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A Statistical Study of Technical Geometrical Vocabularies Found in Seven Plane Geometry Textbooks

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A STATISTICAL STUDY OF TECHNICAL GEOMETRICAL VOCABULARIES FOUND IN SEVEN PLANE GEOMETRY TEXTBOOKS

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CHAPTER I

INTRODUCTION

The Importance of Vocabulary Studies

Teachers and supervisers who have undertaken the task of determing the causes of failures of students, both in high school and the elemtary grades, find the most important cause of those failures is lack of understanding of the basic fundamental terms of the subject.

The importance of the problem of making clear the meanings of mathematical concepts cannot be overestimated. There is scarcely a page in a textbook of mathematics where mention is not made of such fundamental terms as fraction, exponent, angle, circle, and numerous others. Since the concepts form the foundation on which the future work is based, it is evident that the pupils progress will be seriously endangered if he fails to acquire full understanding of the meanings of the fundamental terms of the subject.

In no subject in the school is there greater need for rigor in defining technical words than in geometry. Here the very nature of definition is brought out in great clarity as all the salient attributes of a figure are listed and one is selected which is arbitrarily decided shall be the definition. So it is a matter of selection on the part of the author of a textbook, whether a circle shall be defined as a curved line, the modern conception, or the space enclosed by such a curved line which was the definition fifty years ago.

Tucker makes this statement about geometrical definitions.

> "We seek the definition which has the fewest assumptions. It is considered more elegant. Words are defined in terms of other words. The important consideration in a definition is that the very nature of definition and its relationship to undefined ideas be understood". [1]

If a teacher of geometry wishes to improve the mastery of his subject, he will do well to see to it that his students really acquire the fundamental vocabulary, without which the learning of such a technical subject as geometry is practically impossible. Geometrical concepts can be fully comprehended without formal definitions, and what is wanted is an understanding sufficient to enable the pupil to recognize and use the terms correctly when they occur in mathematical situations.

There have been numerous investigations and studies made in the field of mathematics. Most of these studies have concerned themselves in the field of elementary mathematics and mathematics on the junior high school level. Pressey and Elam have this to say in regard to the types of investigations that have been conducted:

> "Many investigations have been inclined to list all the technical words appearing in mathematics textbooks, sometimes with indications of mathematical importance, and sometimes without, rather than to suggest an essential "core" of words that are absolutly essential". [2]

Teachers are usually careful to introduce and emphasize the meaning of mathematical terms. Nevertheless, as apparent as the need is, comparatively little has been done to ascertain the extent of mastery

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1 Alice N. Tucker, "Vocabulary Building", Mathematic's Teacher 37:233, 1944.

2 Pressy, L. C. and Elam, M. D. "The Fundamental Vocabulary of Elementary School Arithmetic", Elementary School Journal, 33:46-50, September,1932.

or the types of meanings which the pupils recognize for the words. It is generally accepted that people possess two types of vocabularies. These are general vocabulary accumulated from general interest reading which contains the commonest English words, and a technical vocabulary made up of terms obtained from the several technical fields such as mathematics, science, and literature. Ability to read in the lower grades does not insure success in science, geography and mathematics in the intermediate and upper grades. Elementary teachers should be content if they have taught their pupils good reading habits, and correct meaning of words found in a general vocabulary of the first four or five thousand most commonly used words. The task of teaching reading, in so far as the process is dependent upon the knowledge of special meanings, is left to the teacher of each subject. If these teachers are to teach reading in their own field, they must at least know which words are technical and which are not. Teachers should realize that hard words may be constant stumbling blocks in the path of a student, and that a student is not apt to learn the meaning of these words from his general reading. A student must be taught the meaning of the terms used in each subject as a part of his training.

Lists can be used for investigating the cases of students who are failing. Children may be given lists of words from the subjects which they are taking and thus they then will know which words are important in their subject. Many words are so highly technical that they are found to have no general value. This situation is found to be truer perhaps of geometry than of either algebra or arithmetic. It's

fundamental concepts do not seem to enter into the ordinary person's daily life whether or not he goes on into more advanced work, unless his major field is mathematics. Keesler suggests the following procedure in helping the student gain full meaning of geometrical terms.

> "Since the technical vocabulary of geometry is composed largely of derivatives from Latin and Greek words, the teaching of their history, together with pronounciation, meaning, spelling, and use should be included as an important part of the course. English equivalents make it much easier to remember definitions which otherwise may be memorized mechanically. For this reason it is sound practice to discuss derivations whenever they may aid in the assimilation of new words".[1]

L. C. Pressey and W. S. Moore found that in administering 406 to 643 tests in each of the grades from the third to twelfth, in five cities of varying size, that 36 terms in arithmetic, two in algebra, and none in geometry are ever completely learned by every student.[2] Terman estimates the number of words for which an individual can give at least a meager definition as 9,000 for age 14, and 11,700 for the average adult.

Hildreth came to the following conclusion in one of her studies.

> "As frequency of use diminishes, the proportion of words in the total vocabulary rapidly increases."[3]

Previous Vocabulary Studies in Geometry

According to Cole, the first investigations in the field of geometric vocabularies was made by Pressey, which paved the way for a detailed in-

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1 Keesler, Earl R., "Vocabulary in Plane Geometry" Mathematics Teacher, Vol. 35; page 331, November, 1942.

2 Pressey, L. C. and Moore, W. S., "The Growth of Mathematical Vocabulary from the Third Grade Through High School", School Review, 40:449-54, June, 1932.

3 Hildreth, Gertrude, "Word Frequency and Retention", Journal of Educational Research, 41:467-71, February, 1948.

vestigation by Zook, whose work was patterned carefully upon that done by Narragon in algebra. A total of 142 concepts emerged as essential from a combination of these studies. Of this total, 47 words dealt with the names of geometrical figures and their parts, and 21 with relationships between parts. Another 19 were needed in demonstrating theorems, while 31 were borrowed from arithmetic or algebra. There were also 24 symbols. Of the entire number, 50 were duplicates of words appearing in the arithmetic or algebra lists. The 92 new words require a rate of 2.5 per week, if they are to be acquired in a year's study.

