamb, The Amount of Arithmetic Necessary for a Child to Know in Order to Read Intelligently a Fifth Grade Hygiene Book, Thesis, 1931, Ann Arbor, Michigan.

11 John Royal Shoptaugh, The Mathematics Needed for Science Courses in the Louisiana High Schools, Thesis 1931, Louisiana State University, Louisiana.

mathematics is found in the text. "At all levels the courses in mathematics should include such mathematical information as is of greatest immediate value to the pupils."[12] If a teacher has the above principles and concepts in mind, it will be much easier to detect them and stress them in the mathematical courses. Then, too, as stated by the National Committee of Mathematical[13] requirements:

> The primary purpose of the teaching of mathematics should be to develop those powers of understanding and analyzing the interdependencies of quantities and spacial magnitudes which are necessary to a better appreciation of the progress of civilization and a better understanding of life and of the universe about us, and to develop those habits of thinking which will make these powers effective in the life of the individual.

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[12] E. R. Breslich, The Administration of Mathematics in Secondary Schools, p. 185.

[13] National Committee of Mathematical Requirements, p. 10.

CHAPTER II

COLLECTION AND TREATMENT OF DATA

The purpose of this survey is to determine the importance given to the different mathematical abilities in ninth grade general science as judged by the frequencies of their appearance in the textbooks surveyed. It is not the purpose of this survey to compare the textbooks in any manner, but rather to obtain an average of the different abilities required as is shown by the frequencies of their appearance. A list of the textbooks surveyed and the abbreviation that is used for each in the tables may be found in the appendix.

In the formation of the tables, methods used and words compiled by Congdon[1], Williams,[2] Osburn,[3] Lamb,[4] and Shoptaugh[5] have been considered. The five texts have been read and a word count taken. The concepts have been classed and recorded in tables in groups of denominate numbers of the English System and Standard Measurements, denominate numbers of the Metric System, other terms of measurement, geometric terms, and some miscellaneous mathematical concepts. All numbers have been counted

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1 Congdon, op. cit., p. 3.

2 Williams, op. cit., p. 3.

3 J. W. Osburn, Corrective Arithmetic, p. 76.

4 Lamb, op. cit., p. 4.)

5 Shoptaugh, op. cit., p. 4.

and tabulated as to whether they were written in figures, words, or combinations of figures and words. The numbers have also been tabulated according to their denominational size. All symbols appearing in the exposition have been counted and tabulated. The graphs, formulas, maps and charts that involve quantity appearing in the texts have been counted and tabulated. All laboratory experiments have been considered, and the mathematical abilities required, such as measuring and drawing have been tabulated. All problems have been solved and the general principles, specific processes, and fundamental processes used have been tabulated.

Two special symbols have been used in the tables. The symbol, (#), after a word signifies that the concept has appeared ten times or more in the exposition of the text. It is considered that if a term appears at least ten times in a text, it is worthy of being accredited high importance. The sign, (≠), after a number or process signifies that a definite count was impossible, due to the fact that more than one solution was possible for the problem. This was especially true in the dietary problems.

I. Mathematical Concepts.

A. Concepts of Measurement.--Tables I, II, and III list the different concepts of measurement used in the five texts. These concepts are classified under

"Denominate Numbers of English System and Standard Measurements" in Table I, "Denominate Numbers of Metric System" in Table II, and "Terms of Measurement" in Table III.

From a word count of the exposition in the five texts, the frequencies were noted, an average was computed, and the results of both findings were tabulated. As has been previously stated, any concept appearing ten times or more has been marked with a (#). All forms of the word have been listed under one heading.

Tables I and II reveal the fact that concepts of measurement have been used quite extensively. Listing the abbreviations and symbols for one quantity, (Ex. feet, ft., '), as one, Table I shows that there are forty different concepts of the English System and Standard Measurements used. Classifying the terms as to area, length, mass, time, and volume, Table I shows that there were ten different terms pertaining to length, nine to volume, eight to time, five to mass, four to area, and four to quantity. The above shows that out of the forty concepts listed in Table I, length ranked first with 25 per cent of the total terms.

Fourteen different concepts of the Metric System appeared in Table II. Out of this total of fourteen, seven expressed length, five mass, and two volume.

Length, also, ranked first in this table with 50 per cent of the total. Since both of the denominate number systems have been studied before the student reaches the ninth grade, the use of them should not cause too much difficulty.

Table III lists miscellaneous units of measurement that pertain to various scientific principles. Some of them, as the watt, are somewhat familiar to the students because of the common use of electricity in most homes. However, the scientific terms of measurement used in the texts are clearly defined. The uses of these scientific terms in problems are also explained and illustrated. Table III, also, has some concepts listed that are not quite so scientific. Such terms as arm's length, drop, dose, etc. are illustrations of these. They have been included in the table because they are practical, are used quite extensively, and should be apprehended.

B. Geometric Concepts.--Table IV contains a list and the frequencies of the geometric concepts used. There are 47 terms in all which is quite a broad range. At the time the students take ninth grade general science, they have not yet had geometry as a special study. However, a survey of Table IV shows that all geometric concepts used are those which appear in the elementary geometric work included in the intuitive and demonstrative geometric units offered in the seventh and eighth grades.

C. Miscellaneous Mathematical Concepts--Table V includes a list of miscellaneous mathematical concepts that are not included in any of the previous classifications. They are definitely mathematical, however, and should be given recognition. The measuring devices listed are included because they are used to determine quantities. There are one hundred and thirteen of these concepts. With the exception of the different measuring devices and the inverse proportion term, the words are quite common to seventh and eighth grade work. The measuring devices are explained in each of the texts in which they appear. The term inverse proportion is merely mentioned in regard to the density of light. However, the process of comparing the densities of light at different distances is explained quite simply. The table shows that the expression appears on an average of .4 times so is, therefore, quite negligible.

