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WITH IMPLICATIONS FOR REVISION AND IMPROVEMENT.

be accepted as fulfilling this part of the requirements for the degree of Doctor of Education

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STATISTICS WITH IMPLICATIONS FOR REVISION
AND IMPROVEMENT

A dissertation submitted to
The Graduate Faculty of the Teachers College
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CHAPTER I

INTRODUCTION

Statement of the Problem

Historical Development.- The term, statistics, is derived from the Latin word, status, as it was originally used to denote inquiry into the condition of a political state. The meaning has been modified by social and economic changes and by the interpretations of scholars interested in statistical phenomena. Three men of the 18th and 19th centuries prepared the way for the statistics of today. Achenwell (1702-1772), of the University of Göttingen, formulated the subject into a science, (8) and Sussmilch (1700-1769), introduced mathematical deduction (12). The work of Sussmilch was continued by Quetelet (1796-1874), who is sometimes called the father of modern statistics (6). Chaddock (3) has summarized the work of Quetelet in the following manner:

Quetelet's work did much to turn attention from mere description to the use of quantitative data for the purposes of explanation, for measuring similarities and differences, for the study of relationships, for defining antecedent and consequent, cause and effect.

There were no usable statistical textbooks for college until 1901, when Bowley (1), an Englishman, wrote an excellent book which is still in use.

A Subject of the College Curriculum.- The classics and the exact sciences have been taught many years, while statistics is a comparatively new subject of the college curriculum. The constantly expanding use of statistical material in professional and commercial fields necessitates that the subject of statistics occupy an important place in the college curriculum.

Statement of the Problem.- Hence the problem: A Critical Analysis of the Content of the Courses in Elementary Statistics with Implications for Revision and Improvement.

Purposes of the Study

The four purposes of the study are:

I. To determine the nature of the content of elementary statistics as shown by a textbook analysis. This analysis necessitates investigating and answering the following statements as far as possible:

A. The degree to which prefaces and introductions are reliable indices of the fundamental assumptions, methods of treatment and content of textbooks, and the year in college in which the texts should be used.

B. The agreement of writers of elementary statistics upon the concepts to be included in the course.

C. The similarity of methods and definite order of presenting statistical data.

D. The simplicity, completeness, clearness, attractiveness of form, and the ease with which the average student understands illustrative materials, such as maps, charts, diagrams, and figures.

II. To determine by means of a comprehensive test, the degree to which students master the statistical formulas and concepts, commonly presented in courses in elementary statistics. This study involves:

A. The number, distribution, and probable causes of errors which students are making in elementary statistics.

B. The inferences which may be drawn as to the fundamental mathematical background, the instructor's conception of what phases of statistics are most important, and the success with which the subject is being presented.

III. To determine the degree to which statistical concepts presented in textbooks correspond to those actually employed in research work and in ordinary life situations. This is ascertained by an analysis of a random sample of educational and scientific literature which involves statistical method.

IV. To determine from the analysis of textbooks and current literature, the statistical concepts most frequently used, with the view of suggesting minimal essentials for a course in elementary statistics.

Justifications for the Study

1. No investigations of the subject content of college courses of elementary statistics have been made comparable to the studies of Haggerty (5) Topics in Psychology, and of Seidlin (11) A Critical Study of the Teaching of Elementary College Mathematics. As a matter of fact, no study of any college subject has been made as thorough as Buswell and Judd's Summary of Educational Investigations Relating to Arithmetic (2), or Gray's Summary of Investigations Relating to Reading (4).

The above comparisons may be justified on the grounds that college courses are just as susceptible of change as subjects taught in the lower grades and consequently should be kept under constant critical consideration.

2. No attempt has been made to determine the causal relations of successes or failures of students in statistical courses with either the textbooks or the mode of presentation.

3. Statistics (7) is an ever-growing field, extending into practically all phases of life. The determination of how well present statistical courses fulfill their functions will indicate what improvements and innovations are necessary to enable the student to more fully comprehend the vital and practical part that statistics play in every-day life.

Sources of Material and Scope of Study

The material for this study is drawn from three major sources:

1. An analysis of twenty-three textbooks in the field of statistics.
2. The results of a comprehensive achievement test taken by nine hundred thirty-seven students in forty-eight institutions of higher learning.
3. Current social and professional literature involving statistical concepts.

Method of Presentation

The investigation is carried out scientifically; that is, the comprehensive test is formulated by the method expounded by the foremost authorities in the field; the students and colleges participating constitute a representative sample; all calculations are mathematically correct; and the texts and periodicals analyzed are foremost and reputable. The choice of representative subjects for study is made to eliminate irrelevant conditions which might be personal and local.

From the data thus compiled and organized, logical conclusions are drawn. Nevertheless, to make a study such as this analytical and objective in the sense of the exact sciences is

impossible without a complete enumeration, which in turn can not be done, because the students and the courses are variable factors. The inductive method of predictive enumeration used in statistics does not lead to absolute conclusion, but must be interpreted by the investigator, and therefore becomes relatively subjective. The interpretations which are made in this thesis, however, are impartial. This method of presentation is chosen because it is the only one to which the subject lends itself. Although the study cannot lead to dogmatic conclusions, its value is not lessened. It is not simply a presentation of isolated facts, but a body of organized facts exhibiting definite trends. The writer points out these trends, and uses them as premises on which to base her conclusions.

Techniques for Gathering and Treating Data

Tabulation of Textbook Data.- The data are compiled and placed in statistical tables which show the frequencies of the various statistical concepts, terms, formulas, illustrative materials, problems for solution, references, introductions, and prefaces, and the types of methods used in presenting the subject matter in the twenty-three textbooks¹.

¹

Chapter II, pp. 11-68

Schools Participating in the Testing Program.- The catalogues of the schools which are listed in Patterson's American Educational Directory (9) and Robertson's American Universities and Colleges (10) were consulted to determine in which schools statistics are taught. A letter of introduction² was written by Dr. C. A. Gregory to various state universities, state colleges, state teachers colleges, municipal universities, and privately endowed colleges and universities, asking for cooperation in administering the comprehensive examination. The total number of schools which replied to this letter was two hundred sixty.³ Many of the schools did not give the course in 1932-33. The institutions which consented to give the test are representative of all sections of the United States. The reason for sending the tests to different types of schools is not to make comparisons between the schools, but to get a sample of sufficient range to insure reliability and validity.

The tests were forwarded to the colleges and universities which consented to give the examination. A letter⁴ also was sent in which the writer asked the name of the text used, the

² Appendix A, p. 178

³ Appendix B, p. 196

⁴ Appendix A, p. 179

classification of the students, the number and the length of recitations per week, the number of weeks the course was to be pursued and whether the course was taken as a requirement for an advanced degree or as a substitute for one of the languages required for a doctor's degree, or for both a degree requirement and a language substitute. Fifty colleges and universities⁵ gave the test.⁶

Follow-up Letters.- Follow-up letters were sent out in the summer of 1932 to those who had received the tests in the spring of 1932, but had not returned them. In September, 1932 letters were again sent to those who had no classes in the spring, but offered to give the tests that fall. Another follow-up letter was sent during the month of January, 1933.

Construction of the Test.- The test questions are based on those topics in the first term's work common to the majority of the texts. The test is comprised of eighty statements and thirteen problems. The statements are distributed as follows: fifty true-false, fourteen multiple-choice, and sixteen match-answer.

Current Literature.- The third type of data is secured from periodicals for the months of December, 1932, and January,

5

Table XI, Chapter III, Pp. 71, 72

6

The tests from Iowa State Teachers College, Cedar Falls, Iowa, and Hobart College, Geneva, New York, came after the test data had been compiled.

1933, and the quarterly publications issued for the months of November, 1932, and February, 1933. The Reader's Guide and the Educational Index for January, 1929, to June, 1932, were consulted in the selection of periodicals to be perused. Deductions from the information thus accumulated are considered in relation to the textbooks and the results of the test.

Order of Presentation

The order in which the data are presented in the subsequent chapters is:

1. Analysis of textbook content.
2. Analysis of the data of the comprehensive test.
3. Information and conclusions drawn from an analysis of statistical data found in current literature.
4. A summary of the trends indicated in the preceding chapters, as well as suggestions for the minimal essentials for a course in elementary statistics.

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CHAPTER II

ANALYSIS OF THE TEXTBOOKS

Analysis of the Basic Assumptions and Introductions to the Study of Elementary Statistics as Given by Authors of Elementary Statistics

Introduction

In making the analysis of the twenty-three texts, it is found that the authors have posited in the introductory discussions and other accessory parts of their texts as many basic assumptions and collateral material as are deemed necessary for an understanding of the purposes for which their respective textbooks are prepared. These materials appear under the captions of introductions, prefaces, glossaries, bibliographies, and appendices. Regardless of their location in respective texts, they constitute an accessory rather than a central part. Their importance is evident. A careful consideration of these features is of much worth as a background for further analysis of the contents of the twenty-three texts.

The statisticians whose books are reviewed in this chapter, may be divided into three groups:

1. General Statisticians. - Books dealing with the general field of statistics are those of Bowley, Burgess, Gavett, Secrist, and Yule.
2. Educational and Psychological Group. - Books

dealing with educational and psychological data are those of Camp, Garrett, Gregory and Renfrow, Holzinger, Kelley, King, MacDonald, Odell, Otis, Rugg, Thurstone, Tiegs and Crawford, and Williams.

3. Economic Statisticians. - Books dealing with economic data are the following: Chaddock, Crum and Patton, Harper, Lovitt and Holtzclaw, and Mills. In all subsequent tables, this grouping of the authors is followed. Such grouping makes it possible to compare the work, if desired, of the different divisions.

Introductions and Prefaces

The keynote of a book is generally struck in the introduction, or preface, or both. Hence, the summarizing statements and a table of the contents of the introductions and prefaces give an authoritative insight into the books, and thus form one of the first approaches to a critical analysis of the statistical concepts included there. Whenever possible, the following points are embodied in the discussion on prefaces and introductions,¹ and in Table I:

1. Aims of the authors.
2. The amount of mathematics necessary for the course.
3. The college rank of those who elect the course.
4. Length of time given to the course.
5. Variety of fields covered.

¹
Appendix C, P 204

Each author classifies his text as one suitable for beginners. Seventy-four per cent of the authors say that their texts aim to present the subject matter so that it will be easily understood by those who have had little training in mathematics. Fifty-two per cent of the authors state that there are no mathematical prerequisites. A wide range of mathematical requirements is listed by some authors in the prefaces. These requirements include high school and college algebra, trigonometry, analytical geometry, and calculus. The prefaces, with the exception of those of Williams (22:3), Odell (16:2) and Bowley (1:2), do not truly represent the situation in regard to the mathematics required.

Most of the prefaces show that the subject matter covered in the statistical courses is not limited to one field, but includes illustrations which are drawn from various fields. The majority of the introductions and prefaces indicate that the textual material is of such a character that it is applicable to more than one group of statistical workers.

The length of time stated for the course by forty-three per cent of the authors, varies from one-half year to one year. Approximately nine per cent of the authors indicate the year in college when the presentation of the course would be the most acceptable.

2

Table I, Appendix C² is a summary of the statements of the authors in the prefaces and introductions of their texts.

3

The tabulation of Table IV, Appendix C³ expresses the participation in average per cent for each item of Table I, by each of the divisions of the statisticians.

Indices and Glossaries

The index of a book is a detailed analysis of the contents, as well as a guide to the location in the text and the frequency with which topics occur, authorities cited, terms and vocabulary used. Two texts (3), (22) have no indices. These omissions make the analysis of the texts more difficult, as more time is required to locate concepts.

The textbooks of Gregory and Renfrow (8), and MacDonald (14) are the only ones which include glossaries of terms. Seven authors have glossaries of symbols and four have⁴ glossaries of formulas in their texts.

2 Appendix C, P 204

3 Appendix C, P 214

4 Appendix C, Table III, P 208

Bibliographies

Bibliographies are vital to any text because they serve at least four purposes. These purposes are:

1. To show to what extent the author is conversant with the fields about which he is writing.
2. To facilitate the verification and validity of his statements.
3. To indicate the authorities whom the textwriter regards the best on the subject.
4. To recommend outside readings for those using his text.

The bibliographies vary in length from no references (3) to two hundred sixty-six (18). The majority of the authors recommend books, periodicals, governmental and other miscellaneous reports. Appendix C contains a table on the placement of bibliographies in the texts.

Appendices

An appendix of a book contains matter of too much importance to be omitted from the text, but the subject matter is often of such character that it should not be placed in the

main part. It may include points which supplement the author's main thesis, and which are necessary for a clearer understanding of the subject, yet their insertion in the body of the text would give so much detail, that the reader would lose the main ideas. The appendices of the statistical textbooks include tables, figures, glossaries, mathematical and statistical formulas with or without derivation, sample tests, symbols, abbreviations, and bibliographies. There is found little⁶ similarity in the placement of topics in the appendices. For instance, Garrett (8:93) has a table on the "Fractional Parts of the Total Area under the Normal Probability Curve" in the body of his text, while others of the authors have these tables in the appendices.

The number of appendices in the textbooks vary from none to seven (22). In Table III, Appendix C⁷, the distribution of appendices and their content, which has been grouped under the headings of statistical, mathematical, and miscellaneous topics, is considered. Twenty-one authors have one or more appendices in their texts.

⁶ Appendix C, Table III, P 208

⁷ Appendix C, Table III, P 208

The findings on the parts of the text just considered give background for and indications of the contents of bodies of texts, the analysis of which is considered in the rest of the chapter.

An Analysis of the Presentation of Statistical Concepts

The topics considered under Analysis of the Presentation of Statistical Concepts of each text are as follows:

1. Illustrative materials, which include maps, charts, diagrams, figures, tables, and examples.
2. Problems for solution.
3. Terminology, and statistical and mathematical symbols.
4. Subject content by topics.
5. Methods used in the presentation of statistical concepts.
6. Summary of Part II, Chapter II.

Illustrative Materials

With changing social and economic conditions, textbooks, in general, have changed in regard to the amount and character of illustrative materials used. The early texts were meagerly illustrated. Today, texts in the elementary schools vie with each other in the quality and amount of illustrative material which they present. In many instances, the arithmetics published in the last five years have beautifully colored charts as well as black and white illustrations. Geometry teachers, in secondary schools, often create colorful geometric patterns

which add clarity to the concepts, not afforded by the black and white illustrations of the texts.

The clearness of the illustrations in a text is often an index to the author's sympathetic understanding of the possible difficulties of the students, as well as indication of the vividness with which the fundamental concepts of the subject appear to him.

In order to find to what extent and how the college texts in elementary statistics are illustrated by the various authors, an analysis of the illustrated material found in them is made. The analysis that follows is comparative in that the number of pages and the per cent of the space given by each textbook to the different types of illustrative materials is ascertained.

Maps, Charts, Diagrams, and Figures. - In the various texts, the explanations and construction of maps, charts, diagrams, and figures are found in the chapter, the heading of which is Graphic Representation. The authors show how to construct and interpret the types of illustrations which are used in presenting statistical concepts and problems. Of these four terms, the only one to have the same meaning assigned to it by all the authors is map. The other three terms are interpreted differently by the various authors. For instance, Chaddock uses the word figure for the same type of illustration that Crum and

Patton call a chart, and which Rugg designates as a diagram.

Figure I⁸ is an illustration of the type of graphic representation which is labelled by any one of these three names.

From the analyst's point of view, the amount of space devoted to clear graphic representation is an index of the ease with which the reader may interpret the subject illustrated. Maps occupy⁹ a negligible per cent¹⁰ of space¹¹ in the textbooks; charts occupy one and one-half per cent; diagrams and figures each utilize nine per cent of the total book space. Together maps, charts, diagrams, and figures occupy an average of nine per cent of space in each text.

Tables. - The second class of materials is tables. The term, table, has the same significance in all the texts. It is one of the most common forms of illustrations used by the writers, as it allows the presentation of maximum data in minimum space with precision and clarity. These tables are used to show the tabulation of materials and in some cases the solutions of illustrative problems are presented in tabular form. Tables

⁸ Figure 1, p. 24

⁹ Table I, Pp. 22, 23.

¹⁰

The per cents stated for the amounts of textbook space occupied by the various types of illustrative materials always refer to the average amount of space for the number of books in which such illustrations are found.

¹¹

Tables II and III, Pp. 26, 27.

are found in each of the twenty-three texts. The average amount of space allotted to tables is eleven per cent.

The amount of space used for the different forms of illustrations is stated in Table I, which summarizes the following items:

1. The number of maps, charts, figures, and tables found in each of the twenty-three texts.
2. The number of pages of each type of illustration.
3. The per cent of text given to illustrative material.
4. The total per cent given to these types of illustrations in the textbooks, and the mean amount of space devoted by all the texts.

The average amount of space, in per cent, of each text given to charts, maps, figures, and examples or illustrative problems, is fifty-four per cent.

Figures I, II, III, and IV are graphic representations of the per cent of book space given by the authors to illustrative materials. The writer acknowledges the possibility that one page of illustrations of one text may serve the purpose as well as six or seven pages of another text, although, in the writer's judgment, such a condition does not exist in any of the texts examined.

In the tables and in the figures, the authors are grouped according to classification given at the beginning of this chapter.

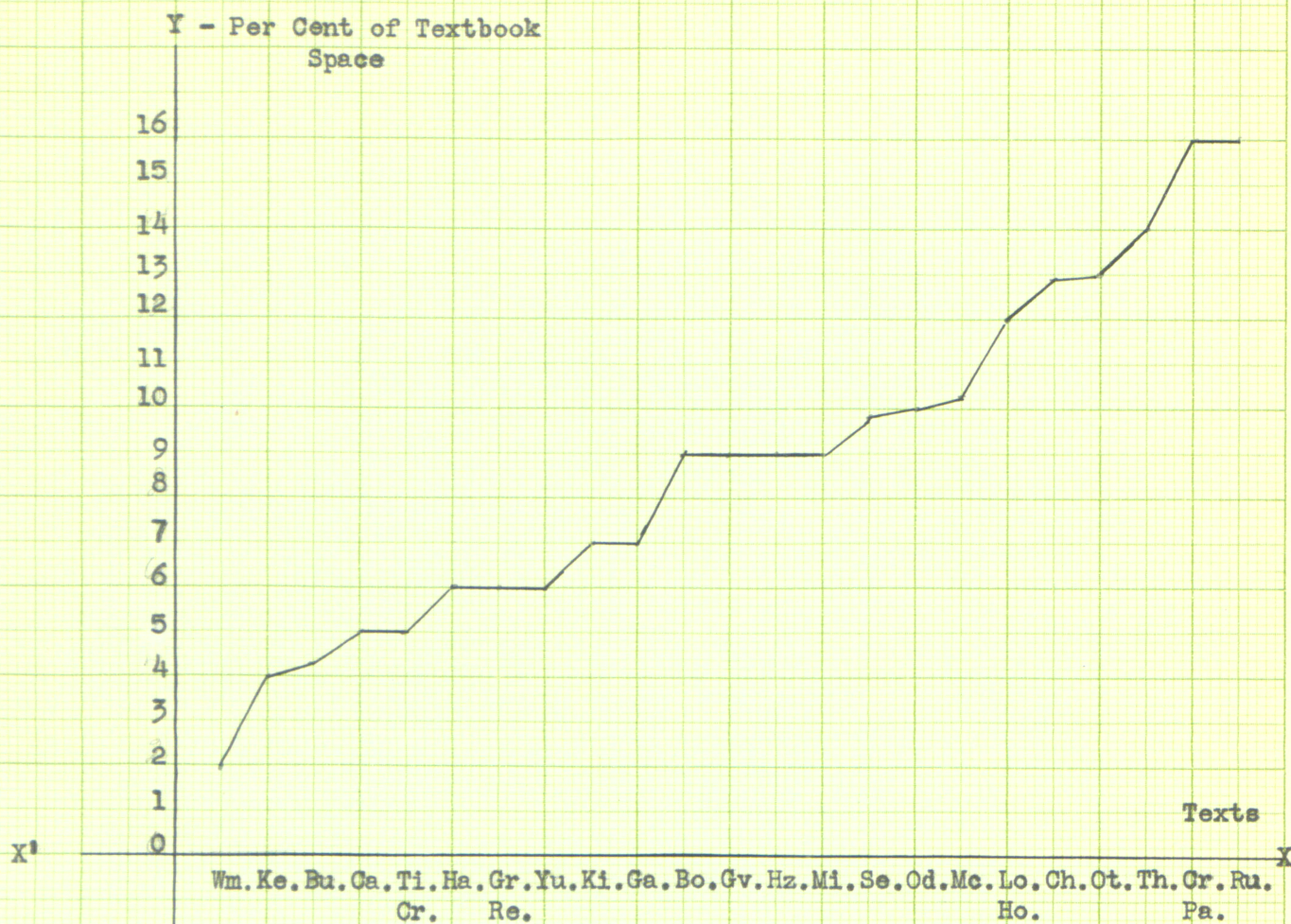
TABLE I

THE NUMBER OF PAGES AND THE PER CENT OF TEXTBOOK
SPACE GIVEN TO ILLUSTRATIVE MATERIALS, AS MAPS,
CHARTS, FIGURES, DIAGRAMS, AND TABLES

Authors	Maps Nos.	Chart Nos.	Fig- ures Nos.	Dia- grams Nos.	Ta- bles Nos.	Pages	Per Cent	Total Per Cent of Text
1. Bowley			92		137	40.0 75.0	9.0 18.0	27.0
2. Burgess		2		22	45	1.0 12.0 16.0	.3 4.0 5.0	9.3
3. Gavett			65		87	27.0 41.5	9.0 12.0	21.0
4. Secrist	4		86		104	4.0 52.5 68.0	.6 9.0 12.0	21.6
5. Yule			54		55	24.0 37.8	6.0 9.0	15.0
6. Camp			61		197	20.0 66.0	5.0 17.0	22.0
7. Garrett				31	29	21.0 33.5	7.0 11.0	18.0
8. Gregory & Renfrow			28		41	14.0 21.8	6.0 10.0	16.0
9. Holzinger			75		93	32.0 46.4	9.0 12.0	21.0
10. Kelley		25			74	14.5 38.8	4.0 10.0	14.0
11. King			26		28	17.5 18.0	7.0 7.0	14.0

TABLE I (Continued)

Authors	Maps Nos.	Chart Nos.	Fig- ures Nos.	Dia- grams Nos.	Ta- bles Nos.	Pages	Per Cent	Total Per Cent of Text
12. MacDonald		5	37		10	16.8 5.0 3.0	10.0 .3 2.0	12.3
13. Odell			24		19	35.0 19.5	10.0 6.0	16.0
14. Otis			68		51	44.0 27.5	13.0 8.0	21.0
15. Rugg				100	102	65.7 98.9	16.0 24.0	40.0
16. Thurstone			38		18	32.0 14.0	14.0 6.0	20.0
17. Tiegs & Crawford			18		27	10.6 21.0	5.0 10.0	15.0
18. Williams			11		9	4.8 5.5	2.0 3.0	5.0
19. Chaddock			97		80	57.5 56.4	12.9 12.6	25.5
20. Crum & Patton			147		140	79.0 99.0	16.0 20.0	36.0
21. Harper			40		88	20.5 46.0	6.0 14.0	20.0
22. Lovitt & Holtzclaw			63		88	36.5 39.3	12.0 13.0	25.0
23. Mills			83		128	56.0 90.2	9.0 15.0	24.0



Y

Figure I

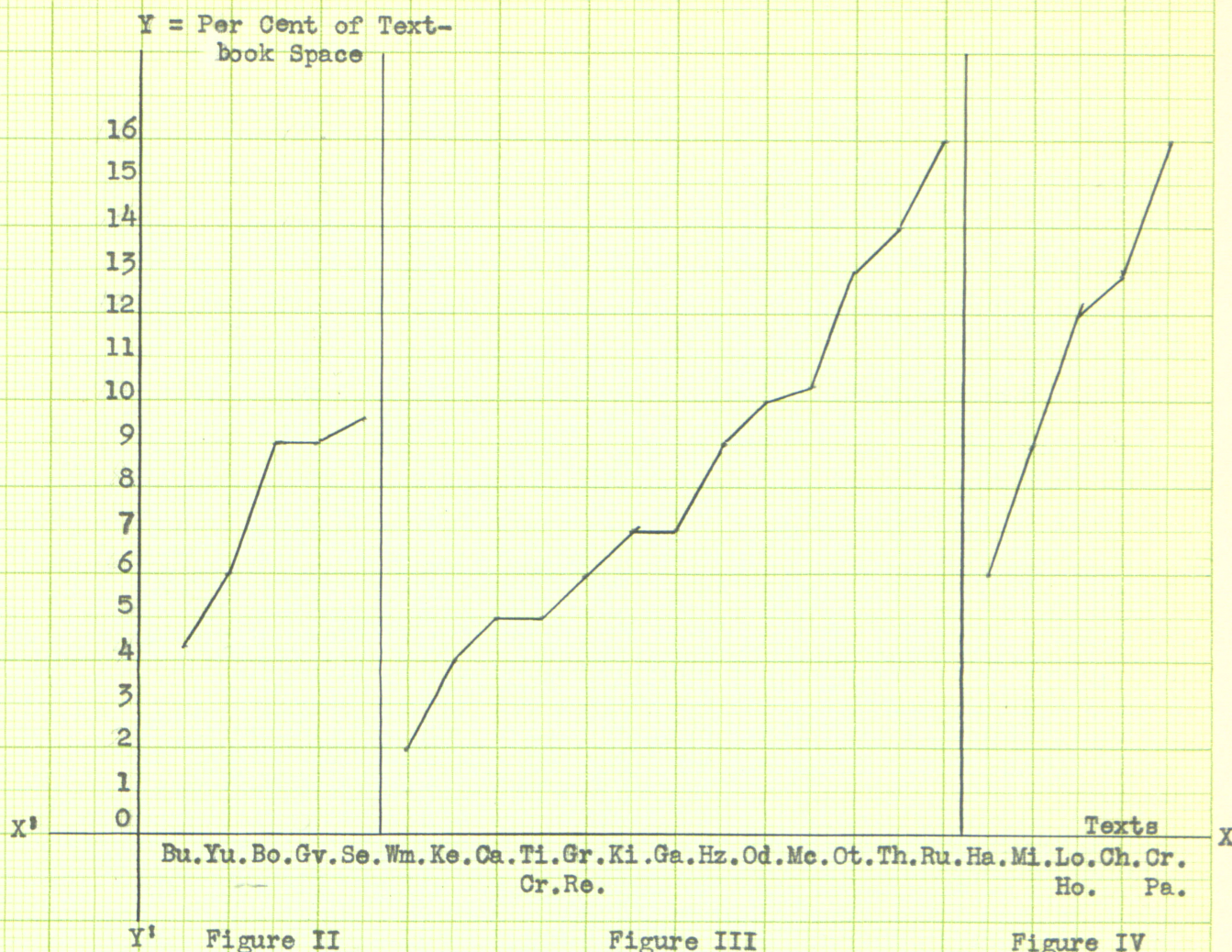
A Presentation of the Per Cent of Book Space Given by
Each Author to Maps, Charts, Figures, and Diagrams.

Key to Abbreviations of the Authors of Texts

Wm., Williams
Ke., Kelley
Bu., Burgess
Ca., Camp
Ti., Tiegs and
Cr., Crawford
Ha., Harper
Gr., Gregory and
Re., Renfrow

Yu., Yule
Ki., King
Ga., Gavett
Bo., Bowley
Gv., Gavett
Hg., Holzinger
Mi., Mills
Se., Secrist
Od., Odell
Mc., MacDonald

Lo., Lovitt and
Ho., Holtzclaw
Ch., Chaddock
Ot., Otis
Th., Thurstone
Cr., Crum and
Pa., Patton
Ru., Rugg



Figures II, III, and IV

A Presentation of the Per Cent of Textbook Space Given by the Authors of Each of the Three Groups of Statisticians to Maps, Charts, Figures, and Diagrams

Key to Groups and Abbreviations of Authors of Texts

Statisticians			
General	Educational and Psychological		Economic
Bu., Burgess	Wm., Williams	Ga., Garrett	Ha., Harper
Yu., Yule	Ke., Kelley	Hs., Holzinger	Mi., Mills
Bo., Bowley	Ca., Camp	Od., Odell	Lo., Lovitt and
Gv., Gavett	Ti., Tiegs and	Mc., MacDonald	Ho., Holtzclaw
Se., Secrist	Cr., Crawford	Ot., Otis	Ch., Chaddock
	Gr., Gregory and	Th., Thurstone	Cr., Crum and
	Re., Renfrow	Ru., Rugg	Pa., Patton
		Ki., King	

Illustrative Problems. - The third class of illustrations is comprised of the problems which are used as examples in order to illustrate some statistical principle and to show the student the steps that are involved in the solution of similar problems.

Some of these illustrative problems are impractical, because the material used for illustrating the statistical concept either has not been observed by the student (2) or he has had no experience with it. Whenever these situations arise, it is more difficult for the student to understand the illustrative problems.

Table II presents the total number and average frequencies of illustrative problems, the total and average number of pages given to the problems in each text, and the total and average per cent of space that is allotted to them in each text. Such examples take thirty-four per cent of the total textbook space. A comparison of the amount of space in each text given to illustrative materials indicates that the writers regard illustrative problems to be of utmost importance. These illustrative problems range from the simplest example to those which require two or more pages for their completion.

Table III is a summary expressed in per cent of the average amount of space in each textbook given to each type of illustrative material and the total for all types.

TABLE II

ILLUSTRATIVE PROBLEMS IN TERMS OF FREQUENCY, NUMBER OF PAGES, AND PER CENT OF SPACE GIVEN TO THEM IN EACH OF THE TWENTY-THREE TEXTBOOKS IN STATISTICS

Authors	Number of Examples	Number of Pages	Amount of Space of Text in Per Cent
I. General Statisticians			
1. Bowley	150	163.5	38.0
2. Burgess	65	58.5	19.0
3. Gavett	95	61.0	18.0
4. Secrist	73	45.0	8.0
5. Yule	66	72.5	17.0
II. Educational and Psychological			
6. Camp	150	113.7	30.0
7. Garrett	89	72.3	17.0
8. Gregory, Renfrow	107	66.3	29.0
9. Holzinger	276	155.5	42.0
10. Kelley	164	136.0	34.0
11. King	69	51.7	21.0
12. MacDonald	71	54.6	31.0
13. Odell	148	149.0	42.0
14. Otis	218	148.0	41.0
15. Rugg	217	106.5	26.0
16. Thurstone	137	128.6	50.0
17. Tiegs, Crawford	80	70.0	30.0
18. Williams	96	66.6	30.0
III. Economic			
19. Chaddock	312	221.8	46.0
20. Crum, Patton	346	256.0	52.0
21. Harper	178	224.5	69.0
22. Lovitt, Holtzclaw	236	151.0	50.0
23. Mills	246	248.9	41.0
Average	156.0	122.9	34.2

TABLE III

PER CENT OF SPACE IN EACH OF THE TWENTY-THREE
TEXTBOOKS GIVEN TO VARIOUS TYPES OF ILLUSTRATIVE MATERIALS

Authors	Stated in Per Cent			
	Maps, Charts, Figures, Diagrams	Tables	Examples	Total Amount of Illustrative Material
I. General Statisticians				
1. Bowley	9.0	18.0	38.0	65.0
2. Burgess	4.3	5.0	19.0	28.3
3. Gavett	9.0	12.0	18.0	39.0
4. Secrist	9.6	12.0	8.0	29.6
5. Yule	6.0	9.0	17.0	32.0
II. Educational and Psychological				
6. Camp	5.0	17.0	30.0	52.0
7. Garrett	7.0	11.0	23.0	41.0
8. Gregory, Renfrow	6.0	10.0	29.0	45.0
9. Holzinger	9.0	12.0	42.0	63.0
10. Kelley	4.0	10.0	34.0	48.0
11. King	7.0	7.0	21.0	35.0
12. MacDonald	10.3	2.0	31.0	43.3
13. Odell	10.0	6.0	42.0	58.0
14. Otis	13.0	8.0	41.0	62.0
15. Rugg	16.0	24.0	26.0	66.0
16. Thurstone	14.0	6.0	50.0	70.0
17. Tiegs, Crawford	5.0	10.0	30.0	45.0
18. Williams	2.0	3.0	30.0	35.0
III. Economic				
19. Chaddock	12.9	12.6	52.0	77.5
20. Crum, Patton	16.0	20.0	46.0	82.0
21. Harper	6.0	14.0	69.0	89.0

TABLE III (Continued)

Authors	Stated in Per Cent			
	Maps, Charts, Figures, Dia- grams	Tables	Examples	Total Amount of Illustra- tive Material
III. (Continued)				
22. Lovitt, Holtzclaw	12.0	13.0	50.0	75.0
23. Mills	9.0	15.0	41.0	65.0
Averages	8.8	11.2	34.2	54.1

Problems

Problems for Solution. - Seven of the examined books contain no problems for solution. The number of problems for solution in the remaining sixteen texts varies from twenty-two to nine hundred fourteen. Some of the problems have many parts; each of the parts is equivalent to another problem. The location of the problems is almost evenly balanced between placing them at the close of the chapter and scattering them throughout the chapter. Some of the problems state concrete situations, within the grasp of the students; others are not so understandable because of the content of the problem. Sometimes, either an impossible or an improbable (10) situation is used as a basis for the application of a statistical principle or the material to which the principle is to be applied is old data.

Some texts make little association with the fields in which statistics may be used, thus helping the student to acquire the notion that statistics has a very limited field of usefulness. He may never realize the part statistics plays in practically all lines of human occupation.

The distribution, the placement, and the amount of problem material for solution in the texts are indicated in Table IV, which follows.

TABLE IV

PLACEMENT, AND AMOUNT OF PROBLEM MATERIAL FOR SOLVING

Authors	Only at close of Chapter	In Chapter & at its Close	Number of Problems Listed	Additional Parts	Total	Answers	
						To All	To Some
*Bowley		x	68	11	79		
Burgess	x		190	38	228		
Gavett							
*Secrist							
Tule	x		173	19	192	x	
Camp		x	487	254	741		x
Garrett	x		53	39	92	x	
Gregory, Renfrow		x	52	70	122	x	
Holzinger	x		111	222	333		
Kelley	x		35	26	61		x
*King							
MacDonald		x	532	28	560		
Odell	x		79	162	241		
Otis		x	53	123	176	x	
Rugg	x		22	46	68		
Thurstone	x		62	68	130		
Tlegs, Crawford		x	53	123	177	x	
Williams	x		914		914		
*Chaddock							
*Crum, Patton							
*Harper							
Lovitt, Holtzclaw		x	242	89	331		x
*Mills							
Total	9	7	3127	1318	4445	5	3

*No problems for the students to solve.

The mean of the ungrouped scores in column five, for the authors giving the problems, is $277.8 = 278$.

The mean for grouped scores, class interval 0 to 99.99 is 275, median is 180.