Overlapping from one list to another must be considered in the determination of the total technical vocabulary necessary for a mastery of elementary and secondary school mathematics. Assuming that arithmetic precedes the other two subjects and that algebra precedes geometry, there is enough overlapping to reduce the apparent total of 502 words to 392. The number of years devoted to study of mathematics is either eight or nine years. The average number of words per week is therefore only 1.4, a total well within the learning capacity of even second grade children.[1]

In this same study, Cole listed a total of 142 geometric concepts, 30 of which were borrowed from algebra and arithmetic.

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1 Cole, L. C. The Teacher's Handbook of Technical Vocabulary, Public School Publishing Co., page 7, Bloomington, Ill., 1940.

Among the vocabulary studies in the secondary field, very few have dealt with the technical vocabularies of special school subjects. Probably the most important study is that conducted by Pressey and Pressey.[1] In this study they have listed the mathematical technical terms found in arithmetic, algebra, and geometry.

> "During the last twenty years, attention has been focused upon the determination of prime essentials in the elementary and high school subjects. As one evidence of this tendency, much research into essential vocabulary has appeared. Most investigations in this field have terminated in one or more lists of "special" or "technical" terms. These lists have usually been long and unwieldy. They have often appeared in so unassimilated and unorganized a form as to be useful mainly for research purposes. Although there is great value in these wearisome lists of specific terms, relatively little help has yet been derived from them by the average teacher".[2]

No two subjects have received the same amount of investigation. The vocabulary load in a subject, its importance in the curriculum, and number of people who happen to have been interested in it have all contributed to varying numbers of investigations per subject. Most of these studies have concerned themselves in the field of elementary mathematics, and mathematics on the junior high school level. For the most part the studies can be classified into two groups. One group has attempted to set up vocabulary lists for a given subject, and another group has attempted to set up means and devices of measuring the attainment and retention of concepts pertaining to a certain subject.

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1 Pressey, L. C. and Pressey, S. L. "The Determination of the Technical Vocabulary of the School Subjects", School and Society, 20:91-96 July, 1924.

2 Cole, L. C., The Teacher's Handbook of Technical Vocabulary, Public School Publishing Co., Bloomington, Ill., 1940, page 1.

Need for Further Study

The need for further study of technical geometry terms is perfectly obvious. Up to the present time there have been very few studies dealing directly with the vocabulary of geometry. As was said earlier in the chapter, in no subject in the school is there greater need for rigor in defining technical words than in geometry. Cole says that "Some teachers seem to have the naive idea that "Words" are of little significance, and that only "Ideas" are important. However, a list of the essential words in a subject is substantially a list of the outstanding elementary ideas which must be mastered for the understanding of subject matter. Most students who fail are not hopelessly stupid; they have simply not acquired the basic concepts. The initial miles of the reading to learning are paved with specific, individual concepts, not with generalities. These latter have their place, naturally, but not at the beginning of a subject. A pupil can neither appreciate nor react to ideas that he does not comprehend".[1]

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1 Cole, L. C., Teachers Handbook of Technical Vocabulary, Public School Publishing Co., Bloomington, Ill., 1940, page 1.

CHAPTER II

THE PROBLEM

Statement of the Problem

As has been brought out in the various studies of the technical geometrical vocabularies it is apparent that lack of understanding is the cause of serious difficulties in the study of mathematics. A frequent difficulty is the lack of understanding of basic mathematical concepts.

All geometry textbooks have a considerable burden of technical terms. All of these words have some usefulness, but some are more useful than others. It is the purpose of this writing to determine which of the technical terms make up the essential core of several textbooks in geometry and to compare such a list with other studies in order to determine the level of the word difficulty. The purposes of this study are listed briefly as follows.

1. To study the technical geometrical terms found in seven present day textbooks of geometry.
2. To make a frequency word count of the technical words found in these textbooks.
3. To study the technical terms found and determine the level of word difficulty.
4. To make a list of words found to be common to all seven textbooks.
5. To make a list of the words most frequently used by modern authors of textbooks in geometry.

Delimitations of the Problem

In determining which terms to classify as geometric, Cole's[1] word list was used as a base. However Cole's list also contained words that were borrowed from arithmetic and algebra. Some of the words that were definitely in the field of arithmetic were eliminated because of infrequency of occurrence.

The words were then rated according to the Thorndike and Lorge 30,000 word list.[2] The Thorndike and Lorge list included only the "root" form of the word, so plurals were included under the main word. Words such as "add" and "added" were counted under the word add. It is assumed then that the words with different endings would be found in approximatly the same place as the main word. With that assumption then, it would be possible to rate more words by the Thorndike and Lorge 30,000 word list, and determine the number and type of geometric concepts to be found below the 8,500 word count.

Method of Procedure

The words from Cole's list was used to set up the first word count. These words were arranged in alphabetical order, and about eight words were distributed on a sheet of paper. To eliminate ommissions and errors in the word count of the first book, only eight words were counted at a time. Later, as experience in recognizing

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1 Cole, L. C., Teachers Handbook of Technical Vocabulary, Public School Publishing Co., Bloomington, Ill., 1940.

2 Thorndike, E. L. and Lorge, I., The Teachers Wordbook of 30,000 Words, Teachers College Press, 1944.

words was gained, more words were added until a maximum of forty words were counted at one time. During the first counts, notations were made of words that could be added to Cole's list. These were later added to the original list and a count made of them in all seven textbooks.

The textbooks selected for this study were plane geometry textbooks with the most recent copyright date available. In order to keep the identity of the word lists, they were assigned the Roman numeral which corresponded with the number assigned to the textbook from which taken. For convenience in tabulating, and conservation of space, the textbooks used in this study were assigned the following Roman numerals:

I Hawkes, Luby, Touton, New Plane Geometry, Ginn & Co., 1941, 405 pages.

II Avery, Plane Geometry, Allyn & Bacon, 1946, 440 pages.

III Reichgott and Spiller, Today's Geometry, Prentice Hall, 1944, 351 pages.

IV Schultz, Sevenoak, Stone, Plane Geometry, MacMillan Co., 1947, 342 pages.

V Nyberg, Fundamentals of Plane Geometry, American Book Co., 1944, 352 pages.

VI Smith-Reeves-Morse, Text in Plane Geometry, Ginn & Co., 1943, 247 pages.