TABLE I

DENOMINATE NUMBERS, ENGLISH SYSTEM
AND STANDARD MEASUREMENTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
acre	#	6	5	9	#	40/	8/
barrel	0	2	2	2	0	6	1.2
bushel	7	5	6	7	3	28	5.6
cent	#	1	1	9	8	29/	5.8/
¢	2	0	0	0	9	11	2.2
century	#	#	#	6	#	46/	9.2/
cord	0	2	0	0	0	2	.4
cubic foot	#	#	#	#	4	44/	8.8/
cu. ft.	4	2	0	0	0	6	1.2
cubic inch	2	1	0	3	5	11	2.2
cu. in.	4	2	0	0	0	6	1.2
day	#	#	#	#	#	50/	10/
d.	0	0	0	0	4	4	.8
degree (circular)	#	#	#	#	#	50/	10/
dime	0	2	0	1	0	3	.6
dollar	#	5	0	6	5	26/	5.2/
$	#	6	3	#	#	39/	7.8/
dozen	4	0	3	3	2	12	2.4
doz.	0	0	0	0	0	0	0
dram	0	0	0	0	2	2	.4
foot	#	#	#	#	#	50/	10/
ft.	5	2	0	3	2	12	2.4

TABLE I (CONTINUED)

DENOMINATE NUMBERS, ENGLISH SYSTEM
AND STANDARD MEASUREMENTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
' (foot)	1	0	0	#	0	11/	2.2/
gallon	9	#	8	#	4	41/	8.2/
gal.	6	0	0	0	0	6	1.2
grain	0	#	0	3	2	15/	3/
hour	#	#	#	#	#	50/	10/
hr.	0	6	0	4	8	18	3.6
hundredweight	0	3	0	0	0	3	.6
inch	#	#	#	#	#	50/	10/
in.	3	4	5	5	2	19	3.8
" (inch)	#	6	#	#	0	36/	7.2/
knot	4	5	0	0	2	11	2.2
mile	#	#	#	#	#	50/	10/
mi.	0	3	0	0	0	3	.6
minute	#	#	#	#	#	50/	10/
minute, circular	0	0	4	0	0	4	.8
min. (time)	0	5	2	2	2	11	2.2
'(minute,circular)	0	7	0	0	1	8	1.6
m.(minute, time)	0	0	0	0	6	6	1.2
month	7	#	#	#	8	45/	9/
nautical mile	1	2	0	0	0	3	.6
ounce	#	#	8	#	#	48/	9.6/
oz.	4	#	0	4	#	28/	5.6/

TABLE I (CONTINUED)

DENOMINATE NUMBERS, ENGLISH SYSTEM
AND STANDARD MEASUREMENTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
pint	#	7	4	8	8	37/	7.4/
pt.	0	0	0	0	2	2	.4
pound	#	#	#	#	#	50/	10/
lb.	#	#	#	#	#	50/	10/
quart	#	3	9	#	#	42/	8.4/
qt.	0	0	0	0	#	10/	2/
rod	1	0	0	0	0	1	.2
second, circular	0	4	3	0	0	7	1.4
second, time	#	#	3	#	#	43/	8.6/
"(sec. circular)	0	1	0	0	2	3	.6
square foot	3	#	3	3	5	24/	4.8/
sq.ft.	0	0	0	0	2	2	.4
square inch	7	#	#	#	#	47/	9.4/
sq. in.	3	2	0	0	2	7	1.4
square mile	2	5	3	4	2	16	3.2
ton	#	#	#	9	6	45/	9/
week	#	#	#	#	8	48/	9.6/
yard	2	3	6	0	#	21/	4.2/
year	#	#	#	#	#	50/	10/
yr.	0	6	0	7	2	15	3
				Total		1513/	302.6/

TABLE II

DENOMINATE NUMBERS, METRIC SYSTEM

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
centimeter	0	#	0	0	4	14/	2.8/
cm.	0	3	0	0	1	4	.8
centimeter gram	0	4	0	0	0	4	.8
cubic centimeter	0	#	0	0	1	11/	2.2/
c.c.	2	#	0	#	#	32/	6.4/
decimeter	0	0	0	0	2	2	.4
dm.	0	0	0	0	1	1	.2
dekameter	0	0	0	0	2	2	.4
Dm.	0	0	0	0	1	1	.2
dyne	0	1	0	0	0	1	.2
gram	#	#	#	6	#	46/	9.2/
hektometer	0	0	0	0	2	2	.4
Hm.	0	0	0	0	1	1	.2
kilogram	0	5	0	0	2	7	1.4
Kg.	0	1	0	0	1	2	.4
kilometer	0	2	0	0	3	5	1
Km.	0	2	0	0	1	3	.6
liter	2	0	0	0	4	6	1.2
meter	2	#	2	6	7	27/	5.4/
m.	0	1	0	0	1	2	.4
metric ton	0	1	0	0	0	1	.2
millimeter	0	5	0	1	3	9	1.8
mm.	0	1	0	0	1	2	.4
					Total	185/	37/

TABLE III

MISCELLANEOUS NUMBERS OF MEASUREMENT

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
ampere	#	#	#	#	#	50/	10/
Amp.	0	0	1	0	0	1	.2
arm's length	1	0	0	0	0	1	.2
Brit. Therm. Unit	3	1	1	1	3	9	1.8
B. T. U.	2	2	2	4	5	15	3
block	0	3	0	0	0	3	.6
calorie	#	#	#	#	#	50/	10/
Calorie (large calorie)	#	0	1	5	6	22/	4.4/
C. (Calorie)							
candle power	7	#	2	#	4	33/	6.6/
c.p.	0	0	0	0	2	2	.4
Centigrade degree	#	#	#	#	#	50/	10/
cup	3	1	#	#	#	34/	6.8/
decibel	0	0	0	3	0	3	.6
dose	0	0	1	0	0	1	.2
erg	0	8	0	0	0	8	1.6
Fahrenheit degree	#	#	#	#	#	50/	10/
flight (stairs)	0	0	1	0	0	1	.2
floor	2	0	2	1	0	5	1
foot candle	4	0	0	3	3	10	2
foot pound	#	#	7	#	8	45/	9/
ft. lb.	4	0	0	0	0	4	.8

TABLE III (CONTINUED)