Number of Problems Solved During the Term

The number of problems actually solved by classes was ascertained through the answers received from the institutions of higher learning to the question, "During the term, how many problems are required to be solved by the students?" The number of problems required varies from three to two hundred. When a small number of required problems was given, the instructor almost invariably stated that such problems covered many of the statistical concepts covered in the course. The approximate median for the number of problems solved is fifty-three. This is a contrast to the median of one hundred eighty problems offered for solution by the authors of the various texts.¹³

The replies to this question are tabulated in Table V.

TABLE V
THE NUMBER OF PROBLEMS SOLVED
BY EACH COLLEGE AND UNIVERSITY

Colleges and Universities	Number of Problems Required for Solution
I. State Universities	
1. Arizona.....	70
2. Idaho*	--
3. Illinois.....	30
4. Indiana.....	100
5. Kansas.....	150
6. Louisiana.....	100
7. Maine*	"Many worked"
8. Maryland.....	40
9. Missouri.....	35
10. Montana.....	30
11. Nebraska.....	75
12. New Jersey.....	18
13. New Mexico.....	45
14. Ohio*	--
15. Virginia.....	20
16. Washington*	--
17. West Virginia.....	20
18. Wyoming.....	120
II. State Teachers Colleges**	
1. California, San Diego.....	63
2. Colorado, Greeley.....	75
3. District of Columbia, Ormand-Wilson Teachers College*	--
4. Indiana, Terre Haute.....	100 to 150
5. Kansas, Emporia.....	200
6. Kansas, Pittsburg.....	15
7. Minnesota, St. Cloud.....	4
8. New Jersey, Montclair.....	120

* Number of problems solved not stated.

** Cities and states given in order to designate which teachers college participated.

TABLE V (Continued)

Colleges and Universities	Number of Problems Required for Solution
II. (Continued)	
9. Washington, Pullman.....	50
III. State Colleges	
1. Kansas State College.....	50
2. Miami University.....	50
3. Purdue University*.....	--
IV. Municipal Universities	
1. Akron.....	100
2. Cincinnati.....	100
V. Private Colleges and Universities	
1. Antioch College.....	75
2. Brown University.....	10 to 15
3. Bucknell University#.....	150 and more
4. Chicago University.....	50
5. Columbia University, Teachers College.	2 to 4
6. Denver University.....	55
7. Duke University.....	50
8. Eureka College.....	50
9. Hood College.....	50
10. Mills College.....	25
11. Ohio Wesleyan University*.....	--
12. The George Peabody Teachers College...	20
13. Pennsylvania University*.....	--
14. Princeton University*.....	--
15. Rockford College.....	30
16. Wilson College.....	50

* Number of problems solved not stated.

Uses machine for computing.

Terminology, and Statistical and Mathematical Symbolism

The terminology and symbolism used in an elementary text are of the utmost importance, as they are the media through which the student is to be introduced to a new subject and new concepts. Unless the utmost simplicity is adopted, difficulties arise which, in the case of statistics, may be grouped into two divisions—one involving statistical terminology, and the other involving mathematical and statistical symbolism.

Terminology. - A Student learning statistics is confronted with difficulties with the terminology and symbolism. He must acquire a new vocabulary of terms. For example, in the glossary of Gregory and Renfrow (8:228), there are found one hundred sixty-four terms. MacDonald (14:176), in the brief presentation of elementary statistics has a glossary of ninety terms. The writer found that in the twenty-three texts there are approximately one thousand new terms for the average student to master.

Odell (24:5) has written a separate glossary of the meanings of three hundred terms used in his book, Educational Measurements and Research.

Difficulties with terminology are not confined to the student group. In the correspondence regarding the test, two

letters¹⁴, one from Columbia University, New York, and the other from Ohio State University, inquired about the use of the word, problem, and asked why the last section of the test was captioned Problem Section. It was found that the various authors use the terms, problem, example, and exercise for the same type of material. For instance, Burgess apparently does not distinguish between the terms, example, exercise, and problem, for he uses all three terms for problems for the student to solve. If there is a distinction, the writer does not see on what basis it rests. For example, Burgess calls the following a problem (2:40):

Compute the proportion of population of the United States in each State.

The following is labelled an example (2:48):

Show that a railroad with five divisions might have a lower cost per ton-mile in July than in June on every division, and yet have a higher cost per ton-mile for the railroad as a whole.

The next is called an exercise (2:236):

If an urn contains twenty-five black balls and seventy-five white balls, and the ball drawn after each draw, what is the probability of getting two black balls and one white ball in three draws? Of getting one black ball and three white balls in four draws?

A similar ambiguity was pointed out under the heading

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Prof. H. Walker, Teachers College, Columbia University, New York City, and Prof. H. H. Edgerton, Ohio State University, Columbus, Ohio.

of Illustrative Materials¹⁵, in regard to the use of figure, chart, and diagram for the denotation of the same type of illustration. This use of terms or words synonymously is of little significance, except as an example of the lack of agreement in the exact usage of common terms exhibited in the works of experts, but it becomes much more serious when that ambiguity appears in the use of technical terms. Since statistical concepts are so varied, there should be more emphasis placed on the terminology so that students reading more than one text will not have too great difficulty in the interpretation of the terms.

Table VI gives some notion of the variability of terminology, through the tabulation of the words, exercise, example, problem, and table, which have all been used by various authors to indicate a problem for solution. The term, illustrative problem, has two distinct meanings: one, a problem which is completely solved in the text to illustrate a concept: the other, a problem which is to be solved by the students to illustrate some statistical principle. Some authors place the majority of their problems for solution in tabular form.

¹⁵Chapter II, p. 18

TABLE VI

SOME OF THE INCONSISTENCIES IN TERMINOLOGY
NOTED FOR THE TWENTY-THREE AUTHORS

Authors	Example	Exercise	Problem for So- lution	Illustra- tive Prob- lems	Table
1. Bowley*	x				
2. Burgess	x	x	x		
3. Gavett		x			x
4. Secrist*					x
5. Yule	x	x		x	
6. Camp	x	x	x		
7. Garrett	x		x	x	x
8. Gregory, Renfrow			x		x
9. Holzinger		x			
10. Kelley			x		x
11. King			x		x
12. MacDonald	x		x		
13. Odell		x	x		
14. Otis		x			
15. Rugg			x	x	
16. Thurstone			x		
17. Tiegs, Crawford		x	x		
18. Williams			x	x	
19. Chaddock*					x
20. Crum, Patton*					x
21. Harper					x
22. Lovitt, Holtzclaw		x			x
23. Mills					x
Totals	6	9	12	4	11
Totals in Per Cents	27	39	52	17	48

* No problems for the students. Chaddock has a separate exercise book.

Even in the apparently easy field of graphic representation, there are terms that demand qualifying adjectives to describe their various uses. Some of the texts use the expressions, greater than or less than curves and charts, while other texts use the terms, cumulative curves and ogive curves.

The common arithmetical terms such as mean and average have various connotations by the different authors. Otis (17:90) gives the following statement:

The term, average, is considered by certain authorities as referring to any measure of central tendency, while the term, mean, refers to what is commonly known as the average. In case, however, it is convenient to use the term, average deviation, since the abbreviation Avg. Dev. (sometimes written A. D.) is not likely to be confused with Med. Dev. (sometimes written M. D.). Since M. D. might be understood as standing for mean deviation, it is safer to write Med. Dev.

Camp (3:8) and Lovitt and Holtzclaw (13:97), each has terminology varying from that of the twenty-one other authors.

Symbolism.— Paul V. West (25:218), in his intensive analysis of sixteen texts, found that the symbolism varies from text to text, and that two or more symbols for the same thing are sometimes used in one text. If any statistical literature is read, other symbols are likely to be found which are not included in the textbook. The student must distinguish what terms and symbols to use.

Six¹⁶ of the authors have glossaries of symbols, while three¹⁷ have glossaries of formulas. Only two authors use the

¹⁶ Table III, Appendix C, p. 208

¹⁷ Table III, Appendix C, p. 208

same symbols in developing the mean¹⁸. Even the authors use different symbols at the conclusion of the short method for finding the true mean.

In developing the formula for such universal terms as median, mean, and mode, the authors use many different symbols. In Table VII, the diversity of symbols used in the formula for the mean will be shown. It is evident from Table VII that there has been no standardization of symbols for statistical formulas.

TABLE VII
THE DIVERSITY OF SYMBOLISM USED BY THE TWENTY-
THREE AUTHORS FOR THE MEAN

General Statisticians	Formulas
Bowley	Formula for the Mean $A = \frac{Q}{N}$ Q means quantity
Burgess	$\bar{X} = \frac{\sum x}{N}$ $\bar{X} = x_m / c$
Gavett	$A = \frac{\sum x}{N}$ $A = \frac{\sum dx^i}{N} / x^i$
Secrist	Gives no formula, but uses the long method and average

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See Table VII, p.39. The two authors whose symbols are alike for the mean are Gregory and Renfrow, and MacDonald.

TABLE VII (Continued)

Yule	$M = \frac{1}{N}(x_1 + x_2 + \dots + x_n)$ $M = \frac{1}{N} (x)$ $M = A + \frac{1}{N} \sum fd$
Educational and Psychological Statisticians	
Camp	$\bar{t} = \frac{1}{N} \sum^n t_1 f_1$ $\sum t = 1.$
Garrett	$Av. = \frac{\sum (F \times M)}{N}$ $Av. = \frac{\sum (\text{Measures})}{N}$
Gregory and Renfrow	$M = \frac{\sum fm}{N}$ $M = Gm + \frac{\sum fd}{N} \text{ C.I.}$
Holzinger	$M = \frac{\sum X}{N}$ $M = A + \frac{\sum fd \cdot h}{N}$
King	$\Sigma \text{ derived from}$ $\frac{K A}{N} + K_2 = K A$ $\frac{K M_1 + K M_2 + K M_3}{N} = K A.$
Kelley	$M = \frac{\sum M}{N}$ $M = \text{Arbitrary origin} + \frac{\sum f \cdot C.I.}{N}$

TABLE VII (Continued)

MacDonald	$M = \frac{\sum M}{N}$ $M = \frac{\sum fm}{N} \neq \frac{\sum f(alg.) \cdot S}{N}$ $M = \frac{M}{N}$ (Actual) (Approximate)
Odell	$M = \frac{\sum X}{N}$ Average given
Otis	$M = \frac{\sum S}{N}$
Rugg	$M = \frac{\sum M}{N}$ $M = \frac{\sum fm}{N}$ $M = \text{Est. } M. \neq \frac{\sum fd}{N} \times$ No. of units in interval.
Thurstone	$M = \frac{\sum S}{N}$ $M = M_a \neq C$ $C = \frac{\sum fE}{N}$
Tiegs and Crawford	$\text{Mean} = \text{Assumed mean} \neq \frac{\sum f d}{N} \times \text{Interval}$
Williams	$M = \frac{\sum M}{N}$ $M = \text{Est. } M \neq \frac{\sum fd \cdot \text{Int.}}{N}$
Statisticians of Economics	

TABLE VII (Continued)

Chaddock	$M = GA \neq c$ $c = \frac{\sum fd}{N}$
Crum and Patton	No formulas. Long and short methods explained and illustrated by examples.
Harper	Explains short method by working a problem. $M = \frac{1}{N} \sum X$
Lovitt and Holtzclaw	$X = X_0 \neq \frac{fs}{N}$ $\frac{6}{X} = \frac{\sum fx}{N}$
Mills	$M = \frac{\sum M}{N}$ $M = M \neq M' \neq C$

From Table VII, it is ascertained that the formulas for the mean or average have twenty-two variations. These variations among the authors make reference work very difficult for the student, because he must study the meaning of the symbols before he is able to understand the references. Thus, time is lost by the student while he is studying the symbols in the reference texts.

If the background of the student in mathematics is

insufficient, mathematical terms and symbols are another source of trouble. This lack of background in mathematics prevents understanding of some statistical concept which is preceded by a mathematical deduction. Suppose a reference has been given to Kelley's text (11:95), which reference includes the following mathematical symbols: $N_{a2} = \int_{-\infty}^{\infty} yx^2 dx = N\sigma^2 = \frac{k}{c} \sqrt{\frac{2}{c} \pi}$, a formula given for the deduction of the Normal Probability Curve. How many average students will understand Figure 19, in Yule's text? (23:166) This figure is on The Ideal Symmetrical Surface, with the Extremes Truncated. They will not be able to understand the derivation of the standard deviation presented by Gavett (7:137). They will have difficulty in comprehending Camp's text (3:18), which starts with moments and differentials.

Subject Content by Topics

There are statistical concepts which are common to practically all texts in elementary statistics. Various groupings of these concepts are given by the authors and are cited by some authorities in the introductions and prefaces of their books as the basis of a course in elementary statistics. It, therefore, is logical and expedient to list the topics so emphasized, and to suggest that those statistical concepts which are discussed by at least seventy-five per cent of the authors, be made the minimal essentials of a course in elementary statistics. While Table VIII

shows the ranking of topics which occur in seventy-five per cent of the texts, the writer thought it desirable to place the frequencies of distribution of topics on a quartile basis and arbitrarily decided that only those topics found in the upper quartile should be considered for the minimum essentials of a beginning course in elementary statistics.

In subsequent chapters, Table VIII will be referred to in making comparisons with the topics in the Comprehensive Test in Statistics and with the statistical concepts found in current literature.

The frequencies of statistical concepts found in Tables VIII and IX will be ranked in per cent of occurrence in the twenty-three texts. This ranking will constitute Table X, which will follow Table IX.

Table IX will give the topics that are found in less than seventy-five per cent of the texts. The topic, Index Numbers, is listed in sixty-one per cent of the texts. There is reason to believe from the comment made by Holzinger (10:10) that index numbers may receive a higher ranking in the future.

In Table X, the ogive curve is ranked low. This fact may be partly accounted for by the fact that in some texts the ogive curve is not mentioned, but curves of similar characteristics are called cumulative or less than curves.

Curves called symmetrical and asymmetrical are found

in few texts, but similar curves in other texts are designated as normal probability, bell-shaped, and skewed curves.

TABLE VIII

TOPICS COMMON TO AT LEAST SEVENTY PER CENT OF THE TEXTS

Topics	Bowley	Burgess	Gavett	Secretist	Yule	Camp	Garrett	Gregory, Kentrow	Holzinger	Kelley	King	MacDonald	Odell	Otis	Rues	Thurstone	Thies, Crawford	Williams	Chaddock	Crum, Paton	Harper	Lovitt, Holtz	Mills	Total	Per Cent
1. Introduction to terms, purposes, definitions	x	x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	18	78
2. Measures of Central Tendency																									
A. Mean	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
B. Median	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
C. Mode	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
D. Geometric Mean	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x				17	74
3. Measures of Dispersion or Variability																									
A. Standard Deviation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
B. Quartile Deviation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
C. Mean Deviation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
D. Skewness	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20	87
E. Range																								20	87
F. Percentile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20	87
G. Probable Error	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
4. Graphic Presentation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100
5. Tabulation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	21	91

TABLE VIII (Continued)

Topics	Howley	Burkess	Gavett	Secretist	Tile	Camp	Garrett	Gregory, Kentrow	Holzinger	Kelley	King	MacDonald	Odell	Otis	Bugs	Thurstone	Thurs, Crawford	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtzclaw	Mills	Total	Per Cent	
6. Probability	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	19	83	
7. Correlation																										
A. Pearson's Product Moment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100	
B. Pearson's Rank Difference	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	18	78	
C. Probable Error of Correlation Coefficient	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20	87	
D. Regression Lines	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20	87	
E. Linear Correlation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	22	96	
F. Curvelinear Correlation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16	70	
G. Correlation Coefficient	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100	
H. Correlation Ratio	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	19	83	
I. Positive and Negative Correlation																										
8. Binomial Expansion	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100	
9. Sampling	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	19	83	
10. Coin or Dice Throwing	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16	70	

TABLE IX

TOPICS FOUND IN LESS THAN SEVENTY PER CENT OF THE TEXTS

Topics	Howley	Burgess	Gavett	Secretist	File	Camp	Garrett	Gregory, Renfrow	Holzinger	Kelley	King	Macdonald	Odeh	Otis	Rues	Thurstone	Tiegs, Crawford	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holzman	Mills	Totals	Per Cent
1. Harmonic Mean																								11	48
2. Coefficient of Variation																								13	57
3. Coefficient of Contingency																								11	48
4. Coefficient of Colligation																								6	26
5. Coefficient of Association																								8	35
6. Coefficient of Attenuation																								6	26
7. Spearman's Foot-rule																								7	30
8. Ogive Curve																								11	48
9. Biserial "r"																								5	22
10. Biserial "eta"																								7	30
11. Logarithmic Tables (Appendix)																								9	39
12. Index Numbers																								14	61
13. Moments																								13	57
14. Experimental Curves																								5	22
15. Logarithmic Curves																								9	39
16. Index of Correlation																								10	43

TABLE IX (Continued)

Topics	Bowley	Burgess	Gavett	Secret	Title	Camp	Garrett	Gregory, Renfrow	Holzman	Kelly	King	MacDonald	Ozell	Ols	Ruge	Thurstone	Thies, Crawford	Williams	Chaddo ck	Crum, Patton	Harper	Lovitt, Holteclaw	Mills	Totals	Per Cent
17. Logging	x	x	x	x	x	x	x												x	x				7	30
18. Least Squares	x	x	x	x	x	x	x												x	x				11	48
19. Long Time Trends	x	x	x	x	x	x	x												x	x				9	39
20. Symmetry	x	x	x	x	x	x	x												x	x				10	43
21. Asymmetry	x	x	x	x	x	x	x												x	x				9	39
22. Smoothing Curves	x	x	x	x	x	x	x												x	x				12	52
23. Permutations and Combinations																								5	22
24. Exponential Trends																								2	9
25. Bertillon																								2	9
26. Bernoulli																								4	17
27. Kurtosis	x																							8	35
28. Charlier																								6	26
29. Chi square																								2	9

TABLE X

THE PER CENT OF TEXTBOOKS CONTAINING VARIOUS STATISTICAL CONCEPTS RANKED IN ORDER OF FREQUENCY

Class Interval in Per Cent		Statistical Concepts
		1. Measures of Central Tendency a. Mean b. Median c. Mode
		2. Measures of Dispersion a. Standard Deviation b. Quartile Deviation c. Mean Deviation d. Probable Error
100	.....	3. Graphic Representation
		4. Correlation a. Pearson's Product Moment Formula b. Correlation coefficient
95-100	.....	5. Linear Tabulation
90-95	.....	6. Tabulation
		7. Probable error of correlation
		8. Skewness
		9. Range
85-90	.....	10. Percentile Rank
		11. Regression lines
		12. Probability
		13. Correlation ratio
80-85	.....	14. Binomial expansion
		15. Sampling
75-80	.....	16. Definitions and introduction to terms
		17. Rank difference - Method
		18. Coin tossing and dice throwing
70-75	.....	19. Curvelinear correlation
65-70	.....	20. Geometric mean
60-65	.....	-----
		21. Index Numbers
		22. Moments
55-60	.....	23. Coefficient of variation

TABLE X (Continued)

Class Interval in Per Cent	Statistical Concepts
50-55	24. Smoothing curves
	25. Least squares
	26. Ogive curves
	27. Harmonic mean
45-50	28. Coefficient of contingency
	29. Index of correlation
40-45	30. Symmetry
	31. Kurtosis
	32. Asymmetry
	33. Long time trends
	34. Logarithmic curves
	35. Logarithmic tables
35-40	36. Coefficient of association
	37. Spearman's foot rule
30-35	38. Biserial "eta"
	39. Lagging
	40. Coefficient of attenuation
	41. Coefficient of colligation
25-30	42. Charlier
	43. Permutations and combinations
20-25	44. Biserial "r"
	45. Experimental curves
15-20	46. Bernoulli
10-15	47. Exponential trends
	48. Bertillon
5-10	49. Chi square

Methods of Presentation of Subject Content

The general form of presenting the subject content of the various elementary textbooks is similar. The topics are usually presented by an explanatory discourse, which is followed by

one or more definitions. The meaning of the discourse and definitions is further exemplified through the use of illustrations, which may be charts, maps, diagrams, figures, and numerical problems. The textbooks in elementary statistics, in most cases, follow the time-honored custom of rule first, followed by discussion, examples, and problems to be worked. This plan is found in all the older grammars, arithmetics, and algebras. There is no definite sequence in the texts for presenting the concepts.

There are two other modes of presenting subject matter. One is by giving formulas without derivation, and following them with problems which necessitate their use. The other method includes derivations of the formulas. The deducing of formulas clearly and concisely presents many difficulties. The number of symbols and detailed explanations may be too numerous or the derivations may be obscured through brevity. The following example from Odell's text (16:273) will illustrate the use of formulas which require an advanced mathematical background.

$$\sin \left[.1686 \pi (1-.85^2) \sqrt{\frac{1}{28} + \frac{1}{4} + \frac{1}{2} + \frac{1}{6}} \right] = \sin 8^\circ 13' = .14$$

Some authors have endeavored to write their texts in too simple a style. Williams (22:62) uses words instead of symbols in computing the median. MacDonald (14:76), in the formula for the true mean, writes out the word, approximate. Formerly, arithmetical writers wrote the words for add, divide, subtract, and multiply. Now signs are used to indicate the

operation. The same rule should be applied to statistical formulas.

Unlike the other authors, Bowley, Secrist, and Crum and Patton follow the general treatments of the statistical concepts with applications to many fields of activity. Bowley is the only writer who uses the expression, arithmetic average, for the function which the other writers term mean. The other writers give both methods, but they do not develop the short process in the same way. Camp and Lovitt and Holtzclaw employ very complicated terminology in discussing the mean. All of the authors give a complete explanation for finding the median. The majority of them indicate a preference for the use of $\frac{N}{2}$. There is no definite order of presentation of topics. Gregory and Renfrow present the greatest number of explanatory cases for the median.

Some texts give the formula for the long method of determining the mean deviation; some state the formula for the short method; and others omit all formulas concerning this process. The expedient use of this function, however, is thoroughly discussed by most writers. In contrast to the varied development of mean deviation by the authors, it is found that standard deviation is treated more uniformly than any of the other measures.

The study of twenty-three texts shows the greatest variation to be in the amount of material given by the authors for a course in Elementary Statistics, rather than in the mode of

presentation. On page 16 of this Chapter, it was pointed out that some topics are placed in an appendix by some authors, and used as chapter headings by others. The texts differ in their organization of the work. For instance, some writers have a chapter called Measures of Dispersion, while others include the same contents under the heading of Measures of Variability.

The content of Yule's text (28:12) is excellent, but the placement of the problems and the small type used in printing them detract from their presentation and from the statistical concepts so illustrated. Some authors use the continuous paragraph form of exposition of their materials; others mass certain aspects of the subject. For instance, Rugg (18) has placed many graphical forms in a concluding chapter. These graphs would be of more assistance to the student if they were scattered throughout the text. The graphs and tables of Otis (17) and Tiegs and Crawford (21) are crowded. In many instances the type is very small. Tiegs and Crawford's, and Williams' texts have the least number of figures. The amount of space given by Tiegs and Crawford is five per cent of the total number of pages of their text. Williams uses only two per cent of the number of pages of his book for graphical representations.

Presupposition

Statements from the prefaces in regard to the simplicity

of the mathematical prerequisites required for the course in elementary statistics have already been noted.¹⁹

Presuppositions deal with the supposed background of the students of elementary statistics. For instance, it is found that differential functions, parabolic, exponential, and logarithmic equations are given in some of the texts. The authors, in using such equations, evidently presuppose a preparation including higher mathematics.

The following phases of mathematics are given in some of the texts, which show that despite the prefaced statements about mathematical requirements, the student is usually expected to have had at least one extensive course in higher mathematics. (The phases of mathematics given in the appendices have already been cited.)

In Bowley's text are found integral and differential functions, parabolic, exponential, and logarithmic equations for curves. One of his appendices, which is ten pages in length, is for the explanation of the mathematics used in his text.

Gavett leaves out of the body of his text, the derivations from calculus. He has included the equations of the various curves, such as circle, parabola, exponential, and logarithmic. The proofs for many of the formulas are not given, but

their uses are illustrated through their applications to problems.

Gregory and Renfrow's text contains little of advanced mathematics. There is a reference to logarithms. The authors endeavor to make the mathematics as simple as possible without crippling the clearness of the statistical concepts. The long and rigid mathematical deductions are omitted. These authors, in partial and multiple correlations, explain the computations by determinants, and by the use of the multiple and partial formulas.

In King's book, which is one of the first texts in Statistics in the United States, histograms and logarithmic curves are found. The text is not difficult to read.

Kelley's text is very difficult to read. In the fourth chapter he uses a nomenclature for a series (11:80, 94) that is not easily understood by any except mathematicians. Calculus is used in the derivation of the equation for the normal probability curve. Statistical formulas are most carefully derived mathematically, but this derivation is often difficult to understand. Kelley's text would be suitable for a person well versed in mathematics or for the specialist in statistics. Trigonometry, analytical geometry, college algebra, and calculus are all necessary as a background for this text.

Holzinger is another author whose text is mathematically difficult for the beginner. The same mathematics are required for comprehending this text as are necessitated by Kelley's book. In

one of the first chapters of Holzinger's text, logarithms are given a lengthy discussion.

Odell, in his text, uses very simple mathematics. However, just as the other authors do, he cites the formula $r = 2 \sin \left(\frac{\pi}{6} p \right)$ as a background for $R = \frac{6 \sum G}{N^2 - 1}$. Nevertheless, he and many of the other writers do not show in what way the formula is derived.

Rugg's text is mainly developed through the use of algebraic equations. However, analytical geometry and trigonometry are used. For example, tangent to the angle is mentioned casually. Unless students know what is the significance of a tangent to an angle, the meaning of an entire page is lost. In like manner, the meaning of such a trigonometrically derived formula as $R = 2 \cos 2 \pi \left(\frac{2 \sum G}{N-1} \right)$ will not be understood.

One of the earliest texts in statistics published in the United States was written by Thurstone. For the most part, it is simple and easily understood. The advanced mathematics in the text are concerned mainly with the equations for curve-linear relationships, such as the equation of the logarithmic curve. He uses a few trigonometrically derived formulas, such as $r = 2 \sin \left(\frac{\pi}{6} \rho \right)$.

Chaddock introduces logarithms in connection with the geometric mean. He refers to the work of such men as La Place

and Gauss. He uses the equations for curvilinear relationships, but does not derive them from elaborate mathematical deductions. Rather, he shows their applications through the use of many illustrative problems. One of his few deductions, namely, that of a straight line, is stated simply and clearly enough for the average student.

Camp uses a nomenclature which involves Greek symbols for his mathematical and statistical formulas. He uses all phases of advanced mathematics taught in two or three years of college. His text is not suited to the average student, since it requires an exceptional background in college mathematics.

Harper, in his text, uses only the Greek letters π , and the small and capital σ . Few authors use so small a number of Greek letters. The only phases of advanced mathematics which he uses are logarithmic and parabolic curves. He includes many illustrations to show the applications of statistical formulas. These formulas are derived mathematically.

Lovitt and Holtzclaw say in their text that they attempt to put the discussion in the simplest form. The statistical formulas do not have mathematical deductions. There are no other authors that give so many equations for the curve. Equations are given for the second degree curves through the n th degree which includes parabolic, rectangular, hyperbolic, exponential, and logarithmic curves. Explanations of the advanced

mathematics used in the texts are found in the appendices.

The text of Mills is easy reading. About the only phase of advanced mathematics with which the student must be conversant is the topic of logarithms. He uses an abundance of illustrations showing the application of statistical principles. These principles are rarely deduced.

Yule bases the explanations of his text on algebra. He uses algebraic curves, curvilinear equations, and logarithms. His text gives an excellent background of the correct mathematical development of statistical formulas which should please the statistician, but not the student of elementary statistics.

Summary

The findings from the analysis of the textbooks, namely, prefaces and introductions, indices and glossaries, bibliographies, appendices, illustrative materials, problems for solution, terminology and symbolism, methods of presentation of subject matter, and presuppositions are as follows:

1. Prefaces and Introductions. - Analysis of the prefaces and introductions reveals that most of the authors consider their presentation of statistics to be very elementary, their texts adapted to beginners, and the mathematics necessary for foundation to be of the simplest type. Most of the books are far more advanced than would be inferred from reading the prefaces and introductions. Some authors list high school and college algebra, trigonometry, analytical geometry, and calculus as necessary prerequisites. In general, it may be stated that there is a tendency in the prefaces of the texts to minimize the difficulties of the statistics presented.

2. Indices and Glossaries. - The findings in reference to indices and glossaries show marked differences in the textbooks. Only two books of the twenty-three have glossaries of terms. Both of the books are recent publications, which would seem to indicate that the value of defining terms exactly in the technical sense in which they are used is gradually gaining recognition by the authors of elementary statistics texts. The

writer believes this is to be a definite advance in the completeness and helpfulness of the texts.

The differences noted as to the kinds and placement of indices are perhaps of some significance. The omission of an index is serious, because it necessitates extra time in locating statistical concepts, formulas, and discussions. Indices indicate the author's detailed analysis of his text. One book has two indices, one personal, and the other general. The value of a personal index is a matter of convenience. Two texts have no indices (3), (22). The indices of the other twenty texts have no marked characteristics other than that they are serviceable, adequate, and satisfactory.

3. Bibliographies. There is a wide variance in the placement of references. These differences are indicated in Table II of Appendix C.²⁰

A general reference to a book without the proper designation of pages or chapters provides little guidance to the reader. Twenty of the examined books have the chapters or pages, or chapters and pages of references indicated. No author indicates what references are most valuable. Eighteen of the twenty-three authors include current reports with the textbooks suggested as references. In the writer's opinion, references, to

be of value, should be placed at the bottom of the page and at the close of the chapter, and should be an integral part of the daily assignment. A few authors give no references. (3) (22)

4. Appendices. - Twenty-one authors have one or more appendices in their texts. The nature of the content of the various appendices differs somewhat from text to text. For the main part, the materials which are placed in the appendices consist of tables, figures, glossaries, extended discussions, explanations, or analyses of concepts, formulas, and other materials which the authors consider of sufficient importance for advanced students to include in their texts rather than to refer the students to bibliographical references.

5. Illustrative Materials. - Illustrative materials include maps, charts, diagrams, figures, tables, and examples. The average per cent of the number of pages occupied by maps, charts, diagrams, and figures is nine per cent of the total space for each textbook. The number of pages given in the different texts varies from two to sixteen per cent of the total number of pages of the respective textbooks. The illustrative examples are given an average of thirty-four per cent of book space. The number of pages for this type of illustration ranges from eight to sixty-nine per cent of the book space in the respective books. The variations in length of these examples are from a few lines to several pages. An average of eleven per cent of the space of

each textbook is given to tables which indicate how tabulations are to be made, and how problems may be stated in tabular form. The total average of the amount of space devoted to illustrative materials is fifty-four per cent.

The explanations for graphic materials, in some texts (21:56), are printed in very small type and the illustrations are crowded. The texts use graphic materials for many purposes, but they rarely give problems to the students which require the construction of graphs.

6. Problems for Solution. - Some writers place the problems for solution at the end of the chapters, while others place them after the concepts on which they are based. A few writers combine the two modes of presentation. In some texts, the problems are printed in very small type. The number of problems given for solution ranges from twenty-two to nine hundred fourteen. Many of the problems are subdivided and each part constitutes a separate problem. The median of the number of problems to be solved by the students offered by the teachers of the forty-eight colleges and universities is fifty-three. The median for the textbook problems to be solved by students is one hundred and eighty. The content of the problems does not always deal with practical and present-day situations. The purpose of the problems is to give sufficient practice, so that the concept illustrated by them will be understood and remembered.

7. Terminology and Symbols.— There is a marked difference in the way in which the authors use certain technical terms. Some words are used equivocally by one writer (14). In other cases, a number of terms are used synonymously. Quite often, a statistical term is given a meaning which differs radically from the one commonly associated with it. Texts differ from each other in the number of technical terms used and the meaning implied. The terms, charts, figures, and diagrams, are used for identically the same type of graphic representation. Mean and average constitute another illustration of different terms with an unlike or the same meaning implied. The textbooks on Elementary Statistics have no common symbolisms. For example, there are twenty-two variations of symbols in formulas for solving the mean. In some texts, there are mathematical symbols and terms introduced which demand a thorough knowledge of mathematics. The examination of the texts reveals no apparent standardization of symbols and terminology.

8. Methods of Presentation of Subject Matter.— The texts vary in difficulty from the simplest primer in Statistics by Williams, to the works of Yule, Kelley, Camp, and Lovitt and Holtzclaw, which are highly mathematical, technical, and incomprehensible to most students in statistics. Yet, all of these books are spoken of by their authors in the prefaces, and by inference, at least, as simple. The latter texts base the

majority of their proofs on mathematical derivations. Part of the difficulty may be due to presentation of concepts. The methods of presentation of subject matter include discussion of illustrative materials, choice of terminology and symbols used, and arrangement of topics according to the author's conception of appropriate sequence. The topics are usually presented by explanatory discourse, followed by one or more derivations of formulas. The derivations vary from the simplest to those involving integral functions. Some authors use very few symbols, and others employ new and numerous ones. So called short methods of computing grouped data are considered in very few textbooks. The methods of presenting and computing standard deviation is practically the only one dealing with the various measures of central tendency and variability, which receives uniform treatment. The authors rarely give the reason for using certain statistical concepts and their statistical significance. There is apparently no agreement among the authors on whether to present the statistical concepts with the necessary mathematical background or to omit the mathematical explanations and teach the subject by rote. There is no apparent agreement of the writers of elementary statistics upon either the number of concepts to be included in the course or the order in which the concepts should be presented.

9. Presuppositions. - The majority of the texts

necessitate the student's having a knowledge of algebra, geometry, trigonometry, analytical geometry, and calculus. These requirements are illustrated in this chapter by numerous citations from the texts. Some of the texts require more mathematics than their introductions and prefaces indicate. Taken as a whole, the texts in Statistics are in many ways still copying the models set up by the first writers of statistical textbooks. Thurstone and King, the earliest statistical authors in the United States, modeled their texts after those of the English writers, Bowley, Yule, and Pearson.

Conclusion

Since statistics has been taught a comparatively short time; the college levels for which the text is suited are rarely stated; and the prerequisites necessary for success in the course are variable quantities, the following situations have arisen:

1. Not merely is there an indefiniteness in the number and in the order of concepts, but also in their extensive and intensive presentation.
2. The types of problems, the amount of illustrative materials, and the nature and number of references for bibliographies are not always adequate.
3. There is a great lack of uniformity of terminology and symbolism.

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CHAPTER III

THE SCHOOLS ADMINISTERING THE TEST AND A PRELIMINARY DISCUSSION OF THE TEST

The discussion in the present chapter consists of two parts. The first part considers the data collected from the returned letters¹ of inquiry sent with the tests, and the replies to the questions² on the first page of the test. These data give the following information:

1. The number, type, and names of the institutions of higher learning.
2. The prerequisites, class references, and the textbooks used.
3. The years in college in which statistical classes are offered.
4. The number of graduate and undergraduate students in these classes, and the degrees sought by them.
5. The department in college from which the student elected the course.