VII Seymour and Smith, Plane Geometry, MacMillan Co., 1949, 407 pages.

Method of Tabulating

The following tabulations were made from the word lists after the word count was completed.

1. An alphabetic list of the terms and symbols showing the frequency of the different concepts in the different textbooks. These were checked against the Thorndike and Lorge list for rating.

2. A list of the concepts and symbols according to their frequency.

3. A table showing the number of concepts that are common to any two of the different textbooks.

4. A table showing the comparison between this word list and Cole's word list.

CHAPTER III

THE INTERPRETATION OF RESULTS

In making a vocabulary study of technical geometric terms, it was necessary to make a word count to determine the frequency of the technical terms found in each of the seven textbooks. Table I shows the alphabetical list of the technical geometrical terms, and the frequency which they appeared in each textbook under the Roman numerals heading each column.

Each word is also rated according to Thorndike and Lorge's The Teachers Word Book of 30,000 Words. This rating is found in the eighth column. The code used in the Thorndike and Lorge list is as follows: In the eighth column after the word is a number stating the occurrences per million words. The numeral 1 means at least one occurrence per million and not so many as two per million; 2 means at least two per million and not so many as three per million; and similarly up to 49; A means at least 50 per million; and not so many as 100 per million; AA means 100 per million or over. Words occurring less than once per million, but more than once per four million, are indicated by the letter B and numbers from 5 to 17 reporting the number of occurrences per eighteen million words. Words occurring four times per eighteen million are indicated by the letter BB.

The table shows that there is great variation in the number of terms used by the different authors as well as great variation in the number of times the terms appear in each book.

The variation of total number of terms as well as the variation in the number of times a term is used is shown by the fact that the term "proposition" is used 423 times by one author and not used at all by two other authors. The term "arc" is used 378 times by one author and only 69 times by another.

TABLE 1

THE FREQUENCY AND RATING OF THE GEOMETRICAL CONCEPTS

CONCEPT	BOOKS							THORNDIKE LORGE PLACEMENT
	I	II	III	IV	V	VI	VII	
1. abscissa	-	-	-	-	-	-	-	-
2. absurdity	0	1	0	0	0	3	-	5
3. acute angle	52	62	50	38	30	34	50	--
4. acute triangle	3	6	11	5	1	5	10	--
5. add	27	21	46	35	16	29	17	AA
6. adjacent	155	75	29	32	34	43	22	9
7. altitude	181	290	149	184	161	36	195	14
8. alternate	7	11	5	12	6	5	4	11
9. apothem	28	16	15	16	9	19	45	B9
10. arc	378	337	147	159	230	69	262	9
11. area	329	508	391	266	272	75	320	A
12. axiom	23	129	19	43	20	55	159	1
13. base	155	355	246	196	154	127	216	AA
14. bisect	206	422	133	220	210	253	257	1
15. center	168	200	139	123	176	148	171	AA
16. central angle	46	34	38	32	40	39	65	--
17. chord	262	351	83	121	177	129	256	8
18. circle	725	826	310	524	631	430	696	AA
19. circumference	52	36	56	63	39	40	36	6
20. circumscribe	69	111	14	58	45	71	63	1
21. coincide	59	54	14	34	40	48	14	3

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRICAL CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
22. common	94	64	25	63	52	52	61	AA
23. complementary angle	27	42	27	50	1	15	26	--
24. concave polygon	5	1	2	0	0	0	0	--
25. concentric circle	9	13	2	19	6	7	12	--
26. congruent	115	112	1	85	101	86	98	B5
27. construct	357	368	220	64	73	381	380	31
28. converse	43	14	0	31	59	34	73	11
29. convex polygon	11	1	3	0	0	0	0	--
30. corollary	62	89	22	118	50	3	96	--
31. corresponding	141	147	77	114	102	80	120	8
32. decagon	13	3	3	8	6	4	5	--
33. degree	134	127	85	68	6	29	127	AA
34. demonstration	30	2	0	0	0	12	2	18
35. denominator	3	6	7	9	9	1	4	B12
36. diagonal	96	179	65	124	114	78	172	2
37. diameter	108	167	204	117	93	95	101	17
38. difference	23	20	33	31	39	20	29	AA
39. dimensions	16	2	49	9	0	11	28	10
40. direction	27	8	61	20	36	18	21	AA
41. directly proportional	0	0	0	0	0	0	0	--

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRICAL CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VIII	
42. distance	102	108	132	90	84	113	131	AA
43. divide	148	134	70	106	104	133	90	AA
44. equal	674	1074	433	810	630	514	620	A
45. equation	53	11	2	41	79	41	73	4
46. equiangular triangle	16	10	9	8	6	2	8	--
47. equidistant	40	32	56	72	60	57	111	B12
48. equilateral polygon	15	12	3	9	0	0	11	B5
49. equilateral triangle	72	85	50	93	54	61	53	--
50. equivalent	35	32	0	15	1	12	1	12
51. exterior	58	62	45	52	21	17	50	7
52. extreme	6	7	10	5	10	8	6	38
53. external	38	48	19	23	23	0	47	10
54. equiangular polygon	14	9	2	28	16	14	24	--
55. figure	334	219	789	55	363	780	260	AA
56. formula	27	14	46	28	28	48	38	11
57. geometric	54	47	26	11	10	115	44	1
58. given	486	870	237	819	345	705	650	AA
59. height	10	22	71	24	15	46	36	AA
60. hence	91	47	45	26	129	40	51	A
61. hexagon	38	46	44	38	9	50	38	1
62. hypotenuse	72	134	40	103	64	45	62	B6

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRICAL CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
63. horizontal	9	9	31	15	18	15	15	9
64. hypothesis	94	17	0	9	63	5	23	4
65. included	40	54	23	41	24	33	30	AA
66. inscribe	154	246	52	148	101	138	135	6
67. interior angle	52	63	42	48	27	22	45	--
68. intercept	45	63	37	47	9	24	39	6
69. intersect	170	138	96	102	101	123	255	2
70. inversely proportion	5	4	2	4	16	0	2	--
71. isosceles trapezoid	8	17	14	0	5	13	10	--
72. isosceles triangle	87	187	49	94	97	70	82	--
73. lateral area	0	0	42	0	0	0	0	--
74. lateral edge	0	0	12	0	0	0	0	--
75. lateral faces	0	0	12	0	0	0	0	--
76. legs	0	99	56	6	2	0	75	AA
77. length	95	182	148	76	0	104	127	AA
78. locus	69	72	0	63	69	103	156	B5
79. mean proportional	7	7	3	5	11	3	5	--
80. means	5	9	18	6	37	31	9	AA
81. measure	146	148	170	107	69	145	169	AA
82. median	38	62	15	72	42	24	59	2
83. midpoint	84	134	31	93	97	45	112	--