MISCELLANEOUS NUMBERS OF MEASUREMENT

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
handful	0	2	1	0	3	6	1.2
horse power	#	#	8	#	4	42/	8.4/
H. P.	3	0	0	4	5	12	2.4
kilocycle	0	1	0	0	2	3	.6
kilowatt	5	#	7	#	#	42/	8.4/
knee deep	0	0	1	0	0	1	.2
light year	0	5	5	9	#	29/	5.8/
magnitude	4	2	3	#	4	23/	4.6/
ohm	4	6	2	6	4	22	4.4
R (ohm)	2	0	0	4	0	6	1.2
parsec	0	0	1	1	0	2	.4
penny	3	0	3	0	0	6	1.2
period (time)	#	#	#	#	#	50/	10/
pinch	3	2	3	3	2	13	2.6
season	#	#	#	#	#	50/	10/
story	3	8	4	1	3	19	3.8
tablespoon	2	0	0	#	3	15/	3/
tbsp.	0	0	6	4	3	13	2.6
teaspoon	7	4	7	9	#	37/	7.4/
volt	#	#	#	#	#	50/	10/
V.	0	0	0	1	0	1	.2
watt	#	#	#	#	#	50/	10/
W. (watt)	0	2	0	1	0	3	.6
				Total		956/	191.2/

TABLE IV

GEOMETRIC CONCEPTS

Terms	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Adjacent	1	1	4	0	3	9	1.8
Altitude	#	#	#	#	#	50/	10/
Angle	#	#	#	#	#	50/	10/
Arc	#	3	4	#	#	37/	7.4/
Area	#	#	#	#	#	50/	10/
Axis	#	#	#	#	#	50/	10/
Base	#	#	#	#	#	50/	10/
Center	#	#	#	#	#	50/	10/
Circle	#	#	#	#	#	50/	10/
Circumference	2	7	4	2	1	16	3.2
Cone	3	#	8	4	3	28/	5.6/
Concave	2	#	9	#	3	34/	6.8/
Concavo convex	0	0	1	0	3	4	.8
Convex	6	#	8	#	#	44/	8.8/
Convex concave	1	0	0	0	0	1	.2
Cube	5	1	0	0	6	12	2.4
Cylinder	#	#	#	#	#	50/	10/
Diagonal	0	1	3	0	2	6	1.2
Diameter	#	#	#	8	#	48/	9.6/
Double concave	1	1	1	0	0	3	.6
Double convex	2	7	4	0	4	17	3.4
Ellipse	0	0	1	2	2	5	1

TABLE IV (CONTINUED)

GEOMETRIC CONCEPTS

Terms	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
Hemisphere	#	#	#	8	9	47/	9.4/
Hexagonal	0	0	1	0	0	1	.2
Horizontal	#	#	#	5	7	42/	8.4/
Line	#	#	#	#	#	50/	10/
Oblique, (angle)	1	2	2	0	1	6	1.2
Parallel	#	#	#	#	#	50/	10/
Perimeter	0	0	0	0	1	1	.2
Perpendicular	1	6	2	2	6	17	3.4
Plane	8	#	#	#	8	46/	9.2/
Plano concave	1	0	0	0	0	1	.2
Plano convex	1	2	1	0	2	6	1.2
Point	#	#	#	#	#	50/	10/
Prism, Rect.	6	0	0	4	6	16	3.2
Prism, Tri.	2	4	#	3	4	23/	4.6/
Pyramid	3	0	0	0	2	5	1
Quadrilateral	0	1	0	0	0	1	.2
Radius	0	2	5	0	2	9	1.8
Rectangle	0	2	2	0	2	6	1.2
Right angle	2	2	#	7	5	26/	5.2/
Sphere	2	#	3	4	9	28/	5.6/
Square	#	6	#	2	#	38/	7.6/
Tangent	0	0	1	2	0	3	.6
Triangle	2	7	#	4	6	29/	5.8/
Vertical	#	#	#	8	#	48/	9.6/
Volume	#	#	#	#	#	50/	10/
				Total		1263/	252.6/

TABLE V

MISCELLANEOUS MATHEMATICAL CONCEPTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
Add	#	#	#	#	#	50+	10+
Alternate	#	#	#	#	#	50+	10+
Altimeter	0	0	1	0	2	3	.6
Ammeter	5	0	1	5	2	13	2.6
Amount	#	#	#	#	#	50+	10+
Anemometer	1	1	0	4	2	8	1.6
Aneroid barometer	6	0	1	5	3	15	3
Annual	8	8	#	#	#	46+	9.2+
Average	#	#	#	#	#	50+	10+
Balance (noun)	#	#	#	#	#	50+	10+
Balance (verb)	#	#	#	#	#	50+	10+
Barograph	2	0	0	2	1	5	1
Barometer	#	9	#	#	#	48+	9.6+
Biennial	0	0	0	3	0	3	.6
Both	#	#	#	#	#	50+	10+
Bomb calorimeter	2	0	0	0	0	2	.4
Calculate	#	#	#	#	#	50+	10+
Calipers	0	0	1	0	0	1	.2
Calorimeter	1	0	0	0	0	1	.2
Capacity	#	#	#	#	#	50+	10+
Centrifugal	2	#	5	3	2	22+	4.4+
Centripetal	1	0	0	0	0	1	.2
Chronometer	7	3	0	1	4	15	3

TABLE V (CONTINUED)

MISCELLANEOUS MATHEMATICAL CONCEPTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
Circumpolar	0	0	0	1	0	1	.2
Clock	#	#	7	#	#	47/	9.4/
Column	#	#	#	#	#	50/	10/
Constant	#	#	#	#	#	50/	10/
Curve	#	#	#	#	#	50/	10/
Cycle	#	#	#	#	#	50/	10/
Degree (Am't)	#	#	#	#	#	50/	10/
Difference	#	#	#	#	#	50/	10/
Divide	#	#	#	#	#	50/	10/
Dividend (interest)	0	0	0	1	0	1	.2
Double	#	#	#	#	#	50/	10/
Electric Meter	3	2	2	2	3	12	2.5
Encircle	2	1	2	1	1	7	1.4
English System	0	4	0	0	0	4	.8
Equal	#	#	#	#	#	50/	10/
Face	2	3	6	3	3	17	3.4
Fathometer	0	0	0	0	1	1	.2
Figures (Shapes)	0	2	2	#	#	24/	4.8/
Fraction	4	5	1	6	8	24	4.8
Frequency	5	2	4	3	#	24/	4.8/
Gain (noun)	4	5	4	#	8	31/	6.2/
Gain (verb)	2	8	6	2	4	22	4.4
Galvanometer	0	5	0	4	5	14	2.8