¹ Appendix A, P. 178

² Appendix A, P. 179

6. The number of recitation hours per week, and the length of the term, and the credit in hours given by the various colleges and universities.

The second part of the discussion is concerned with the following items:

1. The purpose of the test.
2. That which the test purports to measure.
3. The making of the test.
4. The nature of the test.
5. The sections into which the test is divided.
6. The basis for scoring.
7. The administering of the test.

Part I

Institutions of Higher Learning

The data from the elementary statistical classes of forty-eight ³ of the fifty institutions of higher learning are compiled and are considered in this chapter and in Chapter V. There are eighteen state universities, ten state teachers colleges, one teachers college under the control of the District

COLLEGE OF THE DISTRICT OF COLUMBIA

3

The tests from the State Teachers College, Cedar Falls, Iowa, and Hobart College, Geneva, New York, were received after the data of Chapter V had been compiled.

of Columbia ⁴, three state colleges, sixteen privately endowed colleges and universities, and two municipal universities. This grouping of colleges and universities will be followed in subsequent tables and discussions. These colleges are listed in Table XI.

TABLE XI

LIST OF COLLEGES AND UNIVERSITIES COOPERATING
BY GIVING THE COMPREHENSIVE TEST

I. State Universities

1. Arizona, Tucson
2. Idaho, Moscow
3. Illinois, Urbana
4. Indiana, Bloomington
5. Kansas, Lawrence
6. Louisiana, Baton Rouge
7. Maine, Orono
8. Maryland, College Park
9. Missouri, Columbia
10. Montana, Missoula
11. Nebraska, Lincoln
12. New Jersey, New Brunswick (Rutgers University)
13. New Mexico, Albuquerque
14. Ohio, Columbus
15. Virginia, Charlottesville
16. Washington, Seattle
17. West Virginia, Morgantown
18. Wyoming, Laramie

II. State Colleges

1. Kansas State College, Manhattan, Kansas
2. Miami University, Oxford, Ohio
3. Purdue University, Lafayette, Indiana

III. State Teachers Colleges

1. State Teachers College, San Diego, California
2. State Teachers College, Greeley, Colorado
3. Ormand Wilson Teachers College, Washington, D.C.
4. State Teachers College, Terre Haute, Indiana
5. State Teachers College, Cedar Falls, Iowa
6. Kansas State Teachers College, Pittsburg, Kansas

⁴

The Ormand Wilson Teachers College is controlled by the District of Columbia.

TABLE XI (Continued)

-
- | | |
|--|--|
| <ul style="list-style-type: none"> *7. Kansas State Teachers College, Emporia, Kansas 8. State Teachers College, St. Cloud, Minnesota 9. State Teachers College, Montclair, New Jersey 10. State Teachers College, Pullman, Washington | <ul style="list-style-type: none"> 10. Mills College, Oakland, California 11. Ohio Wesleyan University, Delaware, Ohio 12. Peabody Teachers College, Nashville, Tennessee 13. Pennsylvania University, Philadelphia, Pennsylvania 14. Princeton University, Princeton, New Jersey 15. Rockford College, Rockford, Illinois 16. Wilson College, Chambersburg, Pennsylvania |
|--|--|
-
- IV. Municipal Universities
- 1. Akron University, Akron, Ohio
 - 2. University of Cincinnati, Cincinnati, Ohio.
-
- V. Private Colleges and Universities.
- 1. Antioch College, Yellow Springs, Ohio
 - 2. Brown University, Providence, Rhode Island
 - 3. Bucknell University, Lewisburg, Pennsylvania
 - 4. Chicago University, Chicago, Illinois
 - 5. Columbia University, Teachers College, New York
 - 6. Denver University, Denver, Colorado
 - 7. Duke University, Durham, North Carolina
 - 8. Eureka College, Eureka, Illinois
 - 9. Hood College, Frederick, Maryland

Prerequisites, References, and Textbooks.- As is stated in Chapter II⁵, there is little uniformity in the prerequisites for courses in elementary statistics. The replies from forty-eight teachers of elementary statistics to the letter⁶ accompanying the test indicate a correspondingly wide variation in prerequisites as well as in the number and type of references for class use. In many cases, the instructors do not list the references but indicate by "yes" or "no" whether they give references for class study. The prerequisites and references are summarized in Table XII.

Fourteen⁷ per cent of the colleges and universities have no required text for class use, but employ the lecture method either with or without mimeographed materials. Forty per cent study Garrett's text. The textbooks for the remaining forty-six per cent of the schools as shown in Table XIV are written by the following authors: Chaddock, Camp, Gregory and Renfrow, Gavitt, Harper, Holzinger, MacDonald, Mills, Richardson, Rugg

⁵ Chapter II, p. 13

⁶ Appendix A, p. 179

⁷ The nearest per cent is used. If the result is 23.7%, the final per cent is given as 24.

Odell, Lovitt and Holtzclaw, and Rigglesman and Frisbee. The tabulation on the required books for class use is found in Table XII.

TABLE XII

PREREQUISITES FOR COURSE IN ELEMENTARY STATISTICS
AND REFERENCES FOR CLASS STUDY

Colleges and Universities	Prerequisites for Course of Elementary Statistics	Suggested References
I. State Universities		
1. Arizona	Senior or Graduate standing	Optional
2. Idaho	None	Day and Secrist
3. Illinois	Graduate standing	Yes
4. Indiana	None	None first semester
5. Kansas	Nine hours of education	To limited extent
6. Louisiana	Junior standing	Yes
7. Maine	Sophomore standing	Yes
*8. Maryland	.....	Fischer
9. Missouri	Senior standing	None
10. Montana	One and one-half years of Algebra	Very few
11. Nebraska	None- Graduate Stand-	Yes
*12. New Jersey	..ing.....	Yes
13. New Mexico	Junior standing	Yes
	General Psychology	
14. Ohio	None	Yes
15. Virginia	Mathematics of Finance and Economics	Brown, Bingham, and Tammmeroff "Laboratory Textbooks of Statistical Methods"
*16. Washington	.....	Yes
17. West Virginia	First Course of Educational Psychology	None
*18. Wyoming	Graduate standing	Yes

*No statement was made about prerequisites

*Reference books for the course given in Wyoming University are Holzinger, Morton, Odell, Rugg, and Kelley.

TABLE XII (Continued)

Colleges and Universities	Prerequisites for Course of Elementary Statistics	Suggested References
II. State Teachers Colleges		
1. California, San Diego	None	Yule, Thurstone, Holzinger, Garrett Reitz and Cra-thorne
2. Colorado, Greeley	None	Yes, but not required
3. District of Columbia, Ormand Wilson	.....	.....
4. Indiana, Terre Haute	None	Lindquist-Stoddard Manual
5. Kansas, Emporia	Senior standing	
6. Kansas, Pittsburg	College Algebra	Carver, Mills, Kelley Ezekial
7. Minnesota, St. Cloud	Junior standing	Yes
8. New Jersey, Montclair	None	Rugg - primer
9. Washington, Pullman	None	Yes
III. State Colleges		
1. Kansas State	Six hours in Education College Algebra	Very few
2. Miami	Course in Freshman Mathematics	Yule, Burgess, Rietz, Garrett
3. Purdue	Junior standing, one year (6 hrs.) Psychology of Education	Yes

TABLE XII (Continued)

Colleges and Universities	Prerequisites for Course of Elementary Statistics	Suggested References
IV. Municipal Universities		
1. Akron	Senior or Graduate standing	To some extent
2. Cincinnati	None	Holzinger, Rugg, and others
V. Private Colleges and Universities		
1. Antioch	20 weeks of Mathematics and 20 of Psychology	Yes
2. Brown	Junior standing	None
3. Bucknell	One semester of College Algebra	Occasionally Mills Thurstone, Yule
4. Chicago	None	Many
5. Columbia	None	Many
6. Denver	High School Algebra, at least, College Senior Standing	Lindquist-Stoddard Manual
7. Duke	Senior standing	None
8. Eureka	Junior standing, Elementary and Educational Psychology	A little from Holzinger
9. Hood	Freshman Math. and Analytic Geometry	Not required
10. Mills	None	None
11. Ohio Wesleyan	.....	None
12. Peabody	.....	About 20 references
13. Pennsylvania	None	None
14. Princeton	Elementary Economics	.....
15. Rockford	Freshman Math.	Holzinger, Medical Biometry; Burgess Tables, as Crelle's and Barlow's
16. Wilson	College Algebra	

Distribution of College Classes in the Elementary

Statistical Courses.- The data from the statistical classes of the forty-eight colleges and universities indicated in Table XIV⁸ give the basis for the results found in Table XV⁹. These statistics are for the number and per cent of freshmen, sophomores, juniors, seniors, and graduate students found in the beginning classes in elementary statistics allocated for the various college years. The departments of the colleges and universities represented are noted also. The difference between the number of undergraduate and graduate students is not large. The greatest difference is in the number found in the classes placed in the first and second years of college. The freshman and sophomore classes represent fourteen per cent of the entire group of students taking the test.

Departments of College.- The students who took the test come from twenty-seven educational, five psychological, one commercial, five economical, and ten mathematical departments. According to Table XIV, only twenty-seven per cent of the freshman and sophomore classes are from the educational department.

Tables XIII and XIV follow:

⁸ Table XIV, pp. 81-84

⁹ Table XV, p. 85

TABLE XIII

TEXTBOOKS USED BY THE COLLEGES AND UNIVERSITIES FOR
THE COURSE OF ELEMENTARY STATISTICS

Type of School	Chaddock	Chaddock & Creighton	Camp	Garrett	Gregory & Renfrow	Harper	Holzinger	Gavett	MacDonald	Odell	Mills	Richardson	Rugg
I. State Universities													
1. Arizona				X									
*2. Idaho				X									
3. Illinois										X			
4. Indiana				X			X						
5. Kansas				X									
6. Louisiana	X												
7. Maine				X									
8. Maryland											X		
**9. Missouri													
10. Montana						X							
11. Nebraska				X									
12. New Jersey										X			
13. New Mexico				X									
**14. Ohio													
15. Virginia				X									
**16. Washington													
17. West Virginia				X									
18. Wyoming				X									
Totals	1			9		1	1			2	1		
II. State Teachers Colleges													
1. California San Diego										X			
2. Colorado, Greeley				X									
3. District of Columbia, Ormand Wilson													

* No data received.

** No text used.

TABLE XIII (Continued)

Type of School	Chaddock	Chaddock & Croxson	Camp	Garrett	Gregory & Henfrow	Harper	Holzinger	Gavett	MacDonald	Odell	Mills	Richardson	Rugg
*4. Indiana, Terre Haute				X									
5. Kansas, Emporia				X									
**6. Kansas, Pittsburg													
7. Minnesota, St. Cloud				X									
8. New Jersey, Montclair				X									
9. Washington, Pullman							X						X
Totals				5			1			1			1
III. State Colleges													
1. Kansas State				X									
2. Miami			X										
3. Purdue													
Totals			1	1									
IV. Municipal Universities													
1. Akron				X									
2. Cincinnati					X								
Totals				1	1								

*On preceding page.

**No textbook used, lecture method instead.

TABLE XIII (Continued)

Type of School	Chaddock	Chaddock & Croxson	Camp	Garrett	Gregory & Henfrow	Harper	Holzinger	Gavett	MacDonald	Odell	Mills	Richardson	Rugg
V. Private Colleges and Universities													
1. Antioch		x		x									
2. Brown								x					
3. Bucknell												x	
4. Chicago							x						
*5. Columbia													
6. Denver				x									
7. Duke				x									
*8. Eureka													
9. Hood	x												
10. Mills									x				
*11. Ohio Wesleyan													
*12. Peabody													
*13. Pennsylvania													
*14. Princeton													
15. Rockford	x												
16. Wilson			x								x		
Totals	2	1	1	3			1	1	1	1	1		
Grand Totals	2	1	2	19	1	1	3	1	1	3	2	1	1

* No text used.

Pennsylvania used mimeographed sheets.

TABLE XIV

DEPARTMENT, CLASS STANDING, DEGREES SOUGHT, NUMBER OF UNDERGRADUATES,
AND GRADUATE STUDENTS, AND CLASS SIZE

Type of School	Department	Freshman	Sophomore	Junior	Senior	M. A.	M. Ed.	M. S.	Ph. D. or Ph. Ed.	Specials	Undergrad- ates	Graduates	Number in Class
I. State Universities													
1. Arizona	Ed.					7			2			9	9
2. Idaho	Ed.					3		7	6	1		7	7
3. Illinois	Ed.							4	4			14	14
4. Indiana	Ed.							2				6	6
5. Kansas	Ed.					5	5	3			2	13	15
*6. Louisiana	Comm.		2	22	1	2		1			27	3	30
7. Maine	Math.			6	3					1	13		13
*8. Maryland	Ec.		2	25	5	1		3	3	1	32	7	39
9. Missouri	Ed.				1	14					1	15	16
10. Montana	Math.	2	13	10	7	51		1	3		32	55	32
11. Nebraska	Ed.			3	6					3	9		64
12. New Jersey	Ec.			2	11	8					16		16
13. New Mexico	Psych.			6	4					3	11	8	19
14. Ohio	Psych.			1	2	21		1	2		3	24	27

* These Universities had several departments listed. The department which had the highest frequency was placed in the column under "Department".

TABLE XIV (Continued)

Type of School	Department	Freshman	Sophomore	Junior	Senior	M. A.	M. E.	M. S.	Ph. D. or	Special	Undergraduates	Graduates	Number in Class
*15. Virginia	Ed.				2	3		3	3	4	2	6	8
16. Washington	Ed.				2	30	4	1	3		2	42	144
17. West Virginia	Ed.				2	13		6	1	1	2	21	23
18. Wyoming	Ed.					2		1	2			5	5
II. State Teachers Colleges													
1. California, San Diego	Ed.		1	4	13	1					18	1	19
2. Colorado, Greeley	Ed.				1	11	1		2		1	14	15
3. District of Columbia, Ormand													
4. Indiana, Terre Haute	Ed.	3	23	1						1	28		28
5. Kansas, Emporia	Ed.				1	7		12			1	19	20
6. Kansas, Pittsburg	Psych.		1		1	4	2	10			2	16	18
	Math.			1	11			1		1	12	2	14

* On preceding page

TABLE XIV (Continued)

Type of School	Department	Freshman	Sophomore	Junior	Senior	M. A.	M. E.	M. S.	Ph. D. or	Special	Undergraduates	Graduates	Number in Class
*7. Minnesota, St. Cloud	Ed.			1	3	1				1	4	2	6
8. New Jersey, Montclair	Math.		36	3							39		39
9. Washington, Pullman	Ed.			3	2	2				2	5	4	9
III. State Colleges													
1. Kansas	Ed.			6	14			9		1	20	10	30
2. Miami	Math.	1	2	2	2			7			7	7	7
3. Purdue	Psych.	1									3		10
IV. Municipal Universities													
1. Akron	Ed.				4	6	3	3		1	4	13	17
2. Cincinnati	Ed.			8	26	44	1	1	6	1	34	53	87
V. Private Colleges and Universities													
1. Antioch	Ed.		1	12	6					2	20		20
2. Brown	Math.			3	4	3	1		3		8	7	15

*On preceding page

TABLE XIV (Continued)

Type of School	Department	Freshmen	Sophomore	Junior	Senior	M. A.	M. E.	M. S.	Ph. D. or	Special	No. of Un- dergraduates	No. of graduates	No. in Class
*3. Bucknell	Math.			4	4	1		1	7			1	9
4. Chicago	Ed.					5			10			13	13
5. Columbia	Ed. Psy.					5						14	14
6. Denver	Ed.				1	10	1			1	1	11	12
7. Duke	Ed.				9	2	1			1	9	4	13
8. Eureka	Ed.				6	1					6	1	7
9. Hood	Math.			2	4	1				4	10	5	10
10. Mills	Ed.			6	8	1					14	5	19
11. Ohio Wesleyan	Ec.		5	9	11	4			7	1	22	12	22
12. Peabody	Ed.			1	2						1	1	13
13. Pennsylvania	Math.	24	8	4	8			1			38	1	39
14. Princeton	Ec.		2	1	4						14		14
15. Rockford	Ec.		2	1	1						7		7
16. Wilson	Math.		2	1	1						4		4

*On preceding page.

TABLE XV

THE NUMBER AND PER CENT OF UNDERGRADUATE AND GRADUATE
STUDENTS IN ELEMENTARY STATISTICS COURSE, AND THE
DEGREES SOUGHT BY GRADUATE STUDENTS

Standing of Students	Number of Students	Per Cent of Total No. of Students	No. of be- ginning Classes	Per Cent of Institutions so repre- sented
I. Undergraduates				
1. Freshman	31	3.0	5	10.0
2. Sophomore	101	11.0	11	23.0
3. Junior	155	17.0	16	33.0
4. Senior	198	21.0	9	19.0
Total	485			
II. Graduates				
1. M. A.	267	28.9	7	15.0
2. M. E.	19	2.0		
3. M. S.	78	8.0		
4. Ph. D. and D. E.	61	7.0		
5. Special	27	3.0		
Total	452			
Grand Total	937		48	

Table XVI gives the data for the hours per week that the classes meet, the weeks per term, and the number of hours' credit, which the groups of colleges and universities represented in the test gave to the courses in elementary statistics.

The number of recitation periods of an hour's length vary from two to six hours per week. The range in the number of hours per term for recitation periods is from thirty-six to sixty. The variation in the number of hours per week indicates a wide difference in the conception of the amount of time that should be given to a course in elementary statistics.

Table XVII gives the average number for the following items:

1. Weeks per term.
2. Hours per week the classes convened.
3. Hours' credit for the course.

The average number of recitation periods per week is three. The average term's credit is three hours.

TABLE XVI

THE DISTRIBUTION BY COLLEGES AND UNIVERSITIES OF THE
HOURS PER WEEK THE CLASSES MEET, THE NUMBER OF WEEKS
IN A TERM, AND THE NUMBER OF HOURS CREDIT EARNED

Type of School	Hours per Week	Weeks per Term	Hours Credit
I. State Universities			
1. Arizona	2	18	2
2. Idaho	5	16	3
3. Illinois	2	18	4
*4. Indiana	5	18	3
5. Kansas	3	18	3
*6. Louisiana	3	17	3
*7. Maine	2	18	2
8. Maryland	3	18	3
9. Missouri	3	18	3
#10. Montana	5	12	5
11. Nebraska	3	18	3
12. New Jersey	3	17	3
13. New Mexico	3	18	3
14. Ohio	4	12	4
15. Virginia	3	15.5 (2 terms)	3
16. Washington	5	15	5
17. West Virginia	3	18	3
18. Wyoming	3	12	3
II. State Teachers Colleges			
1. California, San Diego	3	18	3
2. Colorado, Greeley	4	12	4

*Indiana and Louisiana receive six hours credit for the year,
Maine receives four hours credit for the year.

#Five quarter hours equals a semester work of 18 weeks, three
times a week.

TABLE XVI (Continued)

Type of School	Hours per Week	Weeks per Term	Hours Credit
*3. District of Columbia, Ormand Wilson	3	18	3
4. Indiana, Terre Haute	4	12	4
5. Kansas, Emporia	3	18	3
6. Kansas, Pittsburg	3	18	3
7. Minnesota, St. Cloud	4	12	4
8. New Jersey, Montclair	4	13	4
9. Washington, Pullman	2	18	2
III. State Colleges			
1. Kansas State	3	17	3
2. Miami	3	18	3
3. Purdue	3	18	3
IV. Municipal Universities			
1. Akron	2.1	18	2.1
2. Cincinnati	2.3	18	2.3
V. Private Colleges and Universities			
1. Antioch	3	20	6
2. Brown	3	15	3
3. Bucknell	3	18	3
**4. Chicago	4	10	3.3
#5. Columbia	3	16	3
6. Denver	3	12	3.3
7. Duke	3	17	3
8. Eureka	3	20	3
9. Hood	3	16	3
10. Mills	3	16	3
11. Ohio Wesleyan			
12. Peabody	4	12	4
13. Pennsylvania	3	18	1

* On preceding page.

** Holzinger says quarter hours are equivalent to 3.3 semester hours

Has classes 2, 3, and 4 hours in length.

TABLE XVI (Continued)

Type of School	Hours per Week	Weeks per Term	Hours Credit
*14. Princeton	4	13	3
**15. Rockford	3	17	2
16. Wilson	2	15	2

*On preceding page

**Runs two semesters or 34 weeks, each term 3 hours.

TABLE XVII

THE AVERAGE NUMBER OF HOURS PER WEEK, NUMBER OF WEEKS PER TERM, AND HOURS' CREDIT FOR EACH OF THE TYPES OF INSTITUTIONS OFFERING COURSES IN ELEMENTARY STATISTICS

Type of School	Hours per Week	Weeks per Term	Hours Credit per Term
1. State Universities	3.1	17.0	3.3
2. State Teachers Colleges	3.3	14.9	3.3
3. State Colleges	3.0	17.6	3.0
4. Municipal Universities	2.1	18.0	2.1
5. Private Colleges and Universities	3.3	15.8	3.0
Averages	3.0	17.0	3.0

Summary of Factors and Conditions Affecting
the Results of the Comprehensive Test
Found in Part I

Schools, Students, and Courses.- As stated in the beginning of this chapter, forty-eight colleges and universities from twenty-seven states are represented by nine hundred thirty-seven students who took the Comprehensive Examination. These students have widely different backgrounds and preparation for the test, the influence of which is clearly manifested in the test results. Not only are their backgrounds different, but the demands made by the various schools for satisfactory completion of a course in statistics vary greatly. The net result of these two factors is a wide range of achievement on the comprehensive test. This variation is to be expected, since three per cent of the students are freshmen, eleven per cent sophomores, seventeen per cent juniors, twenty-one per cent seniors, and forty-eight per cent graduate students. Candidates for the doctorate may have had as much as seven years university training beyond that of the freshmen taking the same test. This raises a very fundamental question as to what the college level should be for a course in elementary statistics. The distribution of classes in statistics in terms of college levels, is as follows: freshman, five; sophomore, eleven; junior, sixteen; senior, nine; and graduate, seven. The mode for

the classes is on the junior level. Other factors which tend to make a wide range of achievement on the comprehensive test are the number of hours per week and the length of the term. The hours per week that the classes met range from two to five. The length of the term and the hours' credit are variable quantities. The average number of hours' credit is three. The total number of hours the student spent in the elementary classes of statistics ranges from thirty-six to seventy-five hours for the term. Since the variation in amount of time given to this course is so great the query is raised, how can the intensive work on the concepts be the same.

PART II

THE TEST

The second part of the chapter deals with the purpose, the construction, and the administration of the test.

Purpose of the Test.- The purpose of the test is to ascertain the achievement of the students, their difficulties and failures, and the possible remedial measures to be used.

How the Test was Made.- The statistical concepts found in the test are taken from a list selected from the table of contents of twenty-three texts. The authors of these texts are regarded as experts. Hence, tests based on the material which

they present should be reliable and valid. The following quotation taken from Ruch and Stoddard (1:305) in their book,

Tests and Measurements in High School, ably expresses the writer's idea:

In subjects which are yet in the development state, such as general sciences, correlated mathematics, and social studies, this method is practically the only one open to the testbuilder. Items which occur in fifty to one hundred per cent of the leading textbooks in a given field certainly can be said to be the most representative of general teaching practice in that subject. Such items are valid under normal conditions. The teaching practice of ninety per cent of the teachers is to follow the organized procedure of the textbook used.

Statistics is one of the comparatively new subjects of the college curriculum; therefore, the practices applied to such school subjects as Ruch and Stoddard mentions, are applicable to the making of a test for elementary statistics.

Divisions, Administration, and Scoring of the Test.-

The use of four types of tests which include various phases of statistical concepts, should present broad enough aspects of the subject to be comprehensive and to measure the achievement of the students. The first section consists of fifty true-false statements; the second is comprised of fourteen multiple-choice statements; the third has sixteen match-answer parts; and the fourth contains thirteen problems.

The length of the different parts of the test is arbitrarily decided. The various forms of objective tests are

used in order to give the student a greater opportunity to obtain a satisfactory grade, inasmuch as it is claimed that some students do better on one form than on another. Directions are given before each section. It is arbitrarily determined to give one point on each statement of the first three sections, and five points on each problem of the last section. The total score for all sections is one hundred forty-five points. The general achievement of the students in the different groups of colleges and universities is found by taking the medians of the raw scores made on the test. The students' achievement is found in the analysis of the test results in Chapter IV. The test requires two fifty-minute periods for administering.

Summary of Part II

A comprehensive test, made up of concepts selected from twenty-three texts and arranged in a true-false, multiple-choice, match-answer, and problem section, obtains first hand information concerning the weakness of the elementary statistical course as now taught.

BIBLIOGRAPHY

Ruch, G. M., and Stoddard, G. D. Tests and Measurements in High School, p. 305. Yonkers, New York: World Book Company, 1927.

CHAPTER IV
ANALYSIS OF THE COMPREHENSIVE TEST

Introduction

Method of Analysis.— The purpose, administration, construction, scoring, and the schools cooperating in giving the test, are considered in Chapter III.

Chapter IV is an analytical study of the errors made on the four sections of the test. This study is made for the purpose of locating points of difficulty, their probable causes, and of suggesting possible remedial measures. The aim of the chapter, therefore, is to show through various tabulations of test data, (1) the relationship between the average of the medians of the raw scores of the test and the average per cents of failure on the concepts; (2) the statistical concepts that caused the highest per cent of failure; (3) whether the difficulties are distributed over all the statistical concepts of the test, or are located in a few concepts; (4) whether the assumption is true that the course in elementary statistics has a varying number of concepts in different institutions of higher learning; (5) the relation between the distribution of successes and failures in the test and the college levels of the students; (6) whether the lack of mathematical preparation affects the

student's success or failure in elementary statistics; (7) whether test results give evidence of much variation of methodology; and, (8) whether the course of elementary statistics was understood by the majority of the students.

General Attainment of the Students on the Test

The degrees of attainment of the students on the test are indicated by the raw scores. A median of the raw scores is shown for each institution represented. Finally, a median for all colleges and universities is calculated. The medians for the different groups of colleges have little variation.

¹
The raw scores range from ten to one hundred thirty-seven ². The highest possible score is one hundred forty-five. The median for the groups of colleges and universities is 73.9 out of one hundred forty-five possible correct answers. This shows that a little more than fifty per cent succeeded in answering fifty per cent of the test.

Table XVIII contains the medians for the separate colleges. Table XIX gives the medians for the entire group.

¹
University of Pennsylvania

²
University of Illinois

TABLE XVIII

THE RANGES AND THE MEDIANS OF THE RAW SCORES
FOR COLLEGES AND UNIVERSITIES

Type of School	Ranges	Medians
I. State Universities		
1. Arizona	59---84	69
2. Idaho	54---80	76
3. Illinois	84---137	110
4. Indiana	66---106	92
5. Kansas	54---113	85
6. Louisiana	34---78	58
7. Maine	68---106	89
8. Maryland	16---88	46
9. Missouri	26---74	50
10. Montana	34---88	58
11. Nebraska	50---114	75
12. New Jersey	37---54	44
13. New Mexico	55---108	78
14. Ohio	26---88	57
15. Virginia	42---60	54
16. Washington	42---112	89
17. West Virginia	16---96	66
18. Wyoming	101---114	107
II. State Teachers College		
1. California, San Diego	37---119	70
2. Colorado, Greeley	36---124	73
3. District of Columbia, Ormand Wilson	52---99	71
4. Indiana, Terre Haute	38---109	70
5. Kansas, Emporia	43---122	75
6. Kansas, Pittsburg	52---99	68
7. Minnesota, St. Cloud	61---108	82
8. New Jersey, Montclair	60---108	82
9. Washington, Pullman	28---108	89

TABLE XVIII

Type of School	Ranges	Medians
III. State Colleges		
1. Miami	72--107	91
2. Purdue	63--104	78
3. Kansas State	25--91	47
IV. Municipal Universities		
1. Akron	59--91	65
*2. Cincinnati	61--125	97
V. Private Colleges and Universities		
1. Antioch	28--82	49
2. Brown	60--108	91
3. Bucknell	60--107	89
4. Chicago	56--85	74
5. Columbia	67--122	92
6. Denver	38--85	66
7. Duke	32--96	63
8. Eureka	43--89	78
9. Hood	82--115	98
10. Mills	61--109	80
11. Ohio Wesleyan	39--76	59
12. Peabody	27--75	54
13. Pennsylvania	10--58	28
14. Princeton	37--103	66
15. Rockford	42--89	63
16. Wilson	42--75	62

* Cincinnati contributed four sections to the test. 97% is the average of the medians of these sections. The range for the advanced statistical class is 98 to 138, with a median of 117.

TABLE XIX

AVERAGE OF THE MEDIANS OF THE RAW
SCORES FOR THE DIFFERENT GROUPS OF
COLLEGES AND UNIVERSITIES

Types of Institutions	Average of the Medians of the Raw Scores Expressed in Per Cent
1. State Universities	73.00
2. State Teachers Colleges	74.00
3. State Colleges	72.00
4. Municipal Universities	80.80
5. Private Colleges and Universities	69.50
Average	73.86 73.9 or 74

Sections of the Test

In each of the four sections, tables have been prepared to represent the distribution of per cent of error for each item of a statistical concept; the average per cent of error per item for each class and for the groups of schools; and the average per cent of class failure on each of the statistical concepts by groups of colleges and universities. There are summary tables on the items and the concepts for the groups of colleges and universities.

A sample sheet of the work tables is presented before each section. Its purpose is to show how the results of the test were compiled. The data of the tables in Appendix D³ are obtained from work sheets similar to the sample sheet inserted before the tables for each of the four sections in this chapter. These tables summarize the results of the data found in the tables of Appendix D.

True-False Section.- The statistical concepts, discussed in the fifty statements of the true-false section, are as follows:

1. Reliability of Measures.
2. Measures of Dispersion.
3. Percentile Rank.
4. Measures of Central Tendency.
5. Quartiles and Semi-inter-quartile Range.
6. Correlation.
7. Definition of probability.
8. Reliability and Validity of Tests.
9. Class and Score Intervals.
10. Series.
11. Curves and Graphs.
12. Skewness.
13. Sampling.

The sample sheet, or Table XX, precedes Table XXI, XXII, XXIII, and XXIV. The data from which these tables are formed is found in Tables I and II of Appendix D.⁴

The results of the true-false section are summarized in Tables XXII and XXIV, which represent the average per cent of error for each item of the statistical concepts and the average per cent of failure on each of the concepts by all the colleges and universities, respectively. The failures by all the classes on the concepts range from twenty-six to sixty-eight per cent.

