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A study of the vocabulary burden of three Junior high school mathematics texts

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Thesis

A Study of the Vocabulary Burden of Three Junior High School Mathematics Texts

Submitted by

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Thesis Outline.

A Study of the Vocabulary Burden
of Three Junior High School
Mathematics Texts.

A STUDY OF THE VOCABULARY BURDEN OF THREE JUNIOR HIGH SCHOOL MATHEMATICS TEXTS.

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I. Introduction.

(1) Need for Investigation.

Unquestionably "the teacher makes the school," but next in importance is the text book. It has been advocated from time to time that no texts be used in the schools, but experience has shown that such a method is too wasteful of energy and time, both for the pupil and the teacher. Since text books are a necessary part of classroom apparatus, they should be the best possible, and in accord with the best actual teaching - a real help to the pupils and teacher.

(2) Problem Stated.

It is generally conceded that the results of mathematics teaching in general, and Junior High School Mathematics teaching in particular, are not nearly up to the maximum of efficiency. Is much of the difficulty and inefficiency due to the text books used - granted the teaching is of the best type? This thesis is an attempt to study one phase of the question, as in any text book the Vocabulary Burden (difficulty of the words used) is of prime importance.

(3) Material Used.

The three Junior High School Mathematics texts studied are:

1. Drushel-Noonan-Withers -
   "Arithmetical Essentials, Book Three" -
   Lyons & Carnahan - New York - 1921 -
   Seventh Year - Part I - Pp. 1-152.
   Eighth Year - Part II - Pp. 153-296.
2. Hawkes-Luby-Touton -
   "New First Course in Algebra" -
   Ginn & Co., New York - 1925 -
   Eighth Year - Pp. 1-214 (in some schools)
   Ninth Year - Pp. 215-351 (in some schools)
3. Vosburgh-Gentleman-Hassler -
   "Junior High School Mathematics -
   Third Course - Revised Edition" -
   Macmillan Co., New York - 1924 -
   Ninth Year.

II. Vocabulary Burden. (1)

(1) Method Used.

The problem of determining the Vocabulary Burden of a given text necessarily first involves three questions of procedure -

1. How many words must any sampling include to give a reliable indication of the text's vocabulary?
2. How must these words be selected?

(1) See bibliography #3.

1. How can the difficulty of these words be measured?

The answer to the first question depends, of course, on the degree of reliability required. A perfect but impracticable method would be to analyze every word in the text. Such a procedure is, however, unnecessarily minute and laborious, since a systematic sampling throughout the book will yield sufficient data upon which to base general conclusions. It has been found that a thousand-word unit gives a reasonably reliable indication regarding the vocabulary. If still greater accuracy is desired, several such units may be analyzed. The following Study is based on one thousand-word sampling from each of the three texts.

The answer to the second question is determined by the number of pages in each book. As the sampling must be evenly distributed throughout the text, a systematic number of words must be chosen from each page to make up the thousand. For instance, in "Arithmetical Essentials, Book Three" - Drushel-Noonan-Withers - there are 296 pages, so four words were taken from every odd numbered page and three words from every even numbered page through page 270. Then from the last 26 pages (Pp. 271 through 296) two words were taken from every page.

It was necessary sometimes to take more than the allotted number of words from a page, because the one preceding was made up entirely of numbers as, for example, Pp. 34, 37, 161, etc. In every instance, however, the effort was made to make the sampling fair. Also, as far as possible, the second line of the text was used, beginning usually with the first word.

The answer to question three is found in Thorndike's "Word Book". All the different words in the samplings were listed first in alphabetical order with the number of times each was used in the text and the index-number for each word, according to Thorndike. The interpretation of the index-numbers is as follows: "words having a credit-number (which measures range and frequency of the word's occurrence) of 49 or over are found in the 1st 1000 words in importance (including abbreviations and proper names); those having a credit-number of 29-48 are found in the 2nd 1000, and so on; while those having a credit-number of 8 lie between the 5545th and the 6047th word in importance, and so on. Thus -

Credit-Number		Position of Word
49 or over	-	1 to 1000
29 to 48	-	1001 to 2000
19 to 28	-	2001 to 3000
14 to 18	-	3001 to 4000

Credit-Number		Position of Word
10 to 13	-	4001 to 5144
9	-	5145 to 5544
8	-	5545 to 6047
7	-	6048 to 6618
6	-	6619 to 7262
5	-	7263 to 8145
4	-	8146 to 9190
3	-	9191 to 10000

In the case of the 5000 most important words, the credit-number is followed by a second number combined with a letter which indicates in which thousand and in which half thereof the word belongs. Thus, 2a means that the word is in the 1st half of the 2nd 1000, 3b means that the word is in the 2nd half of the 3rd 1000. Within the 1st 500 words there is a further distinction, - 1a1 meaning that the word is one of the 1st 100; 1a2 meaning that it is in the 2nd 100; 1a3, that it is in the 3rd 100; 1a4, that it is in the 4th 100; 1a5, that it is in the 5th 100."(1) Words which were not listed in the "Word Book", and so are not among the 10000 most commonly used, are designated as zero-value words. Also in the Thorndike list" separate entries are not made of plurals in s; plurals where y is replaced by ies; adverbs formed by adding ly; comparatives and superlatives formed by adding er and est (including changes of y to ies and

(1) See bibliography #12.

iest), or r and st; verb forms in s, d, ed (including changes of y to ies and ied) and ing; past participles formed by adding n, and adjectives formed by adding n to proper nouns. For example:

boys, girls, berries, are counted in with boy, girl, berry;

badly, sadly, are counted in with bad, sad;

longer, bravest, are counted in with long, brave;

plays, playing, played, are counted in with play;

thrown, outgrown, are counted in with throw, outgrow;

Austrian, Bavarian, are counted in with Austria, Bavaria." (1)

Some of the derivatives, which are "not to be known easily from knowledge of the primary word" (2) do appear separately in the Thorndike list, and so receive a special index-number. "Thus, likely would not be known from like; being and building should probably often be learned independently of be and build." (3)

Having collected and tabulated the necessary statistical data, the problem of the Vocabulary Burden of a text resolves itself into three questions -

1. How great is the range of the vocabulary - or how many different words are there in the thousand-word unit?
2. How many zero-value words are used?

(1), (2), (3) See bibliography #12

3. What is the weighted median index-number?

(a) Vocabulary Range.

To answer the first question the total number of different words per thousand was found by counting them from the statistics. The various derivations of a word were, of course, counted with the word as one. For instance, add and adding counted for one word; pay, paying, and pays counted for one word; etc. If, however, a separate index-number was given in Thorndike's list for derivatives - as for dividend, dividing, division, and divisor - such words were counted separately, and not as one word with divide.

(b) Zero-value Words.

The second question is answered by counting the number of different zero-value words in the index-number statistics. Thus, in "Arithmetical Essentials, Book Three" - Drushel-Noonan-Withers - there are 25 different words used, which do not appear at all in the Thorndike list of the most common 10000 words.

(c) Weighted Median Index-Number.

The answer to the third question is the middle index-number of the vocabulary range (or the total number of different words per thousand), counting the zero-value words twice to weight the median reasonably. To find the middle number the index-numbers were arranged in number order, beginning with 0, 3, 4, 5, etc., and also in letter order - as, for instance,

36-2a precedes 36-2b. As will be seen in the statistics following, the index-number is given at the left. To the right is given the number of different words used, and the words. The exponent after each indicates the number of repetitions, or how many times that word was used in the thousand-word sampling. Thus, in the Drushel unit there were 7 words with an index-number of 3, and accurate was used once. Then to the number of different words, or vocabulary range, was added again the number of zero-value words. Thus, in the above-mentioned text the total number of different words is 404. If 25, the number of zero-value words, is added, the total becomes 429, and the middle number is 215, which words have the index-number 50-1b. This, therefore, is the weighted median index-number. Of course, the higher the weighted median index-number is, the easier is the vocabulary, since it varies according to the number of times the words of low index-number are used.