TABLE V (CONTINUED)

MISCELLANEOUS MATHEMATICAL CONCEPTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
Gas Meter	2	0	0	0	0	2	.4
Hydrometer	4	4	0	5	4	17	3.4
Hygrometer	4	0	5	1	2	12	2.4
Inverse Proportion	0	0	1	0	1	2	.4
Last	#	#	#	#	#	50/	10/
Lose	#	#	#	#	#	50/	10/
Loss	#	#	#	#	#	50/	10/
Log	5	2	2	1	2	12	2.4
Manometer	0	0	0	0	2	2	.4
Maximum	3	4	1	1	5	14	2.8
Mean	0	3	0	0	1	4	.8
Measure	#	#	#	#	#	50/	10/
Meter stick	3	4	2	3	4	16	3.2
Metric System	0	5	0	0	3	8	1.6
Micrometer	0	0	2	5	0	7	1.4
Minimum	2	2	2	1	5	12	2.4
Multiply	6	#	#	#	#	46/	9.2/
Number (noun)	#	#	#	#	#	50/	10/
Number (verb)	1	2	1	3	2	9	1.8
Oblong	0	0	0	0	1	1	.2
Once	#	#	#	#	#	50/	10/
Pair	7	5	8	#	6	36/	7.2/
Per cent	2	7	6	7	8	30	6
Percentage	3	7	2	2	5	19	3.8

TABLE V (CONTINUED)

MISCELLANEOUS MATHEMATICAL CONCEPTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Ave.
Perennial	0	0	3	#	0	13/	2.6/
Plus (add)	6	0	1	2	0	9	1.8
Product (Ans.)	1	1	2	2	1	7	1.4
Profit	0	0	0	2	2	4	.8
Proportion	#	#	#	#	#	50/	10/
Protractor	0	2	0	0	2	4	.8
Quarter	#	#	#	#	#	50/	10/
Radiometer	1	0	1	0	3	5	1
Rate	#	#	#	#	#	50/	10/
Ratio	#	#	3	3	5	31/	6.2/
Round	#	#	#	#	#	50/	10/
Ruler	0	0	4	7	2	13	2.6
Scale (unit)	4	6	#	#	#	40/	8/
Series	#	#	#	#	#	50/	10/
Sextant	6	2	2	1	4	15	3
Sight meter	0	0	0	3	0	3	.6
Single	#	#	#	#	#	50/	10/
Six-sided	1	0	0	2	0	3	.6
Speedometer	2	4	0	5	0	11	2.2
Spiral	0	6	2	2	6	16	3.2
Spirometer	1	0	0	0	0	1	.2
Square (verb)	1	0	1	6	2	10	2
Straight	#	#	#	#	#	50/	10/
Subtract	#	1	0	2	3	16/	3.2/

TABLE V (CONTINUED)

MISCELLANEOUS MATHEMATICAL CONCEPTS

Term	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Sum	1	0	1	1	6	9	1.8
Surface	#	#	#	#	#	50/	10/
Thermograph	2	0	0	0	0	2	.4
Thermometer	#	#	#	5	#	45/	9/
Thermostat	7	3	#	7	6	33/	6.6/
Times (verb)	#	#	#	#	#	50/	10/
To (ratio)	3	0	0	0	0	3	.6
Total	#	#	#	#	#	50/	10/
Triple	1	0	0	3	0	4	.8
Twice	#	#	#	#	#	50/	10/
Unequal	#	#	#	#	#	50/	10/
Unit	#	#	#	#	#	50/	10/
Vary inversely	1	0	0	1	1	3	.6
Volt meter	3	0	1	0	2	6	1.2
Watch	#	6	4	9	#	39	7.8
Weigh	#	#	#	#	#	50/	10/
Yard Stick	6	2	2	0	2	12	2.4
Zero (degrees)	#	6	9	#	#	45/	9/
				Total		2964/	592.8/

D. Number Concepts.--Tables VI, VII, VIII, and IX deal with the number concepts. The number concepts are classified as numbers in figures, numbers in words, numbers in combinations of figures and words, and numbers rated according to size. Comparing Tables VI, VII, and VIII, it will be found that out of the 19,350 number concepts appearing in all five texts, 57 per cent of them are written in figures, 42.8 per cent of them are written in words, and .1 per cent in combinations of figures and words.

1. Numbers in Figures.--Table VI has a list of all the numbers that appear in figures in the texts. In compiling this list, the numbers of the pages, exercises, tables, diagrams, etc. were not counted. The numbers in this group covered a very broad range. They ranged from quantities expressed in fractions to quantities expressed in 21 digits. The table shows that 76.7 per cent of the numbers used were whole numbers. This table, also, shows that students in the ninth grade should be able to read and comprehend to a certain extent large numbers.

2. Numbers in Words.--Table VII contains a list of all the numbers that appear in words. Out of the average of 1656.6 words to each text, 76.3 per cent of these are whole numbers. The numbers appearing in words range from fractions to ten trillion.

3. Numbers in Combinations of Figures and Words.--Table VIII has all the numerical concepts that appear in combinations of figures and words. In this group, as in the two groups previously listed, the majority of the terms are whole numbers, 93.7 per cent of them being devoted to this group. These numbers range from "1 thousand" to "66 with 33 ciphers."

4. Numbers Rated According to Size.--Table IX has all the numbers listed that appear in Tables VI, VII, and VIII arranged according to size. It may be readily seen that the great majority of the terms used are of reasonable size containing only four digits or less. In fact, 89.65 per cent of them range in values from 0 to 1000. As can be noted from the table, the use of extremely large numbers is negligible. In the exposition of the texts, their use has been restricted almost entirely to expressing distances of the heavenly bodies.