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRICAL CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
84. minute	14	3	36	8	2	1	5	AA
85. multiply	8	29	43	6	3	12	11	24
86. numerator	3	6	1	8	6	0	4	BB
87. oblique angle	0	4	10	5	0	4	6	--
88. obtuse angle	17	21	220	14	12	16	15	--
89. obtuse triangle	5	11	12	10	1	4	12	--
90. octagon	16	7	9	11	2	14	11	1
91. opposite	142	171	73	90	123	114	110	A
92. original	7	8	15	1	1	0	1	A
93. pi	1	0	1	0	0	0	0	B6
94. parallel	213	210	146	203	207	159	115	23
95. parallelogram	134	206	84	160	153	88	143	B16
96. pentagon	21	19	12	18	7	21	61	B12
97. perimeter	73	75	51	68	43	80	90	B8
98. perpendicular	174	211	109	132	213	165	181	8
99. plane surface	5	1	4	4	0	0	8	--
100. polygon	339	235	159	287	152	133	361	B5
101. postulate	110	25	124	19	4	140	63	1
102. product	54	69	44	42	20	40	47	A
103. proof	217	315	3	170	107	346	195	48

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRIC CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
104. proposition	12	124	0	165	0	173	423	19
105. proportion	145	146	75	87	185	173	40	A
106. prove	462	725	173	625	443	482	522	AA
107. quadrilateral	82	86	39	63	58	70	160	B8
108. quotient	2	4	4	3	4	0	4	1
109. reflex angle	0	0	6	0	0	0	4	--
110. radii	66	66	33	59	65	48	59	BB
111. radius	181	271	144	155	169	117	189	6
112. ratio	105	157	88	95	115	84	172	11
113. rectangle	82	21	84	70	73	72	130	5
114. regular polygon	110	93	23	73	26	73	131	--
115. respectively	178	75	71	114	46	80	59	8
116. rhombus	21	74	21	37	35	20	54	--
117. right triangle	116	157	118	122	85	78	94	--
118. right angle	131	174	70	106	95	32	94	--
119. round angle	0	0	0	0	0	0	1	--
120. scalene triangle	0	8	4	11	0	0	11	--
121. secant	46	68	27	43	33	37	41	--
122. second	7	3	9	3	22	12	2	AA
123. sector	16	33	12	52	8	0	33	2
124. segment	145	232	123	106	71	246	380	5

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRIC CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
125. semicircle	26	19	12	14	15	15	20	2
126. similar	177	152	112	178	122	129	106	A
127. size	21	46	37	7	9	60	38	AA
128. solids	2	0	35	0	1	3	9	42
129. square	135	202	114	148	176	134	162	AA
130. square root	0	6	35	6	0	4	15	--
131. substitute	15	18	1	25	15	25	8	29
132. subtract	20	13	20	27	6	20	16	4
133. subtend	9	22	12	6	0	0	5	--
134. sum	156	177	95	123	65	83	97	A
135. supplementary angle	57	68	50	90	12	32	43	--
136. symmetry	38	0	2	0	10	21	0	3
137. straight angle	59	15	37	65	16	0	49	--
138. tangent	255	274	125	211	222	178	196	1
139. theorem	362	262	111	97	241	145	112	2
140. transversal	26	47	39	23	12	49	35	2
141. trapezoid	84	105	55	91	47	46	83	--
142. triangle	833	1072	599	730	605	442	802	8
143. trisect	0	0	0	0	0	1	0	--
144. vector	0	0	26	0	0	0	0	BB

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRIC CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
145. vertex	83	131	74	44	64	44	93	B16
146. vertical	20	27	42	22	26	24	21	10
147. vertices	56	50	23	44	45	38	53	BB
148. width	7	16	15	13	7	54	12	28
149. 90°	2	1	7	5	2	22	0	--
150. =	1803	2296	1877	1669	1792	1760	1838	--
151. +	434	297	208	340	380	370	351	--
152. —	256	167	63	132	172	64	360	--
153. ÷	5	0	3	1	4	4	2	--
154. x	19	55	229	107	88	74	71	--
155. //	107	235	69	176	102	114	123	--
156. △	618	972	187	579	545	212	441	--
157. ⊥	85	284	65	98	111	130	126	---
158. ⊙	61	117	2	46	0	178	24	--
159. ▱	25	76	3	56	0	59	46	--
160. ▭	10	0	0	0	10	10	0	--
161. ∠	1252	2072	1044	1465	89	697	1191	--
162. ≳	128	103	8	116	89	86	68	--
163. ≋	92	92	0	89	65	69	91	--
164. ≲	28	28	6	16	30	37	17	--

TABLE 1 (continued)

THE FREQUENCY AND RATING OF THE GEOMETRIC CONCEPTS

CONCEPT	BOOKS							THORN-DIKE LORGE PLACE-MENT
	I	II	III	IV	V	VI	VII	
165. -----	529	580	1376	618	380	420	467	--
166. -----	0	166	164	273	78	208	157	--
167. -----	77	46	66	45	48	0	45	--
168. -----	203	0	0	337	457	0	340	--
169. -----	55	548	35	223	15	82	261	--
170. -----	845	96	997	33	6	84	24	--
171. -----	0	1246	628	1135	578	1006	480	--
172. -----	38	82	3	77	30	51	74	--

Level of Difficulty of Geometric Concepts

In Table 2, the total of all the concepts and symbols are listed according to frequency. At the same time they are also rated according to Thorndike's Teachers Word Book of 20,000 Words. The code of the rating in Thorndike's word list is as follows: 1a means the word is found in the first 500 most frequently used words; 1b means the word is found in the second 500 most frequently used words; and so on with 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b,. The numeral 6 means in the sixth thousand, and 7 means in the seventh thousand, and so on up to 20.