The Vocabulary Burden statistics for the three texts studied will be found in the following pages. The "set-up" for getting these statistics from "Arithmetical Essentials, Book Three" - Drushel-Noonan-Withers - has already been given on Pp. 5-6.

Table I - Showing for "Arithmetical Essentials, Book Three" - Drushel-Noonan-Withers, the analysis of 1000 random words.

Column 1 gives the index-number, Column 2 gives the number of words, and Column 3 gives the separate words with exponents, indicating the number of times the words occur in the 1000 list.

Index Number	Number of Different Words	Words
0	25	annum^{1}, arc^{1}, bisect^{2}, Boyd^{1}, Bros.^{1}, Chapin^{1}, convex^{1}, diphtheria^{1}, Feb.^{2}, graph^{2}, Grimes^{1}, inventory^{1}, isosceles^{1}, Lake Superior^{1}, Minneapolis^{1}, oblong^{1}, Ogden^{1}, parentheses^{1}, perimeter^{1}, polygon^{1}, Spalding^{1}, Stanford^{1}, St. Mary's River^{1}, trapezoid^{2}, vertex^{1}.
3	7	accurate^{1}, broker^{1}, decimal^{2}, diagonal^{1}, reservoir^{1}, specify^{1}, subtraction^{1}.
4	5	assess^{1}, bbl.^{1}, compensation^{1}, discount^{2}, Stewart^{1}.
5	4	divisor^{1}, duplicate^{1}, investment^{1}, tumbler^{1}.
6	7	arithmetic^{1}, Cincinnati^{1}, economical^{1}, factor^{1}, fitness^{1}, inspection^{1}, verify^{1}.
7	5	achievement^{1}, doz.^{1}, effective^{1}, Oct.^{1}, subscription^{1}.
8	3	altitude^{3}, buyer^{1}, teller^{1}.
9	3	¢^{2}, levy^{1}, triangle^{1}.
10-5b	8	announce^{1}, banker^{1}, gravel^{1}, in.^{2}, Jan.^{1}, legal^{1}, physical^{1}, proposition^{1}.

Table I - continued.

Index Number	Number of Different Words	Words
11-5b	2	corporation[1], rectangle[1].
12-5a	1	quote[1].
13-5a	8	Adam[1], distribute[1], fraction[1], income[1], invest[1], project[1], Samuel[1], shrink[1].
14-4b	4	lb.[3], postage[1], thickness[1], transportation[1].
15-4b	7	angle[4], community[1], convert[1], enable[1], irregular[1], magazine[1], umbrella[1].
16-4a	3	fee[1], previous[1], statement[1].
17-4a	1	ft.[4]
18-4a	1	circular[1].
19-3b	2	breadth[1], quart[1].
20-3b	3	attach[2], receipt[1], remainder[1].
21-3b	3	cash[2], Chicago[2], hog[1].
22-3b	1	curve[1].
23-3a	3	ounce[1], problem[2], relative[1].
24-3a	4	average[1], method[2], multiply[2], original[1].
25-3a	6	area[1], bond[1], population[1], register[1], ton[2], uniform[1].
26-3a	4	bushel[1], department[1], raw[1], recent[1].
26-4a	1	accident[1].
27-3a	1	width[1].
28-3a	4	lend[1], package[1], slide[1], Smith[1].
29-2b	2	alike[1], assist[1].
30-2b	1	Indicate[1].

Table I - continued.

Index Number	Number of Different Words	Words
31-2b	5	balance[2], collect[1], grade[2], lawn[1], per[3].
33-2b	3	expense[1], group[1], product[2].
34-2b	5	acre[2], dine[1], period[1], profit[1], test[1].
35-2b	2	depend[1], glove[1].
36-2a	2	January[1], net[2].
36-2b	1	surface[1].
37-2a	2	paid[1], total[3].
38-2a	1	potato[1].
39-2a	4	correct[2], merchant[1], pupil[2], term[2].
40-2a	3	brick[1], describe[1], represent[1].
41-2a	3	due[4], example[1], upper[1].
42-2a	2	James[1], prevent[1].
43-2a	5	degree[1], furnish[1], hen[1], produce[1], weigh[1].
44-2a	1	record[1].
45-2a	3	bush[1], knowledge[1], sum[2].
46-2a	6	below[1], bought[1], bounded[1], rate[2], root[1], slip[1].
47-2a	4	agree[1], block[1], check[4], map[1].
48-2a	4	card[1], inside[1], July[1], result[4].
49-1b	1	date[2].
50-1b	3	difference[1], load[1], object[1].
51-1b	6	amount[4], exercise[1], inch[2], loss[1], proper[1], stock[1].
52-1b	1	New York[1].
53-1b	3	firm[1], require[1], sand[1].

Table I - continued.

Index Number	Number of Different Words	Words
54-1b	1	following[4].
55-1b	1	Golden[1].
56-1b	2	American[1], single[1].
57-1b	5	duty[1], neither[1], sold[2], therefore[1], value[4].
58-1b	3	grain[1], manner[1], pull[1].
59-1b	2	farmer[1], price[1].
60-1b	1	class[1].
61-1b	1	nature[1].
62-1b	2	common[2], direct[1].
63-1b	3	account[2], deal[1], Mr.[4].
64-1b	1	square[2].
65-1b	2	page[2], party[1].
67-1b	2	bill[2], within[1].
68-1b	6	figure[3], interest[3], offer[1], sell[2], straight[1], study[1].
70-1b	3	cost[2], either[2], worth[1].
71-1b	3	age[3], board[1], store[1].
72-1b	1	whose[4].
73-1b	1	business[1].
75-1a	1	add[2].
75-1a5	1	east[1].
75-1b	1	rule[2].
77-1a5	3	certain[1], John[1], Soldier[1].
78-1a5	3	apple[1], corn[1], length[1].
79-1a5	1	measure[1].

Table I - continued.

Index Number	Number of Different Words	Words
80-1a5	1	buy[1].
81-1a5	1	general[1].
82-1a5	3	death[1], feet[2], month[3].
83-1a5	3	across[1], bank[3], remember[1].
84-1a5	2	less[1], week[1].
86-1a4	1	free[1].
88-1a4	3	children[2], north[1], receive[3],
89-1a4	1	draw[2].
90-1a4	1	table[2].
91-1a4	2	answer[4], piece[1].
92-1a4	1	paper[1].
93-1a4	2	pay[4], write[3].
94-1a4	3	ask[1], fill[1], short[1].
96-1a3	1	given[1].
97-1a3	3	begin[1], next[1], whole[1].
99-1a3	1	foot[1].
100-1a3	2	mean[1], order[1].
101-1a3	3	above[1], change[2], does[1].
104-1a3	2	number[6], wish[2].
105-1a1	1	point[1].
107-1a3	2	state[2], without[1].
109-1a3	3	help[1], money[3], read[1].
110-1a3	2	country[1], want[1].
112-1a2	1	pass[1].
113-1a2	1	cut[2].

Table I - continued.