⁴

Appendix D, Table I, P. 213
Appendix D, Table II, P.219

TABLE XX

ANALYSIS OF THE TRUE-FALSE SECTION OF THE COMPREHENSIVE TEST FOR THE PERCENTS OF THE ERRORS FOR THE ITEMS OF A STATISTICAL CONCEPT AND FOR THE CONCEPTS FOR EACH COLLEGE CLASS

State Teachers Colleges	Reliability of Measures								
	Number in Class	Median as Rel. Corr.	Std. Error of Diff.	Reliab. of a Mean	Var. of Std. Error	Reliability and Spread	Rel. Form. Measure	Sq. of Dev. about Mean	True Mean is Arith. Mean
1. Colorado, Greeley	15	3	4	8	4	3	4	2	7
(a) No. of errors		120							
(b) All possible errors		20	27	54	27	20	27	13	47
(c) Per Cent of error per item									
(d) Av. per cent of error on the statistical concept for class									29
2. Indiana, Terre Haute	20	4	9	13	10	3	8	3	5
(a) No. of errors		160							
(b) All possible errors		20	45	65	50	15	40	15	25
(c) Per Cent of error per item									
(d) Av. per cent of error on the statistical concept for class									34
3. Kansas, Emporia	18	6	8	7	3	7	9	3	6
(a) No. of errors		144							
(b) All possible errors		33	44	39	17	39	50	17	33
(c) Per cent of error per item									
(d) Av. per cent of error on the statistical concept for class									34

TABLE XXI

THE AVERAGE PER CENT OF ERRORS FOR EACH DIVISION OF THE
STATISTICAL CONCEPTS OF THE TRUE-FALSE SECTION

Divisions	State Uni- versities	State Teach- ers Colleges	State Col- leges	Municipal Universities	Private Col- leges and U- niversities
I. Central Tendency					
Mean	50	44	50	40	79
Median	34	46	28	34	72
Mode	47	50	48	57	85
II. Measures of Dispersion					
Mean Deviation	13	13	13	26	19
Comparable Measures	12	12	7	18	20
Standard Deviation	42	47	33	31	49
Sq. of Deviations about Mean	36	34	41	24	44
III. Q_1 and Q_3 S. I. Q. R.					
Q_1 in a Skewed Distribution	33	34	27	24	35
Position of Q_1 and Q_3	32	32	26	32	29
S. I. Q. R. vs. P.E.	67	61	56	56	40
IV. Skewness					
Zero Skewness	24	17	3	54	22
Positive Skewness	33	44	26	28	41
V. Sampling					
Character of Sampling and Deduction	39	45	42	31	57
VI. Percentile Rank					
Defined	41	31	50	55	50
Common Basis	14	30	9	26	30

TABLE XXI (Continued)

Divisions	State Uni- versities	State Teach- ers Colleges	State Col- leges	Municipal Universi- ties	Private Col- leges and U- niversities
VII. Tests					
Validity	56	60	54	60	69
Reliability	23	26	40	23	76
VIII. Intervals					
Limits of Score Intervals	61	58	80	58	28
Class Intervals	37	23	65	41	29
IX. Reliability					
Median as a reli- able Coefficient	44	48	45	33	49
Standard Error of Difference	45	44	46	43	59
Reliability of a Mean	57	45	65	54	74
Variation of Standard Error	43	39	37	29	49
Reliability and Spread	34	32	30	39	50
Reliability Formu- las and Measures	55	48	49	66	62
Sq. of Deviations about the Mean	17	10	17	13	24
True Measure is Arithmetic Mean	40	45	67	26	44
X. Graphs					
Histograms	39	23	24	36	33
XI. Interpretation of Curves					
Curvelinear	38	45	47	57	51
Deduction from a Normal Probabil- ity Curve	53	55	54	57	67
Symmetrical	25	3	12	54	22

TABLE XXI (Continued)

Divisions	State Un- versities	State Teach- ers Colleges	State Col- leges	Municipal Universi- ties	Private Col- leges and Universi- ties
*Ogive	19	19	15	10	21
Curve of Error	22	19	20	14	29
Bilaterally Sym- metrical	21	23	7	26	21
Curves Defined	53	48	41	48	54
XII. <u>Series</u>					
Discrete and Continuous	34	39	29	40	49
XIII. <u>Correlation</u>					
Pearson's Product Moment	46	43	46	42	52
Spearman's foot- rule	43	49	66	63	60
Coefficient of Alienation	56	37	39	29	51
Limits of Correla- tion	35	22	37	25	27
Magnitude of Corre- lation	39	42	57	16	28
Regression Lines	21	24	28	4	20
Regressed Scores	23	21	30	5	32
Errors of Prediction	36	48	27	25	44
Partial Correlation	51	72	69	60	69
Corr. Coefficient and Regression Coef- ficient	67	69	52	68	70
Coefficient of Atten- Correlation Ratio	38	44	36	39	50
Negative Correlation	53	47	58	56	63
	35	35	28	29	42
XIV. <u>Probability</u>					
Defined	55	44	47	50	5

TABLE XXII

THE AVERAGE PER CENT OF ERROR FOR EACH ITEM OF THE STATISTICAL CONCEPTS OF THE TRUE-FALSE SECTION FOR ALL COLLEGES AND UNIVERSITIES

ITEM	Average Per Cent of Error
<u>I. Central Tendency</u>	
Mean	55
Median	43
Mode	57
<u>II. Measures of Dispersion</u>	
Mean Deviation	17
Comparable Measures	14
Standard Deviation	40
Square of Deviations about the Mean	36
<u>III. Q_1 and Q_3</u>	
<u>S. I. Q. R.</u>	
Q_1 in a Skewed Distribution	31
Position of Q_1 and Q_3	30
S. I. Q. R. vs. P. E.	56
<u>IV. Skewness</u>	
Zero Skewness	24
Positive Skewness	34
<u>V. Sampling</u>	
Character of Sampling	13
Deduction	43
<u>VI. Percentile Rank</u>	
Defined	45
Common Basis	38
<u>VII. Tests</u>	
Validity	60
Reliability	38

TABLE XXIII

THE AVERAGE PER CENTS OF CLASS FAILURE FOR EACH GROUP
OF COLLEGES AND UNIVERSITIES ON THE CONCEPTS OF THE
TRUE-FALSE SECTION OF THE COMPREHENSIVE TEST

Items of True-False Section	State Uni- versities	State Teach- ers Colleges	State Colleges	Municipal Universities	Private Colleges & Universities
1. Measures of Central Tendency	50	47	41	45	47
2. Measures of Dispersion	28	33	24	22	33
3. Skewness	28	39	10	42	32
4. Sampling	25	33	18	21	35
5. Percentile Rank	25	30	30	36	47
6. Tests	42	45	43	41	45
7. Intervals	57	68	51	47	54
8. Scores	67	58	80	58	79
9. Graphs	42	32	23	36	33
10. Curves	30	37	31	43	39
11. Series	34	27	39	40	49
12. Correlation	35	48	42	56	47
13. Probability	54	46	44	50	51
14. Reliability of Measures	41	40	42	37	50
15. Q_1 and Q_3 S. I. Q_2 R.	46	52	63	37	48

TABLE XXIV

THE AVERAGE PER CENTS OF CLASS FAILURES FOR COLLEGES
AND UNIVERSITIES ON THE STATISTICAL CONCEPTS OF THE
TRUE-FALSE SECTION OF THE COMPREHENSIVE
TEST

Statistical Concepts	Average Per Cent
1. Scores	68
2. Intervals.	55
3. Probability	49
4. Q_1 and Q_3 , S. I. Q. R.	49
5. Measures of Central Tendency	46
6. Correlation	46
7. Tests	43
8. Reliability of Measures	42
9. Series	38
10. Curves	36
11. Percentile Rank	34
12. Graphs	33
13. Skewness	30
14. Measures of Dispersion	28
15. Sampling	26

Multiple Choice Section.— The multiple-choice section presents the following nine statistical concepts with twenty-one items in fourteen statements:

1. Frequency polygons
2. Skewness
3. Probable Error
4. Normal Probability Curve
5. Tests
6. Measures of Central Tendency
7. Reliability
8. Series
9. Probability

There is no repetition of phases of concepts found in the true-false section. On the whole, the scores for the true-false section and the multiple-choice section are similar. In the latter, the range of failures on the concepts is from twenty-five to eighty per cent, while the true-false ranges from twenty-six to sixty-eight.

One of the outstanding difficulties in this section is the determination of the form of curve ⁵ which will fit the teachers' marks expressed in per cent for all the school children throughout the United States.

5

Appendix A, p. 185, statement 10

A sample page, labelled Table XXV, precedes Tables XXVI, XXVII, XXVIII, and XXIX. These tables are derived from the data⁶ which forms the basis for the construction of table IV .

The multiple-choice section is summarized in Tables XXVII and XXIX, in which are found respectively, the average per cents of failures on the items and statistical concepts for all the colleges and universities. Tables XXVII and XXIX are further summaries of Tables XXVI and XXVIII.

TABLE XXV

THE PER CENTS OF THE ERRORS ON EACH ITEM OF A STATISTICAL CONCEPT AND THE
PER CENTS OF ERRORS ON EACH CONCEPT OF THE MULTIPLE-CHOICE SECTION OF THE
COMPREHENSIVE TEST FOR EACH COLLEGE CLASS

State Universities	Number in Class	Probability				Probable Error			
		Coin Tossing	Areas under Curves	Reliability of Signs	Corr. Coef. and Prob- able Error	Defined			
1. Arizona (a) No. of errors (b) All possible errors (c) Per cent of errors per item (d) Av. per cent of error on the statistical concept for class	9	3 18 33.3	1 11.1 22.2	3 27 33.3	6 66.7	2 22.2 40.7			
2. Idaho (a) No. of errors (b) All possible errors (c) Per cent of errors per item (d) Av. per cent of error on the statistical concept for class	7	2 14 28.6	0 0.0 14.3	2 21 28.6	1 14.3	3 42.9 28.6			

TABLE XXV (Continued)

State Universities	Number in class	Probability		Probable Error		
		Coin tossing	Areas under curves	Reliability of P. E. and Sigma	Corr. Coef. and Probable Error	Defined
3. <u>Illinois</u> (a) No. of errors (b) All possible errors (c) Per cent of errors per item (d) Av. per cent of error on the statistical concept for class	14	1 28	2	5 42	0	4
		7.1	14.2	35.5	0.0	28.4
			10.7			21.3

TABLE XXVI

THE AVERAGE PER CENT OF ERRORS OF EACH GROUP OF COLLEGES
AND UNIVERSITIES ON EACH ITEM OF THE TOPICS OF THE MULTI-
PLE CHOICE SECTION OF THE COMPREHENSIVE TEST

Items of the Multiple- Choice Section	State Universities	State Colleges	State Teachers Colleges	Municipal Universities	Private Colleges
1. <u>Central Tendency</u>					
Mean	32	23	34	31	27
Mode	45	56	50	37	44
2. <u>Probability</u>					
Coin Tossing	31	22	31	36	27
Areas under Curves	19	32	18	10	30
3. <u>Skewness</u>					
Position of Mode	46	56	50	37	50
Position of Median	41	64	34	36	39
Teachers grades in per cent	72	55	80	70	88
Sigma vs. Skewness	51	34	43	57	41
4. <u>Probable Error</u>					
Relation of P. E. and Sigma	55	81	56	45	67
Correlation Coef. and probable error	30	44	28	22	34
P. E. defined	42	59	67	33	52
5. <u>Tests</u>					
Reliability	52	26	37	48	52
6. <u>Series</u>					
Continuous	19	25	23	31	19

TABLE XXVI (Continued)

Items of the Multiple-Choice Section	State Universities	State Colleges	State Teachers Colleges	Municipal Universities	Private Colleges
7. <u>Normal Probability Curve</u>					
Frequency polygons vs. Norm. Prob. Curve	29	32	25	17	35
Areas around the Mean	21	22	19	8	30
Frequency polygons and Teachers grades	76	89	80	69	89
8. <u>Reliability</u>					
Coefficient of Correlation	30	44	28	26	33
Relative Variability of distribution	18	13	23	57	31
9. <u>Frequency Polygons</u>	75	89	86	69	82

TABLE XXVII

THE AVERAGE PER CENT OF ERRORS OF COLLEGES AND UNIVERSITIES ON THE ITEMS OF THE STATISTICAL CONCEPTS OF THE MULTIPLE-CHOICE SECTION OF THE COMPREHENSIVE TEST

Statistical Concepts	Average Per Cent	
1. <u>Frequency Polygons</u>	80	80
2. <u>Skewness</u>		
Position of mode	48	
Position of Median	43	
Teachers' grades in per cent	73	52
Sigma versus skewness	45	
3. <u>Probable Error</u>		
Relation of P. E. and Sigma	61	
Corr. Coeff. and probable error	32	48
P. E. defined	51	
4. <u>Normal Probability Curve</u>		
Frequency Polygons vs. Normal Probability Curve	28	
Areas around the mean	20	43
Frequency Polygons and Teachers' Grades	81	
5. <u>Tests</u>		
Reliability	43	43
6. <u>Central Tendency</u>		
Mean	29	
Mode	46	38
7. <u>Reliability</u>		
Coefficient of Correlation	32	
Rel. Variability of Distribution	28	30

TABLE XXVII (Continued)

Statistical Concepts	Average Per Cent	
8. <u>Probability</u>		
Coin Tossing	29	26
Areas under Curves	22	
9. <u>Series</u>		
Continuous	21	21

TABLE XXVIII

THE AVERAGE PER CENT OF CLASS FAILURES OF EACH GROUP OF COLLEGES AND UNIVERSITIES ON THE TOPICS OF THE MULTIPLE-CHOICE SECTION OF THE COMPREHENSIVE TEST

Topics of the Multiple-Choice Section	State Universities	State Teachers Colleges	State Colleges	Municipal Universities	Private Colleges
1. Probability	25	25	22	25	28
2. Skewness	54	52	51	43	56
3. Probable Error	43	50	53	35	52
4. Measures of Central Tendency	41	40	40	32	37
5. Tests	52	35	26	48	52
6. Series	22	69	25	28	21
7. Normal Probability Curve	45	41	47	34	51
8. Reliability	30	39	29	39	30
9. Frequency Polygons	75	86	89	69	82

TABLE XXIX

THE AVERAGE PER CENTS OF CLASS FAILURES OF COLLEGES AND
UNIVERSITIES ON THE STATISTICAL CONCEPTS OF THE MULTIPLE-
CHOICE SECTION OF THE COMPREHENSIVE TEST

Statistical Concepts	Average Per Cent
1. Frequency Polygons	80
2. Skewness	51
3. Probable Error	47
4. Normal Probability Curve	44
5. Tests	43
6. Measures of Central Tendency	38
7. Reliability	33
8. Series	33
9. Probability	25

Match-Answer Section.- There are sixteen statements to be fitted together. The statistical concepts represented are:

1. Measures of Central Tendency.
2. T-Scores.
3. Correlation.
4. Reliability of Measures.
5. Probable Error.
6. Frequency Tables.
7. Graphs - Histogram.
8. Curves.
9. Intervals.

The failures of the match-answer section range from twenty-five to seventy-five per cent of the classes. The topic of central tendency shows the highest per cent of failure, while in the true-false section, it ranks second highest. Table XXX, a sample sheet, presents data which show a very wide range in the variation of the per cent of error for the mean. The range is from twenty-five to eighty-one per cent.

The final summaries of the results of the match-answer section are given in Tables XXXII⁷ and XXXIV⁸. These tables are derived from the data which form the basis for the construction of Tables V and VI of Appendix D. Tables XXXII and XXXIV respectively summarize Tables XXXI and XXXIII.

7 Appendix D, Table V, P. 251

8 Appendix D, Table VI, P. 258

TABLE XXX

THE MATCH-ANSWER SECTION OF THE COMPREHENSIVE TEST FOR
THE PER CENTS OF THE ERRORS FOR EACH ITEM OF A STATIS-
TICAL CONCEPT AND THE PER CENTS OF ERRORS ON EACH CON-
CEPT FOR EACH COLLEGE CLASS

State Universities	No. in Class	Measures of Central Tend.		Correlation		
		Mean	Harmonic Mean	Coeffl- cient of Assoc.	Spearman's Foot-rule	Zero order of coef.
1. <u>Arizona</u>	9					
(a) No. of errors		8	8	8	3	0
(b) All possible errors		18		27		
(c) Per cent of errors per item		88.9	88.9	88.9	3313	0.0
(d) Av. per cent of er- ror on the statisti- cal concept for class			88.9			40.7
2. <u>Idaho</u>	7					
(a) No. of errors		7	6	7	1	7
(b) All possible errors		14		21		
(c) Per cent of errors per item		100.0	85.7	100.0	14.3	100.0
(d) Av. per cent of er- ror on the statisti- cal concept for class			93.0			71.5
3. <u>Illinois</u>	14					
(a) No. of errors		1	2	3	3	2
(b) All possible errors		28		42		
(c) Per cent of errors per item		7.1	14.6	21.4	21.4	14.6
(d) Av. per cent of error on the statistical concept for class			10.7			19.0

TABLE XXXI

THE AVERAGE PER CENT OF ERRORS OF EACH GROUP OF COLLEGES
AND UNIVERSITIES ON EACH ITEM OF THE TOPICS OF THE MATCH-
ANSWER SECTION OF THE COMPREHENSIVE TEST

Items of the Match-Answer Section	State Uni- versities	State Col- leges	State Teachers Colleges	Municipal Universities	Private Colleges
1. Central Tendency					
(a) Mean	75	83	78	89	79
(b) Harmonic Mean	75	58	67	68	72
2. Correlation					
(a) Coefficient of Association	80	64	95	67	85
(b) Spearman's foot-rule	50	41	69	60	69
(c) Zero order of coef- ficient	60	66	73	52	76
3. Curves					
(a) Histogram	30	34	34	46	27
(b) Ogive	28	22	18	25	24
(c) Pi diagram	33	27	28	42	35
4. Graphs					
(a) Histogram	30	34	25	41	27
(b) Frequency Polygon	34	45	32	47	40
5. Frequency Tables	44	38	48	47	30
6. T-Scores	66	73	76	61	74
7. Reliability of Measure					
(a) Sigma Measures	61	55	59	53	50
(b) Standard error	54	42	57	38	50
8. Intervals	28	29	24	28	16
9. Probable Error	41	32	57	37	48

TABLE XXXII

THE AVERAGE PER CENTS OF ERRORS OF COLLEGES AND UNIVERSITIES ON THE ITEMS OF THE STATISTICAL CONCEPTS OF THE MATCH-ANSWER SECTION OF THE COMPREHENSIVE TEST

Statistical Concepts	Average Per Cent	
1. <u>Central Tendency</u>		
(a) Mean	81	75
(b) Harmonic Mean	68	
2. <u>T-Scores</u>	70	70
3. <u>Correlation</u>		
(a) Coefficient of Association	78	67
(b) Spearman's foot-rule	58	
(c) Zero order of coefficient	65	
4. <u>Reliability of Measure</u>		
(a) Sigma measures	56	52
(b) Standard error	48	
5. <u>Probable Error</u>		
(a) Value of Sigma $a = .6745$	43	43
6. <u>Frequency Tables</u>	41	41
7. <u>Graphs</u>		
(a) Histogram	31	36
(b) Frequency Polygon	40	
8. <u>Curves</u>		
(a) Histogram	34	30
(b) Ogive	22	
(c) Pi Diagram	33	
9. <u>Intervals</u>		
(a) Class Interval defined	25	25

TABLE XXXIII

THE AVERAGE PER CENT OF THE CLASS FAILURES OF EACH OF
THE GROUPS OF THE COLLEGES AND UNIVERSITIES ON THE
TOPICS OF THE MATCH-ANSWER SECTION OF THE COMPREHEN-
SIVE TEST

Topics of the Match-Answer Section	State Uni- versities	State Teachers Colleges	State Colleges	Municipal Universi- ties	Private Colleges & Universi- ties
1. Measures of Central Tendency	76	73	71	60	75
2. Correlation	63	77	56	56	77
3. Curves	31	36	31	41	29
4. Graphs	35	34	40	44	34
5. Frequency Tables	44	37	38	47	30
6. T-Scores	65	74	72	61	74
7. Reliability of Measures	54	63	42	51	50
8. Intervals	28	24	29	31	11
9. Probable Errors	41	57	29	42	48

TABLE XXXIV

THE AVERAGE PER CENT OF CLASS FAILURES OF COLLEGES AND
UNIVERSITIES ON THE STATISTICAL CONCEPTS OF THE MATCH-ALL
ANSWER SECTION OF THE COMPREHENSIVE TEST

Statistical Concepts	Average Per Cent
1. Measures of Central Tendency	71
2. T-Scores	69
3. Correlation	66
4. Reliability of Measures	52
5. Probable Errors	43
6. Frequency Tables	39
7. Graphs	37
8. Curves	34
9. Intervals	25

The median of failure for the true-false section is forty-one per cent; for the multiple choice, 41.25 per cent; and, for the match-answer, 42.50 per cent. These data lead to the inference that approximately fifty-eight per cent of the group passed. However, a failure of 41.6 per cent is not in accord with the modern spirit of pedagogy, which recommends three to five per cent of a class as a sufficient number of failures.

The average per cent of the failures for the three sections ranges from twenty-six to seventy-six.

Problem Section.- The problem section consists of thirteen problems which are applications of the following statistical concepts:

A. Measures of Central Tendency

1. Arithmetic Mean

2. Median

B. Measures of Dispersion

3. Standard Deviation

4. Mean Deviation

5. Quartile Deviation

C. Straight Lines

6. Plotting a straight line

7. Equation of a Straight Line

D. 8. Probable Error of the Correlation Coefficient

E. 9. Coefficient of Variability

F.10. Percentile Rank

G.11. Random Sample

12. Pearson's Product Moment Formula

13. Spearman's Foot-rule or Rank Difference Method

An analysis has been made of the possible errors in each problem. The number of correct, incorrect, and omitted problems has been tabulated for each class. The per cent of error for the items of a problem may look incorrect in comparison to the

per cent of the class failing. For illustration, suppose there are twenty in the class, all of whom attempt a problem. Five fail to get it. The per cent of the class failing is twenty-five per cent. The problem has eight possibilities for error; seven mistakes are made; the total possibilities for errors are one hundred sixty; therefore, the per cent of error for the items is 4.3, which is a contrast to the per cent of the class failing.

In the subsequent tables, data are secured from which the per cents of the items wrong and the per cents of classes failing are obtained for all the colleges.

In the following discussion, some phase of each problem which caused difficulty is presented.

Discussion of Problems

1. Arithmetic Mean.— In the first problem, the Arithmetic Mean is to be found by the short method. The part of the solution which gives the highest per cent of error is the "Guessed Mean". Some students placed it at the beginning, and others at the end of an interval, rather than at the mid-point.

Other mistakes are due to incorrectly stated formulas, or if a correct formula was given, the student was unable to apply it. On some papers, the work of the problems indicates no definite knowledge of the subject. Some made no distinction between the

short method of solving for the true mean and for finding the average.

2. The Median.-- The source of mistakes is due to faulty interpolation and to the choosing of the wrong limit of the interval to which to add the correction. That is, there was no definite understanding of class and score intervals, and of equal distribution over the interval.

3. Standard Deviation.-- In the solution for standard deviation, there are many opportunities for mistakes. The correction to be subtracted was often confused with the correction for the true Mean. The majority of the mistakes in this problem are arithmetical rather than statistical. The arithmetical mistakes are found either in the summation of the frequencies times the differences (fd 's), the division of the number of terms (N), or in squaring the correction (c). Other mistakes are due to the omission of class interval, the incorrect algebraic sum of the fd 's squared, and to the squaring of the frequencies instead of the differences.

4. Mean Deviation.-- The problem involving the mean deviation was omitted by many. Twenty-four per cent of those who attempted Mean Deviation, stated the formula but were unable to apply it. The quantities N_a and N_b stand for the sums of the frequencies above and below the zero point, respectively. If N_a and N_b are incorrect, it is often due to the fact that the

students did not know to which one they should add the frequencies which are opposite the zero of the differences. Another mistake was made when the correction was multiplied by zero; the fact that zero times anything is zero, was not used.

5. Quartiles.— Thirty-one per cent of the classes failed in interpolation of the quartiles. Some of the same students who were able to interpolate correctly for the Median, were unable to interpolate for the Quartile.

6. and 7. The Straight Line.— The results of the two problems involving the straight line show that there are seventeen per cent who did not know where to place the coordinates of the points. Thirty-two per cent exchanged x and y when plotting them. Forty-three per cent were unable to state the equation of a straight line. Of those who were able to state the equation, forty-eight per cent failed in the substitution of values for the letters.

8. Probable Error of Correlation.— In the problem based on the probable error of correlation, thirteen per cent of the mistakes are due to incorrect handling of the decimal point. As a rule, the formula was stated correctly. Only six per cent of those stating the formula did not know how to proceed.

9. Coefficient of Variability.— Seventy-five per cent of the students failed on the question involving coefficient of variability. The majority of those failing did not state the formula.

10. Percentile Rank.-- Over fifty per cent of the students omitted the problem involving Percentile Rank. Those who worked the problem had various ways of arriving at the result.

11. Random Sample.-- The process for working problems illustrating the principle of Random Sample, was known in most of the cases, but many of the students were not able to give the per cent for the areas that are found about the mean or median in a normal probability curve.

12. Pearson's Product Moment Formula.-- The problem based on Pearson's Product Moment formula was solved in many ways. Many of the students have the work correct up to the taking of the square root in the last step. The failure to extract the square root correctly led one student to say that there was no correlation.

13. Spearman's Foot Rule or Pearson's Rank Difference Method.-- The last problem was solved by either Spearman's Foot Rule or the Rank Difference method. Most of the students used the latter method as a means of solution. Many mistakes were made in the rankings, the gains, and in the differences. The majority of the students were able to state one of the formulas, but it is evident from the mistakes in ranking, gains, or differences that the meaning of these terms was not clear. When one-half of the students fail on the problem section, it is evident that both authors and teachers should give more problems for drill purposes.

Table XXXV is a sample page showing the method of analyzing the problems in an effort to find the cause of error.

Tables XXXVI, XXXVII, XXXVIII, and XXXIX⁹ summarize the findings on the problems. The concepts are ranked according to descending per cent of failure.

The median for failure of the problem section is sixty-seven per cent, as compared with approximately forty-one per cent for the first three sections. The range is from forty-five to ninety-eight. This compares unfavorably with the other sections where the range is from twenty-six to seventy-six.

Table XL shows how the four sections compare in average per cent of difficulty in the handling of the various concepts.

⁹

Appendix D, Table VII, P. 264
Appendix D, Table VIII, P. 268
Appendix D, Table IX, P. 271

TABLE XXXV

RESULTS OF THE ANALYSIS OF THE ERRORS OF THE PROBLEM
SECTION STATED IN PER CENT AND THE PERCENTAGE OF CLASS
FAILURE ON EACH PROBLEM

STATE TEACHERS COLLEGES				
Measures of Central Tendency	Washington	Per Cent of Error for each Division of Problem	Wilson	Per Cent of Error for each Division of Problem
No. in class	9		28	
No. attempting problem	9		28	
No. wrong	3		11	
Per cent of class failing in the problem		33.3		39.3
Per Cent of class omitting the problem		0		0
Total Per Cent of class failing on problem		33.3		39.3
<u>Errors Pert. to Median</u>				
Possible Errors	108		336	
(a) Tabulation	1	1		
(b) Formula				
(c) Number				
(d) Guessed Median				
(e) Cl. Int. Omit				
(f) Class Interval			1	.3
(g) Score to which to add correction				
(h) Interpolation	5	4.6	4	1.2
(i) Arithmetically	1	1		
(j) Statistically			1	.3
(k) Lower limit of Inter- val used				
(l) Mid-point of Interval used				
Total Per Cent of Error in Problem		6.6		1.8

TABLE XXXVI

AVERAGE PER CENT OF ERRORS FOR EACH DIVISION OF EACH
PROBLEM OF THE PROBLEM SECTION OF THE TEST FOR ALL
COLLEGES AND UNIVERSITIES (Each Division regarded as
a Unit)

Central Tendencies	Colleges and Universities	
Errors Pertaining to:	Average Per Cent	
<u>Arithmetic Mean</u>		
(a) Tabulation	0.1	7.9
(b) Formula	6.4	
(c) Guessed Mean	18.0	
(d) Alg. sum of $fd's.$	15.7	
(e) Alg. sum of $\frac{fd}{N}$	4.4	
(f) Alg. signs	1.9	
(g) Class interval	3.6	
(h) Class interval omit.	10.1	
(i) Number	2.5	
(j) Correction	16.6	
<u>Median</u>		
(a) Tabulation	3.0	3.3
(b) Formulas	5.8	
(c) Number	0.5	
(d) Guessed median	4.4	
(e) Class Interval omit.	0.9	
(f) Class Interval	1.4	
(g) Score to which to add correction	2.7	
(h) Correction wr. arith- metically	7.9	
(i) Correction wr. statis- tically	10.0	
(j) Lower limit of interval used	4.4	
(k) Mid-point of interval used	2.4	
(l) Interpolation	6.2	

TABLE XXXVI (Continued)

Measures of Dispersion	Colleges and Universities	
Errors Pertaining to:	Average Per Cent	
<u>Standard Deviation</u>		
(a) Arithmetic Correction	6.8	5.5 for each
(b) Statistical Correction	10.1	
(c) C^2 mult. by Class Int.	2.4	
(d) C^2 omitted	1.3	
(e) Number	4.8	
(f) Class Interval omitted	12.5	
(g) Sq. root not taken	2.9	
(h) Sq. root	2.3	
(i) Alg. sum of fds.	5.0	
(j) Alg. sum of fd's squared	15.0	
(k) <u>Alg. sum of fd's</u>	5.9	
N		
(l) Alg. signs	1.1	
(m) Long method	1.8	
<u>Mean Deviation</u>		
(a) Arithmetic correction	1.0	7.1
(b) Statistical correction	1.7	
(c) C not added or subtracted from sq. root of N	6.6	
(d) Class Int. omitted	9.3	
(e) Process not understood	24.0	
(f) Formula	5.3	
(g) Mean	2.0	
(h) N_a and N_b	11.4	
(i) Algebraic sum of fd's	2.5	
<u>Q_1 and Q_3 and S. I. Q. R.</u>		
(a) Formula	1.3	9.2
(b) Process	15.1	
(c) Number	1.4	
(d) Interpolation	31.1	
(e) S. I. Q. R.	6.4	
(f) Q_1 and Q_3 added	5.7	
(g) Difference not div.	4.3	

TABLE XXXVI (Continued)

Measures of Dispersion Straight Line, etc. Errors Pertaining to:	Colleges and Universities Average Per Cent	
<u>Coefficient of Variability</u>		
(a) Process	13.0	3.6
(b) Formula	4.2	
(c) 100 omitted	0.4	
(d) Decimals	0.0	
(e) Division	0.6	
<u>Straight Line</u>		
(a) Coordinates x and y exchanged	31.9	34.8
(b) Do not know where to place the points	16.9	
(c) Equation	42.6	
(d) Substitution of values	47.7	
<u>Spearman's Foot-rule and Rank Difference</u>		
(a) Process	6.0	15.8
(b) Ranking	7.2	
(c) Differences	25.5	
(d) Gains	33.6	
(e) Sum of squares	3.1	
(f) Squares	3.5	
<u>Random Sample</u>		
(a) Process	23.9	15.4
(b) Areas in per cent	21.2	
(c) Arithmetic (Made in Subtraction)	1.1	
<u>Percentile Rank</u>		
(a) Process	50.9	9.4
(b) Formula	2.3	
(c) 100 omitted	0.0	
(d) Average omitted	1.1	
(e) Rank	1.8	
(f) 2 omitted	0.2	

TABLE XXXVI (Continued)

Correlation	Colleges and Universities	
Errors Pertaining to:	Average Per Cent	
<u>Probable Error of Coefficient of Correlation</u>		
(a) Formula	3.6	
(b) Process not known	6.0	
(c) .6745 omitted	9.0	
(d) Division of decimal by 10	6.2	4.9
(e) Mult. of decimal	5.6	
(f) Subt. of decimal from interger	1.7	
(g) .9 squared	4.4	
(h) sq. rt. not taken	2.9	
<u>Pearson's Product Moment</u>		
(a) Formula	5.0	
(b) Average	0.3	
(c) Average omitted	0.0	
(d) dx	3.1	
(e) dy	2.8	
(f) sq. of sigma xy	6.1	3.2
(g) sigma x ²	8.0	
(h) sigma y ²	7.7	
(i) sq. root of factors taken separately	0.2	
(j) Mult. of factors	2.0	
(k) Arith. sq. root	0.4	
(l) Sq. root under radical in the denominator	2.2	

TABLE XXXVII

THE AVERAGE PER CENTS OF ERRORS FOR ALL THE ITEMS OF
EACH PROBLEM FOR ALL THE COLLEGES AND UNIVERSITIES
(Each Item Regarded as a Unit)

Problems	Per Cent of Failure
1. Equation of a Straight Line	45.1
2. Plotting of Points for a Straight Line	29.4
3. Spearman's Foot-rule or Rank Difference	15.8
4. Random Sample	15.4
5. Percentile Rank	9.4
6. Q_1 and Q_3 and S. I. Q. R.	9.2
7. Arithmetic Mean	7.9
8. Mean Deviation	7.1
9. Standard Deviation	5.5
10. Probable Error of Coefficient of Correlation	4.9
11. Coefficient of Variability	3.6
12. Median	3.3
13. Pearson's Product Moment	3.2

TABLE XXXVIII

DISTRIBUTION FOR ALL COLLEGES AND UNIVERSITIES OF THE
AVERAGE PER CENT OF ERRORS FOR EACH ITEM OF THE STATIS-
TICAL CONCEPTS IN THE PROBLEM SECTION OF THE COMPREHEN-
SIVE TEST

(Each item regarded as a unit)

Statistical Concepts	Per Cents of Failure
1. Central Tendency	5.6
2. Measures of Dispersion	5.1
3. Straight Line	34.8
4. Percentile Rank	9.4
5. Random Sample	15.4
6. Correlation	7.8

TABLE XXXIX

THE AVERAGE PER CENT OF CLASS FAILURE FOR THE UNIVERSITIES AND COLLEGES ON EACH PROBLEM OF THE PROBLEM SECTION OF THE COMPREHENSIVE TEST

Statistical Concepts	Average Per Cent	
A. Measures of Central Tendency		
1. Mean	46.0	45.0
2. Median	44.0	
B. Measures of Dispersion		
3. Standard Deviation	51.0	68.0
4. Mean Deviation	82.0	
5. Quartile Deviation	65.0	
6. Coefficient of Variability	75.4	
C. Correlation		
7. Probable Error of Correlation	72.1	78.2
8. Pearson's Product Moment	75.9	
9. Spearman's Foot-rule and Rank Difference	86.7	
D. 10. Random Sample	56.7	
E. 11. Percentile Rank	97.7	56.7
F. Straight Line		
12. Plotting	49.8	67.4
13. Equation	85.0	
Ranked Order		
1. Percentile Rank	98.0	
2. Correlation	78.0	
3. Measures of Dispersion	68.0	
4. Straight Line	67.0	
5. Random Sample	57.0	
6. Measures of Central Tendency	45.0	

TABLE XL

RANKING OF STATISTICAL CONCEPTS FOR THE TRUE-FALSE,
MULTIPLE-CHOICE, MATCH-ANSWER, AND PROBLEM SECTION
ACCORDING TO AVERAGE PER CENT OF DIFFICULTY

Statistical Concepts	True-False	Mult.-Choice	Match-Answer	Problem
<u>1. Central Tendency</u>				
(a) Mean	55	29	81	46
(b) Median	43			44
(c) Mode	57	46		
(d) Harmonic Mean			68	
<u>2. Measures of Dispersion</u>				
(a) Mean deviation	17			82
(b) Standard deviation	40			51
(c) Q_1 and Q_2 , S.I.Q.R.	39			65
(d) Coefficient of Variability				75
<u>3. Correlation</u>				
(a) Coefficient of Assoc.			78	
(b) Spearman's Foot-rule and Rank Difference	56		58	87
(c) Pearson's Product Moment	46			76
(d) Zero Order of Coef.			65	
(e) Coef. of alienation	42			
(f) Limits of Correlation	29			
(g) Magnitude of Corr.	36			
(h) Regression lines	19			
(i) Partial Corr.	66			
(j) Corr. Coef. and Regression lines	69			
(k) Coef. of attenuation	41			
(l) Corr. ratio	55			
(m) Negative correlation	32			
(n) Regressed scores	22			
(o) Errors of Prediction	36			
(p) Probable error of correlation				72

TABLE XL (Continued)

Statistical Concepts	True-False	Mult. Choice	Match Answer	Problem
4. Scores	66			
5. <u>Tests</u>				
(a) Validity	60			
(b) Reliability	38	43	70	
(c) T-Scores				
6. <u>Probability</u>				
(a) Defined	49			
(b) Coin Tossing		29		
(c) Areas under curves		22		
7. <u>Intervals</u>				
(a) Limits of score interval	57			
(b) Class Intervals	40			
(c) Class Interval defined			25	
(d)				
8. <u>Series</u>				
(a) Discrete and continuous	38	21		
9. <u>Reliability</u>				
(a) Median as a Reliable Coef. of reliability	44			
(b) Standard error of Difference	47			
(c) Reliability of Mean	59			
(d) Variation of Standard Error	35			
(e) Reliability and Spread	37			
(f) Reliability formulas and Measures	56			
(g) Squares of Deviation about the Mean	16			
(h) True measure is Arithmetic Mean	44			
(i) Comparable Measures	14			
(j) Coefficient of Correlation		32		72
(k) Variability of Distribution		28		
(l) Sigma Measures			56	

TABLE XL (Continued)

Statistical Concepts	True-False	Mult. Choice	Match Answer	Problem
*(m) Sigma Measures			48	
(n) Reliability formulas and measures	56			
10. <u>Interpretation of Curves</u>				
(a) Curvelinear	48			
(b) Deduction from a Normal Probability Curve	57			
(c) Symmetrical	23			
(d) Ogive	17		22	
(e) Curve of error	21			
(f) Bilaterally Symmetrical	20			
(g) Curve defined	49			
(h) Histogram			34	
(i) Pie Diagram			33	
11. <u>Percentile Rank</u>				
(a) Defined	45			
(b) Common Basis	38			
(c) Problem				98
12. <u>Graphs</u>				
(a) Histogram	31		31	
(b) Frequency Polygon			40	
13. <u>Skewness</u>				
(a) Zero skewness	24			
(b) Positive skewness	34			
(c) Position of Mode		48		
(d) Position of Median		43		
(e) Teachers' grades in per cent		73		
(f) Sigma versus skewness		45		
14. <u>Sampling</u>				
(a) Character of	13			
(b) Sampling and deduction	43			
(c) Problem				57

* On preceding page.