TABLE VI

NUMBERS IN FIGURES

Kind	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C	Total	Av.	%
Whole Numbers	2155	1354	824	1986	2152	8401	1694.2	76.7
Common Fractions	40	9	6	37	57	149	29.8	1.3
Mixed Numbers	22	14	5	29	13	83	16.6	.7
Decimal Fractions	28	39	4	16	1128	1215	243	11.0
Mixed Decimals	103	247	6	21	695	1072	214.4	9.7
Ordinals	16	3	2	14	10	45	9	.4
					Total	11035	2207	99.8

TABLE VII

NUMBERS IN WORDS

Kind	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
Whole Numbers	1155	1640	1292	1480	759	6326	1265.2	76.3
Common Fractions	78	138	50	156	101	523	104.6	6.3
Mixed Numbers	1	12	1	7	0	21	4.2	.2
Decimal Fractions	0	0	0	0	0	0	0	0
Mixed Decimals	0	0	0	0	0	0	0	0
Ordinals	243	300	195	372	303	1413	282.6	17.0
				Total		8283	1656.6	99.8

TABLE VIII

NUMBERS IN COMBINATIONS OF FIGURES AND WORDS

Kind	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
Whole Numbers	9	6	0	11	4	30	6	93.7
Mixed Numbers	1	1	0	0	0	2	.4	6.2
					Total	32	6.4	99.9

TABLE IX

NUMBERS RATED ACCORDING TO SIZE

Value	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
From 0 to 1000 (Value to 4 digits)	3237	3291	2194	3801	4825	17348	3469.6	89.65
From 1000 to 10,000 (4 digit numbers)	419	291	124	161	311	1306	261.2	6.74
5 digit numbers	76	40	12	81	28	237	47.4	1.22
6 digit numbers	31	55	11	27	17	141	28.2	.72
7 digit numbers	34	26	25	17	8	110	22	.56
8 digit numbers	17	23	4	17	14	75	15	.38
9 digit numbers	12	16	6	7	9	50	10	.25
10 digit numbers	17	9	7	17	2	52	10.4	.26
11 digit numbers	3	4	1	1	4	13	2.6	.06
12 digit numbers	3	2	0	0	0	5	1	.02
13 digit numbers	0	2	0	0	0	2	.4	.01
14 digit numbers	1	1	1	0	1	4	.8	.02
15 digit numbers	0	3	0	0	1	4	.8	.02
21 digit numbers	1	0	0	0	0	1	.2	.00
35 digit numbers	0	0	0	0	2	2	.4	.01
				Total		19350	3870.	99.92

E. Symbols.--Table X lists the different mathematical symbols that appear in the texts surveyed. The survey would be incomplete if the symbols were not included. The field of mathematics depends a great deal upon its signs and symbols to express its various processes.

The chemical sign, ($\rightarrow$), which signifies that the action is not reversible was used but once, and then, no computations were required with it; thus making its use negligible.

F. Formulas, Tables, Graphs, Maps, and Charts.--Table XI deals with the formulas, tables, graphs, maps, and charts found in the five texts. In selecting these, only those pertaining to quantity in some manner were chosen.

As the table shows, two of the texts did not include the formula for "Horse Power". Even though they did not actually have the formula written out, they made use of it. That is, they either had the rule written out in italics or they explained the process step by step. Table XIII, "General Principles Involved", shows that many of these formulas were actually used in each of the texts even though they didn't appear as a formula in the exposition. There was on an average of 12.8 chemical formulas for each text, but they were merely mentioned in the exposition and required no mathematical

computations. Table XIII, also, shows that other formulas common to arithmetic are required.

The tables, graphs, maps, and charts listed were restricted solely to those comparing or expressing quantitative values. Table XI reveals the fact that tables, maps, charts, and graphs were used quite extensively, there being on an average of 50.2 of them to each text. This is well, because there is no more striking way of expressing statistical facts than by one of these devices.

TABLE X

SYMBOLS USED

Symbol	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
→ (chemical sign)	0	0	0	0	1	1	.2
X (by, dimension)	8	3	0	0	5	16	3.2
# (number)	8	0	0	0	0	8	1.6
X (multiply by)	#	#	#	#	7	47/	9.4/
= (equals)	#	1	3	#	#	34/	6.8/
/ (add)	5	0	0	0	2	7	1.4
— (divide)	6	1	3	#	#	30/	6/
- (minus)	1	0	0	0	2	3	.6
/ (positive, Electricity)	9	3	1	1	#	24/	4.8/
- (negative, Electricity)	9	#	1	1	#	31/	6.2/
@ (at, each)	#	0	0	0	0	10/	2/
: (ratio)	2	0	3	2	8	15	3
÷ (divide by)	0	0	1	2	2	5	1
' (Ex. '18=1918)	0	0	0	#	0	10/	2/
π	0	0	0	1	0	1	.2
r^2	0	0	0	1	0	1	.2
°	#	#	#	#	#	50/	10/
%	#	#	5	8	8	41/	8.2/
				Total		334/	66.7/

TABLE XI

FORMULAS, TABLES, GRAPHS, MAPS, AND CHARTS
LISTED IN THE TEXTS

Formulas, Tables, Graphs, Maps and Charts	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
$W = F \times D$	1	0	0	0	0	1	.2
$E \times ED = R \times RD$	1	0	0	0	2	3	.6
$\text{Efficiency} = \frac{\text{Load x Height}}{\text{Effort x Length}}$	1	0	0	1	0	2	.4
$\text{H.P.} = \frac{\text{Pounds x Feet}}{\text{Min. x 3000}}$	1	0	1	1	0	3	.6
$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$	1	1	0	2	0	4	.8
Volts x Amperes = Watts	0	1	0	1	0	2	.4
$\frac{\text{Amp. x Volts x hrs.}}{1000} = \text{Kwn.}$	0	0	1	0	0	1	.2
$\text{Sp.Gr} = \frac{\text{Wt. of Object}}{\text{Wt. of equal vol. of water}}$	0	0	0	1	0	1	.2
$A = \pi r^2$	0	0	0	1	0	1	.2
Chemical Formulas	40	0	0	8	16	64	12.8
Graphs, Bar	9	5	0	2	4	20	4
Graphs, Circle	12	0	0	1	6	19	3.8
Graphs, Line	0	2	0	3	0	5	1
Graphs, Picture	7	4	2	6	10	29	5.8
Maps and Charts	8	14	4	13	10	49	9.8
Tables	7	12	2	13	13	47	9.4
						251	50.2

II. Mathematical Computations

Two ways of making mathematical computations are by laboratory work and by problem solving. Tables XII, XIII, XIV, and XV deal with mathematical computations. In compiling these tables, it was necessary to adopt a sign for indefiniteness. The sign, (/), placed after some of the reports signifies that it was impossible to get an exact count due to the indefiniteness of the assignment. In each of these cases, a reasonable minimum was recorded.