Index Number	Number of Different Words	Words
114-1a2	4	book[1], city[1], found[2], its[1].
115-1a2	4	far[1], must[3], said[1], tree[1].
116-1a2	1	another[1].
117-1a2	1	leave[1].
118-1a2	1	small[1].
119-1a2	3	also[2], between[1], left[1].
120-1a2	1	right[4].
121-1a2	1	tell[1].
122-1a2	2	boy[1], land[1].
123-1a2	3	could[1], large[3], show[5].
124-1a2	1	think[1].
125-1a2	1	most[2].
126-1a2	2	open[1], people[2].
128-1a2	1	home[1].
129-1a2	1	same[1].
130-1a2	1	should[2].
131-1a2	2	find[11], side[2].
132-1a2	2	head[1], upon[1].
133-1a2	1	back[1].
136-1a2	1	three[1].
137-1a2	1	use[5].
140-1a2	1	just[1].
141-1a2	2	did[1], high[3].
142 -1a2	1	each[6].
145-1a2	1	part[3].

Table I - continued.

Index Number	Number of Different Words	Words
146-1a2	2	call[2], has[3].
149-1a2	1	may[6].
151-1a1	3	two[2], work[2], year[3].
153-1a1	1	many[3].
156-1a1	2	only[2], place[3].
157-1a1	3	much[3], such[1], than[2].
158-1a1	2	after[4], any[2].
159-1a1	1	your[4].
163-1a1	1	can[6].
167-1a1	1	way[1].
168-1a1	3	good[1], other[5], over.[1]
170-1a1	1	we[2].
171-1a1	1	how[11].
172-1a1	2	had[1], see[1].
173-1a1	1	then[5].
175-1a1	1	man[2].
176-1a1	2	day[4], make[1].
178-1a1	1	if[2].
180-1a1	1	were[2].
181-1a1	5	an[8], or[6], some[4], them[1], which[8].
183-1a1	2	are[8], time[5].
184-1a1	1	who[5].
187-1a1	1	is[15].
188-1a1	4	so[1], was[7], what[8], you[2].
191-1a1	2	by[8], this[3].

Table I - continued.

Index Number	Number of Different Words	Words
193-1a1	2	out^{2}, when^{2}.
194-1a1	5	have^{3}, he^{4}, his^{4}, there^{4}, they^{3}.
195-1a1	1	from^{5}.
199-1a1	2	it^{6}, one^{2}.
200-1a1	1	on^{8}.
201-1a1	1	for^{10}.
203-1a1	2	all^{4}, at^{7}.
204-1a1	1	as^{5}.
205-1a1	1	of^{47}.
206-1a1	1	be^{3}.
208-1a1	4	a^{34}, the^{96}, to^{27}, with^{9}.
209-1a1	1	that^{3}.
210-1a1	1	and^{26}.
211-1a1	1	in^{24}.
	404	

Note - The total of the exponents is 1000.

Vocabulary Range - 404 words.

Zero-Value Words - 25 words.

Weighted Median Index-Number - 50-1b.

The "set-up" for getting the following statistics from "New First Course in Algebra" - Hawkes-Luby-Touton - was three words taken from every page through Page 300. Then from the last fifty pages two words were taken from each page. Since there were 357 pages in the text, the thousand-word sampling was thus obtained. As was before stated, it was necessary sometimes to take more than the allotted number of words from a page, because the one preceding was made up entirely of numbers, as, for example, Pp. 212, 218, 262, etc., in which case six words, instead of three, were taken from Pp. 213, 219, 263, etc. Usually the second line of the text was used, beginning with the first words; if, however, the first line were a heading, then the third line was used.

Table 2 - Showing for "New First Course in Algebra" - Hawkes-Luby-Touton, the analysis of 1000 random words.

Column 1 gives the index-number, Column 2 gives the number of words, and Column 3 gives the separate words with exponents, indicating the number of times the words occur in the 1000 list.

Index Number	Number of Different Words	Words
0	23	axiom^{1}, binomial^{1}, coefficient^{3}, denominator^{4}, digits^{1}, equation^{9}, exponents^{1}, graphically^{2}, half-dollars^{1}, half-fare^{1}, integer^{1}, literal^{1}, numerator^{5}, one-digit^{1}, polynomial^{1}, quadratic^{1}, ratio^{1}, sheet-metal^{1}, simplify^{3}, tangent^{1}, transposing^{1}, transposition^{1}, two-digit^{1}.

Table 2 - continued.

Index Number	Number of Different Words	Words
3	6	census[1], classify[1], diagonal[1], dividing[3], percentage[1], shortage[1].
4	3	bracket[1], cancel[1], query[1].
5	3	acute[1], divisor[1], Rhode Island[1].
6	8	algebra[2], arithmetic[2], chauffeur[1], equivalent[1], factor[4], quotient[1], verify[2], warehouse[1].
7	1	dividend[1].
8	7	altitude[1], axis[1], expand[1], illustration[1], kerosene[1], mathematics[1], subtract[2].
9	5	¢[1], invert[1], negative[2], triangle[1], unit[1].
10-5b	4	explanation[1], solution[2], successive[1], thermometer[1].
11-5b	1	extract[1].
12-5a	1	respective[1].
13-5a	5	chalk[1], expression[7], fraction[5], illustrate[2], zero[1].
14-4b	3	involve[1], symbol[2], unlike[1].
15-4b	4	angle[2], hint[3], Massachusetts[1], tank[1].
16-4a	2	prime[1], substitute[1].
19-3b	1	retain[1].
20-3b	3	basin[1], remainder[1], solve[5].
21-3b	2	application[1], connection[1].
23-3a	3	difficulty[1], problem[1], process[4].
24-3a	4	arise[1], combine[1], method[3], multiply[1].

Table 2 - continued.

Index Number	Number of Different words	Words
25-3a	4	area[4], barrel[1], exceed[1], likely[1].
26-3a	4	division[1], eighth[1], relation[1], type[2].
28-3a	1	passenger[1].
29-2b	2	operation[5], unknown[2].
30-2b	4	error[1], indicate[5], odd[1], student[1].
31-2b	2	collect[1], per[5].
32-2b	1	throughout[1].
33-2b	2	consist[1], product[3].
34-2b	3	perform[3], period[1], test[1].
35-2b	2	arrange[1], impossible[1].
36-2b	1	really[1].
37-2a	3	constant[1], hence[1], total[2].
38-2a	1	fare[1].
39-2a	1	term[8].
40-2a	3	final[2], represent[2], support[1].
41-2a	3	example[3], satisfy[1], system[2].
42-2a	1	observe[1].
43-2a	2	twice[1], written[1].
44-2a	3	character[1], remove[1], women[1].
45-2a	1	sum[3].
46-2a	4	dollar[1], fifty[1], rate[1], root[5].
47-2a	1	check[3].
48-2a	4	according[1], exact[2], obtain[1], result[3].
50-1b	2	difference[4], space[1].
51-1b	6	amount[2], cent[2], entire[1], exercise[4], inch[1], proper[1].

Table 2 - continued.

Index Number	Number of Different words	Words
52-1b	1	member[1].
53-1b	1	increase[3].
54-1b	3	fact[2], following[7], height[1].
55-1b	2	express[5], usual[1].
56-1b	2	contain[2], single[1].
57-1b	1	value[6].
58-1b	5	boat[1], manner[1], simple[1], themselves[1], yard[2].
59-1b	3	nine[1], possible[1], whether[1].
60-1b	5	distance[1], equal[2], lot[1], pair[1], pound[1].
62-1b	2	common[1], direct[1].
64-1b	1	square[5].
65-1b	1	page[1].
66-1b	1	count[1].
67-1b	1	divide[2].
68-1b	2	interest[2], study[1].
69-1b	1	travel[2].
70-1b	1	cost[3].
71-1b	2	thus[2], wife[1].
72-1b	1	whose[3].
73-1b	1	seven[1].
74-1b	1	question[1].
75-1a	2	add[5], box[1].
75-1b	1	rule[1].
77-1a5	1	case[2].