Not counting the symbols and signs, there were 105 concepts rated in the Thorndike and Lorge list and 41 concepts that were not rated in the list. Assuming that the non-rated concepts appear above the 10,000 most common word level then it can be said that 47.2 percent of the technical concepts found in present day geometry books may be considered to be very difficult.

According to Terman, the average adult can give at least a meager definition of about 11,700 words. If this is true, it can be expected that the average present day geometry textbook vocabulary is made up of technical terms, that the average tenth grade student has had difficulty in learning the meaning.

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
equal sign	13,035	--
angle sign	7,810	--
triangle	5,083	6
'	5,073	--
equal	4,755	8
°	4,370	--
circle	4,142	1b
given	4,112	1a
prove	3,612	1b
triangle sign	3,554	--
figure	2,800	1b
plus sign	2,380	--
area	2,161	3a
"	2,085	--
construct	1,843	3b
bisect	1,701	13
polygon	1,672	19
arc	1,582	7
tangent	1,461	16
base	1,449	2a
chord	1,379	7

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
proof	1,353	2b
∴	1,334	--
segment	1,330	7
theorem	1,330	15
parallel	1,253	4b
radius	1,226	8
⋰	1,219	--
—	1,214	--
altitude	1,196	6
perpendicular	1,185	8
center	1,165	1b
square	1,071	1b
⌒	1,046	--
intersect	985	12
similar	976	3b
inscribe	974	8
parallelogram	968	16
measure	954	1a
//	926	--
⊥	899	--
proposition	897	5b
diameter	885	8

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
divide	885	1b
proportion	840	3a
diagonal	828	9
opposite	823	2b
ratio	816	7
sum	796	2a
corresponding	781	4b
right triangle	770	--
distance	760	1b
length	732	1a
right angle	702	--
isosceles triangel	666	20
X	643	--
respectively	623	5a
congruent	598	20
>	598	--
midpoint	596	4a
degree	576	2a
quadrilateral	558	19
vertex	533	17
rectangle	532	8
locus	532	--

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
circumscribe	531	12
regular polygon	529	--
hypotenuse	520	19
trapezoid	511	--
≅	498	--
postulate	485	14
perimeter	480	20
equilateral triangle	468	--
axiom	448	16
corollary	440	16
hence	429	2a
equidistant	428	17
⊙	428	--
common	411	1b
radii	396	20
adjacent	390	7
~	355	--
supplementary angle	352	12
π	327	--
circumference	322	8
product	316	2b

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
acute angle	316	7
median	312	13
vertices	309	--
geometric	307	13
exterior	305	--
interior angle	299	4a
secant	295	--
central angle	294	--
	265	--
intercept	264	8
coincide	263	11
hexagon	263	11
rhombus	262	--
equation	260	8
converse	254	5a
included	245	2a
straight angle	241	--
legs	238	1b
transversal	231	11
formula	229	8
height	224	1b
size	218	1b

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
hypothesis	211	11
external	198	8
difference	195	1b
direction	191	2a
verticle	182	6
add	171	1a
<	162	—
pentagon	159	14
sector	154	16
apothem	148	—
width	124	3a
subtract	122	6
semicircle	121	13
dimensions	115	7
means	115	1a
obtuse angle	115	14
horizontal	112	7
multiply	112	3a
regular polygon	107	—
substitute	107	4a
equivalent	96	7

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
symmetry	71	11
octagon	69	17
minute	69	1b
concentric circle	68	--
isosceles trapezoid	67	--
square root	66	--
equiangular triangle	59	--
second	58	1a
obtuse angle	55	14
subtend	54	--
extreme	52	2b
solids	50	3a
equilateral polygon	50	--
alternate	50	11
demonstration	46	7
lateral area	42	--
decagon	42	--
mean proportional	41	--
acute triangle	41	--
denominator	39	20
scalene triangle	34	--
inversly proportion	33	--

TABLE 2

THE SIGNS AND CONCEPTS ARRANGED IN ORDER OF FREQUENCY

CONCEPT	FREQUENCY	THORNDIKE RATING
original	33	3a
	30	--
oblique angle	29	9
numerator	28	--
vector	26	--
plane surface	22	--
quotient	21	9
	19	--
concave polygon	15	--
lateral edges	12	--
lateral faces	12	--
reflex angle	10	--
concave polygon	8	--
absurdity	4	9
pi	3	--
round angle	1	--
directly proportional	1	--

Thorndike-Lorge Rating of Geometric Concepts, and a Comparison with Cole's List

Table 3 gives the alphabetical list of all the concepts, showing the rating according to Thorndike and Lorge in four different sets of reading matter, and it also indicates whether or not the concepts are found in Cole's list.

In the first column a c will indicate that the concept is found in Cole's list. The other four columns are numbers giving the number of occurrences in approximately 4½ million words of T, the Thorndike general count of 1931; L, the Lorge magazine count; J, the Thorndike count of 120 juvenile books; and S, the Lorge-Thorndike sematic count. The numbers under T are computations from the Thorndike 1931 data. An M in the T column means that the word was one of the 500 commonest words according to the Thorndike count, and occurred from 800 to 100,000, or more times, per 4½ million words. An M in the L column means that the word occurred 1,000 times or more in the Lorge magazine count. An M in the J column means that the word occurred 1,000 times or more in the count of 120 juvenile books; and M* means that it probably did. M and M* in the S column means that the word had 1,000 or more occurrences in the semantic count.

Table 3 tells anyone who wishes to know whether to use a word in writing, speaking, or teaching how common the word is in standard English reading matter.

The numbers in the T, L, J, and S columns however, may be of value in certain cases. The count emphasized frequency in readers, textbooks, and the Bible, and the English classics. The L count included only recent and popular magazines. The J counts included only books recommended for boys and girls in grades 3 to 8. The S counts used a miscellany of juvenile and adult literature of old and recent date, and matter-of-fact and imaginative reading materials, but it omitted school readers and textbooks.