TABLE XL (Continued)

Statistical Concepts	True-False	Mult. Choice	Match-Answer	Problem
15. <u>Probable Error</u>				
(a) Relation of P. E. and Sigma		61		
(b) Corr. Coeff. and Prob. Error		32		
(c) P. E. defined		51		
(d) Value of sigma a = .6745			43	
16. <u>Straight Line</u>				
(a) Plot points				50
(b) Equation				85
17. <u>Normal Probability Curve</u>				
(a) Frequency Polygons v. Normal Probability Curve		28		
(b) Areas around the Mean		20		
(c) Frequency Polygons and Teachers grades		81		
18. <u>Frequency Tables</u>			41	

Measures of Central Tendency

Since the Measures of Central Tendency are among the most commonly found statistical concepts in all the texts, and represented in all the sections of the test, the high per cent of failure of all the colleges and universities is significant. The following data allocate the per cent of failure for the Measures of Central Tendency throughout the test:

Sections of the Test	Per Cent of Failure
1. True-False	46
2. Multiple-Choice	38
3. Match-Answer	71
4. Problem	45

These data give an average of fifty per cent failure for all colleges and universities on the concepts of the Measures of Central Tendency.

The median, seventy-four, of the raw scores on the test is fifty-one per cent of the highest possible score; namely, one hundred forty-five. The average per cent of failure on the Measures of Central Tendency being fifty, the average per cent of success is fifty. If the per cent of success in the Measures of Central Tendency is indicative of the success in the remainder of the test, the median of the raw scores for the entire test, which represents fifty-one per cent of the test answered correctly, is comparable to the average per cent of success or failure in the Measures of Central Tendency.

Table XLa states the statistical concepts that cause the highest per cents of failure in the various sections of the test, and is referred to in paragraph two of the summary .

TABLE XIa

STATISTICAL CONCEPTS WITH THE HIGHEST PER CENT OF FAILURE

CONCEPTS	TRUE- FALSE	MULT. CHOICE	MATCH ANSWER	PROBLEM
1. <u>Correlation</u>				
Coef. of Association			78	
Coef. of Relation	69			72
Correlation Ratio	55			
Partial Correlation	66			
Prob. Er. of Corr. Coef.				72
Pearson's Prod. Mom. Form.				76
Zero Order of Corr. Coef.			65	
Spearman's Foot Rule and Rank Difference	56		58	87
2. <u>Measures of Central Tendency</u>				
Mode	57			
Mean	55		81	
Harmonic Mean			68	
Mean Deviation				82
Standard Deviation				51
3. <u>Measures of Dispersion</u>				
Reliab. of the Mean	59			
Q_1 and Q_2 and S.I.Q.R.				65
Teachers Grades and Frequency Curve		81		
Reliability of Formulas and Measures	56	61		
Sigma Measures			56	
Coef. of Variability				75
Relation of Probable Er- ror and Sigma				85
4. <u>Scores</u>				
Scores	66			
Limits of Score Intervals	57			
T-Scores			70	
5. <u>Percentile Rank</u>				98
6. <u>Sampling</u>				57
7. <u>Straight Line</u>				
Equation of Str. Line				85
Plotting Points				50
8. <u>Tests</u>				
Validity of Tests	60			

Summary

At the beginning of this chapter, there are stated eight queries, the answers to which are derived from the analysis of results obtained from the test administered to the students of forty-eight colleges and universities. A brief summarization of the resultant conclusions follows:

1. Relation of Raw Scores of Test and Failures on Concepts.-- The relationship between the average of the medians of the raw scores of the test and the average per cents of failure on the concepts is very close. The median of the colleges and universities is seventy-four (73.9) out of a hundred forty-five possible correct answers, that is, a little more than fifty per cent of the students succeeded in answering fifty per cent of the test. The median for failure on the four sections of the test is forty-eight per cent, which indicates also that approximately fifty per cent of the students taking the test were successful.

2. Statistical Concepts with Highest Scores for Failure.-- The statistical concepts with the highest scores for failure are tabulated in Table XLa, on the preceding page. The per cents of error range from fifty-five to ninety-eight per cent. The topics cover a wide range of textbook material of a course of elementary statistics.

3. Distribution of Failures.- The failures and difficulties in statistical method are general and cover the entire range from the simplest concepts to the most general concepts. There is no evidence that the difficulties are confined to any specific part of the subject. Table XL¹¹ shows the wide range of concepts which are not mastered by the students.

4. Variation of Statistical Concepts in the Course of Elementary Statistics.- The analysis of the test does not show necessarily that there are a different number of concepts included in the course offered at the different colleges and universities. The test does show, however, that there is a difference in the intensity with which each topic is treated, the terminology and symbols employed, and methodology of presentation of the subject to the classes. The differences in intensive treatment may be due to the assumption that elementary statistics can be mastered in a two or three hour course for one semester. The number of hours given to the course of elementary statistics varies from two to five per week. The semester's credit for the subject shows a like variation. The analysis of the test indicates that the schools giving more time to the subject are obtaining better results from the beginning statistical classes.¹² The minimum time should be four or five periods a week for one semester, as there is a fairly

¹¹ Table XL, P. 135

¹² Table XVI, P. 87 and Table XVIII, P.96

definite content for the course in statistics. If part of this content is not taught, the course is not complete and is of necessity inadequate. It seems, therefore, that if the content ordinarily presented is to remain constant, the time for the mastery of the subject must be extended.

5. Success of Students on Various College Levels.-

Upper-classmen and graduates greatly excelled the first and second year students in scores. The highest scores are located among the graduate classes.

13
6. Mathematical Background.- In Chapter II are listed the variable mathematical prerequisites for the course. The work on the problem section of the test demonstrates not only varied mathematical preparation, but in some cases also a lack of such preparation for a course of elementary statistics. Inasmuch as seniors and graduate students present the highest scores on the test, it may be deduced that one element of their success on the test is attributable to a better background in mathematics than is possessed by the first and second year students. The mathematical mistakes on the test involve arithmetic, and, either a complete course of advanced algebra, or college algebra.

7. Methodology.- There is apparently no agreement among the forty-eight colleges and universities on the classroom presentation of statistical concepts. For instance, the work found on the test papers indicates a variation of the formula to be used in solving the median, although the majority of the texts use the same method. The work of the students on the Arithmetic Mean, problem I, indicates in many instances no knowledge of the short method of solution of the mean.

8. Success in The Course of Elementary Statistics.- The results from the test clearly show that a large per cent of the students have mastered neither the theory nor the application of statistical method. Many know the formulas but are unable to use them. Others can not compute results because of their inability to manipulate the simplest algebraic formulas. Therefore, the test shows that for most students, three things are not being done well:

- " (a) The mastery of the theory.
- (b) Knowledge of where the theory is to be applied.
- (c) Mechanical manipulation of simple mathematical formulas.

Since the arrangement of statistics is logical, and the presentation has a fairly definite order, the evidence points convincingly to the fact that the subject is being mastered to a lesser degree than other subjects of presumably the same difficulty.

Suggestive Remedial Measures

The writer respectfully submits the following remedial measures, deduced from the analysis of the test:

1. A parallel course of related mathematics for all students of elementary statistics.
2. Four to five hours per week for the course of elementary statistics.
3. Some agreement by the colleges and universities on the important concepts, and what phases of these should be presented to the classes.
4. The selection and the teaching of those formulas which enable the student to derive correct results in the shortest possible way.
5. Uniform terminology and symbolism.

CHAPTER V

STATISTICAL CONCEPTS FOUND MOST FREQUENTLY IN CURRENT LITERATURE

Techniques in Securing Data

Periodical literature, for the months of December, 1932, and January, 1933, was examined to ascertain the statistical concepts in current use. The only exception to this procedure was the inclusion of those quarterly publications which were issued in November, 1932, and February, 1933. The number of periodicals examined was five hundred. The articles read came from eighty-nine different periodicals and newspapers. The bibliography indicates the investigation is not limited to any one type of current literature.

Statistics in current literature enters into every known relationship of the private individual, of the state, and of the nation. These fields, for convenience, are grouped categorically into vital, business, commercial, industrial, religious, medical, governmental, social, scientific, and educational. The latter term includes educational classifications of all academic groups, as well as all experimentations with subjects of school curricula.

The statistical measures found in common use in the journals, are central tendency, dispersion, reliability, correlation, graphic representation, and derived scores. These are the

same measures that are found in Table XI, Chapter II. This tabulation also coincides with the results of a study made by Harold A. Edgerton (2), who investigated four volumes each of five educational periodicals to see which statistical concepts appeared the most frequently. Among the first sixteen items, according to frequency of occurrence, are per cent, median, arithmetic mean, standard deviation, range, the coefficient of correlation, and the validity of tests. These same measures are included in the first sixteen in a list of minimal statistical essentials prepared by Brown (1:99), after a study of one volume each of fifteen educational journals.

Increasing Use of Statistics

The increasing use of statistics as a tool in the educational world is clearly brought out by Harvey Lehman and Paul Witty (3:175-184), who ascertained that of two hundred four doctors' dissertations published during the past twenty years by the Teachers' College of Columbia University, sixty-five per cent employ statistics and only twenty-four per cent use foreign languages. The present trend toward increased utilization of statistics in education is illustrated further by the fact that the per cent of doctors' dissertations which were published as contributions from teachers' colleges to education, employing statistics as the tool of investigation for the years 1905 to 1915,

was seventy-eight; and at the present time, four out of every five teachers' college dissertations employ statistics. Mr. Witty says that the masters' theses recently written in the Department of Education in the University of Kansas almost invariably employ statistical devices to some degree, and he thinks that the University of Kansas is not unique in this particular.

Walker (7:609) states the following: "More and more the modern temper relies upon statistical method in its attempt to understand and to chart the workings of the world in which we live." Whalen (8:609-11), in an article, "Cult of Statistics", says, "One of the distinguishing marks of the present age is the tendency to express ideas statistically."

During the summer of 1932, Holzinger of Chicago found that out of a class of one hundred, only ten per cent were taking statistics to acquire just statistical facts. The other ninety per cent were taking the course in order to be able to read articles in educational publications intelligently. Tyler (6:205-11), of the University of North Carolina, in his statistics classes found the same proportion of purposes for studying statistics. He went a step further and examined three textbooks, in which he found only three pages devoted to discussions of the conditions under which a given statistical measure is appropriately used. Magazine articles cannot be satisfactorily interpreted,

unless the reader recognizes that the statistical assumptions have a sound basis for use in that particular article.

The statistical measures found in the eighty-nine articles of current literature are tabulated in Table XLI. In Table XLII, which follows Table XLI, the statistical concepts are ranked according to the descending frequencies.

TABLE XLI
THE STATISTICAL CONCEPTS FOUND IN EIGHTY-NINE
ARTICLES OF CURRENT LITERATURE

Statistical Concepts	Frequencies	Statistical Concepts	Frequencies
<u>Measures of Central Tendency</u>		<u>Reliability of Measures</u>	
Mean	9	PE _n	1
Median	13	PE _{diff}	1
Mode	1	O _{diff}	1
Geometric Mean	1	Index of Reliability	2
Harmonic Mean	2	Coefficient of Reliability	1
Average	16	Reliability of Average	1
<u>Measures of Variability</u>		<u>*Indices</u>	4
Standard Deviation	4	Living index price	1
Mean Deviation	2	Wage index	4
Quartiles Q ₁ and Q ₃	3	Indices of cost	1
S. I. Q. R.	1	Link relatives	1
Range	3	Index of rail-road wages	1
Coefficient of Variability	17		
Probable error	2		

* No mention of the kinds of indices used.

TABLE XLI (Continued)

Statistical Concepts	Frequencies	Statistical Concepts	Frequencies
<u>*Correlation</u>		<u>**Index of num-</u>	
Correlation	8	bers of	
Regression Coeffi-		producers	1
cient	2	Consumers'	
Regression equation	3	goods	3
Partial Correlation	3	<u>Skewness</u>	2
Multiple Correla-		<u>Percentiles</u>	1
tion	6	<u>Probability</u>	3
Correlation Coeffi-		<u>Random Sample</u>	3
cient	7	<u>Series</u>	
Contingency Coeffi-	2	Continuous	1
cient		<u>Straight Lines</u>	
Attenuation Coeffi-	1	Ordinates	2
cient	2	Abcissa	2
Prediction		<u>Percentage</u>	57
Pearson's Product-	1	<u>Other Statisti-</u>	
Moment Formula	1	cal Terms	
Correlation Ratio	1	Frequency Dis-	
Correlation Chart	1	tribution	3
Pearson's Rank		Criteria	3
Difference Method	1	Scores	3
		Norms	1
		Trend Rates	1
		Intelligence	
		Tests	1
		Spearman-Brown	
		Prophecy	
		Formula	1

*There was no mention of the phases of correlation

**On preceding page.

TABLE XLII

THE STATISTICAL CONCEPTS FOUND IN CURRENT LITERATURE
LISTED IN RANK ORDER

	Frequencies		Frequencies
Average	16	S.I.Q.R.	1
Median	13	Percentiles	1
Coefficient of Variation	11	PE_m	1
Standard Deviation	11	PE_{diff}	1
Mean	9	Coefficient of Reliability	1
*Correlation	8	Reliability of Average	1
Correlation Coefficient	7	Living index price	1
Multiple Correlation	6	Wage index	1
Indices (in general)	4	Link relative	1
Validity	4	Index of Rail-road Wages	1
Indices of cost	3	Index of Numbers of Producers	1
Range	3	Consumers' Goods	1
Probability	3	Coefficient of Attenuation	1
Random Sampling	3	Pearson's Product Moment	1
Regression Equation	3	Correlation Ratio	1
Partial Correlation	3	Pearson's Rank Difference	1
Frequency Distribution	3	Correlation Chart	1
Criteria	3	Continuous Series	1
Scores	3	Norms	1
Quartiles Q_1 and Q_3	3	Trend Rates	1
Harmonic Mean	2		
Mean Deviation	2		
Probable Error	2		
Skewness	2		
Index of Reliability	2		
Regression Coefficient	2		
Contingency Coefficient	2		
Prediction	2		

* Mentioned correlation, but no particular phase.

TABLE XLII (Continued)

	Frequencies		Frequencies
Ordinates	2	Intelligence	
Abscissa	2	Tests	1
Mode	1	Spearman-	
Geometric Mean	1	Brown	
		Prophecy	
		Form	1
		O _{diff}	1

The following illustration from a recent educational research project shows how extensively the use of statistics is found in the study of child development, which may be regarded as a branch of vital statistics. An experiment was carried on at the Iowa State University over a period of five years (1925-1930) by G. D. Stoddard (5:504-510), and is entitled "Utilization of Graphic and Statistical Methods in Certain Problems of Child Development." The following materials constituted a background for the study: contributions from Columbia University; eighteen monographs and eleven theses from Iowa State Welfare Research Station; and nine educational journals. There was a total of one hundred seventy-two articles reviewed, and one hundred thirty-one of these articles included statistical measures. A table of the concepts encountered by Stoddard follows.

TABLE XLIII

STATISTICAL MEASURES USED IN PROBLEMS OF CHILDHOOD DEVELOPMENT

The Table prepared by Stoddard is as follows:

	Per Cent of Articles
Central Tendency	
Mean	55
Mode	3
Median	28
Geometric Mean	0
Percentiles	11
Dispersion	
Standard Deviation	25
Arithmetic Deviation	6
Quartiles	2
Normal Curve	2
Range	23
Reliability	
Probable Error	38
Probable Error of Difference	12
Probable Error of Sample	1
Correlation	
Simple	30
Partial	6
Rank	3
Special	4
Eta	0
Graphic Representation	
Frequency Polygon	7
Histogram	7
Growth Curve	9
Ogive Curve	1
Normal Curve	1
Miscellaneous	10

TABLE XLIII (Continued)

	Per Cent of Articles
Derived Scores	
Z - scores	2
T - scores	4
Weighted scores	3

Comparisons Between the Statistical Concepts
Found in
"Childhood Development" and "Current Literature"

In comparing the data for "Childhood Development" with that for "Current Literature", care was taken to compare like concepts in Table XLIV. One of the outstanding differences is the large number of frequencies for graphic representation found in "Current Literature."

Since the number of articles reviewed by Stoddard is one hundred thirty-one, and the number reviewed by the writer, eighty-nine, the ratio of the latter to the former is sixty-eight per cent. Using the frequencies given for the statistical concepts by Stoddard as a basis, and regarding the number of concepts of current literature to be in direct proportion, sixty-eight per cent of the frequencies found by Stoddard would give the corresponding frequencies for concepts in current literature. Stoddard's frequencies of the statistical concepts were obtained from

educational magazines, hence, the derived frequencies for current literature indicate what concepts used in educational periodicals are to be taken as a basis for judging other literature; Table XLV represents the latter data.

A comparison of Tables XLIV and XLV shows that the derived scores for Current Literature give greater frequencies for Measures of Central Tendency, Measures of Dispersion, Reliability, Derived Scores and Percentile, while Correlation and Graphic representations are much larger on the original scale. Hence, the latter two concepts occur more often in the Current Literature than in Stoddard's "Childhood Development."

TABLE XLIV

COMPARISON OF THE FREQUENCIES OF THE STATISTICAL CONCEPTS
FOUND BY GODDARD WITH THOSE FOUND IN THIS STUDY

Statistical Concepts	Current Literature	Childhood Development
Measures of Central Tendency	42	86
Measures of Dispersion	32	58
Reliability	15	51
Correlation	38	43
Graphic Representation	208	35
Derived Scores	0	7
Percentiles	1	11
	336	291
Sum of frequencies for other statistical concepts found in current literature.....	95	0
	431	291

TABLE XLV

FREQUENCIES FOR THE CONCEPTS OF CURRENT LITERATURE
DERIVED FROM THE CONCEPTS OF CHILDHOOD DEVELOPMENT

Statistical Concepts	Derived Scores for Current Literature	Childhood Develop- ment.
Measures of Central Tendency	58	86
Measures of Dispersion	39	58
Reliability	35	51
Correlation	28	43
Graphic Representation	24	35
Derived Scores	3	7
Percentiles	7	11

A Comparison of Certain Concepts Found in
Current Literature, the Texts, and the Test

A comparison of the concepts commonly found in current literature, the textbooks, and the test, shows that at least fifty per cent of the students are failing on these concepts. These concepts are enumerated, the per cents of frequencies of the books using the concept, the frequencies for the concepts found in the eighty-nine articles read, and the per cent of failures in the test are stated in Table XLVI.

TABLE XLVI

A COMPARISON OF FREQUENCIES OF CONCEPTS FOUND IN CURRENT LITERATURE, PER CENT OF TEXTS CONTAINING THE CONCEPTS, AND THE PER CENT OF FAILURES ON THESE CONCEPTS FOUND IN THE COMPREHENSIVE TEST

Statistical Concepts	Per Cent of Frequencies of Texts	Frequencies of Concepts in Current Literature	Per Cent of Failures Found in Comprehensive Test
1. Measures of Central Tendency	100	42	50
2. Measures of Dispersion	100	32	48
3. Graphic Representation	100	208	54
4. Correlation	100	38	60
5. Percentile Rank	80 to 85	1	66

Graphic Representation

Graphic representations are used in many articles for the purpose of simplifying a situation so that the reader may comprehend the full significance. This is taken into account by Lovejoy (4:74), in his article, "How Graphs Clarify Statistics for the Layman".

Most writers of articles in current literature distinguish between the different forms of graphs, but there are some who call all such representations graphs. Hence, the term, graph, is given a place in the list of graphic representations tabulated from the investigations of current literature. The titles of the following graphs illustrate the avenues of work where graphic representations are used. Table XLVII gives the frequencies and kinds of graphs found in the study of current literature.

TABLE XLVII

THE NUMBER OF TYPES OF GRAPHIC REPRESENTATION FOUND IN
CURRENT LITERATURE EXAMINED

Graphs		Curves	
Line.....	53	Ogive.....	2
Pictoriograms.....	11	Normal Probability.....	2
Histograms.....	7	Parabolic.....	1
*Horizontal Bars.....	25	Logarithmic.....	3
*Vertical Bars.....	11	Percentile.....	1
Block Diagrams.....	2	Skew.....	2
Charts.....	35	Learning.....	1

* The horizontal and vertical bars were outlined, filled in solidly and cross-hatch. There are a total of two hundred eight graphs found in the eighty-nine articles.

TABLE XLVII (Continued)

Graphs		Curves	
Maps	8	Curvelinear	1
Silhouette	3	Smooth	1
Graphs	20	Mortality	1
Pie Diagram	7	Growth	1
Circle Charts	3	Scatter Dot Diagram	2
		Cumulative	5

Titles of Twenty-five Graphs Selected
at Random from the Examined Current
Literature

The fields of widespread usefulness to which the phase of statistics known as Graphic Representation is contributing, are indicated by the titles of the following graphs:

1. Trends of World Consumption of Gold.
2. Graphs to Classify the Life of Some 21,329 Tin Gas Meters.
3. Prices of British Cereals in 1932.
4. The Training Check-Up Through Trade Analysis.
5. Respiration of Two Subjects During the Taking of a Sample of the Alveolar Air.
6. Chart to Show How the Percentage of the World Total

of Nitrogen Supplied by Chilean Nitrate Has Fallen While the Synthetic Product Has Grown.

7. Amount of Equalized Valuation per Census Child.

8. Distribution of Cotton Mills According to Nationality of Ownership.

9. Life Chart of Automobiles.

10. Total Oxygen Consumption by the Oxidation of Glucose, Lactate, Acetate, Ethyl Alcohol.

11. Chlorine Treatment of Swimming Pools.

12. Line Fatigue Principle in Fosdick's Sermons.

13. Cycles in Real Estate.

14. Sources of Income from Taxation for the State of Ohio.

15. Prices Received by the Farmers for Fluid Milk Used for Different Purposes in the New York Market, 1913-1932.

16. Breaking Strength of Cement Mortar Briquettes.

17. Length of Life of Lamps at Market Voltage.

18. Percentage Ash-Content in Increments of Coal.

19. Frequency of Mention of General Objective in City and State Courses at Secondary School Level.

20. To show the Increase of Clinics.

21. Increase in Energy.

22. Crop Rotation.

23. Increasing Sensitivity of the Human Eye for Total Darkness.

24. The Location of the Stars.

25. Effect of Sugar Ingestion on the Right and the Left Hand Grip.

The literature from which these titles were selected are presented at the close of the chapter. They further emphasize the wide field of human interests making use of graphic representation.

The Analysis of Current Literature

The examination of literature indicated the following facts which are significant primarily to the general reader. In order to get a random sample of the general literature, and to avoid over-emphasis in educational and psychological literature, the writer chose eighty-nine articles which may be classed as general literature. While five statistical concepts have a much higher frequency than others in the literature examined, nevertheless, the entire field of statistics as now taught in elementary courses of statistics is represented. For example, graphs which

have a very high frequency are used in more than twenty-five distinct fields.

The use that business and the professions, in general, are making of statistical method, leads one to believe that education is no longer the foremost exponent of statistical method. Outside of graphic representations, the measures of central tendency have the highest degree of frequency. While measures of correlation and the various measures of variability are used more frequently by writers of educational articles, yet practically all types of statistical measures that are used by educational writers are found in semi-scientific literature.

Summary

The analysis of current literature containing statistical method indicates the following facts relative to the problem in question:

1. A very wide use of graphical method of presentation.
2. All concepts and methods used in the comprehensive tests are found in the literature examined.
3. Concepts which have the greatest frequency of use in the textbooks also have the greatest frequency in the literature.
4. On five of the most frequently used concepts in

the test and in current literature, more than fifty per cent of the students failed.

5. The analysis clearly shows that much of the non-technical literature uses statistics to some degree, and that the reader must have a knowledge of statistics is imperative for a clear understanding.

6. The fields in which statistical method is employed are almost as many and varied as the life experiences of man.

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CHAPTER VI
GENERAL SUMMARY
AND
IMPLICATIONS FOR REVISION AND IMPROVEMENT
OF THE COURSE OF ELEMENTARY STATISTICS

The four major phases of the problem stated on pages two and three of the Introduction logically become the basis for the suggestions and implications by the writer relative to a better selected and a better organized course of elementary statistics.

In order to facilitate further discussion of the implications for the improvement of the course of elementary statistics, a summary of the content of preceding chapters is presented:

The Content of Textbooks of
Elementary Statistics

The auxiliary phases of the textbook content such as introductions, prefaces, bibliography, appendices, glossaries and indices, may be passed over by pointing out a few of the salient features, with suggestions for improvement. These are enumerated as follows:

1. Textbooks of statistics could be improved greatly, if

the authors would state clearly and concisely in their prefaces and introductions, just what the nature of the content is and the prerequisites necessary for its mastery. A frank statement of the actual difficulties to be met would be much more appreciated by the student than the underestimation of the difficulties, given with few exceptions, by the authors in the prefaces and introductions of their texts.

2. Bibliographical references which would aid the student in the mastery of concepts that are not treated fully and clearly in the textbooks for class use, are conspicuously lacking.

3. The analysis of texts indicates that the authors are not agreed on the materials for the main parts of the texts, hence the number and the content of the appendices ¹ vary widely.

4. Time would be saved if more of the texts presented glossaries of terms. As was previously pointed out, ² only two of the texts (6) (9) have such glossaries.

5. All texts, except two, show through their indices, a very complete analysis of their contents (3) (15).

The trends of the bodies of the texts may be listed as follows:

1. In only a few cases (9) (15) does the writer find the treatment too simple. On the contrary, some discussions are highly

¹ Appendix C, Table III, p. 206

² Chapter II, p. 14

mathematical with little attempt on the part of the author to make a practical application of the mathematics employed.

2. There is a tendency for authors to introduce more subjects than they can treat adequately. Hence, the psychological approach is many times ignored and the students jump from one subject to the other without getting the integrated concept.

3. The school level on which the subject is taught has a range of at least seven years. Obviously, a textbook written for the students on the graduate level and approaching their doctor's degree would not be suitable for the freshman and sophomores with six and seven years less of university training. Yet the study shows the fact that authors write texts expecting them to meet the needs of all levels of college students.

4. The analysis of the texts indicates that entirely too much is taken for granted by the authors. The student is often unable to grasp the concepts because only a skeletal outline is presented. One illustration will make this point clear. At least seven definite types of problems are met in computing the median. The majority of textbooks discuss the computation of only two or three types of the median. When, in actual life situations, the student meets a new type of problem in the determination of a median, he is unable to solve it because that type was not presented either in the textbook or by the instructor. What has been said about the median is applicable to every other statistical concept. Both the textbook analy-

sis and the results of the comprehensive test clearly show that this major defect should be corrected.

5. Another defect that would easily yield to treatment is the order and arrangement of the material in the textbooks. While a fairly definite order is followed by the authors, nevertheless there are gaps between subjects and approaches to new subjects which the average student cannot span from the presentation in the text without the aid of the instructor. Frequently, this bridging of the gaps with necessary content is not done. The student's statistical knowledge is therefore so limited that it is impossible for him to comprehend anything containing statistical method.

6. Statistical method, being a relatively new subject, lacks a standardized terminology and symbolism. This makes bibliographical references difficult to read because the cross references force the student to master a new symbolism before he can improve his knowledge of the subject in question.

7. There are proofs from the majority of the texts and the comprehensive test that the mathematics and mathematical reasoning involved in the contents of the texts, constitute causes for failure in the subject of elementary statistics. In his recent thesis, Mathematical Difficulties of Students of Educational Statistics, Brown (2:50) found:

From the report of one thousand students, that a fourth

of them had studied no mathematics beyond plane geometry, one-half of them had studied no college mathematics, and a sixth of them had studied calculus.

If the student has had no mathematics beyond geometry, the probability is that subjects involving the reasoning of a mathematical type are distasteful to him. Without any further mathematical preparation, he will have difficulty in mastering statistics unless he uses a textbook in which the statistical concepts are more simply presented.

8. If current literature is taken as a criterion of the statistical content of textbooks, there is much evidence that the present topical content when extending to Partial and Multiple Correlation, is satisfactory, and should not be changed radically. The weakness of the content is in the meagerness of examples given by the instructors and the method of presentation and organization of the content. Although the present texts generally include the statistical concepts suitable for a course of elementary statistics, the methodology in many of them is beyond the comprehension of the student.

In giving the foregoing summary of the content of the texts, the writer has included concise and sufficient data to substantiate further findings in regard to:

1. The degree to which students are mastering this content, as shown by the comprehensive examination.
2. The degree to which the content and methods correspond with those being used in research and ordinary life situations.

The Degree to Which Students Are Mastering the Content of the Course of Elementary Statistics

The Comprehensive Test

The comprehensive test shows that the difficulties are not specific and confined to a few phases of the subject, but are general and indigenous to all phases. This seems to warrant the conclusion that the time devoted to the subject is so short, or there is so much material of a new type for the student to learn, that most students are not able to master the content in the time allotted. The test results indicate that at least four or five hours a week should be given to the course in order to enable the student to master the present content of elementary statistics sufficiently to make it a tool in the solution of problems.

While it is to be expected that some variation in the method of solution of problems would be found, the results of the test show such variety of solutions, symbolisms, and formulas, that standardization of terminology and symbolism is unquestionably an imperative necessity.

A fifty per cent failure on the test by nine hundred thirty-seven students affirms the writer's contention that the present statistical concepts contained in the course require a more intensive and understanding treatment. The greatest degree of success on the test is attained by the seniors and graduate students. The random sample shows that the majority of colleges and universi-

ties offer the statistical course in the junior year, but the greater number of students elect the subject in the senior or graduate year.

The Degree to Which the Content and Methods Correspond
With That of Research and Ordinary Life Situations

Seidlin (12), in commenting on the one hundred fifty observations of sixty-six teachers of the first year college mathematics, claims that it does not matter whether the teacher has taught five or twenty years, the methods are the same. In the majority of the classes no time is given to constructive thinking; the main aim is to cover the course in the allotted time. The query arises, are such comments applicable to the teachers of elementary statistics. If there is the same situation among the teachers of statistics, then they are not keeping pace with the advancing standards of the world. The suggested improvements of methodology due to research on text content, and the amount of mathematics needed for the course of elementary statistics, have come from a few interested individuals rather than from the entire group of teachers of elementary statistics. Individual effort for the improvement of the course shows an awakening interest, which is encouraging, but an important subject such as elementary statistics demands the benefit which will accrue from the united efforts of the trained minds of university and college teachers of statistics.

The status of the following phases of the course of elementary statistics is unscientific and is not in accord with life situations:

1. The Standardization of Symbolism and Terminology.-

In this study, it has been pointed out that many different terms are given the same meaning. Both West (14) and Brown (2) have made contributions to this field and have found that there is a multiplicity of symbols for the same thing, as well as the numerous meanings often given to the same symbol. West further illustrates these inconsistencies in his study of sixteen texts. Monroe (10) has offered a standardized symbolism, but until it is acted upon by all of the teachers of statistics, and constructively criticized by a committee representing all of them, no lasting benefit will be sustained.

2. Selection of Content.- Each author has followed his own judgment and the precedent set by Pearson (11), Yule (16), Thurstone (13) and King (8) for the concepts which are included in his text. The result is that the concepts range from the few presented in a simple manner by MacDonald (9) and Williams (15) to the numerous difficult ones found in the texts of Kelley and Yule. To be scientific, the teachers of elementary statistics should meet and discuss the desirability of a core of statistical concepts formed from those found in one hundred per cent of the texts for an elementary course of statistics. Such concepts should be presented so that the student will see definite relations to

practical life situations.

3. College Level and Prerequisites.- Other points of discussion must concern the college level for which the course is suitable. When this is done, the prerequisites can be definitely determined.

4. Hours for Recitation.- The test results indicate that not enough time is given to the course. The suggestion for further consideration is that the work be conducted on a laboratory plan, that is, four or five hours a week be given to the subject. Two or three of these should be used for solving problems under the direction of the teacher; reading literature involving statistical method; learning the use of simple machines, such as the slide-rule and adding machine; and becoming acquainted with the historical phases of statistics, for instance, the contributions of Galton (4) to statistics. The class period may either be used as a lecture period, a discussion period of laboratory findings and of the statistics used in current occupations and literature, or as is best for a more thorough understanding of the subject.

5. Ways and Means.- Ways and means of meeting the situation when the college administration makes it impossible to separate students of various years of preparation, should be considered by all the teachers.

6. Experimentation.- Experiments should be provided in

order to ascertain the correlation between the success of students who have much mathematical training and those who have little mathematical background.

Bauer (1) of Vermont claims that his students greatly improved their grades in statistics since they are required to precede the course by a related course of mathematics.

Further experimentation should be carried out with controlled and uncontrolled groups of students to ascertain the most effective ways to present concepts, and to determine the number of concepts and how intensively they should be taught within the varying time limits given the course of elementary statistics; also to determine whether there is more gained by a group following a text or by a group using material selected from data found in newspapers, magazines, and business offices of the locality.

7. Delimitation of Prerequisites.- Such experiments as suggested in the preceding paragraph could be further developed to delimit the exact course necessary for the success of the majority of students taking statistics.

8. Some Textbook Requirements.- Granted that the present texts contain excellent material, do their contents meet the standards of research for scientifically developed content, worked out with the idea of the modicum of waste energy and disappointment for the students, and with the idea of creating an incentive for further investigation and statistical research into the vital affairs of

professional or business life. Unless the scientifically trained minds of the university and college faculties that are teaching elementary statistics are willing to work unitedly on the problems of difficulty that are presented in an elementary course of statistics, the progress of methodology will be very slow.

Suggested Minimal Essentials for a Course of
Elementary Statistics

3

In determining the four purposes³, it is implied, from the discussions and conclusions deduced from the analysis of the textbooks, results of the comprehensive test, and the statistical concepts most commonly used in current literature, that there are definite trends which conclusively suggest the minimal essentials for a course of elementary statistics. A further implication is that the presentation of concepts should be without mathematical deduction.

Good (5) has already written a book on the Elements of Statistics, which promulgates the different points of view of authors of new statistical texts. Brown (2) suggests a similar outline of topics with implications for simplicity of treatment.

The minimal essentials include the following concepts:

- (a) Graphical Representation
- (b) Tabulation

- (c) Measures of Central Tendency, as mean, median and mode
- (d) Coefficient of variation
- (e) Pearson's Product Moment formula (11) and rank-difference methods for correlation
- (f) Probable Error
- (g) Percentile Rank, or the rank of an individual in a group
- (h) Meaning of Sampling with practical application

In using the foregoing concepts as a basis for a text in a course of elementary statistics, the following aims are to be kept in view:

1. To acquire facility in the use of statistical concepts
2. To be able to understand the value and the use of statistics in current occupations
3. To interpret graphs and statistical procedure encountered in professional and general literature
4. To enable readers and students of the text to understand when and why certain measures should be used

The writer has attempted, throughout this entire study, to be critical and unbiased in submitting a body of organized inferences, drawn from the various analyses and, therefore, feels warranted in stating that the present course in elementary statistics accomplishes only a fifty per cent fulfillment of its purpose and is indubitably in need of a revision of its mode of text presentation and teaching procedure.