Table 2 - continued.

Index Number	Number of Different Words	Words
78-1a5	1	length[1].
79-1a5	1	mile[2].
80-1a5	1	known[1].
81-1a5	2	general[2], several[1].
82-1a5	1	feet[6].
83-1a5	1	bank[1].
84-1a5	1	less[1].
88-1a4	1	become[1].
89-1a4	1	wide[1].
90-1a4	2	though[2], top[1].
91-1a4	2	deep[1], low[1].
92-1a4	1	second[4].
93-1a4	1	write[1].
94-1a4	1	thousand[1].
96-1a3	1	given[4].
97-1a3	2	line[3], she[1].
98-1a3	2	done[1], form[4].
100-1a3	1	mean[2].
101-1a3	2	above[3], five[2].
104-1a3	1	number[10].
105-1a3	3	hour[1], point[3], round[1].
106-1a3	1	hold[1].
107-1a3	4	made[1], state[2], those[1], without[2].
108-1a3	1	since[1].
109-1a3	1	follow[1].

Table 2 - continued.

Index Number	Number of Different Words	Words
110-1a3	1	set[1].
111-1a3	1	once[1].
112-1a2	1	pass[1].
114-1a2	3	book[1], found[3], its[4].
115-1a2	3	both[2], must[5], run[1].
117-1a2	2	even[1], near[2].
118-1a2	1	small[1].
119-1a2	3	also[1], between[1], left[1].
120-1a2	1	right[2].
123-1a2	1	large[1].
126-1a2	1	half[1].
129-1a2	1	same[2].
130-1a2	1	should[1].
131-1a2	2	find[10], side[2].
132-1a2	1	let[1].
136-1a2	2	first[6], three[2].
137-1a2	1	use[4].
139-1a2	1	water[1].
141-1a2	1	high[1].
142-1a2	2	each[4], these[2].
145-1a2	2	give[2], part[1].
146-1a2	2	call[2], has[1].
149-1a2	1	may[7].
151-1a1	3	two[7], work[1], year[1].
153-1a1	1	many[2].
155-1a1	1	here[1].

Table 2 - continued.

Index Number	Number of Different Words	Words
157-1a1	2	much[1], than[5].
158-1a1	1	any[3].
159-1a1	3	been[1], before[1], great[2].
162-1a1	1	take[1].
163-1a1	1	into[1].
166-1a1	3	where[2], will[1], would[1].
167-1a1	2	more[7], way[1].
168-1a1	2	other[2], over[1].
170 - 1a1	1	we[5].
171-1a1	1	how[4].
172-1a1	2	about[1], had[1].
173-1a1	1	then[3].
174-1a1	1	long[2].
176-1a1	1	day[2].
177-1a1	1	their[2].
178-1a1	1	if[5].
180-1a1	1	were[1].
181-1a1	5	an[8], or[5], some[1], them[1], which[7].
183-1a1	2	are[9], time[5].
187-1a1	1	is[31].
188-1a1	2	was[2], what[11].
191-1a1	2	by[16], this[5].
193-1a1	2	out[1], when[5].
194-1a1	5	have[7], he[1], his[2], there[2], they[4].
195-1a1	1	from[6].

Table 2 - continued.

Index Number	Number of Different Words	Words
199-1a1	2	it[5], one[6].
200-1a1	1	on[4].
201-1a1	1	for[13].
203-1a1	2	all[3], at[9].
204-1a1	1	as[13].
205-1a1	1	of[47].
206-1a1	1	be[10].
208-1a1	4	a[17], the[114], to[16], with[3].
209-1a1	1	that[8].
210-1a1	1	and[22].
211-1a1	1	in[24].
	329	

Vocabulary Range - 329 words.

Zero-Value Words - 23 words.

Weighted Median Index-Number - 54-1b.

The following statistics from "Junior High School Mathematics - Third Course" - Vosburgh-Gentleman-Hassler - were obtained by the same method used for the preceding texts, except that since there were 282 pages in the book, the thousand-word sampling was got by taking four words from every even-numbered page through Page 260, and three words from every odd-numbered page through Page 261. Then from the last twenty pages four words were taken from every page. To make up the exact thousand, seven words, instead of four, were taken from the last page, which completed the total number.

Table 3 - Showing for "Junior High School Mathematics - Third Course" - Vossburgh-Gentleman-Hassler - the analysis of 1000 random words.

Column 1 gives the index-number, Column 2 gives the number of words, and Column 3 gives the separate words with exponents, indicating the number of times the words occur in the 1000 list.

Index Number	Number of Different Words	Words
0	28	Ahmes[1], axiom[2], centigrade[1], cm.[1], consecutive[1], denominator[1], electromotive[1], eliminating[1], elimination[1], equation[8], exponent[1], fig.[3], formula[3], fulcrum[1], halfway[1], integer[2], isosceles[1], l.c.m.[1], mid-points[1], monomial[2], perimeter[1], protractor[1], quadratic[1], ratio[2], simplify[2], trinomial[1], velocity[1], vertex[1].
3	5	accurate[1], decimal[1], motorist[1], percentage[1], pulley[1].

Table 3 - continued.

Index Number	Number of Different Words	Words
4	1	minus[2].
5	4	acute[1], circumference[1], geometry[1], radius[2].
6	8	adjacent[1], algebra[1], arithmetic[1], factor[3], identify[1], plus[2], quotient[2], verify[1].
7	2	define[2], kilometer[1].
8	2	multiplication[1], vertical[2].
9	4	hemisphere[1], suggestion[1], triangle[2], unit[4].
10-5b	3	explanation[1], solution[8], thermometer[1].
11-5b	1	rectangle[1].
13-5a	4	expression[1], fraction[5], illustrate[1], positive[1].
14-4b	4	Bible[1], correspond[1], involve[1], lb.[1].
15-4b	4	angle[9], drawn[2], etc.[1], plane[2].
16-4a	3	bicycle[1], statement[2], substitute[2].
17-4a	1	overtake[1].
18-4a	2	chapter[1], revolution[1].
19-3b	2	combination[1], transport[1].
20-3b	2	remainder[1], solve[5].
21-3b	4	application[1], examination[1], similar[1], temperature[1].
23-3a	5	cell[1], electric[1], locate[1], problem[1], process[2].
24-3a	5	blank[1], column[1], method[2], multiply[3], relate[1].
25-3a	2	area[5], exceed[2].
26-3a	3	division[1], type[1], vary[1].

Table 3 - continued.

Index Number	Number of Different Words	Words
27-3a	2	conclude[1], pitch[1].
28-3a	1	neighborhood[1].
28-2b	2	brass[1], volume[2].
29-2b	2	flight[1], occur[1].
30-2b	3	axe[1], candy[1], error[1].
31-2b	2	grade[1], per[2].
32-2b	2	metal[1], proof[1].
33-2b	2	automobile[1], product[1].
34-2b	1	rode[1].
35-2b	1	Heap[1].
36-2a	1	trace[1].
36-2b	1	rope[1].
37-2a	4	connect[1], frequent[1], hence[1], total[1].
38-2a	2	proceed[1], respect[2].
39-2a	4	apart[1], explain[1], flour[1], term[2].
40-2a	1	final[1].
41-2a	3	example[4], quantity[2], slight[1].
42-2a	1	trunk[1].
43-2a	4	degree[1], mention[1], twice[1], weigh[1].
45-2a	2	mix[1], sum[3].
46-2a	5	consider[1], plate[2], rate[2], root[3], scale[1].
47-2a	1	check[5].
48-2a	3	base[1], compare[1], exact[1].
49-2a	1	stretch[1].
51-1b	4	amount[2], cent[2], complete,[2] inch[2].