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,
AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
absurdity	c	28	37	10	26
acute angle	c	-	-	-	-
acute triangle	-	-	-	-	0
add	c	AA	M	M	M
adjacent	c	57	28	15	66
altitude	c	57	53	20	126
alternate	c	36	54	34	78
apothem	-	-	-	-	-
arc	c	57	37	15	61
area	c	220	215	220*	635
axiom	c	8	4	0	8
base	c	430	337	430*	627
bisect	c	12	2	0	5
center	c	700	641	700*	760
central angle	-	-	-	-	-
chord	c	57	36	32	28
circle	c	700	388	379*	369
circumference	c	50	8	17	37
circumscribe	c	14	3	0	7
coincide	c	16	13	8	23
common	c	700	568	857*	M

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,
AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
complementary angle	c	-	-	-	-
concave polygon	-	-	-	-	-
concentric circle	-	14	5	2	12
congruent	c	-	-	-	-
construct	c	160	81	107	226
converse	c	80	35	32	58
convex polygon	-	-	-	-	-
corollary	c	-	-	-	-
corresponding	c	41	14	21	77
decagon	-	-	-	-	-
degree	c	380	391	380*	834
demonstration	c	57	112	38	127
denominator	c	-	-	-	-
diagonal	c	15	6	22	7
diameter	c	50	36	92	135
difference	c	700	426	565*	569
dimensions	c	57	30	28	77
direction	c	420	441	420*	793
directly proportional	c	-	-	-	-
distance	c	700	370	700*	735

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS, AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
divide	c	700	194	468	509
equal	c	494	300	494	504
equation	c	50	7	2	26
equiangular triangle	c	-	-	-	-
equidistant	c	-	-	-	-
equilateral polygon	-	-	-	-	-
equilateral triangle	c	-	-	-	-
equivalent	c	57	59	6	98
exterior	c	57	48	10	25
extreme	c	135	143	135*	276
external	c	45	26	17	96
equiangular polygon	-	-	-	-	-
figure	c	700	M	700*	M
formula	c	50	59	5	92
geometric	c	12	6	0	2
given	c	M	M	M*	M*
height	c	700	284	550*	407
hence	c	320	118	264*	353
hexagon	c	16	4	1	0
hypotenuse	c	-	-	-	-

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,

AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
hypothesis	-	15	6	1	59
horizontal	c	42	38	35	61
included	c	380	533	380*	M
inscribe	c	50	23	19	30
interior angle	c	-	-	-	-
intercept	c	50	15	12	33
intersect	c	14	3	10	23
inversely proportional	c	-	-	-	-
isosceles trapezoid	-	-	-	-	-
isosceles triangle	c	-	-	-	-
lateral area	-	-	-	-	-
lateral edges	-	-	-	-	-
lateral faces	-	-	-	-	-
legs	c	700	642	700*	324
length	c	M	328	?	620
locus	c	-	-	-	-
mean proportional	c	-	-	-	-
means	c	M	M	M	M
measure	c	M	184	530*	876
median	-	12	2	1	26
midpoint	c	-	-	-	-

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,
AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
minute	c	700	M	700*	780
multiply	c	200	45	108*	80
numerator	c	-	-	-	-
oblique angle	c	-	-	-	-
obtuse angle	c	-	-	-	-
obtuse triangle	-	-	-	-	-
octagon	-	3	1	7	12
opposite	c	290	293	290*	281
original	c	164	299	164	481
pi	c	-	-	-	-
parallel	c	115	65	62	180
parallelogram	c	-	-	-	-
pentagon	-	-	-	-	-
perimeter	c	-	-	-	-
perpendicular	c	50	14	33	49
plane surface	c	-	-	-	-
polygon	c	-	-	-	-
postulate	-	11	1	0	7
product	c	280	353	280*	709
proof	c	270	141	243*	216

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,

AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
proposition	c	90	110	28	131
proportion	c	200	197	200*	387
prove	c	700	783	700*	899
quadralateral	c	-	-	-	-
quotient	c	28	2	0	4
reflex angle	-	-	-	-	-
radii	c	-	-	-	-
radius	c	50	17	11	32
ratio	c	57	14	4	133
rectangle	c	90	9	3	5
regular polygon	c	-	-	-	-
respectively	c	46	12	12	89
rhombus	c	-	-	-	-
right angle	c	-	-	-	-
right triangle	c	-	-	-	-
round angle	c	-	-	-	-
scalene triangle	-	-	-	-	-
secant	c	-	-	-	-
second	c	M	926	M*	M
sector	-	8	14	1	21
segment	c	57	9	14	16

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,

AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
semicircle	c	12	8	11	14
similar	c	142	264	183	681
size	c	700	501	573*	518
solid	-	192	178	192*	205
square	c	700	573	626*	552
square root	-	-	-	-	-
substitute	c	130	155	49	201
subtract	c	57	6	1	14
subtend	-	-	-	-	-
sum	c	400	289	400*	462
supplementary angles	c	-	-	-	-
symmetry	c	16	9	5	30
straight angle	c	-	-	-	-
tangent	c	8	4	2	21
theorem	c	10	2	0	28
transversal	c	-	-	-	-
trapezoid	c	-	-	-	-
triangle	c	57	38	30	26
trisect	-	-	-	-	-
vector	-	-	-	-	-

TABLE 3

THORNDIKE AND LORGE RATINGS OF THE GEOMETRIC CONCEPTS,

AND A COMPARISON WITH COLE'S LIST

CONCEPT	COLE	T	L	J	S
vertex	c	-	-	-	-
vertical	c	47	24	29	95
verticies	c	-	-	-	-
width	c	235	65	129*	86

Table 4 shows the number of concepts that are common to any two textbooks. The table should be read as follows: There are 147 concepts common to Books I and II; 142 concepts common to Books II and III, and so forth.

TABLE 4

NUMBER OF CONCEPTS COMMON TO ANY TWO TEXTBOOKS

TEXTBOOK	I	II	III	IV	V	VI	VII
I	...	147	142	146	141	138	147
II	...	...	147	150	141	140	151
III	...	...	...	145	137	134	146
IV	...	...	...	...	141	138	151
V	...	...	...	...	...	134	140
VI	...	...	...	...	...	...	139
VII	...	...	...	...	...	...	...
Number of different concepts	153	154	148	151	146	143	156

Table 5 shows the number of concepts that appear only once, two to five times, six to nine times, ten to nineteen times, and twenty or more times in each of the different books.