A. Laboratory Work.--Table XII tabulates the different physical requirements asked of the students under experimental work. The terms are expressed quite definitely and should be easily interpreted. The expressions, such as, "Cube of definite dimensions, Comprehend", have reference to the fact that the students were asked to use a cube of definite dimensions for an experiment. Therefore, it was considered a laboratory skill that should not be omitted.

B. Problem Solving.--Tables XIII, XIV, and XV are concerned with problem solving. All problems occurring in the laboratory work, exercises, assigned problems, and explanatory problems were solved and the different principles, processes, and fundamentals involved for each problem were recorded. The explanatory problems were included because it seemed justifiable that the students

should understand and be able to solve not only the problems asked of them but also those explained in the texts.

1. General Principles Involved.--Table XIII records the general principles involved in solving the problems. These principles have been classified under eleven headings, namely: Average, Buoyancy, Dietary, Electricity, Energy, Longitude and Time, Machine, Mensuration, Percentage, Specific Gravity, and Thermometer Problems. The table shows that 25 per cent of the computations required were concerned with machine problems, 17.1 per cent with energy problems, and 11.8 per cent with dietary and mensuration problems each. The majority of the principles used were concerned with machine and energy problems. The students have not had these in the seventh and eighth grades. However, since these are problems that are based definitely upon formulas and the formulas are given in the texts, the students should be able to solve them as they have had substitution in formulas in the seventh and eighth grades.

2. Specific Operations Involved in the Problems.--Table XIV includes the specific operations involved in the solving of the problems. As will be noted from the table, these are processes that occur within the problems mentioned under general principles in Table XIII or processes that are concerned with simple problems that do not have one of the principles mentioned in Table XIII

involved. It may be noted from Table XIV, that a formula was used on an average of 39.4 times to each text.

3. Fundamental Processes.--Table XV lists the four fundamental processes with their frequencies, average to each text, and per cent of each kind involved. These processes were compiled by keeping an actual count of each time they occurred in the computational work. As may be noted, none of these were definite. However, in arranging these, a plan was devised to make them consistent. The dietary problems were especially very indefinite. In recording the processes for these, in order to be consistent for all, each dietary problem was assigned one addition, ten multiplications, one subtraction, and five divisions. The table shows that 51.7 per cent of the mathematical computations required in the fundamental processes were devoted to multiplication.

TABLE XII

LABORATORY WORK

Procedure	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C	Total	Av.
Amperes, measure	0	7/	0	0	0	7/	1.4/
Angles, arrange at	2	5/	1	3	7/	18/	3.6/
Angles, draw	4/	18/	0	24/	90/	136/	27.2/
Angles, measure	5/	10/	4/	5/	12/	36/	7.2/
Balance, Spring, read	4	6	2	4	8	24	4.8
Balance objects	4	4	11	3	5	27	5.4
Barometer, make	0	1	0	0	0	1	.2
Circle, draw	5	15	6	3	2	31	6.2
Crescent, draw	0	4	2	0	0	6	1.2
Cube of definite dimensions, comprehend	2	11	0	0	3	6	1.2
Diagonally, arrange	0	1	0	0	0	1	.2
Diameter, measure	5	14	6	7	4	36	7.2
Distance in cm., meas.	0	3	1	0	30	34	6.8
Dist. in ft., measure	22	31/	7	11	38/	109/	21.8/
Dist. in in., measure	80	87	44/	60	54/	325/	65/
Dist. in latitude, meas.	4	0	0	0	0	4	.8
Dist. in longitude, meas.	5	3	5	0	5	18	3.6
Dist. in mm., measure	0	6	0	0	0	6	1.2
Dist. in yd., measure	0	0	0	0	1	1	.2
Divide an object into parts	27	32	14	21	20	114	22.8
Draw diagram	1	34/	0	4/	5	44/	8.8/
Draw to scale	2	3	0	0	2	7	1.4

TABLE XII (CONTINUED)

LABORATORY WORK

Procedure	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Electric Meter, Read	2	1	1	1	0	5	1
Ellipse, Draw	0	0	0	0	1	1	.2
Gas Meter, Read	2/	0	0	0	0	2/	.4/
Graphs, Draw Line	1	1	0	0	1	3	.6
Handfuls, Measure	3	1	0	0	0	4	.8
Horizontally, Arrange	4	5	3	0	2	14	2.8
Lines, Draw Straight	12/	38/	5	40/	120/	215/	43/
Lines, Arrange at Straight Lines	1	1	1	1	1	5	1
Liquid in c.c., Measure	7	18	0	15	28	68	13.6
Liquid in cups, Measure	6	0	6	0	0	12	2.4
Liquid in drops, Measure	12	18	9	4	3	46	9.2
Liquid in gallons, Meas.	0	0	0	1	0	1	.2
Liquid in liters, Meas.	0	0	0	0	2	2	.4
Liquid in pints, Meas.	1	5	0	0	1	7	1.4
Liquid in quarts, Meas.	4	1	1	3	2	11	2.2
Mix solution certain %	0	1	0	3	2	6	1.2
Objects in doz., Meas.	1	0	0	0	0	1	.2
Parallel, Arrange	2	2	2	0	0	6	1.2
Parallel Lines, Draw	10	0	0	2	0	12	2.4
Perpendicularly, Arrange	0	0	0	0	2	2	.4
Pinch, Meas. in	0	6	3	2	0	11	2.2
Pressure of Atmosphere Measure	2/	6/	3	0	3	14/	2.8/

TABLE XII (CONTINUED)