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APPENDICES

APPENDIX A

Dear Sir:

Miss Louisa A. VanDyke is making, for her doctor's dissertation, a critical analysis and evaluation of the leading textbooks in Elementary Statistics, with a view of determining the content common to most of them. She is also attempting to determine the general status of students in Statistical courses.

She could secure the latter data, in part, by questionnaire. It would be far more satisfactory, however, if she had a large number of students in Statistics take a comprehensive examination in the fundamentals of the subject. She has accordingly prepared such an examination, which is made up as follows:

- 50 True-False statements and questions.
- 15 or 20 multiple response questions.
- A matching exercise consisting of some 20 items.
- 15 short typical problems to be solved.

The examination is entirely objective, and I am writing you in her behalf to see if you would be willing to give the examination to your students in Elementary Statistics.

As far as I am personally concerned, I would welcome such an examination, due to the fact that I would then be able to know how well my students were doing in the subject as compared with approximately 2,000 others, in some thirty or forty institutions.

Will you be willing to give such examination if sent to you during this semester or quarter? If you desire, you can grade the papers, and find out immediately how well your class has done, or if you will send them back to Miss VanDyke she will grade them, and give you the results and comparative data from other institutions.

I sincerely hope you will be able to render this service to Miss VanDyke, and I believe you will also be doing a service to your students, in having them take the examination. Will you kindly write your reaction to this matter, and mail it to me in the enclosed self-addressed envelope? Please indicate the number of sets of tests you will require.

Thanking you in advance, I am

Very truly yours,

C. A. Gregory
Professor of Education

APPENDIX A

I am sending to you in this mail, the number of tests you asked for. Thank you for cooperating and for returning the tests as soon as possible. I shall be glad to give you the results of the test.

The test requires two periods of fifty minutes each. If you do not have two consecutive periods, I would suggest that you give the test as far as the problems on one day and the problems, the second day.

If you wish to use the test as a final examination, I shall be glad to have you do so - just so the papers are marked in such a way that it will not impede my analysis later. Return tests to me, and I will pay for mailing expenses.

Will you please give me the following information:

1. Name of text-book used _____
2. Approximate number of problems your students solve for the term _____
3. Number of times per week the class meets _____
4. Number of hours credits the course receives _____
5. What are the prerequisites, if any for the course in Statistics _____

6. For how many weeks is the course given _____
7. Do you have them consult other books besides the text _____

Very truly yours,

Louisa A. Van Dyke

APPENDIX A

Student's Name _____

A COMPREHENSIVE TEST
IN
ELEMENTARY STATISTICS

-
1. Date _____
 2. Name of School _____
 3. Standing in school: - Check thus (x) Freshman _____
Sophomore _____ Junior _____ Senior _____
 4. If graduate student, what degree are you seeking? _____
 5. Are you taking statistics in lieu of a foreign language as
a candidate for the doctorate? _____
 6. In what department are you studying statistics?
Education _____ Psychology _____ Mathematics _____
Economics _____ if studied in any other department,
please state _____

The following test is comprised of four parts. These parts are fifty true-false statements; fourteen multiple choice; sixteen match answers; thirteen problems. Directions are given with each section.

Student's Name _____

True-False Section

Directions: Place a circle around the letter "T" if the statement is true and around the "F" if the statement is false.

- T F 1. The product-moment method is an exact method for finding the coefficient of correlation.
- T F 2. Curvelinear relationship makes use of Spearman's "foot-rule."
- T F 3. The greater the coefficient of alienation, the less is the predictive value.
- T F 4. The probability of an event may be expressed by a fraction, the numerator of which equals the total possible outcomes and the denominator equals the expected outcomes.
- T F 5. Statistical method is used less now than it was twenty years ago.
- T F 6. The mean is the center of gravity of a normal distribution and also the center of gravity of either half of it.
- T F 7. The normal probability curve may be deduced from the expansion of the quantity $(a + b + c)^n$.
- T F 8. Mean deviation is the arithmetic mean of the deviations from a measure of central tendency.
- T F 9. Measures are said to be comparable when they are expressed in terms of the same unit with reference to the same zero point.
- T F 10. A symmetrical curve has zero skewness.
- T F 11. The validity of a test is usually determined by finding the correlation between the test and some independent criterion.
- T F 12. Correlation coefficients extend from negative infinity to positive infinity.
- T F 13. The normal probability curve and the curve of error are different in shape and characteristics.
- T F 14. The ogive is a cumulative curve.
- T F 15. The standard deviation of a derived measure is also known as the standard error of that measure.
- T F 16. The limits of a score interval are independent of the number of cases in the class interval.
- T F 17. Semi-interquartile range is applicable to more types of curves than probable error.
- T F 18. When two variables are so related that one depends on the other, either one may be the function of the other.
- T F 19. In a curve of error, the curve changes from the concave to the convex at sigma's distance from the mode.

Student's Name _____

- T F 20. The percentile rank of a measure tells the per cent of measures it exceeds in a universe.
- T F 21. The reliability of a test varies inversely as its length.
- T F 22. In terms of reliability coefficients, the median is more stable than the mean.
- T F 23. If the mean exceeds the median, the skewness is said to be positive.
- T F 24. The magnitude of the correlation is measured by the tangent of the angle that the correlation line makes with the x-axis where it passes through the point of intersection of the x and y axes.
- T F 25. The class interval determines the height of the columns of a histogram.
- T F 26. The median is affected by extreme items whether large or small.
- T F 27. The best fitting straight lines of the means of the rows and the means of the columns are called regression lines.
- T F 28. The first quartile in a skewed distribution may exceed twenty-five per cent of the measures.
- T F 29. The normal curve is bilaterally symmetrical.
- T F 30. For the purpose of making comparisons, measures may be reduced to a common basis as in percentile rank.
- T F 31. A carefully chosen random sample will have approximately the same spread and the same mean as the total population.
- T F 32. If the standard error of the mean is small, it signifies that the obtained mean is very close to the true one.
- T F 33. The deductive method and sampling are similar.
- T F 34. The regressed score from correlation data is of little importance for prediction.
- T F 35. Errors of prediction are deviations from the predicted scores.
- T F 36. The method of partial correlation is an enlarging or synthetic process.
- T F 37. The term "curve" in statistics may mean any line, straight or curved which shows trends or directions.
- T F 38. The standard error of the difference between two obtained means is found by getting the square root of their respective standard errors.
- T F 39. The reliability of the mean varies directly as the number of cases.
- T F 40. The standard error of the mean varies inversely as the square root of the number of cases.
- T F 41. The square of the correlation coefficient is equal to the product of the two regression coefficients.

Student's Name _____

- T F 42. The lowering of the coefficient of correlation between two tests due to errors of measurement is called attenuation.
- T F 43. The correlation ratio is the same as the coefficient of correlation.
- T F 44. Most data in education, psychology, biology, and economics are treated as if discrete.
- T F 45. The reliability of a measure is independent of the spread of the measures within the sample.
- T F 46. Reliability formulas give a measure of the effects of errors due to causes other than those which arise from sampling.
- T F 47. In all distributions the first and third quartiles are the same distance from the mean.
- T F 48. The square of the deviations about an assumed mean are always less than those about a true mean.
- T F 49. A true measure is the arithmetic mean of a large number of obtained measures.
- T F 50. In negative correlation, the correlation line runs through the second and the fourth quadrant.

Student's Name _____

Multiple Choice

Directions: Place check to the left of the correct statement. Check thus - x.

1. If four coins are tossed at one time, the chances for four heads are:

_____ six in sixteen
_____ one in sixteen
_____ one in four

2. Four times the probable error or four P. E. is:

_____ greater than three sigma
_____ equal to three sigma
_____ less than three sigma

3. The relative variability of two distributions may be computed if:

_____ the number of cases is known
_____ their sigmas and their means are known
_____ the ranges of the two distributions are known

4. Which of the following data represented by a frequency polygon will approach a normal probability curve?

_____ grades from all the A-students in the universities of the United States
_____ the number of years of service of teachers
_____ the length of ears of corn chosen at random from a granary

5. The measure of central tendency that lends itself to algebraic treatment the most readily is:

_____ mode
_____ mean
_____ median

6. In a skewed distribution with measures arranged according to magnitude, the mode

_____ coincides with the median
_____ has a greater number of frequencies than the median
_____ is the largest measure in absolute value

Student's Name _____

7. In a skewed distribution, the median
- _____ usually is between the mean and the mode
 - _____ to the left of mean when distribution is skewed to the left
 - _____ to the right of mean when distribution is skewed to the right
8. Between the normal curve, the base line, and the ordinates erected at sigma's distance from the mean, there are
- _____ 68.26% of the total number of cases
 - _____ 50% of the total number of the cases
 - _____ 57.5% of the total number of the cases
9. For the coefficient of correlation to be reliable, the obtained coefficient should be
- _____ at least three times its probable error
 - _____ eight times its probable error
 - _____ one times its probable error
10. If a frequency polygon were drawn to represent the teacher's marks of all school children throughout the United States, the curve would be
- _____ skewed to the left
 - _____ skewed to the right
 - _____ a normal probability curve
11. Which of the following classes of data is continuous?
- _____ number of pupils in a class
 - _____ units of time
 - _____ number of trains entering New York City daily
12. When sigma is
- _____ small and the range is small, the curve will be narrow and peaked
 - _____ small and the range is long the curve will be flat and spread out
 - _____ large in a skewed distribution, it may include as much as 75% of all the cases, when laid off on each side of the measure of central tendency

Student's Name _____

13. The reliability of a test may be increased by

- ☐ decreasing its length
- ☐ increasing its length
- ☐ making the difficulty of the test questions more nearly constant

14. Probable error as now used is

- ☐ a linear distance on the base line
- ☐ an error made in measurement
- ☐ an error of sampling

Student's Name _____

Match Answers

Directions: Place letter on line to the left of the number that matches it.

- | | |
|---------------------------------------|--|
| _____ 1. Histogram | A. Should be used when work is variable, but time constant. |
| _____ 2. Coefficient of Association | B. The width of the columns is determined arbitrarily; the relative heights are determined by the frequencies. |
| _____ 3. Spearman's "footrule" | C. Data represented by circle graphs |
| _____ 4. Arithmetic mean | D. Q equals $\frac{ac-bd}{ac+bd}$ |
| _____ 5. An ogive | E. Equals .6745 sigma |
| _____ 6. Frequency polygon | F. Equals $1 - \frac{6s}{N^2-1}$ |
| _____ 7. Pi diagrams | G. A cumulative curve |
| _____ 8. Class interval | H. The perpendicular distance of a point from the y axis |
| _____ 9. Frequency tables | I. The mid-points of the columns of the histogram connected by straight line. |
| _____ 10. Harmonic mean | J. Synonymous with standard deviation of a derived measure. |
| _____ 11. T-scores of 70. | K. An arbitrary division of a range |
| _____ 12. Sigma | L. Coefficient of correlation with only two variables |
| _____ 13. Probable error | M. Should be used when time is variable and work is constant |
| _____ 14. Standard error of a measure | N. A measure of dispersion of original data. |
| _____ 15. An abscissa of a point is | |
| _____ 16. Zero order of coefficients | |

Student's Name _____

O. Distribution of data according to magnitude

P. A measure two sigmas above the mean of the data in question.

Student's Name _____

Problem Section

Directions: Please show all work. Fill in the headings of the columns.

1. Find the Arithmetic mean from the following raw scores in a Geography test: 20, 8, 18, 10, 16, 5, 7, 17, 16, 13, 8, 12, 9, 12, 8, 11, 12, 8, 13, 10, 9, 7, 5, 6, 12, 15, 10, 12, 14, 13, 12, 14, 10, 13, 14, 6, 11, and 8. Class interval from 4 to 5.99 and so on. Use short method.

Solution of Problem				
Scores	Frequencies			

2. Find the median from the data in Problem 1.

Student's Name _____

3. Find the standard deviation from the data in Problem 1. Use short method.

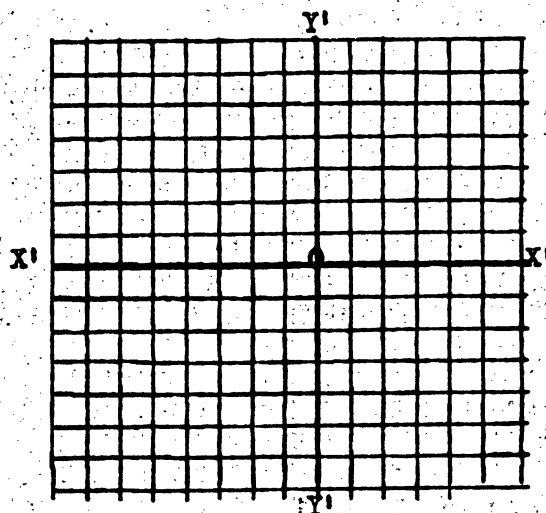
Scores	Frequencies				

4. Find the mean deviation from the median from the data in problem 3, and 2. Use the short method.

5. Find the Q_1 Q_3 and the Semi-inter Quartile Range from the data of any of the preceding problems.

Student's Name _____

6. Give the coordinates 3, 4 and -5, -6 of the points P and Q respectively. Plot the points and draw the line connecting them.



7. Find the equation of the straight line from the data in Problem 6.

8. Find the P. E. of the coefficient of correlation when N equals 100, and "r" is equal to .9.

Student's Name _____

9. Four students in a class of fifty, making the same score, exceeded twenty others in score. Find the percentile rank of the four students.
10. The mean and the standard deviation of the grades of the seventh grade were 65 and 14 respectively. The mean and the standard deviation of the grades of the eighth grade were 72 and 16 respectively. Compare the variability of the seventh with that of the eighth.
11. In a random sample of 500 cases, the mean is 64 and the sigma is 8. What percent of the cases lie above 72? Indicate method of solution. Draw figure.

Student's Name _____

12. Find the correlation between the addition and the handwriting scores of five pupils. Let addition be the x-series and handwriting, the y-series. Use Pearson's formula. Do not throw into class intervals, but solve for actual values. Put in the headings for the columns.

Pupils	Handwriting	Addition					
A	25	10					
B	20	9					
C	15	8					
D	10	7					
E	5	6					

13. Mark of 8 pupils in rate and comprehension in silent reading are as follows: solve by either R or rho.

Pupils	Rate Scores	Comprehension Scores			
A	13	20			
B	16	25			
C	10	15			
D	9	15			
E	17	35			
F	24	27			
G	30	32			
H	15	40			

APPENDIX A

True-False Statements		Multiple-Choice		Match Answers	Problem Section
T 20	T 42	7.	13.		1. $M = 11.79$
F 21	F 43	<u>x</u>	<u> </u>		2. $Me = 12.$
F 22		<u> </u>	<u>x</u>		3. $S.D. = 3.68$
	F 44	<u> </u>	<u> </u>	B 1.	4. $M.D. = 3$
T 1	T 23	1.			5. $Q_1 = 9$
F 2	F 45			D 2.	$Q_3 = 13.9$
	T 24	8.	14.		S.I.Q.R. = 2.45
	F 46	<u>x</u>	<u>x</u>		6. Coordinates of $x_1 y_1$ and $x_2 y_2$ are found in quadrants one and four.
T 3	F 25	<u> </u>	<u>x</u>	F 3.	7. $4y = 5x + 1$ or $5x - 4y = -1$
F 4	F 26	2.	<u> </u>	A 4.	8. $P. E_r = .0108$
	T 27	<u> </u>		G 5.	9. $P. R = 44$
F 5	F 28	<u>x</u>		I 6.	10. Coefficient of variability of 7th grade = 21.54
T 6	T 29	3.	<u>x</u>	C 7.	Coefficient of variability of 8th grade = 22.22
F 7	T 30	<u> </u>	<u> </u>	K 8.	11. 15.87% of all the cases are above 72.
T 8	T 31	<u>x</u>	10.	O 9.	
T 9	T 32	4.	<u> </u>	M 10.	
	F 33	<u> </u>	<u>x</u>	P 11.	
F 10	F 34	<u> </u>	<u> </u>	N 12.	
F 11	T 35	<u> </u>	11.	E 13.	
F 12	F 36	<u>x</u>	<u> </u>	J 14.	
F 13	T 37	5.	<u>x</u>	H 15.	
T 14	F 38	<u> </u>	12.	L 16.	
T 15		<u>x</u>	<u>x</u>		
F 16	F 39	<u> </u>	<u> </u>		
T 17	T 40	6.	<u> </u>		
T 18	T 41	<u> </u>	<u> </u>		
T 19		<u>x</u>	<u> </u>		

True-False
Statements

Multiple-Choice

Match
Answers

Problem
Section

12. "r" or the
coeffi-
cient of
correla-
tion = 1.

13. $R = .48$

APPENDIX B

THE CONTENT AND LIST OF REPLIES FROM THE COLLEGES AND
UNIVERSITIES CONCERNING THE GIVING OF THE TEST

The following key has been made to indicate the response which the colleges and universities made to the introductory letter written by Dr. C. A. Gregory.

- a. Favorable to giving the test.
- b. No class at time of receiving the letter.
- c. Not time to give it.
- d. Tests sent as requested, but not returned and no reply to follow-up letters.
- e. The only school where tests were wanted, but the order overlooked.
- f. Course in business statistics and the use of machines so that territory covered was not completed by school.
- g. Unfavorable to giving the test.
- h. Gave the test.
- i. Tests and Measurement Class.

The colleges and universities will be listed under the respective states that they are in. The letters above will be placed after the names of the colleges and universities.

A total of two hundred sixty-two letters were received. A total of one hundred thirty-three colleges are represented by this correspondence.

Alabama		
State College for Women	Montevalle	a, b
Arizona		
University of Arizona	Tucson	a, h
California		
University of California	Berkeley	a, b
Occidental College	Los Angeles	a, b
University of California	Los Angeles	a, f

APPENDIX B (Continued)

California (Continued)

Stanford University	Palo Alto	a, b
State Teachers College	Santa Barbara	a, b
Mills College	Oakland	a, h
State Teachers College	San Diego	a, h

Colorado

University of Colorado	Boulder	f
Colorado State Teachers College	Greeley	a, h
Denver University	Denver	a, h

Connecticut

Wesleyan University	Middletown	a, b
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Delaware

*University of Delaware	Newark	a
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Florida

Florida State College for Women	Tallahassee	a, b
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Georgia

University of Georgia	Athens	a, b
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Idaho

Lewiston State Teachers College	Lewiston	i
University of Idaho	Moscow	a, h

Illinois

Chicago University	Chicago	a, h
James Millikan University	Decatur	a, b
Illinois Wesleyan University	Bloomington	a, b
Eureka College	Eureka	a, h

* Instructor became ill, and his class schedule was not followed.

APPENDIX B (Continued)

Illinois (Continued)

Western State Teachers College	Macomb	a, b
Rockford College	Rockford	a, h
University of Illinois	Urbana	a, h

Indiana

University of Indiana	Bloomington	a, h
Purdue University	Lafayette	a, h
Butler University	Indianapolis	a, b
Ball State Teachers College	Muncie	a, b
Earlham College	Richmond	a, b
State Teachers College	Terre Haute	a, h

Iowa

Iowa State Teachers College	Cedar Falls	a, h
#Iowa State University	Iowa City	a

Kansas

State Teachers College	Emporia	a, h
University of Kansas	Lawrence	a, h
State College	Manhattan	a, h
State Teachers College	Pittsburg	a, h
University of Wichita	Wichita	a, b

Louisiana

University of Louisiana	Baton Rouge	a, h
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Maine

Bowdoin College	Brunswick	a, b
University of Maine		a, h

Maryland

Goucher College	Baltimore	a, d
University of Maryland	College Park	a, h
Hood College	Frederick	a, h

Gave Kelley's Test.

APPENDIX B (Continued)

Maryland (Continued)

The Catholic University of America	Washington, D. C.	a, c
George Washington University	Washington, D. C.	a, d
The Ormond-Wilson Teachers College	Washington, D. C.	a, h

Massachusetts

Boston University	Boston	a, b
#Harvard University	Cambridge	a, c
Mount Holyoke	South Hadley	a, b
Tufts College	Tufts	a, b
Wellesley College	Wellesley	a, b
Clark University	Worcester	a, b

Michigan

Albion College	Albion	a, b
University of Michigan	Ann Arbor	g, b
University of Detroit	Detroit	a, c
Battle Creek College	Battle Creek	a, b
Michigan State Teachers College	Ypsilanti	a, b

Minnesota

University of Minnesota	Minneapolis	a, c
State Teachers College	St. Cloud	a, h
Macalester College	St. Paul	a, b

Mississippi

Agriculture and Mechanical College	A. and M. College	a, b
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Missouri

University of Missouri	Columbia	a, h
Washington University	St. Louis	a, b
State Teachers College	Warrensburg	a, b

Gave Kelley's Test.

APPENDIX B (Continued)

Montana		
Intermountain Union College	Helena	a, d
University of Montana	Missoula	a, h
Nebraska		
University of Nebraska	Lincoln	a, h
Peru State Teachers College	Peru	a, b
Nevada		
University of Nevada	Reno	a, b
New Hampshire		
University of New Hampshire	Durham	a, d
New Jersey		
State Teachers College	Montclair	a, h
Rutgers University	New Brunswick	a, h
Princeton University	Princeton	a, h
New Mexico		
University of New Mexico	Albuquerque	a, h
New York		
Alfred College	Alfred	a, b
State Teachers College	Buffalo	a, b
University of Buffalo	Buffalo	a, b
St. Lawrence University	Canton	a, d
Fordham University	Fordham	a, b
Colgate University	Hamilton	a, b
Cornell University	Ithaca	a, b
Syracuse University	Syracuse	a, b
College of the City of New York	New York City	a, b
Hobart College	Geneva	a, f
Teachers College, Columbia	New York City	a, h
New York University	New York City	a, d
Dept. of Political Science, Columbia University	New York City	a, b
Hunter's College	New York City	a, c

APPENDIX B (Continued)

North Carolina

University of North Carolina	Chapel Hill	a, h
Duke University	Durham	a, h
North Carolina Teachers College	Greenville	a, b

North Dakota

State Teachers College	Dickinson	a, b
University of North Dakota	Grand Forks	a, b

Oklahoma

Central Teachers College	Edmund	a, b
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Ohio

Akron University	Akron	a, h
Antioch College	Antioch	a, h
Ohio University	Athens	a, b
Ashland College	Ashland	a, b
University of Cincinnati	Cincinnati	a, h
University of Ohio	Columbus	a, h
Miami University	Oxford	a, h
Oberlin University	Oberlin	a, b
Wittenberg College	Springfield	a, b
Marietta College	Marietta	a, b
Ohio Wesleyan	Delaware	a, h
Dennison University	Dennison	a, b

Oregon

# University of Oregon	Eugene	a, g
Willamette University	Salem	a, f

Pennsylvania

Bryn Mawr College	Bryn Mawr	a, e
Wilson College	Chambersburg	a, h
State Teachers College	Indiana	a, c
Bucknell University	Lewisburg	a, h
Pennsylvania University	Philadelphia	a, h
University of Pittsburg	Pittsburg	a, b

Promised to give Kelley's Test.

APPENDIX B (Continued)

Rhode Island		
Brown University	Providence	a, h
South Dakota		
The Northern Normal and Industrial School	Aberdeen	a, b
South Dakota State College	Brookings	a, b
Tennessee		
University of Chattanooga	Chattanooga	a, b
University of Tennessee	Knoxville	a, b
The George Peabody Teachers College	Nashville	a, h
Fisk University	Nashville	a, c
Texas		
Western Texas State Teachers College	Canyon	a, b
Northern Texas State Teachers College	Denton	a, b
Utah		
University of Utah	Salt Lake City	a, b
Virginia		
University of Virginia	Charlottesville	a, h
College of William and Mary	Williamsburg	a, b
Washington		
University of Washington	Seattle	a, h
State Teachers College	Pullman	a, h
West Virginia		
University of West Virginia	Morgantown	a, h
Wisconsin		
University of Wisconsin	Madison	g, c

APPENDIX B (Continued)

Wisconsin (Continued)

Beloit College	Beloit	a, b
Wyoming		
University of Wyoming	Laramie	a, h

APPENDIX "C"

TABLE I

THE COLLEGE RANKS OF STUDENTS, AIMS OF AUTHORS, AND MATHEMATICAL PREREQUISITES FOR THE COURSE OF ELEMENTARY STATISTICS AS EVIDENCED IN THE INTRODUCTIONS AND PREFACES OF TWENTY-THREE TEXTBOOKS OF ELEMENTARY STATISTICS

	Educational & Psycho-										Economics															
	General Stat.					Logical Stat.					Stat.															
	Bowley	Burgess	Geveit	Secretist	Tule	Camp	Garrett	Gregory, Bentrow	Holzinger	Kelley	King	MacDonald	Odeil	Otis	Bues	Thurstone	Mies, Grifford	Quaddock	Crum	Patton	Harper	Lovitt, Holtzclaw	Total	General	Educ. & Psych.	Economics
I. Year in college course is offered					2													3					5	2	3	
II. Aims of authors																										
A. To present subject matter so that those lacking in mathematics may understand	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17	4	9	4
B. To make clear the meaning and implications of statistical procedure						x							x	x	x			x	x				10	2	4	4
C. To develop skill in statistical computations																										
D. To develop the "why" of statistics and concretely relate methods to problems of public and private economics																							4		4	

TABLE II

PLACEMENT OF BIBLIOGRAPHIES

Placement	General										Educational & Psycho-logical stat.										Economic					Totals
	Bowley	Burgess	Gavett	Secretat	Tule	Camp	Garrett	Gregory, Kenitrow	Holzinger	Kelley	King	MacDonald	Odell	Ott	Ruge	Thurstone	Tiegs, Crawford	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtzclaw	Mills			
Alphabetically arranged at the beginning of text																		X							1	
Alphabetically arranged at the close of the book		X							X		X	X	X		X			X	X	X		X	X		10	
At the close of text listed under topics studied					X																X			2		
At close of text listed according to difficulty							X																	1		
Placed only at the close of text		X							X		X													3		
Placed at close of chapter and at close of text					X							X										X		3		
Placed at close of text and at bottom of the pages							X						X								X	X		6		
Placed at close of text, at close of chapter, and at the bottom of the pages																							X	1		

[illegible]

TABLE III

APPENDICES AND THEIR CONTENT

* Omitted in succeeding pages of this table. Gregory and Renfrow have no appendix, but have at the close of their text a table of square roots and squares, a glossary, answers to problems, and review questions. Garrett has included a short list of general reference books and a table of squares and square roots in the last chapter. There is an appendix.

TABLE III (Continued)

Number of Appendices and Topics																					
	Bowley	Burgess	Gavett	Secretat	Tule	Camp	Holzingler	Kelley	King	Macdonald	Odell	Otis	Rugg	Thurstone	Williams	Chaddock	Crum, Patton	Harper	LoVitt, Holtzcler	Mills	Totals
6. Probable error of the Coefficient of correlation due to sampling																					
7. Moments and constants of the second approximation to the generalized curve of errors																					
8. Sheppard's correction for moments of frequency curves	X																				
9. Denominators of a and b coefficients of a parabolic regression formula	X																				
10. Ordinates of the normal probability curve expressed as a fractional part of the mean ordinate y_n																					
11. Fractional parts of the total area (10,000) under the normal probability curve							X						X	X	X	X	X		X		6
12. Sigma areas under the curve	X						X						X			X	X		X		6
	X										X		X			X			X		5

* Tule has supplements to Chapters 6, 9, 12, 15, 17.

TABLE III (Continued)

Number of Appendices and Topics	Totals																				
	Bowley	Burgess	Gavett	Secretat	Tule	Camp	Holzinger	Kelley	King	Macdonald	Odeil	Ottis	Rugg	Thurstone	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtz- class	Mills	
13. Tables for conversion of Rank Co- efficients into Product Moment Coefficients of Correlation											X									1	
14. Table for finding the value of the Coefficients of Correla- tion by Pearson's Cosine Pi () method or Sheppard's unlike signs											X									1	
15. Statistical table of percent- ages											X	X								2	
16. Kelley-Wood Table of the Nor- mal Probability Integral								X												1	
*17. Table of Mean Abscissas						X														1	
18. Correlation Charts																X				1	
19. Figures or Diagrams																				2	
20. Percentile Rank Tables	X																			2	
C. Mathematical Topics																					
1. Table of Square Roots and Squares										X										1	

* Should be included under C, Mathematics, as well as under Statistical Topics.

TABLE III (Continued)

Number of Appendices and Topics																					
	Bowley	Burgess	Gavett	Secret	Tyle	Camp	Holzinger	Kelly	King	MacDonald	Odeh	Ott	Rugg	Thurstone	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtzclaw	Mills	Totals
2. Table of Square Roots only																					1
3. Table of Squares only																					2
4. Tables of Squares, Square Roots, and Cubes																					1
5. Table of Squares, Square Roots, Cubes, and Cube Roots and Reciprocals																					1
6. Uses of Determinants																					1
7. Logarithmic Tables																					1
8. Logarithmic Formulas explained																					7
9. Chance and Probability																					1
10. Wallis' Theorem for the Value of Pi																					1
11. Derivatives and Integrals																					1
12. Stirling Formula for M																					1
13. Euler-Maclaurin Formula which connects summation and integration																					1

TABLE III (Continued)

Number of Appendices and Topics	Bowley	Burgess	Gavett	Secret	Rule	Camp	Holzner	Kelley	King	MacDonald	Odel	Otis	Rues	Thurstone	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtzclaw	Mills	Totals
14. The Method of Least Squares	X																		X		2
15. Decimal Values of Common Fractions																					1
16. Metric System	X																	X			1
17. Permutations and Combinations			X																		1
18. Binomial Expansion		X																			1
19. Measurement of Plane and Solid Figures																					1
20. Ratio of Weighted and Unweighted Averages																		X			1
21. Table of Log. N	X					X															1
22. Table of Lines and Cosines													X								1
23. Percentages of Numbers												X									1
D. Miscellaneous Topics																					
1. Selected Books for Supplementary Reading					X		X	X	X	X	X	X	X	X	X	X	X	X			10
2. Objective Tests									X												1
3. Answers to Problems									X					X							2
4. Calculating Devices (machines)					X				X												3

TABLE III (Continued)

Number of Appendices and Topics																					
	Howley	Burgess	Gavett	Secretist	Tule	Camp	Holzinger	Kelley	King	MacDonald	Odeil	Otis	Rue	Thurstone	Williams	Chaddock	Crum, Patton	Harper	Lovitt, Holtzclaw	Mills	
5. Tables of Economic Data																					
6. Numerical data for certain charts																					
7. Laboratory procedure and exercises																					
*8. Glossary of terms and statistical symbols																					
9. Glossary of formulas																					
Totals																					

*The text of Gregory & Renfrow has a glossary of terms.