The table indicates that just a small percentage of concepts appear only a few times. This fact is an aid to the student in that frequent use will aid in gaining an understanding of the technical terms.

But, the mere fact that a technical term appears frequently is no assurance that the student will gain a working knowledge of it. Textbooks in Geometry have a tendency to use different concepts very often in a chapter or unit, and then the concept might not be used again at any other place in the book.

TABLE 5

NUMBER AND FREQUENCY OF DIFFERENT CONCEPTS USED IN EACH OF THE SEVEN PLANE GEOMETRY TEXTBOOKS

TEXT-BOOK	FREQUENCY 1	2-5	6-9	10-19	20 or MORE	NUMBER OF DIFFERENT CONCEPTS
I	1	11	9	15	117	153
II	5	8	12	15	114	154
III	4	11	8	20	105	148
IV	2	8	14	14	113	151
V	6	9	15	16	100	146
VI	3	10	2	15	113	143
VII	3	11	6	16	120	156

Table 6 shows the percentages of each of the frequencies. The table also shows that there is considerable variation in the frequency of the different concepts. For instance the number of terms that appear 20 times or more, range from about 69 percent in Book V to 77 percent in Book VI and VII. The table shows that there is a tendency for the authors of the textbooks to repeat most of the words twenty or more times, a decided aid in helping to fix the meaning of the signs and words.

TABLE 6

THE PERCENTAGE OF EACH CONCEPT FOUND IN

EACH OF THE SEVEN DIFFERENT TEXTBOOKS

TEXT-BOOK	1	2-5	6-9	10-19	20 OR MORE
I	00.6	07.1	05.7	09.8	76.4
II	03.2	05.1	07.7	09.7	74.0
III	02.7	07.4	05.4	13.5	70.9
IV	01.3	05.3	09.3	09.3	74.8
V	04.1	06.2	10.3	10.9	69.6
VI	02.0	07.0	01.4	10.4	76.9
VII	01.9	07.0	03.8	10.2	76.9

Table 7 shows the great variation in the concepts used by the different authors. Out of the 168 concepts used, 46, or 72 percent, are common to all seven textbooks.

Out of the 142 concepts and symbols that Cole listed, there were 13 concepts that were not found in several books used in this study. These were absurdity, demonstration, dimensions, directly proportional, length, numerator, plane surface, proposition, quotient, symmetry, and the symbol for right angle, right triangle, and rectangle.

The concepts not listed by Cole and found in this study were: acute triangle, apothem, central angel, concave polygon, equiangular polygon, hypothesis, isosceles trapezoid, median, obtause triangle, octagon, pentagon, postulate, reflex angle, scalene triangel, sector, subtend, and vector.

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
absurdity	2	4
acute angle	7	316
acute triangle	7	41
add	7	171
adjacent	7	390
altitude	7	1196
apothem	7	148
arc	7	1582
area	7	2161
axiom	7	448
base	7	1449
bisect	7	1701
center	7	1165
central angle	7	294
chord	7	1379
circle	7	4142
circumference	7	322
circumscribe	7	531
coincide	7	263
common	7	411

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
complementary angle	7	188
concave polygon	3	8
concentric circle	7	68
congruent	7	598
construct	7	1843
converse	6	254
convex polygon	3	15
corollary	7	440
corresponding	7	781
decagon	7	42
degree	7	576
demonstration	4	46
denominator	7	39
diagonal	7	828
diameter	7	885
difference	7	195
dimensions	6	115
direction	7	191
directly proportional	1	1
distance	7	760
divide	7	885

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
equal	7	4755
equation	7	260
equiangular triangle	7	59
equidistant	7	428
equilateral polygon	5	50
equilateral triangle	7	468
equivalent	6	96
exterior	7	305
extreme	7	52
external	6	198
equiangular polygon	7	107
figure	7	2800
formula	7	229
geometric	7	307
given	7	4112
height	7	224
hence	7	429
hexagon	7	263
hypotenuse	7	520
included	7	245

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
inscribe	7	974
interior angle	7	299
intercept	7	264
intersect	7	985
inversely proportional	6	33
isosceles trapezoid	6	67
isosceles triangle	7	666
lateral area	1	42
lateral edges	1	12
lateral faces	1	12
legs	5	238
length	6	732
locus	6	532
mean proportional	7	41
means	7	115
measure	7	954
median	7	312
midpoint	7	596
minute	7	69
multiply	7	112
numerator	6	28

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE

NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
oblique angle	5	29
obtuse angle	7	115
obtuse triangle	7	55
octagon	7	70
opposite	7	823
original	6	33
pi	2	3
parallel	7	1253
parallelogram	7	968
pentagon	7	159
perimeter	7	480
perpendicular	7	1185
plane surface	5	22
polygon	7	1672
postulate	7	485
product	7	316
proof	7	1353
proposition	5	897
proportion	7	840
prove	7	3612
quadrilateral	7	558

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
quotient	6	21
reflex angle	2	10
radii	7	396
radius	7	1226
ratio	7	816
rectangle	7	532
regular polygon	7	529
respectively	7	623
rhombus	7	262
right triangle	7	770
right angle	7	702
round angle	1	1
scalene triangle	4	34
secant	7	295
second	7	58
sector	6	154
segment	7	1330
semicircle	7	121
similar	7	976
size	7	218
solids	5	50

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
square	7	1071
square root	5	66
substitute	7	107
subtract	7	122
subtend	5	54
sum	7	796
supplementary angle	7	352
symmetry	4	71
straight angle	6	241
tangent	7	1461
theorem	7	1330
transversal	7	231
trapezoid	7	511
triangle	7	5083
trisect	1	1
vector	1	26
vertex	7	533
vertical	7	182
vertices	7	309
width	7	124
90°	6	39

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
=	7	13,035
+	7	2380
−	7	1214
÷	6	19
×	7	643
//	7	926
△	7	3554
⊥	7	899
⊙	6	428
▱	6	265
□	3	30
∠	7	7810
≅	7	598
∽	6	498
⌒	7	162
⌓	7	4370
π	6	1046
∴	6	327
∵	4	1334
″	7	1219
	7	2085

TABLE 7

THE FREQUENCY OF EACH GEOMETRIC CONCEPT AND THE NUMBER OF BOOKS IN WHICH IT IS FOUND

CONCEPT	NUMBER OF BOOKS	TOTAL FREQUENCY
′	6	5073
~	7	355

CHAPTER IV

CONCLUSION

It was found in this study that from a standpoint of logical presentation and use of new terms, the vocabulary load of the average geometry textbook is too heavy. Geometry books do not seem to present their materials, nor use their technical terms in a way that lends itself to a complete mastery and understanding of terms.