LABORATORY WORK

Procedure	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Quadrilateral, Draw	0	1	0	0	0	1	.2
Radius, Measure	1	0	0	0	0	1	.2
Radius, Set compasses	5	19	8	3	2	37	7.4
Rectangle, Draw	2	4	0	8	20	34	6.8
Rectangle of definite dimensions, Comprehend	8	7	3	1	8	27	5.4
Rectangular Prism of definite dimensions, Comprehend	4	10	1	0	5	20	4
Square, Draw	1	2	0	0	1	4	.8
Square of definite dimensions, Comprehend	7	3	1	1	4	16	3.2
Table, Make	0	2	0	0	2	4	.8
Table, Refer to	2/	6/	2/	7/	12/	29/	5.8/
Tablespoons, Meas. in	0	0	0	6	3	9	1.8
Teaspoons, Meas. in	6	3	4	6	7	26	5.2
Temperature in C^{o}, Meas.	0	0	2	0	1	3	.6
Temperature in F^{o}, Meas.	36/	44/	4	11	28	123/	24.6/
Thermometer, Make	1	0	0	1	2	4	.8
Time in days, Meas.	7	16/	1	3	8/	35/	7/
Time in hours, Meas.	24	16/	8	4	12	64/	12.8/
Time in min., Meas.	26	40/	7	15	6	94/	18.8/
Time in months, Meas.	0	1	0	0	0	1	.2
Time in sec., Measure	9	3	2	1	2	17	3.4
Time in weeks, Measure	3	2/	0	0	0	5/	1/

TABLE XII (CONTINUED)

LABORATORY WORK

Procedure	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Triangle, Draw	0	1	0	0	0	1	.2
Triangle, Right, Draw	0	0	0	0	2	2	.4
Vertically, Place	2	4	4	0	3	13	2.6
Weight in grams, Measure	6	9	10	1	10	36	7.2
Weight in ounces, Measure	14	12	11	9	10	56	11.2
Weight in pounds, Measure	3	2	3	1	0	9	1.8
						2110/	422/

TABLE XIII

GENERAL PRINCIPLES INVOLVED

Principle	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
Average, Problems finding	2	2	0	2	2	8	1.6	2.8
Buoyancy Problems	1	4	1	2	2	10	2	3.5
Dietary Problems	4/	6/	1/	13/	9/	33/	6.6/	11.8/
Electricity Problems								
1. Using formula, $A=\frac{V}{o}$	0	4	0	3	1	8	1.6	2.8
2. Using formula, $W= V \times A$	1	2	1	6	1	11	2.2	3.9
Energy Problems								
1. Finding H. P.	3	2	2	5/	3	15/	3/	5.3/
2. Power	0	2	0	0	0	2	.4	.7
3. Work	2	17	1	6	5	31	6.2	11.1
Longitude & Time Problems	2	4	5	5	4	20	4	7.1
Machine Problems								
1. Efficiency Law	1	4	2	1	1	9	1.8	3.2
2. Incline Plane	1	2	2	3	8	16	3.2	5.7
3. Lever	0	2	3	2	9	16	3.2	5.7
4. Pulley	0	10	1	5	6	22	4.4	7.9
5. Wheel and Axle	0	2	2	2	1	7	1.4	2.5
Mensuration Problems								
1. Area of a Circle	0	0	0	2	0	2	.4	.7
2. Area of a Rectangle	2	7	2	2	3	16	3.2	5.7
3. Circumference of a Circle	0	1	0	0	0	1	.2	.3

TABLE XIII (CONTINUED)

GENERAL PRINCIPLES INVOLVED

Principle	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
4. Perimeter of a Quadrilateral	0	0	0	0	0	5	1	1.7
5. Volume of a Cylinder	4	1	0	0	0	5	1	1.7
6. Volume of a rectangular Prism	1	2	1	0	1	5	1	1.7
Percentage Problems								
1. Using Formula B X R = P	0	1/	0	2	4	7/	1.4/	2.5/
2. Using Formula P ÷ B = R	1	4	2	1	2	10	2	3.5
Sp. Gravity Problems	0	5	0	5	1	11	2.2	3.9
Thermometer Problems								
1. C.° to F.°, Change	1	2	0	0	1	4	.8	1.4
2. F.° to C.°, Change	1	2	0	0	1	4	.8	1.4
			Total			278/	55.6/	98.5/

TABLE XIV

SPECIFIC OPERATIONS INVOLVED IN THE PROBLEMS

Operation	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.
Amperes, Determine	0	3	0	0	0	3	.6
Cu. ft. to cu. in., Reduce	0	1	0	0	0	1	.2
Decimal to fraction, Change	0	0	0	1	0	1	.2
Decimal to %, Change	1	0	0	1	0	2	.4
Divide both sides of an equation by the same number	0	8/	1	5	5	19/	3.8/
Fraction to decimal, Change	0	0	0	2	0	2	.4
Fraction to %, Change	1	0	0	1	0	2	.4
Ft. to miles, Reduce	0	2	1	0	1	4	.8
Formula used in General Principles	16	66	19	45	51	197	39.4
Hours to min., Reduce	0	0	0	0	1	1	.2
Inches to feet, Reduce	0	2	0	0	0	2	.4
Miles to ft., Reduce	1	0	0	0	0	1	.2
Multiply both sides of an equation by the same number	0	1	0	2	0	3	.6
Multiply a letter by a figure	1	8	1	5	5	20	4
Multiply a fraction composed of a number over a letter by a letter	0	1	0	0	0	1	.2
Pounds to tons, Reduce	0	0	0	1	1	2	.4
Ounces to pounds, Reduce	0	1	0	0	0	1	.2

TABLE XIV (CONTINUED)

SPECIFIC OPERATIONS INVOLVED IN THE PROBLEMS

Operation	Frequency						
	W.C.	P.B.	H.S.	T.S.	W.R.C	Total	Av.
Ratio, Determine	2	4	1	4	0	11	2.2
Scale for graphs, Determine	1	1	0	0	1	3	.6
Scale, Determine (Ex. $\frac{1}{8}$in.=10ft.)	1	2	0	5	1	9	1.8
Seconds to minutes, Reduce	2	2	0	1	0	5	1
Square numbers, (Ex. $3^2 = 9$)	2	2	1	3	2	10	2
Sq. ft. to sq. in., Reduce	0	1	0	0	1	2	.4
Tons to pounds, Reduce	1	0	0	0	0	1	.2
						303	60.6