Table 3 - continued.

Index Number	Number of Different Words	Words
52-1b	2	fourth[1], report[1], roof[1].
54-1b	4	following[1], height[1], row[1], subject[1].
55-1b	3	express[1], post[1], trade[1].
56-1b	2	contain[2], weight[1].
57-1b	3	cool[1], sign[4], value[1].
58-1b	1	bottom[1].
60-1b	3	equal[4], pair[2], pound[4].
63-1b	1	prove[2].
64-1b	2	force[1], square[7].
65-1b	1	note[1].
67-1b	2	bill[1], divide[3].
68-1b	4	figure[4], interest[1], sell[1], study[1].
69-1b	2	office[1], travel[1].
70 -1b	1	cost[3].
72-1b	2	plan[1], whose[3].
74-1b	2	ago[1], lie[2].
77-1a5	3	case[1], certain[2], sight[1].
78-1a5	1	length[1].
79-1a5	3	fast[1], measure[1], mile[2].
80-1a5	2	known[1], remain[1].
82-1a5	1	feet[4].
84-1a5	3	less[1], story[1], window[1].
85-1a4	1	power[1].
86-1a4	1	often[1].
88-1a4	2	clear[1], third[2].
89-1a4	1	draw[1].

Table 3 - continued.

Index Number	Number of Different Words	Words
90-1a4	2	ground[1], ten[1].
91-1a4	4	answer[3], being[1], piece[1], six[1].
92-1a4	3	field[1], paper[1], second[2].
93-1a4	1	letter[1].
94-1a4	1	fill[1].
96-1a3	2	during[1], given[1].
97-1a3	1	next[2].
98-1a3	4	cover[1], form[1], late[1], room[1].
99-1a3	3	few[1], foot[1], Kings[1].
100-1a3	1	mean[2].
101-1a3	2	change[3], does[3].
104-1a3	1	number[15].
105-1a3	3	close[1], hour[2], point[5].
107-1a3	1	state[1].
108-1a3	2	because[1], since[1].
109-1a3	3	follow[3], money[1], read[1].
114-1a2	2	found[1], its[3].
115-1a2	2	must[1], run[1].
116-1a2	1	another[1].
117-1a2	1	near[3].
118-1a2	1	small[2].
119-1a2	2	between[3], left[1].
120-1a2	1	right[1].
122-1a2	1	boy[2].
123-1a2	2	large[3], show[2].
124-1a2	2	think[1], turn[1].

Table 3 - continued.

Index Number	Number of Different Words	Words
129-1a2	1	same[4].
131-1a2	2	find[15], side[2].
132-1a2	1	head[1].
136-1a2	3	first[2], get[1], three[2].
137-1a2	1	use[10].
138-1a2	1	I[1].
139-1a2	1	water[2].
140-1a2	1	say[1].
142-1a2	2	each[7], these[1].
145-1a2	1	give[1].
146-1a2	1	has[1].
148-1a2	1	hand[1].
149-1a2	1	may[1].
151-1a1	3	two[11], work[4], year[3].
153-1a1	1	many[3].
155-1a1	1	old[2].
156-1a1	1	place[1].
157-1a1	4	much[1], such[1], than[1], thing[1].
158-1a1	1	any[2].
159-1a1	2	been[2], before[1], your[2].
160-1a1	1	new[1].
162-1a1	1	take[2].
163-1a1	1	can[5].
166-1a1	1	will[6].
167-1a1	1	more[6].
168-1a1	1	other[2].

Table 3 - continued.

Index Number	Number of Different Words	Words
170-lal	1	we^{2}.
171-lal	1	how^{7}.
172-lal	1	about^{1}.
173-lal	1	then^{4}.
174-lal	1	long^{2}.
175-lal	1	man^{2}.
176-lal	2	day^{1}, make^{4}.
177-lal	1	their^{3}.
178-lal	1	if^{4}.
180-lal	2	do^{1}, were^{1}.
181-lal	5	an^{5}, or^{4}, some^{1}, them^{1}, which^{2}.
183-lal	2	are^{9}, time^{3}.
187-lal	1	is^{29}.
188-lal	4	so^{3}, was^{2}, what^{9}, you^{3}.
191-lal	2	by^{12}, this^{3}.
193-lal	2	out^{1}, when^{3}.
194-lal	5	have^{7}, he^{3}, his^{1}, there^{1}, they^{3}.
195-lal	1	from^{5}.
199-lal	2	it^{4}, one^{7}.
200-lal	1	on^{4}.
201-lal	1	for^{9}.
203-lal	3	all^{4}, at^{1}, not^{1}.
204-lal	1	as^{5}.
205-lal	1	of^{54}.
206-lal	1	be^{7}.
208-lal	4	a^{34}, the^{119} , to^{16}, with^{2}.

Table 3 - continued.

Index Number	Number of Different Words	Words
209-1a1	1	that[8].
210-1a1	1	and[28].
211-1a1	1	in[27].
	343	

Vocabulary Range - 343 words.

Zero-Value Words - 28 words.

Weighted Median Index-Number - 54-1b.

2. Results.

(a) Summary.

A summary of the preceding statistics for the three texts is as follows:

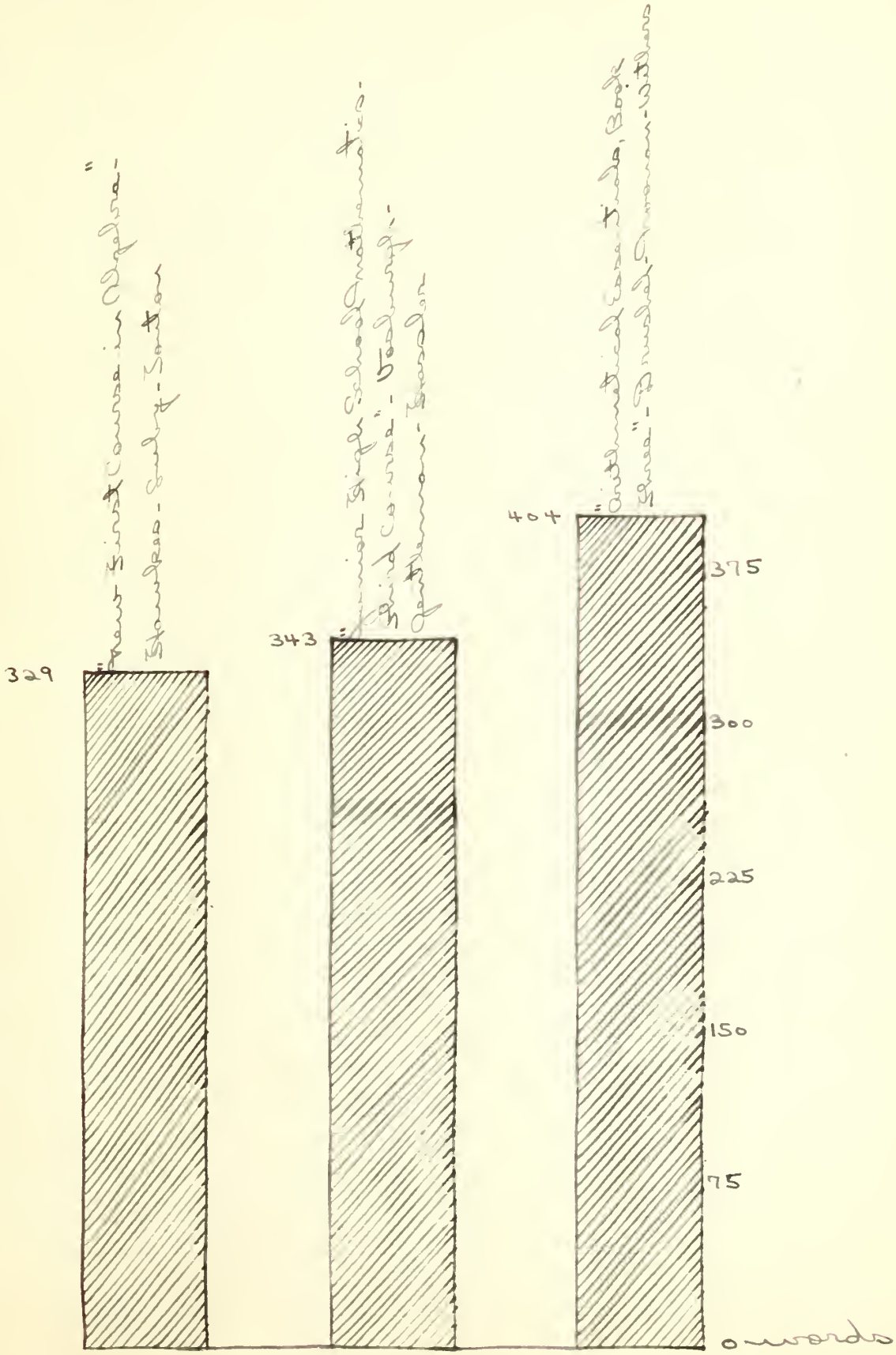
Table 4- Showing Tables 1, 2, and 3 summarized.

One Count	Vocabulary Range	Zero-Value Words	Weighted Median Index-Number
"Arithmetic Essentials - Book Three" - Drushel-Noonan-Withers	404 words	25 words	50-1b
"New First Course in Algebra" - Hawkes-Luby-Touton	329 words	23 words	54-1b
"Junior High School Mathematics - Third Course" - Vosburgh-Gentleman-Hassler	343 words	28 words	54-1b

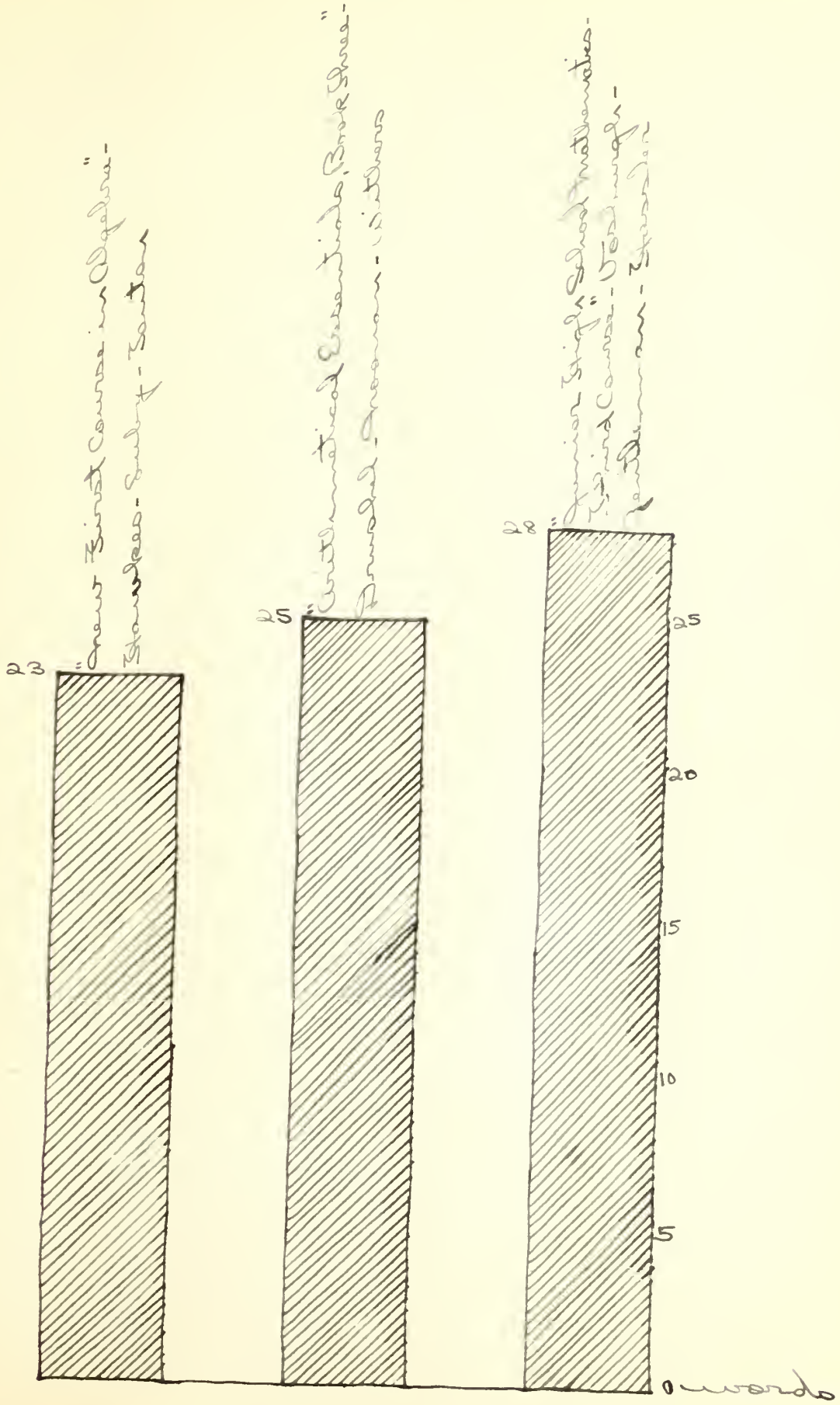
(b) Graphs.

The accompanying graphs represent the foregoing results relatively. As will be seen at a glance, there is a perceptible difference in the range of the vocabularies of the three texts studied, whereas, there is only a small variation in the numbers of zero-value words used and in the weighted median index-numbers.