Present day geometry books have a vocabulary load far above the comprehension of the average tenth grade student. It was found that 47.2 percent of the teachnical geometric terms rate above the 10,000 most commonly used word level, according to Thorndike. This indicates that the average tenth grade student has had very little opportunity to gain a working knowledge of the technical terms found in geometry textbooks. This shows the importance of teaching a geometrical vocabulary to the student.

The technical terms that have a limited frequency of repetition usually are the terms that are the least commonly used. Also there is great variation in the terms used by different authors, as well as great variation in the number of times the different concepts are presented.

There has been a trend in recent years to eliminate the procedure of attempting to teach all the basic concepts and definitions in the first twenty five pages of a text.

An aid in developing an understanding of geometric terms would be to introduce a more comprehensive course of intuitive geometry in the seventh and eighth grade level. Intuitive geometry means that emphasis

is placed on the method of obtaining knowledge by seeing, observing, recognizing, and inspecting. Another aid in eliminating failures due to lack of understanding is to improve the procedure used in teaching mathematical concepts.

New concepts and definitions are introduced when they are needed, never at the beginning of a book or chapter. The most recent procedure of introducing a new term starts with offering experiences in which the concept is involved. The aim is to acquaint the learner with the essential characteristics and properties of the term. Situations are presented which provide well-directed activities. The pupil observes individual instances, contrast them with others, make drawings, measure, make comparisons, ask questions, and analyze carefully. Gradually, understanding of the meaning of the concept is developed.

The vocabulary lists will serve as valuable teaching aids, because they will enable teachers to determine the vocabulary level of geometrical terms; determine to a certain extent the amount of drill and work required to gain an understanding of geometrical terms and determine whether or not a student can be expected to have gained an understanding of a geometric term through outside reading.

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APPENDIX A

GEOMETRIC CONCEPTS COMMON TO ALL SEVEN TEXTBOOKS

acute angle
acute triangle
add
adjacent
altitude
apothem
arc
area
axiom
base
bisect
center
central angle
chord
circle
circumference
circumscribe
coincide
common
complementary angle
concentric circle
congruent
construct
corollary
corresponding
decagon
degree
denominator
diagonal
diameter
difference
direction
distance
divide
equal
equation
equiangular triangle
equidistant
equalateral triangle
exterior
external
equiangular polygon
figure
formula
geometric
given

APPENDIX A (continued)

GEOMETRIC CONCEPTS COMMON TO ALL SEVEN TEXTBOOKS

height
hence
hexagon
hypotenuse
horizontal
included
inscribe
interior angle
intercept
isosceles triangle
menas
measure
median
midpoint
minute
multiply
obtuse angle
octagon
opposite
parallel
parallelogram
pentagon
perimeter
perpendicular
polygon
postulate
product
proof
proportion
prove
quadrilateral
radii
radius
ratio
rectangle
regular polygon
respectively
rhombus
right triangle
right angle
secant
second
segment
semicircle
similar
size
square
substitute

APPENDIX A (continued)

GEOMETRIC CONCEPTS COMMON TO ALL SEVEN TEXTBOOKS

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subtract

sum

supplementary angle

tangent

theorem

transversal

trapezoid

triangle

vertex

width

vertices

APPENDIX B

TWENTY MOST FREQUENTLY USED GEOMETRY TERMS IN SEVEN TEXTBOOKS

CONCEPT	FREQUENCY	THORNDIKE RATING
equal	4,755	8
circle	4,142	1b
given	4,112	1a
prove	3,612	1b
figure	2,800	1b
area	2,161	3a
construct	1,843	3b
bisect	1,701	13
polygon	1,672	19
arc	1,582	7
tangent	1,461	16
base	1,449	2a
chord	1,379	7
proof	1,353	2b
segment	1,330	7
theorem	1,330	15
parallel	1,253	4b
radius	1,226	8
altitude	1,196	6
perpendicular	1,185	8

APPENDIX C

FREQUENCY GROUP LISTS

The frequency groups listed below are made up of geometrical concepts that can be found in Thorndikes word count of 1931. They have been divided into four groups according to their total frequency of use in all seven textbooks. The first group includes concepts that have appeared 1 to 99 times; the second group 100 to 499 times; the third group 500 to 999 times; and the fourth group concepts that appeared 1,000 times or more.

1 to 99.

Absurdity, demonstration, denominator, equivalent, extreme, minute, oblique angle, obtuse angle, octagon, original, quotient, second, and symmetry.

100 to 499.

Add, acute angle, adjacent, axiom, circumference, coincide, converse, common, corollary, difference, direction, dimension, equation, equidistant, external, formula, geometric, hence, height, hexagon, horizontal, hypothesis, included, intercept, interior angle, legs, means, median, multiply, pentagon, perimeter, postulate, product, radii, sector, semicircle, size, substitute, subtract, transversal, vertical, width.

500 to 999.

Circumscribe, congruent corresponding, degree, diameter, distance, divide, diagonal, hypotenuse, inscribe, intersect, length, measure, midpoint, opposite, parallelogram, proportion, proposition, quadrilateral, ratio, rectangle, respectively, similar, sum, vertex.

1,000 times or more

Altitude, arc, area, base, bisect, center, chord, circle, construct, equal, figure, given, parallel, perpendicular, proof, prove, polygon, radius, segment, square, tangent, theorem.

It was found according to Table 2 that among the concepts appearing 1 to 99 times, 23 percent were rated above the 10,000 most commonly used

APPENDIX C (continued)

FREQUENCY GROUP LISTS

word level. In the second group there were about 29 percent; in the third group about 31 percent; and in the fourth group about 18 percent of the concepts were rated above the 10,000 most commonly used word level according to the Thorndike Word Count of 1931.

This indicates that the least common concepts are fairly well distributed among the four frequency groups. So the teacher of geometry will have to allot more time and drills to the uncommon concepts that appear in the low frequency groups.