TABLE IV

A COMPARISON OF THE CONTENTS OF THE INTRODUCTIONS
AND PREFACES FOR EACH OF THE THREE GROUPS OF STATISTICIANS

Items	General Statisticians	Educational & Psycholog- ical Statisticians	Economic and Business Statisticians
Average Per Cent for Each Group			
I. Year in College, the Course Offered	0	15	60
II. <u>Aims of Authors</u>			
A. To present the subject matter clearly to those deficient in mathematics	80	69	80
B. Aim to make the meaning and implications of statistical procedure clear	40	30	80
C. To develop skill in statistical computations	0	30	0
D. To develop the "why" of statistical procedure and to concretely relate methods to public and private economics	20	0	0
III. <u>Mathematical Prerequisites</u>			
A. None mentioned	20	61	60
B. High School Algebra	60	15	40
C. One year College Algebra	15	7	40
D. Least Squares	20	0	
E. Analytical Geometry	20		
F. Trigonometry	20		
G. Logarithms	20		
H. Differential Calculus	40	7	20
IV. Length of Course			
A. Three terms or 1 year	20		
B. Two terms	20	15	40
C. One term or $\frac{1}{2}$ year	20	15	20

APPENDIX D

TABLE I

ANALYSIS OF THE TRUE-FALSE SECTION OF THE COMPREHENSIVE TEST FOR THE PER CENT OF ERROR FOR EACH ITEM OF THE STATISTICAL CONCEPT AND THE AVERAGE PER CENT OF ERRORS FOR EACH GROUP OF COLLEGES AND UNIVERSITIES

Type of School	Measures of Dispersion				Skewness		Sampling		Perc. Rank	Common
	Mean Deviation	Comparable Measures	Standard Deviation	Sq. of Dev.	Normal Skewness	Relative Skewness	Sample Size	Standard Error of Sample		
I. State Universities										
1. Arizona	11	22	67	44	0	0	0	33	56	33
2. Idaho	14	29	14	43	14	14	0	43	29	0
3. Illinois	14	0	36	50	0	29	7	43	29	0
4. Indiana	17	17	17	17	84	33	0	50	84	0
5. Kansas	20	0	27	60	13	20	0	47	53	13
6. Louisiana	7	0	35	24	3	21	0	17	14	0
7. Maine	25	8	15	23	8	0	0	30	23	62
8. Maryland	26	20	51	0	23	46	23	41	72	42
9. Missouri	13	6	38	44	63	81	19	75	63	19
10. Montana	16	3	63	34	75	38	34	0	56	9
11. Nebraska	16	3	37	39	9	41	11	56	23	53
12. New Jersey (Rutgers)	6	31	56	19	25	50	31	50	44	0
13. New Mexico	16	16	37	16	11	26	5	40	26	5
14. Ohio	22	11	48	37	15	37	30	48	48	4
15. Virginia	0	25	63	25	63	50	13	50	13	0
16. Washington	13	11	27	62	0	41	5	27	60	9
17. West Virginia	4	4	44	39	32	39	13	36	17	0
18. Wyoming	0	0	80	80	0	20	0	20	20	0
Average	13	12	42	36	24	33	11	39	41	14

TABLE I (Continued)

Type of School	Measures of Dispersion				Skewness		Sampling		Perc. Rank	
	Mean Deviation	Comparative Measure	Standard Deviation	Sq. of Dev. about Mean	Zero Skewness	Positive Skewness	Char. of Sample	Sample vs. Reduction	P. Rank Defined	Common Basis
II. State Colleges										
1. Kansas	10	10	40	47	10	33	3	40	63	47
2. Miami	0	0	29	57	0	14	0	57	29	43
3. Purdue	30	10	30	20	0	30	0	30	0	0
Average	13	7	33	41	3	26	1	42	31	30
III. State Teachers Colleges										
1. California, San Diego	0	0	63	37	26	47	37	32	84	21
2. Colorado, Greeley	20	20	20	13	7	40	13	40	47	0
3. District of Columbia, Omand Wilson	11	21	36	54	32	75	18	43	61	11
4. Indiana, Terre Haute	15	5	55	25	10	50	5	55	30	20
5. Kansas, Emporia	22	6	39	33	17	67	33	44	50	0
6. Kansas, Pittsburg	0	0	29	25	0	25	14	72	29	0
7. Minnesota, St. Cloud	17	33	67	50	33	50	17	50	67	0
8. New Jersey, Montclair	19	5	23	36	18	5	21	5	36	10
9. Washington, Pullman	22	22	89	33	11	33	22	67	44	22
Average	13	12	47	34	17	44	20	45	50	9

TABLE I (Continued)

Type of School	Measures of Dispersion			Skewness		Sampling Character of Sample	Sample vs. Deduction	Perc. Rank Defined	Perc. Rank Common Basis
	Mean Deviation	Comparable Measures	Standard Deviation	Sq. of Dev. about Mean	Zero Skewness	Positive Skewness			
IV. Municipal Universities									
1. Akron	47	6	41	18	94	29	35	88	18
2. Cincinnati	4	30	21	29	13	26	26	21	33
Average	26	18	31	24	54	28	31	55	26
V. Private Colleges and Universities									
1. Antioch	18	18	50	55	23	23	45	64	23
2. Brown	7	0	27	33	0	0	47	0	20
3. Bucknell	33	0	56	44	0	22	78	33	78
4. Chicago	0	15	62	39	0	46	54	15	0
5. Columbia	36	21	7	36	0	29	1	14	0
6. Denver	25	8	42	50	8	42	33	54	0
7. Duke	23	23	38	46	46	38	69	53	15
8. Eureka	29	100	100	29	14	71	100	86	100
9. Hood	40	20	20	30	0	20	40	50	20
10. Ohio Wesleyan	0	4	43	52	9	22	57	70	4
11. Mills	10	5	70	60	0	90	60	60	10
12. Peabody	15	38	23	31	85	46	46	85	15
13. Pennsylvania	46	62	90	69	77	87	82	64	82
14. Princeton	7	0	28	43	0	43	57	28	64
15. Rockford	14	0	56	14	84	29	70	56	42
16. Wilson	0	0	75	75	0	50	50	75	0
Average	19	20	49	44	22	41	57	50	30

TABLE I (Continued)

Type of School	Reliability of Measure						Sq. of Dev. about Mean	A true Measure is Arithmetic Mean
	Median Coeff.	Stand. Error of a Mean	Reliability of a Mean	Variation of Std. Error	Reliability and Spread	Rel. Form. Measure		
I. State Universities								
1. Arizona	11	33	100	33	11	34	11	44
2. Idaho	57	43	71	29	29	71	14	43
3. Illinois	71	43	71	36	29	71	7	50
4. Indiana	50	0	17	33	33	17	0	17
5. Kansas	67	60	33	40	27	27	20	60
6. Louisiana	28	31	41	21	14	84	3	24
7. Maine	46	46	62	62	31	77	8	23
8. Maryland	67	59	72	51	44	85	39	49
9. Missouri	44	88	69	88	44	81	50	44
10. Montana	69	53	50	56	34	91	0	34
11. Nebraska	55	58	70	53	42	64	28	58
12. New Mexico	42	53	47	11	53	47	16	16
13. Ohio	45	48	74	45	30	30	7	37
14. New Jersey (Rutgers)	44	44	50	75	56	69	19	19
15. Virginia	25	63	50	63	74	38	38	25
16. Washington	11	43	59	16	22	41	18	61
17. West Virginia	48	44	79	44	22	30	4	38
18. Wyoming	20	0	40	20	20	60	20	80
Average	44	39	52	43	34	55	19	45

TABLE I (Continued)

Type of School	Reliability of Measure						True Measure Is Arith. Mean.	
	Median as Real Coef.	Stand. Error of Difference	Reliability of a Mean	Variation of Standard Er.	Reliability and Spread	Rel. Form. Measure		Sq. of Dev. about Mean
II. State Colleges								
1. Kansas	67	60	33	40	27	27	20	60
2. Miami	56	42	71	56	28	56	0	56
3. Purdue	20	30	30	20	40	60	10	20
Average	48	44	45	39	32	48	10	45
III. State Teachers Colleges								
1. California, San Diego	63	26	84	47	37	68	32	37
2. Colorado, Greeley	20	27	54	27	20	27	13	47
3. District of Columbia, Ormand Wilson	68	57	50	57	61	68	11	54
4. Indiana, Terre Haute	20	45	65	50	15	40	15	25
5. Kansas, Emporia	33	44	39	17	39	50	17	33
6. Kansas, Pittsburg	64	64	79	14	29	57	0	21
7. Minnesota, St. Cloud	50	67	67	50	17	50	33	50
8. New Jersey, Montclair	31	38	69	13	8	28	18	36
9. Washington, Pullman	56	44	78	56	44	56	11	33
Average	45	46	65	37	30	49	17	67
IV. Municipal Universities								
1. Akron	35	29	59	35	47	88	6	18
2. Cincinnati	31	57	48	23	30	44	20	33
Average	33	43	54	29	39	66	13	26

TABLE I (Continued)

Type of School	Reliability of Measure							True Measure is Arithmetic Mean
	Median Coef.	Stand. Error of Difference	Reliability of a Mean	Variation of Stand. Error	Reliability and Spread	Rel. Formula Measure	Sq. of Dev. about Mean	
V. Private Colleges and Universities								
1. Antioch	77	41	50	36	23	59	23	54
2. Brown	67	67	87	40	67	47	7	33
3. Bucknell	89	44	56	22	44	44	0	44
4. Chicago	8	62	62	54	31	69	0	39
5. Columbia	31	38	46	38	0	31	8	38
6. Denver	8	17	58	75	67	8	8	50
7. Duke	31	54	63	38	15	46	31	46
8. Eureka	29	71	86	43	29	43	10	29
9. Hood	20	30	50	30	60	70	50	30
10. Ohio Wesleyan	91	74	74	78	51	87	9	51
11. Mills	16	53	74	21	37	77	53	0
12. Peabody	31	38	62	31	31	31	31	31
13. Pennsylvania	80	74	90	87	85	95	74	69
14. Princeton	100	57	79	57	57	71	0	43
15. Rockford	43	57	71	71	71	86	14	14
16. Wilson	100	75	75	100	50	100	50	75
Average	49	59	74	49	50	63	24	44

APPENDIX "D"

TABLE II

ANALYSIS OF THE TRUE-FALSE SECTION OF THE COMPREHENSIVE TEST FOR THE PER CENT OF ERROR FOR EACH ITEM OF THE STATISTICAL CONCEPT AND THE AVERAGE PER CENT OF ERRORS FOR EACH GROUP OF COLLEGES AND UNIVERSITIES
(For Measures of Central Tendency, Tests, Intervals, Q1 and Q3, S.I.Q.R.)

Type of School	Measure of Cent. Tendency		Tests		Intervals		Skewed Dis	Q1 and Q3 S. I. Q. R.		Vs. P. H. Q. R.
	Mean	Median	Mode	Validity	Reliability	Limits of Score Int.		Class Interval	Position of Q1 & Q3	
I. State Universities										
1. Arizona	89	44	56	89	11	89	44	22	11	11
2. Idaho	100	57	43	57	29	29	57	29	29	86
3. Illinois	86	50	29	86	7	78	29	14	0	86
4. Indiana	7	25	33	42	16	50	33	0	0	100
5. Kansas	47	23	40	37	13	67	40	27	53	67
6. Louisiana	24	23	24	35	24	31	21	21	28	38
7. Maine	31	19	23	46	46	62	39	31	54	77
8. Maryland	50	54	26	72	72	69	64	62	56	57
9. Missouri	7	7	88	75	19	88	38	69	19	88
10. Montana	60	41	59	74	31	66	0	44	44	56
11. Nebraska	53	24	58	67	22	70	38	22	30	45
12. New Jersey	59	44	74	50	31	56	50	38	63	50
13. New Mexico	40	24	42	53	53	37	16	53	27	79
14. Ohio	50	43	19	52	11	89	26	44	22	85
15. Virginia	50	44	75	13	0	88	100	50	38	75
16. Washington	47	36	64	61	11	71	20	37	32	73
17. West Virginia	46	46	39	57	30	65	39	26	35	57
18. Wyoming	50	10	100	40	0	100	20	0	40	80
Average	50	34	50	56	23	60	37	33	32	67

TABLE II (Continued)

Type of School	Measure of Central Tendency			Tests		Intervals		Q1 & Q3		No. of Schools
	Mean	Median	Mode	Validity	Reliability	Limiting Score	Class Intervals	Number of Schools	Number of Schools	
II. State Colleges										
1. Kansas	47	38	79	63	26	83	30	28	30	23
2. Miami	57	21	14	57	43	86	29	43	29	72
3. Purdue	44	25	50	60	10	70	10	10	20	80
Average	50	28	48	60	26	80	23	27	26	36
III. State Teachers Colleges										
1. California, San Diego	58	50	74	26	37	63	11	47	42	58
2. Colorado, Greeley	40	47	47	73	27	67	100	33	30	73
3. District of Columbia, Ormand Wilson	31	84	25	57	54	29	41	57	50	71
4. Indiana, Terre Haute	55	38	55	35	45	55	70	25	35	70
5. Kansas, Emporia	61	50	50	50	53	72	94	33	39	61
6. Kansas, Pittsburg	32	39	21	71	21	57	64	7	29	36
7. Minnesota, St. Cloud	42	58	50	50	67	67	67	33	17	83
8. New Jersey, Montclair	30	9	62	46	31	56	87	41	18	8
9. Washington, Pullman	44	39	67	78	22	56	50	33	22	89
Average	44	46	50	54	40	58	65	34	32	61

TABLE II (Continued)

Type of School	Measures of Central Tendency			Tests		Intervals		Q1 & Q3		
	Mean	Median	Mode	Validity	Reliability	Limitation of Score Interval	Class Intervals	Q1 in %	Q3 in %	Position of Q1 & Q3
IV. Municipal Universities										
1. Akron	50	39	65	59	29	65	41	24	35	59
2. Cincinnati	29	29	49	60	17	51	40	23	29	52
Average	40	34	57	60	23	58	41	24	32	56
V. Private Colleges and Universities										
1. Antioch	100	90	85	70	85	45	10	50	45	60
2. Brown	20	53	67	100	80	13	0	0	13	13
3. Bucknell	22	22	56	56	56	0	11	11	0	11
4. Chicago	100	77	85	62	77	15	0	23	15	8
5. Columbia	86	71	64	57	22	14	22	22	14	29
6. Denver	67	58	100	25	92	0	83	33	0	17
7. Duke	100	100	92	69	85	92	38	61	92	100
8. Eureka	100	100	100	57	86	57	29	577	57	86
9. Hood	80	50	90	0	80	30	0	20	30	20
10. Ohio Wesleyan	50	50	91	100	100	18	23	0	18	32
11. Mills	89	89	100	95	95	16	26	11	16	0
12. Peabody	62	69	46	38	31	11	7	46	15	31
13. Pennsylvania	98	98	98	95	98	41	89	87	41	92
14. Princeton	86	71	100	86	64	29	50	29	29	29
15. Rockford	100	57	86	86	71	71	43	57	71	57
16. Wilson	100	100	100	100	100	0	25	50	0	50
Average	79	72	85	69	76	28	29	35	29	40

TABLE II (Continued)

Type of School	Interpretation of Curves						Scores		Graphs	Series
	Curve Linear	Deviation from Prob. Curve	Symmetrical	Bilateral	Curve	Curve Defined	Curve of Error	Limit of Score Int.		
I. State Universities										
1. Arizona	33	56	0	0	22	22	56	89	45	11
2. Idaho	29	43	14	14	43	43	43	29	57	43
3. Illinois	14	36	0	7	0	14	29	79	29	0
4. Indiana	33	50	0	0	0	67	33	100	33	17
5. Kansas	20	67	33	13	7	13	40	67	40	7
6. Louisiana	38	59	3	14	7	3	28	31	21	31
7. Maine	62	31	8	0	0	15	23	62	39	54
8. Maryland	62	72	20	23	54	3	31	69	64	54
9. Missouri	0	63	63	31	13	31	88	88	38	13
10. Montana	81	72	75	31	63	31	66	34	94	63
11. Nebraska	59	74	94	94	13	78	58	70	38	37
12. New Jersey	56	56	25	19	38	25	75	56	50	81
13. New Mexico	32	58	11	0	5	0	47	41	41	21
14. Ohio	71	63	15	15	74	15	19	89	26	74
15. Virginia	25	50	63	0	38	0	75	88	0	38
16. Washington	30	59	0	68	2	9	66	71	20	20
17. West Virginia	39	52	30	13	13	9	83	65	39	144
18. Wyoming	0	0	0	0	0	0	100	80	20	0
Average	38	53	25	19	22	21	53	67	39	34

TABLE II (Continued)

Type of School	Interpretation of Curves						Scores	Graphs	Series
	Curve Linear	Reduction Norm. Curve	Symmetrical Curve	Bilaterally Symmetrical	Ogive	Curve Defined			
II. State Colleges									
1. Kansas	53	57	10	15	47	10	83	30	33
2. Miami	43	57	0	13	0	29	86	29	43
3. Purdue	50	50	0	43	10	30	70	10	40
Average	45	55	3	19	19	23	80	23	39
III. State Teachers Colleges									
1. California, San Diego	74	68	26	16	21	16	63	11	21
2. Colorado, Greeley	33	67	7	13	7	13	67	33	7
3. District of Columbia, Ormand Wilson	16	22	9	0	1	4	8	15	17
4. Indiana, Terre Haute	15	13	2	6	1	2	11	3	5
5. Kansas, Emporia	6	14	3	4	8	4	13	4	5
6. Kansas, Pittsburg	57	71	0	7	0	7	57	7	0
7. Minnesota, St. Cloud	83	83	33	50	50	0	67	67	100
8. New Jersey, Montclair	85	85	18	21	32	10	56	31	13
9. Washington, Pullman	67	67	11	22	56	11	56	44	89
Average	47	54	12	15	20	7	44	24	29

TABLE II (Continued)

Type of School	Interpretation of Curve						Scores		Gra- duate	Series
	Curve Linear	Reduction Norm. Prob.	Symmetri- cal Curve	Bilateral ly Symm.	Or- dinate	Curve Defined	Curve of Error	Limit of Score Int.	His- to-gram	Dis. and Con. Series
IV. Municipal Universities										
1. Akron	77	65	94	12	6	6	65	65	41	47
2. Cincinnati	37	49	13	8	22	46	30	51	30	33
Average	57	57	54	10	14	26	48	58	36	40
V. Private Col- leges and Universities										
1. Antioch	59	74	23	5	19	9	64	68	45	55
2. Brown	33	60	0	7	0	20	27	87	33	0
3. Bucknell	56	0	0	22	22	22	0	56	0	89
4. Chicago	62	54	0	23	8	15	38	92	31	54
5. Columbia	0	43	0	14	7	14	29	79	14	7
6. Denver	42	75	8	8	8	15	33	100	33	33
7. Duke	70	62	46	43	46	23	46	62	85	62
8. Eureka	29	72	14	14	100	14	43	72	43	100
9. Hood	70	40	0	0	0	0	70	40	50	20
10. Ohio Wesleyan	91	91	9	9	23	5	95	82	32	59
11. Mills	26	63	0	21	42	21	32	95	16	47
12. Peabody	15	55	85	23	8	8	77	85	15	8
13. Pennsylvania	98	92	77	85	72	59	77	82	62	87
14. Princeton	100	93	0	14	71	14	79	93	7	57
15. Rockford	71	86	86	43	14	43	57	71	57	86
16. Wilson	100	100	0	0	25	50	100	100	0	25
Average	51	67	22	21	29	21	54	79	33	49

TABLE II (Continued)

ANALYSIS OF THE TRUE-FALSE SECTION OF THE COMPREHENSIVE
TEST FOR THE PER CENT OF ERROR FOR EACH STATISTICAL CON-
CEPT AND THE AVERAGE PER CENT OF ERRORS FOR EACH GROUP
OF COLLEGES AND UNIVERSITIES

Type of School	Correlation						
	Probability Defined	Errors of Prediction	Partial Correlation	Rel. of Corr. and reg. Coefficient	Coef. of Attenuation	Correlation Ratio	Negative Correlation
I. State Universities							
1. Arizona	67	22	33	89	22	56	22
2. Idaho	43	29	100	100	71	57	57
3. Illinois	36	43	36	36	0	36	36
4. Indiana	80	60	60	40	0	20	0
5. Kansas	47	20	53	87	33	33	40
6. Louisiana	31	24	34	34	21	24	28
7. Maine	31	31	62	54	38	46	23
8. Maryland	54	59	54	64	62	59	54
9. Missouri	69	50	81	94	81	69	69
10. Montana	78	44	72	72	50	59	41
11. Nebraska	92	56	70	81	64	59	48
12. New Jersey	44	44	50	57	63	38	38
13. New Mexico	47	16	37	63	42	37	37
14. Ohio	26	48	74	63	52	63	52
15. Virginia	75	50	88	75	38	75	13
16. Washington	73	25	61	46	16	68	27
17. West Virginia	79	26	57	65	30	52	39
18. Wyoming	0	0	80	80	0	100	0
Average	55	36	61	67	38	53	35
II. State Colleges							
1. Kansas	43	23	59	66	53	43	50
2. Miami	29	72	86	72	29	29	14
3. Purdue	60	50	70	70	50	70	40
Average	44	48	72	69	44	47	35

TABLE II (Continued)

Type of School	Correlation						
	Probabili- ty Defined	Errors of Prediction	Partial Correlation	Rel. of Corr. and Reg. Coefficient	Coef. of Attenuation	Correlation Ratio	Negative Correlation
III. State Teachers Colleges							
1. California, San Diego	54	38	100	100	54	62	31
2. Colorado, Greeley	47	25	80	74	47	67	25
3. District of Columbia, Ormand Wilson	68	14	50	43	25	68	32
4. Indiana, Terre Haute	70	45	80	65	25	50	45
5. Kansas, Emporia	39	39	73	62	22	67	28
6. Kansas, Pittsburg	28	21	64	43	43	85	28
7. Minnesota, St. Cloud	67	25	80	74	47	67	25
8. New Jersey, Montclair	21	29	86	26	55	70	18
9. Washington, Pullman	33	33	87	56	56	56	44
Average	47	30	78	60	42	66	31
IV. Municipal Universities							
1. Akron	59	41	83	94	47	65	18
2. Cincinnati	40	9	37	42	30	46	40
Average	50	25	60	68	39	56	29
V. Private Colleges and Universities							
1. Antioch	55	41	68	81	41	68	45
2. Brown	13	27	80	13	27	0	20
3. Bucknell	44	10	0	11	33	33	22

TABLE II (Continued)

Type of School	Correlation						
	Probability Defined	Errors of Prediction	Partial Correlation	Rel. of Corr. and Reg. Coefficient	Coefficient of Attenuation	Correlation Ratio	Negative Correlation
*4. Chicago	62	15	54	77	39	62	15
5. Columbia	36	43	50	21	29	14	7
6. Denver	58	67	58	75	33	67	33
7. Duke	77	39	77	92	46	92	46
8. Eureka	86	29	43	86	29	86	29
9. Hood	30	40	30	70	10	30	30
10. Ohio Wesleyan	39	43	95	86	77	73	30
11. Mills	69	32	74	80	58	58	85
12. Peabody	62	54	46	77	38	54	54
13. Pennsylvania	3	87	64	51	90	95	90
14. Princeton	43	50	85	85	92	50	14
15. Rockford	57	29	78	78	78	43	29
16. Wilson	75	50	75	100	100	75	75
Average	51	44	69	70	50	63	42

*On preceding page

TABLE II (Continued)

Type of School	Correlation						
	Pearson's Product Moment	Spearman's Foot-rule	Coef. of Alienation	Limits of Correlation	Magnitude of Correlation	Regression Lines	Regressed Score
I. State Universities							
1. Arizona	44	33	78	22	0	0	22
2. Idaho	57	29	14	71	14	14	14
3. Illinois	14	7	7	0	7	0	14
4. Indiana	60	40	20	0	80	0	0
5. Kansas	33	20	60	73	40	13	13
6. Louisiana	31	7	34	28	24	0	7
7. Maine	62	62	38	23	46	15	30
8. Maryland	46	72	33	46	67	18	59
9. Missouri	63	100	81	31	69	75	63
10. Montana	82	82	72	62	53	56	41
11. Nebraska	13	59	61	27	70	44	58
12. New Mexico	47	32	37	53	26	16	5
13. Ohio	33	70	33	30	37	15	15
14. New Jersey, (Rutgers)	63	57	50	38	57	25	6
15. Virginia	38	25	38	13	50	0	0
16. Washington	32	30	48	32	16	61	5
17. West Virginia	44	39	39	44	44	22	30
18. Wyoming	20	0	0	20	0	0	0
Average	46	43	56	35	39	21	23
II. State Colleges							
1. Kansas	76	53	43	36	36	23	33
2. Miami	14	43	57	0	29	29	29
3. Purdue	40	50	10	30	60	20	0
Average	43	49	37	22	42	24	21
III. State Teachers Colleges							
1. California, San Diego	85	100	48	31	77	54	67
2. Colorado, Greeley	60	34	25	34	34	13	20

TABLE II (Continued)

Type of School	Correlation						
	Pearson's Product Moment	Spearman's Foot Rule	Coef. of Alienation	Limits of Correlation	Magnitude of Correlation	Regression Lines	Regressed Score
*3. District of Columbia, Ormand Wilson	29	57	18	64	36	39	4
4. Indiana, Terre Haute	35	75	45	55	60	0	15
5. Kansas, Emporia	50	34	57	34	11	17	6
6. Kansas, Pittsburg	7	57	43	14	78	14	36
7. Minnesota, St. Cloud	50	83	83	83	83	50	67
8. New Jersey, Montclair	31	86	18	8	60	29	8
9. Washington, Pullman	67	67	56	11	78	33	44
Average	46	66	39	37	57	28	30
IV. Municipal Universities							
1. Akron	53	77	35	24	24	6	0
2. Cincinnati	31	48	23	25	8	1	9
Average	42	63	29	25	16	4	5
V. Private Colleges and Universities							
1. Antioch	34	59	54	23	50	23	32
2. Brown	40	34	13	7	7	77	47
3. Bucknell	33	56	22	11	56	0	44
4. Chicago	46	62	46	15	23	8	8
5. Columbia	21	0	21	7	43	0	29
6. Denver	50	42	17	17	20	0	20
7. Duke	31	77	39	39	31	46	23
8. Eureka	100	29	14	43	14	14	14

*On preceding page

TABLE II (Continued)

Type of School	Correlation						
	Pearson's Product Moment	Spearman's Foot-rule	Coef. of Alienation	Limits of Correlation	Magnitude of Correlation	Regression Lines	Regressed Score
*9. Hood	60	70	40	0	20	20	10
10. Ohio Wesleyan	77	86	60	22	43	47	56
11. Mills	5	27	64	64	16	11	21
12. Peabody	46	15	69	31	54	15	38
13. Pennsylvania	97	97	85	57	95	44	77
14. Princeton	57	99	64	0	64	7	50
15. Rockford	78	78	57	29	43	29	43
16. Wilson	75	100	100	25	100	50	0
Average	52	60	51	27	28	20	32

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TABLE III

AVERAGE PER CENT OF CLASS FAILING FOR THE STATISTICAL CONCEPT OF THE TRUE-FALSE SECTION OF THE COMPREHENSIVE TEST AND THE AVERAGE PER CENT OF FAILURE FOR EACH GROUP OF COLLEGES AND UNIVERSITIES

Type of School	Measures of Cent. Tendency	Measures of Disp.	Skewness	Sampling	Percentile Rank	Tests
I. State Universities						
1. Arizona	63	37	0	17	44	50
2. Idaho	67	25	14	21	14	43
3. Illinois	55	25	15	21	15	46
4. Indiana	72	17	58	25	42	50
5. Kansas	60	27	17	23	33	43
6. Louisiana	39	16	10	9	12	29
7. Maine	41	17	4	15	42	46
8. Maryland	43	24	33	32	57	72
9. Missouri	34	25	72	47	41	47
10. Montana	50	3	56	17	33	53
11. Nebraska	43	23	25	26	38	45
12. New Jersey	56	28	38	41	22	41
13. New Mexico	34	79	18	18	16	55
14. Ohio	41	30	26	39	26	32
15. Virginia	53	28	56	31	6	6
16. Washington	49	28	22	32	33	36
17. West Virginia	40	23	35	20	9	44
18. Wyoming	53	40	10	10	10	20
Average	50	28	28	25	25	42
II. State Colleges						
1. Kansas	50	27	22	22	55	45
2. Miami	34	22	7	29	36	50
3. Purdue	38	23	2	2	0	35
Average	41	24	10	18	30	43
III. State Teachers Colleges						
1. California, San Diego	64	25	37	35	53	32

TABLE III (Continued)

Type of School	Measures of Cent. Tendency	Measures of Dispersion	Skewness	Sampling	Percentile Rank	Tests
*2. Colorado, Greeley	44	73	23	27	23	44
3. District of Columbia, Ormand Wilson	55	31	57	31	36	56
4. Indiana, Terre Haute	48	25	30	30	25	40
5. Kansas, Emporia	57	25	42	39	25	40
6. Kansas, Pittsburg	33	12	11	43	14	46
7. Minnesota, St. Cloud	50	50	42	34	34	59
8. New Jersey, Montclair	28	28	17	90	13	39
9. Washington, Pullman	47	47	22	45	33	50
Average	47	33	39	33	30	45
IV. Municipal Universities						
1. Akron	51	28	62	18	53	44
2. Cincinnati	38	16	23	25	20	38
Average	45	22	42	21	36	41
V. Private Colleges and Universities						
1. Antioch	49	35	23	25	44	36
2. Brown	29	17	0	27	10	27

*On preceding page

TABLE III (Continued)

Type of School	Measures of Central Tendency	Measures of Dispersion	Skewness	Sampling	Percentile Rank	Tests
*3. Bucknell	33	44	11	39	56	22
4. Chicago	41	28	23	31	77	50
5. Columbia	31	25	14	14	72	29
6. Denver	27	31	25	29	29	42
7. Duke	46	33	42	35	34	39
8. Eureka	62	65	43	65	93	22
9. Hood	48	27	10	25	35	60
10. Ohio Wesleyan	52	26	15	40	37	64
11. Mills	60	21	24	16	9	48
12. Peabody	49	27	66	42	50	58
13. Pennsylvania	43	67	82	55	71	77
14. Princeton	51	28	21	36	46	39
15. Rockford	31	21	57	36	50	50
16. Wilson	94	38	50	50	38	63
Average	47	33	32	35	47	45

*On preceding page

TABLE III (Continued)

Type of School	Intervals	Score	Graphs	Curves	Series
I. State Universities					
1. Arizona	67	89	45	27	11
2. Idaho	43	29	57	33	43
3. Illinois	54	79	29	14	0
4. Indiana	67	100	100	26	17
5. Kansas	53	67	40	25	7
6. Louisiana	26	31	21	15	31
7. Maine	50	62	39	20	54
8. Maryland	67	69	64	38	54
9. Missouri	63	86	38	55	13
10. Montana	89	34	94	52	63
11. Nebraska	54	70	38	33	37
12. New Jersey	53	56	50	42	81
13. New Mexico	26	41	41	22	21
14. Ohio	58	89	26	29	74
15. Virginia	94	88	0	36	38
16. Washington	45	71	20	20	20
17. West Virginia	52	65	39	34	44
18. Wyoming	60	80	20	14	0
Average	57	67	42	30	34
II. State Colleges					
1. Kansas	56	83	30	39	33
2. Miami	57	86	29	26	43
3. Purdue	40	70	10	27	40
Average	51	80	23	31	39
III. State Teachers Colleges					
1. California, San Diego	37	63	11	40	21
2. Colorado, Greeley	83	67	33	27	7
3. District of Columbia, Ormand Wilson	92	29	54	30	61
4. Indiana, Terre Haute	63	55	15	35	25
5. Kansas, Emporia	83	72	22	38	28

TABLE III (Continued)

Type of School	Intervals	Score	Graphs	Curves	Series
*6. Kansas, Pittsburg	61	57	7	23	0
7. Minnesota, St. Cloud	67	67	67	55	100
8. New Jersey, Montclair	72	56	31	38	13
9. Washington, Pullman	50	56	44	43	89
Average	68	58	32	37	27
IV. Municipal Universities					
1. Akron	53	65	41	46	47
2. Cincinnati	41	51	30	39	32
Average	47	58	36	43	40
V. Private Colleges and Universities					
1. Antioch	45	68	45	36	55
2. Brown	50	87	33	21	0
3. Bucknell	28	56	0	18	89
4. Chicago	62	92	31	29	54
5. Columbia	47	79	14	15	7
6. Denver	67	100	33	26	33
7. Duke	73	62	85	45	62
8. Eureka	47	72	43	41	100
9. Hood	45	40	50	30	20
10. Ohio Wesleyan	54	82	32	46	59
11. Mills	56	95	16	29	47
12. Peabody	50	85	15	39	8
13. Pennsylvania	72	82	62	83	87
14. Princeton	50	93	7	53	57
15. Rockford	64	71	57	57	86
16. Wilson	50	100	0	54	25
Average	54	79	33	39	49

*On preceding page

TABLE III (Continued)

Types of Schools	Correlation	Probability	Reliability of Measures	Q ₁ and Q ₃ R. S. I. Q. R.
I. State Universities				
1. Arizona	34	67	29	15
2. Idaho	48	43	48	48
3. Illinois	18	36	47	33
4. Indiana	29	80	21	33
5. Kansas	40	47	42	49
6. Louisiana	23	31	26	29
7. Maine	41	31	42	54
8. Maryland	21	54	53	77
9. Missouri	71	69	63	58
10. Montana	61	78	49	48
11. Nebraska	55	92	45	32
12. New Jersey	25	44	47	76
13. New Mexico	34	47	36	53
14. Ohio	45	26	39	51
15. Virginia	39	75	47	54
16. Washington	36	73	34	47
17. West Virginia	41	78	38	39
18. Wyoming	23	0	33	40
Average	35	54	41	46
II. State Colleges				
1. Kansas	46	43	50	86
2. Miami	38	29	46	48
3. Purdue	43	60	29	55
Average	42	44	42	63

TABLE III (Continued)

Type of School	Correla- tion	Probabili- ty	Reliabili- ty	Q ₁ and Q ₃ R. S. I. Q.
III. State Teachers Colleges				
1. California, San Diego	65	54	45	74
2. Colorado, Greeley	42	47	29	49
3. District of Columbia, Ormand Wilson	42	68	53	89
4. Indiana, Terre Haute	46	70	34	65
5. Kansas, Emporia	38	39	34	41
6. Kansas, Pittsburg	42	28	41	24
7. Minnesota, St. Cloud	65	54	49	44
8. New Jersey, Montclair	40	21	30	34
9. Washington, Pullman	51	33	47	43
Average	48	46	40	52
IV. Municipal Universities				
1. Akron	38	59	40	39
2. Cincinnati	43	40	33	34
Average	42	50	37	37
V. Private Colleges and Universities				
1. Antioch	43	55	45	50
2. Brown	25	13	52	25
3. Bucknell	25	44	43	50
4. Chicago	36	62	40	44
5. Columbia	22	36	29	38
6. Denver	46	58	37	22
7. Duke	47	77	40	57
8. Eureka	41	86	54	67
9. Hood	29	30	30	53
10. Ohio Wesleyan	62	39	73	23
11. Mills	51	69	43	39
12. Peabody	46	62	36	59
13. Pennsylvania	75	3	82	82
14. Princeton	78	43	58	57
15. Rockford	51	57	53	66
16. Wilson	82	75	78	42
Average	47	51	50	48

APPENDIX "D"

TABLE IV

ANALYSIS OF THE MULTIPLE-CHOICE SECTION OF THE COMPREHENSIVE TEST FOR THE PER CENT OF ERRORS FOR EACH ITEM OF EACH GROUP OF COLLEGES AND UNIVERSITIES

Type of School	Probability		Skewness			Probable Error			Central Tendency
	Correct Responses	Areas under Curves	Position of Mode	Position of Median	Teachers' Grades in per cent	Standard Error of Estimate	Standard Error of Estimate	Defined	
I. State Universities									
1. Arizona	33	11	11	68	78	56	33	22	11
2. Idaho	29	0	43	43	29	72	29	43	72
3. Illinois	7	14	7	7	71	28	36	28	7
4. Indiana	17	0	33	67	67	17	17	67	17
5. Kansas	40	7	47	34	93	27	80	40	47
6. Louisiana	13	7	23	23	23	27	63	13	13
7. Maine	46	8	54	54	54	92	31	38	15
8. Maryland	38	38	62	54	59	87	62	33	46
9. Missouri	56	50	69	63	94	69	88	56	69
10. Montana	25	47	53	66	91	57	69	63	41
11. Nebraska	41	23	50	28	55	80	61	28	39
12. New Jersey	7	50	57	50	95	44	82	63	44
13. New Mexico	31	21	42	42	85	68	63	63	31
14. Ohio	25	25	37	22	96	63	56	67	11
15. Virginia	50	0	63	25	88	50	50	13	13
16. Washington	28	0	48	25	90	32	37	35	12
17. West Virginia	34	44	89	65	95	55	47	39	44
18. Wyoming	40	0	40	0	40	40	80	40	40
Average	31	19	46	41	72	51	55	42	32
									45

TABLE IV (Continued)

Type of School	Probability		Skewness			Probable Error			Central Tendency	
	Coin Tossing	Areas under Curves	Position of Mode	Position of Median	Teachers in Grades in per cent	Effect of Stigma	Stigma & Corr. Coeff.	Defined	Mean	Mode
II. State Teachers Colleges										
1. California, San Diego	26	37	63	5	95	53	47	26	47	63
2. Colorado, Greeley	33	13	40	20	67	53	40	20	27	40
3. D. of C., Ormand Wilson	82	4	36	50	89	57	71	36	61	36
4. Indiana, Terre Haute	30	5	45	55	95	20	60	30	10	45
5. Kansas, Emporia	6	6	33	22	39	39	89	44	28	33
6. Kansas, Pittsburg	7	0	43	7	79	21	50	29	29	42
7. Minnesota, St. Cloud	67	0	83	67	100	17	50	33	33	83
8. New Jersey, Montclair	21	31	41	26	97	64	28	21	31	41
9. Washington, Pullman	11	67	67	56	56	67	67	11	44	67
Average	31	18	50	34	80	43	56	28	34	50

TABLE IV (Continued)