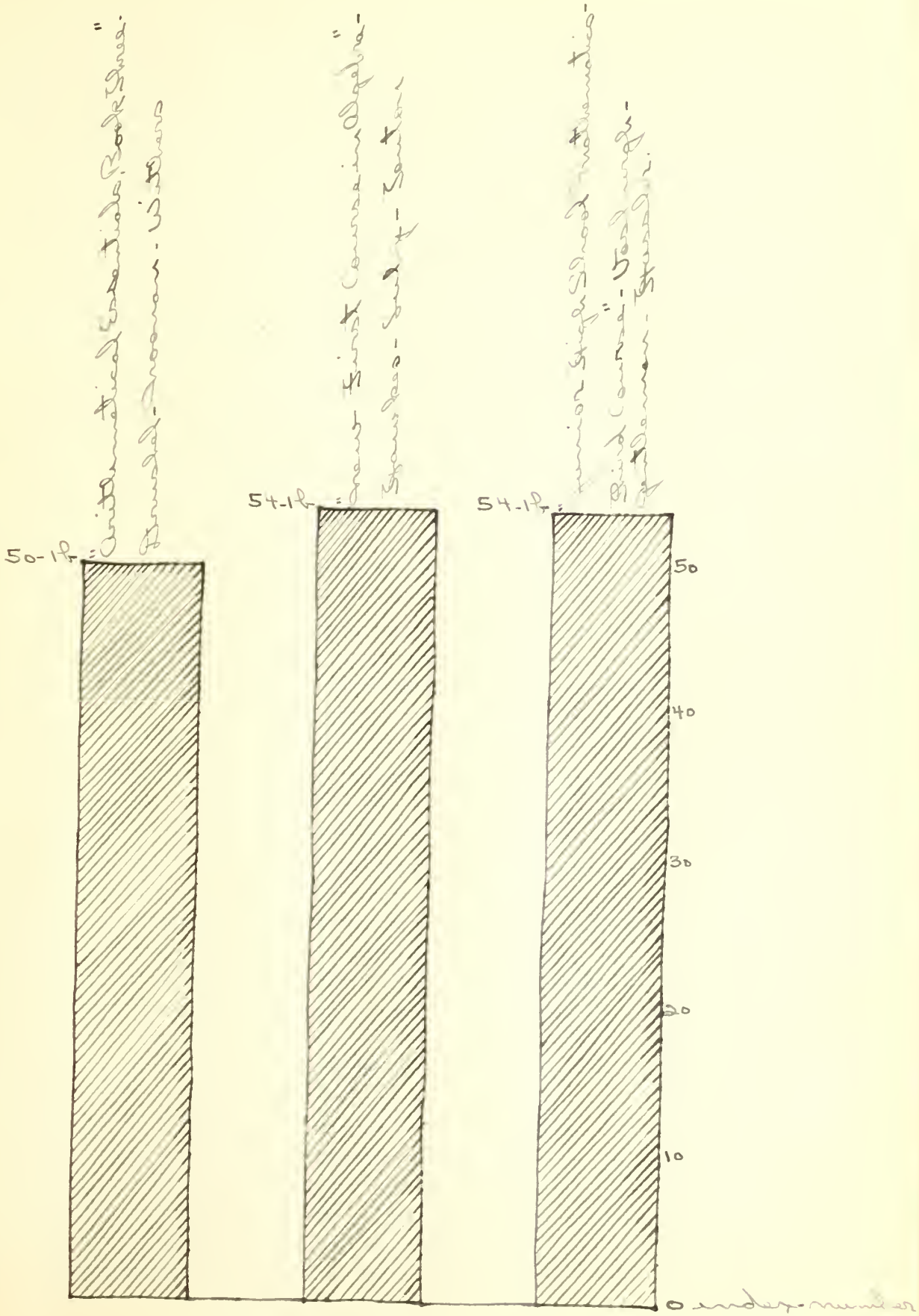
Comparative Range of Vocabularies



Comparative Number of Zero-Value Words



Comparative Weighted Median Index-Numbers



3. Conclusions.

From the results of such a Vocabulary Burden study, six main conclusions may be drawn. First, that whereas great progress has been made in the last few years in improving text books in this respect, there is still need of further simplification and elimination. In the three recent texts studied - the oldest of them published only six years ago - 1921 ("Arithmetical Essentials - Book Three" - Drushel-Noonan-Withers), while "Junior High School Mathematics - Third Course" - Vosburgh-Gentleman-Hassler, revised edition was published in 1924, and "New First Course in Algebra" - Hawkes-Luby-Touton - in 1925 - just two years ago - the vocabulary range for all of them is unquestionably too high. And can there be any justification for the fact that the Drushel-Noonan-Withers text, which is to be used in the Seventh and Eight Grades, has a vocabulary range larger by 75 words, or 22%, than the Hawkes-Luby-Touton book used in Eighthand Ninth Grades, and larger by 61 words, or 17%, than the Vosburgh-Gentleman-Hassler text for use in the Ninth Grade? Certainly a Seventh & Eighth Grade book should have a far lower vocabulary range than a Ninth Grade text. In fact, any mathematics text should have as simple a vocabulary as possible, so that there would be practically no word-burden, since the subject matter itself is quite difficult enough without added language obstacles.

Second, there is no excuse in Junior High School Mathematics books for any words so abstract that they are

not to be found among the 10000 most commonly used. Since such words do not function in ordinary adult life, may they not indicate some non-essentials in general Mathematics teaching which ought to be eliminated? With school mortality so high, it is little short of criminal to waste the pupils' time with subject matter useful only to the expert. In the three texts used for this study, the number of zero-value words was 6% of the vocabulary range in the Drushel-Noonan-Withers book; 6% of the Hawkes-Luby-Touton vocabulary range; and 8% of the Vosburgh-Gentleman-Hassler range.

These words were in the Drushel book:

annum, arc, bisect, Boyd, Bros., Chapin, convex, diphtheria, Feb., graph, Grimes, inventory, isosceles, Lake Superior, Minneapolis, oblong, Ogden, parentheses, perimeter, polygon, Spalding, Stanford. St. Mary's River, trapezoid, vertex.

The Hawkes text had:

axiom, binomial, coefficient, denominator, digits, equation, exponents, half-dollars, half-fare, integer, literal, numerator, one-digit, polynomial, quadratic, ratio, sheet-metal, simplify, tangent, transposing, transposition, two-digit.

In Vosburgh were found:

Ahmes, centigrade, cm., consecutive, electromotive, eliminating, elimination, fig., formula, fulcrum, halfway, l.C.M., mid-points, monomial, protractor, trinomial, velocity - a suggestive list involving a number of mathematical processes.

If to the number of zero-value words there were added the number of low-value words (those not included in the 5000 most important words) in each of the three texts analyzed, it would be found that the number in each case is about doubled, which considerably intensifies the vocabulary difficulty, and indicates the magnitude of the language handicap with which pupils are hampered in their general mathematics work.

Third, the distribution of difficult words in the three texts studied is too heavy at the beginning and in the first part of the books. In the following tabulation, giving the number of zero-value words and low-value words found within hundred-page units, it will be seen that in the Drushel-Noonan-Withers text more than three times as many of the difficult words appear in the first two-thirds of the book; while in the Hawkes-Luby-Touton book there are one-fourth more of the difficult words in the first half than in the last half; and in the Vosburgh-Gentleman-Hassler text the distribution is about even, so that twice as many of the difficult words are found in the first two-thirds of the book as in the last third. Consequently, is not the Vocabulary Burden made just that much greater, whereas, should not the pupils be as free as possible from such a burden in the beginning of new work, and should not the difficult words be distributed in gradually increasing numbers with the weight toward the end of the text rather than at the beginning?

Table 5 - Showing the Distribution of Difficult Words in Arithmetical Essentials, Book Three" - Drushel-Noonan-Withers.

The numbers indicate the pages on which the words occur.

Zero-Value Words	Low-Value Words - (Through 9)
Page 272	Page 215
129	151
126	171
113	183
86	186
217	231
262	103
136	24
95	284
29	81
55	23
71	193
5	222
24	281
60	162
175	49
211	128
30	82
74	83
228	168
21	54
27	52
119	163
217	22
243	42
211	91
127	173
127	208
114	107
	293
	191
	110
	253
	29
	40
	63
	175
	140
	197

Table 6 - Showing the Distribution of Difficult Words in "New First Course in Algebra" - Hawkes-Luby-Touton.