TABLE XV

FOUR FUNDAMENTAL PROCESSES

Process	Frequency							
	W.C.	P.B.	H.S.	T.S.	W.R.C.	Total	Av.	%
Addition	16/	16/	8/	20/	22/	82/	16.4/	5.4/
Division	52/	102/	15/	91/	99/	359/	71.8/	23.6/
Multiplication	119/	168/	156/	185/	157/	785/	157/	51.7/
Subtraction	55/	80/	21/	70/	64/	290/	58/	19.1/
			Total			1516/	303.2/	99.8/

CHAPTER III

SUMMARY AND CONCLUSIONS

This survey of the mathematical abilities involved in certain ninth grade general science textbooks has revealed the following facts:

1. Denominate numbers have been used quite extensively throughout the five texts. Forty different concepts of the English System and Standard Measurements were used with an average of frequencies of 302.6/ to each text. Of the Metric system, 14 different concepts appeared with an average of 37/ to each text. Besides the 54 different concepts just mentioned, 36 other concepts of measurement were used, making a total of 90 concepts of measurement used. The majority of the concepts expressed in the English and Standard Measurements, and Metric systems were devoted to length, with volume, mass, and time following in their respective orders. Terms applying to area and quantity appeared least with four different terms of each.

2. Geometric concepts were used frequently. Forty-seven different geometric terms appeared in the five texts. These terms, however, are terms that are used in the intuitive and demonstrative geometrical work offered in the seventh and eighth grades. Besides the geometric concepts, 113 miscellaneous mathematical concepts were found.

3. The survey showed that there were many number concepts. Out of the total of 19,350 number concepts, 11,035 of these appeared in figures, 8,283 in words, and 32 in combinations of figures and words. Or, quoting in per cent,57 per cent of the numerical concepts were expressed in figures, 42.8 per cent of them in words, and .4 per cent of them in combinations of figures and words. The range of the number concepts was very broad, ranging from zero to numbers with 35 digits. However, 89.65 per cent of them ranged in values from 0 to 1000.

4. With the exception of one chemical symbol, all the symbols used were simple arithmetical signs. There was no work assigned for the use of the chemical sign, therefore, its appearance was negligible. Seventeen different arithmetical symbols appeared in the five texts.

5. Noting the tables, graphs, maps, charts, and formulas comparing or expressing quantitative values that appeared in the five texts, it was found that there were 251 in all with an average of 50.2 to each text. Out of the 73 graphs listed 39.7 per cent of them were picture graphs, 27.3 per cent were bar graphs, 26+per cent were circle graphs, and 6.8 per cent were line graphs.

6. Laboratory work has been used frequently throughout the texts. Out of the 2110/ laboratory skills required of the students, 1202, or an average of 240.4 to each text, of these were devoted to measuring by the use of denominational numbers.

7. In the problem solving, there were on an average of 55.6/ general principles used in each text. Out of the 11 different general principles involved, 25 per cent of them were concerned with machine problems, 17.1 with energy problems, 11.8 per cent with dietary problems, and 11.8 per cent with mensuration problems.

8. In the specific operations involved in problem solving as listed in Table XIV, there were on an average of 60.6/ to each text. Out of this number, the formula was used on an average of 39.4 times in each text, thus indicating that the formula is quite an important factor in solving scientific problems. This is not only true in science but in practically all fields that use mathematics.

Ligda said:

> Every situation in a problem is governed by a characteristic formula. The recognition of such situations and of their characteristic formulas is essential to the understanding and solution of the problem.[1]

9. There were on an average of 303.2/ of the four fundamental operations included in each text. Of this number, 51.7/ per cent of them were concerned with multiplication, 23.6 per cent with division, 19.1/ per cent with subtraction and 5.4/ per cent with addition.

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[1] Paul Ligda, The Teaching of Elementary Algebra, p. 117.

APPENDIX

Textbooks Used in This Survey

"Everyday Problems in Science"
Pieper and Beauchamp (P. B.)
Scott, Foresman and Company, 1933

"Useful Science for High School"
Weed, Rexford and Carroll (W. R. C.)
John C. Winston Company, 1935

"Understanding Our Environment"
Hessler and Schoudy (H. S.)
Benjamin H. Sanborn and Company, 1939

"Science in Daily Life"
Trafton and Smith (T. S.)
J. B. Lippincott Company, 1936

"Our Environment, How We Use and Control It"
Wood and Carpenter (W. C.)
Allyn and Bacon, 1937

BIBLIOGRAPHY

Breslich, E. R. The Administration of Mathematics in Secondary Schools. The University of Chicago Press, 1933.

Congdon, Allan Ray. Training in High School Mathematics Essential for Success in Certain College Subjects. Bureau of Publications, Teachers College, Columbia University, New York City.

Cooley, Sans, Kline and Wahlert. Introduction to Mathematics. Houghton Mifflin Company, 1937.

Judd, Charles H. Psychology of High School Subjects. Ginn and Company, 1927.

Judd, Charles H. Psychology of Secondary Education. Ginn and Company, 1915.

Lamb, Theldon N. The Amount of Arithmetic Necessary for a Child to Know in Order to Read Intelligently a Fifth Grade Hygiene Book. Thesis, Ann Arbor, Michigan, 1931.

Ligda, Paul. The Teaching of Elementary Algebra. Houghton Mifflin Company, 1925.

Morton, R. L. "The National Council Committee on Arithmetic," The Mathematics Teacher, Vol. XXXI, #6, October, 1938: Ohio University, Athens, Ohio.

National Committee of Mathematical Requirements. Reorganization of Mathematics in Secondary Education. Mathematical Association of America, Dartmouth Press, 1923.

Osburn, J. W. Corrective Arithmetic. Houghton Mifflin Company, 1924.

Rendahl, J. L. "The Mathematics Needed in Solving Problems in High School Chemistry," School Science and Mathematics, Vol. XXX, June, 1930.

Shoptaugh, John Royal. The Mathematics Needed for Science Courses in the Louisiana High Schools. Thesis, Louisiana State University, Louisiana, 1931.

Williams, L. W. "The Mathematics Needed in Freshman Chemistry," School Science and Mathematics, Vol. XXI, October, 1921.

Young, J. W. A. The Teaching of Mathematics. Longmans, Green and Company, 1927.

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