The numbers indicate the pages on which the words occur.

Zero-Value Words	Low-Value Words - (Through 9)
Page 57	Page 346
143	41
58	113
119	221
174	41
194	208
225	277
187	87
217	269
267	223
56	27
72	249
73	155
169	298
215	108
224	126
120	148
170	189
264	208
319	190
284	135
281	159
106	197
82	108
302	162
72	183
136	208
185	251
198	331
210	47
204	91
291	228
111	345
172	273
299	30
287	47
45	70
87	71
211	297
343	279
100	345
75	350
291	65

Table 7 - Showing the Distribution of Difficult Words in "Junior High School Mathematics - Third Course" - Vosburgh-Gentleman-Hassler.

The numbers indicate the pages on which the words occur.

Zero-Value Words	Low-Value Words - (Through 9)
Page 74	Page 119
16	262
19	209
85	130
193	236
248	42
179	208
233	215
166	255
169	100
15	133
16	136
71	138
83	68
14	130
71	279
180	106
199	131
122	150
263	27
268	4
116	102
6	126
231	45
1	41
52	148
57	63
10	67
248	205
273	273
244	262
265	25
133	226
136	24
38	80
270	270
180	226
13	259
201	
242	
2	
134	
229	
273	

Table 8 - Showing a Summary of Tables 5, 6 and 7.

Distribution of Difficult Words

Drushel-Noonan-Withers.

	P. 1-99	P. 100-199	P.200-296
Zero-Value Words	12	9	8
Low-Value Words	14	17	8
	26	26	16

Hawkes-Luby-Touton.

	P. 1-99	P.100-199	P.200-299	P.300-357
Zero-Value Words	10	15	15	3
Low-Value Words	11	13	14	5
	21	28	29	8

Vosburgh-Gentleman-Hassler.

	P. 1-99	P. 100-199	P. 200-282
Zero-Value Words	18	12	14
Low-Value Words	11	13	14
	29	25	28

Fourth, the weighted median index-number should be higher than 54-1b - the highest found in the three texts studied. 211-1al is the highest given in the Thorndike list, and if the zero-value and low-value words were for the most part eliminated, the weighted median index-number could be appreciably raised, since it varies inversely with the vocabulary range - the less the range, the higher the index-number. Granted that the Vosburgh-Gentleman-Hassler and the Hawkes-Luby-Touton texts should have a higher weighted median index-number than 54-1b, it will be apparent that the Drushel-Noonan-Withers index-number - 50-1b - is by far too low. Certainly a Seventh and Eighth Grade text should have a higher weighted median index-number than a Ninth Grade book. And every Junior High School Mathematics text should have as high a weighted median index-number as possible, indicating that the vocabulary difficulty has been reduced to the lowest minimum.

Fifth, there is not enough vocabulary over-lapping from grade to grade in the texts studied. In the statistics the words found in the Drushel-Noonan-Withers book were checked, and it was found that only 132 words, or 40%, of the Hawkes-Luby-Touton vocabulary range was found also in the Seventh and Eighth grade book. In the Vosburgh-Gentleman-Hassler statistics, the words used in all three texts were checked , and it was found that there was an over-lapping of only 200 words, or 57%. This is too high, of course, because the Drushel text includes both Seventh and Eighth grade work, while the Hawkes book includes Eighth and Ninth grades,

but it serves to give some idea of how little actual over-lapping there is in texts covering the three years of Junior High School Mathematics. When it is taken into consideration that somewhat more than two-thirds of the Hawkes-Luby-Touton vocabulary range was new, and that more than half of the Vosburgh-Gentleman-Hassler range was new, it will be seen how much heavier the Vocabulary Burden is made due to lack of sufficient over-lapping. There should be as much over-lapping in vocabulary ranges as possible, in order that the pupils may not be at the disadvantage of having to hurdle language obstacles as well as those of subject matter.

And finally it will be of interest to note the type of words found in the samplings. In the Drushel-Noonan-Withers text appear such words as - assessed, compensation, corporations, degrees, discount, inventory, isosceles, legal, levy, polygon, reservoir, trapezoid, vertex, etc., while boys is found once, children twice, home once, pupils twice, sells twice, and store once. But in general it is an adult vocabulary - little suited to the interests of the world of youth. For instance, the words father, mother, brother, sister - even girl, dog, cat, horse, bicycle, radio, football, baseball, hockey, basketball, marbles, clothes, etc., covering so many of the interests of childhood and youth do not appear at all. In the Hawkes-Luby-Touton sampling are found - acute, altitude, angle, area, axiom, axis, binomial, coefficient, digits, linear, polynomial, quadratic, thermometer, transposing, unknown,

etc., while books is used once, student once, and women once, but for the most part the vocabulary is not even a common adult one, and has little or no reference to the interests of the pupils. The Vosburgh-Gentleman-Hassler thousand-word unit contains: Ahmes, axiom, centigrade, circumferences, consecutive, formula, fulcrum, geometric, hemispherical, identities, isosceles, kilometer, monomial, protractor, quadratic, trinomial, velocity, etc., while automobile is used once, bicycle once, boys twice, electric once, and neighborhood once; however, the vocabulary is largely an adult and technical one, little motivated by the interests of the pupils.

From the foregoing discussion, it will be seen that in these three Junior High School Mathematics texts, which have been analyzed, the Vocabulary Burden is a burden, indeed - real and heavy, making much more difficult an already difficult subject. It is necessary to conclude that results in Mathematics teaching will not improve appreciably until the Vocabulary Burden of text books is much lightened or adapted to ~~child~~ pupil interests and needs, for teachers now are forced to spend invaluable energy and time clearing away vocabulary difficulties, and pupils grope around blindly amid perplexing language intricacies, losing time and eventually interest, because they find the book so puzzling and dull. The vocabulary of the Junior High School text should be suited to the interests and needs of the pupils, as well as to adult needs, and not to those of the experts.

III. Summary.

From such a Vocabulary Burden study, six conclusions follow. First, that the vocabulary range of the three texts is too high. There should be much simplification and elimination. Second, that there should be no zero-value words in a Junior High School Mathematics text. The presence of such words in the texts studied quite probably indicates useless processes which should be dropped out, and the work put on a functional basis of pupil-interests and needs, as well as adult needs. Third, the distribution of difficult words should be gradual with the weight toward the end of the book, rather than at the beginning, as was found to be the case in the texts studied. Fourth, the weighted median index-number in the three texts is too low, indicating much vocabulary difficulty. It should be as high as possible, denoting a simple, easy vocabulary. Fifth, there is too little over-lapping in the vocabularies of the Seventh, Eighth, and Ninth Grade texts examined. There should be much over-lapping. Sixth, the type of words found in the three samplings indicates adult rather than pupil situations, and point to lack of motivation.

Thus, it will be seen in conclusion that the Vocabulary Burden of the three texts studied is a really tremendous load for the pupil. In Junior High School Mathematics texts, it ought to be greatly lightened, or done away with entirely, if possible. The question ~~The question~~ raised at the beginning of this thesis is thus answered - so long as the already difficult

subject matter of Junior High School Mathematics is hampered and all but strangled with language difficulties - just so long will it remain almost overwhelmingly difficult, and the results of its teaching appallingly inefficient. The great need of the hour is for text books abreast of the best teaching methods, and adapted to the needs and interests of pupils and not of experts, that the pupils may really have a chance at success in Junior High School Mathematics.

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* A star at the left of the book or article indicates that it was indispensable to this Study. The other references in the bibliography were used as background reading.

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