Type of School	Probability		Skewness			Probable Error			Central Tendency		
	Coin Tossing	Areas under Curves	Position of mode	Position of median	Teachers in Grades in per cent	Effect of Sigma	P. E. and Sigma	Corr. Coeff. and P. E.	Defined	Mean	Mode
III. State Colleges											
1. Kansas	23	36	76	40	86	59	86	36	69	26	76
2. Miami	14	29	72	72	0	14	14	86	57	14	72
3. Purdue	10	0	20	80	80	30	70	10	50	30	20
Average	22	22	56	64	55	34	81	44	59	23	56
IV. Municipal Universities											
1. Akron	35	12	35	47	100	41	53	24	59	6	35
2. Cincinnati	36	8	38	25	40	73	36	19	6	55	38
Average	36	10	37	36	70	57	45	22	33	31	37
V. Private Schools											
1. Antioch	20	30	55	80	90	50	75	35	70	30	55
2. Brown	0	27	13	7	80	40	47	27	47	13	13
3. Bucknell	11	0	56	67	100	11	44	44	22	0	56
4. Chicago	15	31	39	62	100	23	39	15	39	8	39
5. Columbia	14	0	14	50	71	29	43	14	43	0	14
6. Denver	25	0	17	17	67	25	93	8	42	0	17
7. Duke	12	12	69	0	92	46	69	8	12	69	8

TABLE IV (Continued)

Type of School	Prob- ability		Skewness			Probable Error			Central Tendency		
	Coin Tossing	Areas under Curves	Position of Mode	Position of Median	Teachers Grades in per cent	Effect of Sigma	P. E. and Sigma	Corr. Coef. and p. E.	Defined	Mean	Mode
*8. Eureka	57	100	57	100	100	72	86	14	29	14	57
9. Hood	30	0	60	0	90	42	70	10	90	20	50
10. Peabody	15	0	46	0	92	15	85	15	23	31	46
11. Pennsylvania	75	86	91	94	99	99	86	84	99	70	91
12. Princeton	7	21	50	7	78	35	43	43	71	50	28
13. Rockford	50	17	84	17	100	33	71	29	100	0	71
14. Wilson	50	50	50	25	100	75	75	100	50	50	50
15. Ohio Wesleyan	23	77	63	77	50	59	68	86	68	45	63
16. Mills	21	27	42	21	100	48	72	5	27	21	42
Average	27	30	50	39	88	44	67	34	52	27	44

On preceding page

TABLE IV (Continued)

Type of School	Test	Series	Normal Prob. Curve			Reliability		Freq. Poly. v. Teachers Grades
			Freq. Poly. v. Norm. P.C.	Areas about the Mean	Freq. Poly. & Shape of Curve	Coefficient of Corr.	Rel. Var. of Dist.	
I. State Universities								
1. Arizona	44	0	67	11	78	67	0	78
2. Idaho	58	14	29	0	29	14	14	29
3. Illinois	0	0	14	14	78	0	0	79
4. Indiana	69	33	17	0	67	17	0	67
5. Kansas	60	20	13	7	94	0	7	93
6. Louisiana	17	17	41	7	24	14	3	23
7. Maine	77	31	39	54	92	39	23	92
8. Maryland	62	47	42	39	88	34	62	87
9. Missouri	50	19	32	50	95	44	19	94
10. Montana	47	12	43	47	60	62	31	47
11. Nebraska	67	16	30	24	82	29	0	80
12. New Jersey	63	25	44	50	95	63	58	94
13. New Mexico	42	85	0	0	85	15	21	84
14. Virginia	75	0	38	0	88	38	25	88
15. Washington	39	14	14	0	90	30	7	87
16. West Virginia	60	17	44	44	95	48	31	96
17. Wyoming	60	0	0	0	40	0	0	40
18. Ohio	48	0	7	26	96	19	15	96
Average	52	19	29	21	76	30	18	75

TABLE IV (Continued)

Type of School	Reliability	Continuous	Freq. Poly. V. Norm. P.C.	Areas about the mean	Freq. Poly. & Shape of Curve	Coefficient of Corr.	Rel. Var. of Dist.	Freq. Poly. V. Teachers Grades
II. State Teachers Colleges								
1. California, San Diego	26	15	10	37	95	26	26	95
2. Colorado, Greeley	13	0	7	13	10	20	20	67
3. District of Columbia, Ormand Wilson	43	36	54	7	89	36	100	89
4. Indiana, Terre Haute	7	15	20	5	95	30	75	95
5. Kansas, Emporia	17	17	7	7	94	44	6	94
6. Kansas, Pittsburg	21	0	21	0	79	29	7	79
7. Minnesota, St. Cloud	50	33	33	0	100	33	50	100
8. New Jersey, Montclair	75	59	36	31	97	21	3	97
9. Washington, Pullman	67	33	33	67	57	11	11	56
Average	37	23	25	19	80	28	23	75
III. State Colleges								
1. Kansas	33	23	43	36	86	36	30	87
2. Miami	14	43	43	29	100	86	0	100
3. Purdue	30	10	10	0	80	10	10	80
Average	26	25	32	22	89	44	13	89
IV. Municipal Universities								
1. Akron	53	50	24	12	100	24	83	100
2. Cincinnati	43	11	10	5	78	27	31	37
Average	48	31	17	8	69	26	57	69

TABLE IV (Continued)

Type of School	Test Reliability	Series Continuous	Normal Prob. Curve			Reliability		Freq. Poly. v. Mesch. Grades
			Freq. Polygon v Norm. Prob. C.	Areas about the mean	Freq. Poly. & Shape of Curve	Coef. of Corr.	Rel. Var. of Distribution	
V. Private Schools								
1. Antioch	65	20	20	30	90	35	5	90
2. Brown	74	0	0	27	80	27	7	80
3. Bucknell	33	0	0	0	100	44	22	100
4. Chicago	23	15	31	31	100	15	31	100
5. Columbia	21	0	14	0	72	14	7	71
6. Denver	25	25	17	0	67	9	0	67
7. Duke	46	39	54	15	92	8	31	92
8. Eureka	43	29	29	100	100	14	17	100
9. Hood	70	10	50	0	90	10	0	90
10. Mills	42	0	32	27	100	5	5	100
11. Ohio Wesleyan	63	36	40	77	50	86	100	50
12. Peabody	69	15	54	0	92	15	15	92
13. Pennsylvania	91	68	86	94	99	88	73	97
14. Princeton	43	78	71	14	85	21	85	79
15. Rockford	43	0	14	14	100	29	29	100
16. Wilson	75	0	50	50	100	100	75	100
Average	52	19	35	30	89	33	31	22

*On preceding page

TABLE IV (Continued)

THE AVERAGE PER CENT OF CLASS FAILURE FOR THE STATISTICAL CONCEPTS OF THE MULTIPLE-CHOICE SECTION OF THE COMPREHENSIVE TEST

Type of School	Probability	Skewness	Probable Error	Measures of Cent. Tendency
I. State Universities				
1. Arizona	22	78	41	61
2. Idaho	14	47	29	79
3. Illinois	11	29	21	14
4. Indiana	8	46	33	25
5. Kansas	24	50	40	37
6. Louisiana	10	24	32	18
7. Maine	27	64	33	35
8. Maryland	38	61	47	54
9. Missouri	53	74	63	42
10. Montana	36	67	53	47
11. Nebraska	32	53	47	44
12. New Jersey	28	61	69	50
13. New Mexico	26	59	47	37
14. Ohio	25	55	50	24
15. Virginia	25	56	33	38
16. Washington	14	49	34	30
17. West Virginia	39	76	44	66
18. Wyoming	20	30	40	30
Average	25	54	43	41
II. State Colleges				
1. Kansas	30	62	66	51
2. Miami	22	39	52	43
3. Purdue	15	53	43	25
Average	23	51	53	40
III. State Teachers Colleges				
1. California, San Diego	32	54	47	55
2. Colorado, Greeley	23	45	38	34

TABLE IV (Continued)

Type of School	Probability	Skewness	Probable Error	Measures of Central Tendency
*3. District of Columbia Ormand Wilson	43	58	54	29
4. Indiana, Terre Haute	18	54	55	28
5. Kansas, Emporia	6	33	67	31
6. Kansas, Pittsburg	4	38	50	36
7. Minnesota, St. Cloud	34	67	44	58
8. New Jersey, Montclair	26	57	41	36
9. Washington, Pullman	39	62	56	56
Average	25	52	50	40
IV. Municipal Universities				
1. Akron	24	56	45	21
2. Cincinnati	26	29	24	43
Average	25	43	35	32
V. Private Colleges and Universities				
1. Antioch	25	69	60	43
2. Brown	13	35	40	13
3. Bucknell	6	58	37	3
4. Chicago	23	56	31	58
5. Columbia	7	41	33	7
6. Denver	13	32	48	13
7. Duke	15	52	31	4
8. Eureka	79	82	43	36
9. Hood	15	48	57	35
10. Ohio Wesleyan	50	62	74	54
11. Mills	24	53	35	32
12. Peabody	8	38	41	39
13. Pennsylvania	80	94	91	81
14. Princeton	14	43	52	78
15. Rockford	33	63	84	42
16. Wilson	50	63	75	50
Average	28	56	52	37

TABLE IV (Continued)

Type of School	Tests	Series	Normal Prob. Curve	Reliability	Frequency Polygons
I. State Universities					
1. Arizona	44	0	52	39	78
2. Idaho	57	14	20	14	29
3. Illinois	0	0	32	0	79
4. Indiana	47	33	28	8	67
5. Kansas	60	20	38	34	93
6. Louisiana	17	17	24	17	23
7. Maine	77	31	62	31	92
8. Maryland	62	47	56	48	87
9. Missouri	50	19	59	32	94
10. Montana	47	13	12	47	47
11. Nebraska	67	16	44	14	80
12. New Jersey	63	25	63	60	94
13. New Mexico	42	85	39	18	84
14. Ohio	48	0	43	17	96
15. Virginia	75	0	42	31	88
16. Washington	39	14	35	37	87
17. West Virginia	60	17	61	26	96
18. Wyoming	60	0	13	0	40
Average	52	22	45	30	75
II. State Colleges					
1. Kansas	33	23	55	33	87
2. Miami	14	43	57	42	100
3. Purdue	30	10	30	10	80
Average	26	25	47	29	89
III. State Teachers Colleges					
1. California, San Diego	26.3	15.3	47.3	26.3	95
2. Colorado, Greeley	13.3	0.0	9.9	20.0	67

TABLE IV (Continued)

Type of School	Tests	Series	Normal Probability Curve	Reliability	Frequency Polygons
*3. District of Co- lumbia, Or- mand Wilson	42.8	35.6	48.8	67.8	89
4. Indiana, Terre Haute	7.0	15.0	40.0	52.5	95
5. Kansas, Emporia	16.7	16.7	35.2	50.0	94
6. Kansas, Pittsburg	21.4	0.0	33.3	17.9	79
7. Minnesota, St. Cloud	50.0	33.3	44.4	41.5	100
8. New Jersey, Montclair	74.3	58.9	54.7	11.6	97
9. Washington, Pullman	66.7	33.3	52.2	11.1	56
Average	35	69	41	39	86
IV. Municipal Universi- ties					
1. Akron	54.0	50.4	47.9	53.1	100.0
2. Cincinnati	43.1	5.8	19.7	23.9	37.0
Average	48	28	34	39	69
V. Private Colleges and Universities					
1. Antioch	65.0	20.0	46.7	20.0	90.0
2. Brown	73.7	0.0	35.7	16.8	80.0
3. Bucknell	33.3	0.0	33.3	33.3	100.0
4. Chicago	23.0	15.4	56.4	23.1	100.0
5. Columbia	21.4	0.0	28.6	10.6	71.0
6. Denver	25.0	25.0	27.7	4.4	67.0
7. Duke	46.4	38.5	55.9	7.3	92.0
8. Eureka	42.9	28.6	76.3	15.8	100.0
9. Hood	71.0	10.0	46.7	5.0	90.0

*On preceding page

TABLE IV (Continued)

Type of School	Tests	Series	Normal Probability Curve	Reliability	Frequency Polygons
*10. Ohio Wesleyan	63.0	36.0	53.3	92.3	100.0
11. Mills	42.4	0.0	53.0	5.3	50.0
12. Peabody	69.2	15.4	48.7	15.4	92.0
13. Pennsylvania	91.0	67.6	92.9	55.6	97.0
14. Princeton	42.6	78.1	56.9	53.3	79.0
15. Rockford	42.9	0.0	42.9	28.6	100.0
16. Wilson	75.0	0.0	66.7	87.5	100.0
Average	52	21	51	30	82

*On preceding page

TABLE V

ANALYSIS OF THE MATCH-ANSWER SECTION OF THE COMPREHENSIVE
TEST FOR THE PER CENT OF ERRORS ON EACH ITEM

Type of School	Measure of Cent. Tend.		Correlation			Curves			Graphs
	Mean	Harmonic Mean	Coef. of Association	Spearman's Foot-rule	Zero order of Coef.	Histogram	Optive	Pie Diagram	
I. State Universities									
1. Arizona	90	90	90	33	0	22	0	22	22
2. Idaho	100	86	100	14	100	29	29	43	57
3. Illinois	7	15	21	15	0	0	0	0	0
4. Indiana	67	67	67	50	17	0	17	0	17
5. Kansas	100	93	73	100	60	40	0	20	20
6. Louisiana	40	47	50	40	47	13	23	17	30
7. Maine	77	77	85	15	46	23	8	8	31
8. Maryland	95	89	80	98	87	72	67	62	72
9. Missouri	81	81	100	100	93	13	19	38	13
10. Montana	81	63	84	72	78	6	0	16	25
11. Nebraska	88	86	86	13	80	28	63	27	47
12. New Jersey	100	100	25	69	88	69	50	81	100
13. New Mexico	90	79	95	26	26	32	11	47	47
14. Ohio	89	15	96	83	82	37	30	33	67
15. Virginia	88	100	100	50	88	88	38	63	88
16. Washington	68	61	91	16	71	30	7	14	7
17. West Virginia	100	96	91	96	70	39	17	16	43
18. Wyoming	80	100	100	0	40	0	0	0	20
Average	75	75	80	50	60	30	21	33	34

TABLE V (Continued)

Type of School	Measure of Cent. Tendency		Correlation			Curves		Pie Diagram	Frequency Polygon
	Mean	Harmonic Mean	Coef. of Association	Spearman's Foot-note	Zero order of Coef.	Histogram	Ogive		
II. State Teachers Colleges									
1. California, San Diego	68	68	95	95	58	26	37	11	32
2. Colorado, Greeley	73	53	93	13	80	67	13	27	20
3. District of Columbia, Ormand Wilson	97	82	89	11	86	18	0	7	7
4. Indiana, Terre Haute	60	65	95	80	50	10	0	20	15
5. Kansas, Emporia	78	67	89	94	72	33	6	30	39
6. Kansas, Pittsburg	71	64	100	100	93	14	7	14	21
7. Minnesota, St. Cloud	83	83	100	50	67	100	33	50	83
8. New Jersey, Montclair	85	74	97	100	87	28	8	31	15
9. Washington, Pullman	89	44	100	78	67	33	56	44	56
Average	78	67	95	69	73	25	18	28	32

TABLE V (Continued)

Type of School	Measure of Cent. Tend.		Correlation				Curve		Graphs
	Mean	Harmonic Mean	Coef. of Association	Spearman's Foot-rule	Zero order of Coef.	Histogram	Ogive	Pie Diagram	
III. State Colleges									
1. Kansas	100	21	21	0	86	0	14	0	43
2. Miami	80	83	90	93	83	83	43	70	73
3. Purdue	70	70	80	30	30	20	10	40	20
Average	83	58	64	41	66	34	22	27	45
IV. Municipal Universities									
1. Akron	94	88	71	77	41	47	24	59	53
2. Cincinnati	84	47	63	42	62	45	25	25	41
Average	89	68	67	60	52	46	25	42	47
V. Private Schools									
1. Antioch	100	90	85	70	85	45	10	50	60
2. Brown	20	53	67	100	80	13	0	0	13
3. Bucknell	22	22	56	56	56	0	11	11	11

TABLE V (Continued)

Type of School	Measures of Cent. Tendency		Correlation				Curves		Graphs
	Mean	Harmonic Mean	Coef. of Association	Spearman's Foot-rule	Zero order Coef.	Histogram	Ogive	Pie Diagram	
4. Chicago	100	77	85	62	77	15	0	23	8
5. Columbia	86	71	64	57	22	14	22	22	29
6. Denver	67	58	100	25	92	0	8	33	17
7. Duke	100	100	92	69	85	92	38	61	100
8. Dureka	100	100	100	57	86	57	29	57	86
9. Hood	80	50	90	0	80	30	0	20	20
10. Mills	89	89	100	95	95	16	26	11	0
11. Ohio Wesleyan	50	50	91	100	100	18	23	0	32
12. Peabody	62	69	46	38	31	15	7	46	31
13. Pennsylvania	98	98	98	95	98	41	89	87	92
14. Princeton	86	71	100	86	64	29	50	29	29
15. Rockford	100	57	86	86	71	71	43	57	57
16. Wilson	100	100	100	100	100	0	25	50	50
Average	79	72	85	69	76	29	24	35	40

*On preceding page

TABLE V (Continued)

ANALYSIS OF THE MATCH-ANSWER SECTION OF THE COMPREHENSIVE
TEST FOR THE PER CENT OF ERROR FOR EACH ITEM AND THE AV-
ERAGE PER CENT OF ERRORS FOR EACH GROUP OF COLLEGES AND
UNIVERSITIES

Type of School	Freq. Tables	T- Scores	Relia- bility		Inter- vals Class Defined	Prob. Error .6745 Sigma
			Sigma Measure	Standard Error		
I. State Universi- ties						
1. Arizona	44	56	67	56	44	11
2. Idaho	57	86	43	43	57	57
3. Illinois	14	36	28	28	7	0
4. Indiana	0	0	0	17	0	0
5. Kansas	40	74	67	60	7	100
6. Louisiana	26	43	26	17	20	7
7. Maine	47	92	85	77	31	54
8. Maryland	60	91	62	65	63	42
9. Missouri	25	100	95	95	44	88
10. Montana	34	71	52	56	9	37
11. Nebraska	63	64	79	66	27	11
12. New Jersey	88	95	100	63	57	88
13. New Mexico	26	58	26	37	37	26
14. Ohio	44	85	41	52	15	10
15. Virginia	63	75	88	88	38	88
16. Washington	34	50	73	64	14	7
17. West Virginia	83	87	91	65	26	13
18. Wyoming	40	20	80	20	0	100
Average	44	66	61	54	28	41
II. State Teachers Colleges						
1. California, San Diego	38	88	88	69	16	95
2. Colorado, Greeley	74	60	67	54	27	13
3. District of Co- lumbia, Ormand Wilson	40	90	76	29	11	0
4. Indiana, Terre Haute	40	50	76	55	15	25

TABLE V (Continued)

Type of School	Freq. Tables	T- Scores	Relia- bility		Inter- vals	Prob. Error
			Sigma Measure	Standard Error	Class Int. Defined	.6745 Sigma
*5. Kansas, Emporia	49	95	67	73	28	95
6. Kansas, Pittsburg	28	92	36	36	28	99
7. Minnesota, St. Cloud	84	100	100	84	50	67
8. New Jersey, Montclair	49	36	96	49	34	99
9. Washington, Pullman	33	78	22	67	11	22
Average	48	76	59	57	24	57
III. State Colleges						
1. Kansas	56	96	76	63	50	86
2. Miami	27	72	40	43	27	0
3. Purdue	30	50	50	20	10	10
Average	38	73	55	42	29	32
IV. Municipal Universities						
1. Akron	71	88	65	27	41	47
2. Cincinnati	22	34	40	48	15	27
Average	47	61	53	38	28	37
V. Private Schools						
1. Antioch	60	95	60	60	30	40
2. Brown	20	94	40	40	0	100
3. Bucknell	33	78	22	44	11	0
4. Chicago	15	46	46	54	23	39

*On preceding page

TABLE V (Continued)

Type of School	Freq. Tables	T-S Scores	Relia- bility		Inter- vals	Prob. Error
			Sigma Measure	Standard Error	Class int. Defined	.6745 Sigma
*5. Columbia	21	36	43	22	0	57
6. Denver	33	33	33	33	8	8
7. Duke	46	85	39	46	23	31
8. Eureka	9	43	100	29	14	100
9. Hood	10	70	50	50	0	0
10. Mills	21	85	85	64	5	100
11. Ohio Wesleyan	14	86	54	54	23	90
12. Peabody	46	62	54	62	8	31
13. Pennsylvania	40	97	97	92	80	56
14. Princeton	21	78	36	14	14	43
15. Rockford	72	100	43	57	14	0
16. Wilson	25	100	0	75	0	75
Average	30	74	50	50	16	48

*On preceding page

TABLE VI

AVERAGE PER CENT OF CLASS FAILURES FOR THE STATISTICAL CONCEPTS OF THE MATCH-ANSWER SECTION OF THE COMPREHENSIVE TEST

Type of School	Measures of Cent. Tendency	Correlation	Curves	Graphs	Frequency Tables
I. State Universities					
1. Arizona	88.9	40.7	14.8	22.2	44.4
2. Idaho	93.0	71.5	33.3	42.8	57.2
3. Illinois	10.7	19.0	0.0	0.0	14.2
4. Indiana	66.7	44.4	5.6	8.3	0.0
5. Kansas	96.7	77.9	20.0	30.0	40.2
6. Louisiana	43.3	45.6	17.8	43.4	26.4
7. Maine	77.0	48.8	12.8	26.9	46.2
8. Maryland	92.5	88.0	66.7	71.9	59.8
9. Missouri	81.3	98.0	29.2	12.5	25.2
10. Montana	71.9	78.2	72.9	15.6	34.1
11. Nebraska	86.7	59.4	42.4	16.4	63.0
12. New Mexico	84.3	49.2	29.8	39.5	26.0
13. Ohio	51.9	87.6	33.3	51.9	44.0
14. New Jersey (Rutgers)	100	61.0	67.0	85.0	88.2
15. Virginia	94.0	79.3	63.0	88.0	63.0
16. Washington	65.0	59.0	17.0	19.0	34.0
17. West Virginia	98.0	86.0	39.0	41.0	83.0
18. Wyoming	90.0	47.0	0.0	10.0	40.0
Average	76	63	31	35	44
II. State Colleges					
1. Kansas	82.0	89.0	64.0	78.0	56.1
2. Miami	61.0	32.0	5.0	22.0	28.6
3. Purdue	70.0	47.0	23.0	20.0	30.0
Average	71	56	31	40	38

TABLE VI (Continued)

Type of School	Measures of Central Tendency	Correlation	Curves	Graphs	Frequency Tables
III. State Teachers Colleges					
1. California, San Diego	68.0	63.0	25.0	29.0	37.8
2. Colorado, Greeley	63.3	62.2	35.6	43.3	63.6
3. Indiana, Terre Haute	62.5	75.0	10.0	12.5	40.0
4. Kansas, Emporia	72.2	85.2	30.0	36.1	49.4
5. Kansas, Pittsburg	67.9	97.9	11.9	17.9	28.4
6. Minnesota, St. Cloud	83.0	72.0	61.0	92.0	83.5
7. New Jersey, Montclair	79.5	95.0	22.3	21.5	49.4
8. Washington, Pullman	67.0	82.0	44.0	45.0	33.3
9. District of Columbia, Ormand Wilson	89.3	62.0	83.4	12.5	39.6
Average	73	77	36	34	37
IV. Municipal Universities					
1. Akron	91	63	43	50	71
2. Cincinnati	29	49	40	38	22
Average	60	56	41	44	47
V. Private Colleges and Universities					
1. Antioch	95.5	80.5	35.0	53.0	60.0

TABLE VI (Continued)

Type of School	Measures of Central Ten- dency	Correlation	Curves	Graphs	Frequency Tables
*2. Brown	37.0	82.0	4.0	13.0	20.1
3. Bucknell	22.0	56.0	7.0	6.0	33.3
4. Chicago	88.4	74.5	12.8	11.5	15.0
5. Columbia	78.5	47.7	19.1	21.2	21.0
6. Denver	62.5	72.3	13.9	8.3	33.0
7. Duke	100.0	82.0	64.0	96.0	46.2
8. Eureka	100.0	81.0	47.7	71.5	8.6
9. Hood	65.5	57.0	17.0	25.0	10.0
10. Ohio Wesleyan	50.0	97.0	14.0	25.0	13.5
11. Mills	89.0	97.0	18.0	8.0	21.2
12. Peabody	66.0	38.0	21.0	23.0	46.2
13. Pennsylvania	97.5	96.5	72.6	66.7	40.0
14. Princeton	78.0	83.0	36.0	29.0	21.3
15. Rockford	78.0	81.0	57.0	64.0	71.5
16. Wilson	100.0	100.0	25.0	25.0	25.0
Average	75	77	29	34	30

*On preceding page

TABLE VI (Continued)

Type of School	E- Scores	Reliability of Measure	Intervals	Probable Errors
I. State Universities				
1. Arizona	56	61	44	11
2. Idaho	86	43	57	57
3. Illinois	36	28	7	0
4. Indiana	0	0	8	0
5. Kansas	74	64	7	100
6. Louisiana	43	22	20	7
7. Maine	92	81	31	54
8. Maryland	91	64	62	42
9. Missouri	100	94	44	88
10. Montana	71	54	9	37
11. Nebraska	64	17	27	11
12. New Jersey	95	81	57	88
13. New Mexico	58	32	37	26
14. Ohio	85	47	15	11
15. Virginia	75	88	38	88
16. Washington	50	69	14	7
17. West Virginia	87	78	26	13
18. Wyoming	20	50	0	100
Average	65	54	28	41
II. State Colleges				
1. Kansas	96	69	50	86
2. Miami	72	22	29	0
3. Purdue	50	35	10	0
Average	73	42	29	29
III. State Teachers Colleges				
1. California, San Diego	88.1	78.5	15.9	95.4
2. Colorado, Greeley	60.3	60.0	26.8	13.4
3. D. of C. Ormand Wilson	90.0	52.4	10.0	0.0
4. Indiana, Terre Haute	50.0	65.0	15.0	25.0
5. Kansas, Emporia	95.2	70.0	28.0	95.2

TABLE VI (Continued)

Type of School	F-Scores	Reliability of Measure	Intervals	Probable Errors
*6. Kan., Pittsburg	92.3	35.5	28.4	99.4
7. Minnesota, St. Cloud	100.0	91.9	50.1	66.8
8. New Jersey, Montclair	36.4	72.8	33.8	98.8
9. Washington, Pullman	77.8	44.5	11.1	22.2
Average	77	63	24	57
IV. Municipal Universities				
1. Akron	88	56	41	47
2. Cincinnati	34	45	22	37
Average	61	52	32	42
V. Private Colleges & Univers.				
1. Antioch	95.0	60.0	30.0	40.0
2. Brown	93.8	40.2	0.0	100.0
3. Bucknell	77.7	33.3	11.1	0.0
4. Chicago	46.0	50.0	23.0	39.0
5. Columbia	36.0	37.5	0.0	57.0
6. Denver	33.0	33.0	8.0	8.0
7. Duke	84.7	42.4	23.1	30.8
8. Eureka	42.6	64.3	14.3	100.0
9. Hood	70.0	50.0	0.0	0.0
10. Ohio Wesleyan	85.5	54.0	28.5	90.0
11. Mills	84.8	74.2	5.3	100.0
12. Peabody	61.6	57.8	7.7	30.8
13. Pennsylvania	97.0	94.5	80.0	56.0
14. Princeton	78.1	28.9	14.2	42.6
15. Rockford	100.0	50.1	14.3	0.0
16. Wilson	100.0	37.5	0.0	75.0
Average	74	50	11	48

*On preceding page

TABLE VII

o TOTAL AVERAGE PER CENT OF ERRORS FOR EACH ITEM OF EACH
PROBLEM OF THE PROBLEM SECTION OF THE TEST FOR EACH
GROUP OF COLLEGES AND UNIVERSITIES
(The item is taken as the unit)

Central Tendencies Errors pertaining to:-	State Uni- versities	State Colleges	State Teach- ers Colleges	Municipal Universities	Private Col- leges & Uni- versities
1. <u>Arithmetic Mean</u>					
(a) Tabulation	0.6	0.0	0.0	0.0	0.0
(b) Formula	15.5	1.3	9.3	0.0	16.0
(c) Guessed Mean	34.4	5.1	3.9	12.2	34.6
(d) Alg. sum of fd's.	8.7	4.7	25.0	8.8	31.3
(e) Alg. sum $\frac{fd}{N}$	1.8	4.6	8.5	0.0	7.5
(f) Alg. signs	2.3	1.3	2.9	0.0	2.9
(g) Class Interval	10.0	0.0	3.6	0.7	3.7
(h) Class Int. Omitted	13.0	0.3	12.2	0.0	13.0
(i) Number	4.1	0.3	7.2	0.4	0.7
(j) Correction	38.3	1.0	24.4	6.2	13.1
2. <u>Median</u>					
(a) Tabulation	3.6	0.0	5.6	0.0	5.6
(b) Formulas	15.1	4.8	3.4	1.7	3.8
(c) Number	1.3	0.3	.5	0.0	0.5
(d) Guessed median	1.5	3.1	8.6	0.0	8.6
(e) Class Int. Omitted	0.4	0.0	0.0	0.0	0.0
(f) Class Interval	0.4	0.0	3.4	0.0	3.4
(g) Score to which to add correction	2.4	0.0	.9	0.3	10.0
(h) Correct. wr. Arith.	12.0	5.6	9.2	2.0	10.7
(i) Correct. wr. Stat.	49.0	0.0	1.0	0.0	1.0
(j) Lower limit of interval used	0.0	2.8	15.2	1.5	2.3
(k) Mid-point of inter- vals used	0.0	0.0	7.3	1.3	3.4
(l) Interpolation	12.8	0.0	7.1	3.0	8.1

TABLE VII (Continued)

<u>Measures of Dispersion</u>	State Universities	State Colleges	State Teachers Colleges	Municipal Universities	Private Colleges & Universities
Errors pertaining to Standard Deviation, and Mean Deviation					
<u>3. Standard Deviation</u>					
(a) Arithmetic Correction	1.8	2.3	14.5	1.0	14.5
(b) Statistical Correction	3.6	4.0	17.4	8.2	17.4
(c) C^2 mult. by Class interval	5.9	0.3	1.9	2.0	1.9
(d) C^2 omitted	4.1	1.5	0.9	0.0	0.9
(e) Number	1.9	1.1	1.4	0.0	19.6
(f) Cl. Int. omitted	11.4	3.8	32.1	0.0	15.4
(g) Sq. Rt. not taken	2.6	1.2	3.5	0.4	6.9
(h) Square Root	2.3	0.0	5.4	0.9	2.9
(i) Alg. sum of fd's.	10.7	0.8	6.7	3.2	3.8
(j) Alg. sum of fd's. sq.	14.8	2.3	25.3	9.2	22.9
(k) <u>Alg. sum of fd's</u> N	20.5	0.0	2.9	2.3	3.8
(l) Algebraic signs	1.9	0.0	2.1	0.0	1.4
(m) Long method	4.1	0.0	2.0	2.1	1.2
<u>4. Mean Deviation</u>					
(a) Arithmetic Correction	4.7	0.0	0.0	0.5	0.0
(b) Statistical Correction	3.0	0.0	1.1	2.3	2.1
(c) C not added or subtr. from sq. rt. of N	0.0	0.0	8.8	0.4	4.4
(d) Cl. Int. omitted	23.5	0.0	13.3	1.6	8.2
(e) Process not understood	38.7	5.4	45.8	4.7	25.6
(f) Formula	1.0	0.8	12.8	0.0	11.9
(g) Mean	0.3	0.0	3.8	2.9	2.9
(h) N_a and N_b	21.4	0.4	14.1	13.1	7.8
(i) Alg. sum of fd's.	12.4	0.0	0.0	0.0	0.0

TABLE VII (Continued)

<u>Measures of Dispersion, and Straight Line, and errors pertaining to Probable Error of Correlation</u>	State Universities	State Colleges	State Teachers Colleges	Municipal Universities	Private Colleges & Univs.
5. Q_1 and Q_3 and S. I. Q. R.					
(a) Formula	6.6	0.0	2.4	0.0	0.0
(b) Process	11.2	11.6	24.7	4.4	24.0
(c) Number	4.5	0.0	6.7	0.6	1.0
(d) Interpolation	43.8	8.99	39.1	11.7	61.3
(e) S. I. Q. R.	13.6	22.00	9.1	0.0	7.4
(f) Q_1 and Q_3 added	11.4	0.0	9.3	3.7	4.0
(g) Difference not divided	2.0	5.5	1.8	2.7	9.5
6 & 7. <u>Straight Line</u>					
(a) Coordinates x and y exchanged	58.8	10.0	48.9	16.6	25.1
(b) Do not know where to place the points	20.7	6.7	62.4	19.0	35.8
(c) Equation	75.9	0.0	35.66	42.6	58.3
(d) Substitution of values	42.1	15.0	64.8	46.1	70.6
8. Probable Error of Correlation					
(a) Formula	5.8	6.7	1.5	3.9	0.7
(b) Process not known	6.2	1.3	7.8	0.0	11.3
(c) .6745 omitted	15.3	7.9	8.9	0.0	10.9
(d) Division of decimal by 10	10.5	0.0	2.7	2.1	9.3
(e) Mult. of decimal	7.7	0.4	12.5	2.5	4.9
(f) Subt. of decimal from integer	7.9	0.0	6.6	0.4	0.0
(g) .9 squared	10.2	0.0	9.5	0.4	5.8
(h) Sq. Rt. not taken	5.7	0.0	1.3	0.0	1.6

TABLE VII (Continued)

Errors pertaining to Percentile Rank, Coefficient of Vari- ability, Random Sample, and Pearson's Product Moment	State Universi- ties	State Colleges	State Teachers Colleges	Municipal Universities	Private Col- leges & Univs.
9. <u>Percentile Rank</u>					
(a) Process	25.3	6.0	16.2	2.5	33.7
(b) Formula	3.8	0.0	1.7	3.5	2.5
(c) 100 omitted	0.0	0.0	0.0	0.0	0.0
(d) Average omitted	5.6	0.0	0.0	0.0	0.0
(e) 2 omitted	0.9	0.0	0.0	0.0	0.0
10. <u>Coefficient of Vari- ability</u>					
(a) Process	27.9	4.1	7.6	8.0	17.5
(b) Formula	12.7	0.0	2.6	3.5	1.7
(c) 100 omitted	2.0	0.0	0.0	0.0	0.0
(d) Decimals	0.0	0.0	0.0	0.0	0.0
(e) Division	0.0	0.0	0.0	2.8	0.4
11. <u>Random Sample</u>					
(a) Process	33.4	11.5	36.7	2.8	35.1
(b) Areas in per cent	19.1	10.0	37.9	1.4	37.9
(c) Arithmetic (made in subt)	0.0	0.0	0.0	5.6	0.0
12. <u>Pearson's Product Moment</u>					
(a) Formula	8.4	2.4	3.3	0.3	9.8
(b) Average	0.7	0.0	0.0	0.3	0.4
(c) Average omitted	0.0	0.0	0.0	0.0	0.0
(d) Derivative x	5.0	1.7	0.4	7.8	0.8
(e) Derivative y	5.0	0.0	0.4	7.8	0.8

TABLE VII (Continued)

Errors pertaining to Pearson's Product Moment, and Spearman's Foot-rule and Rank Difference	State Universi- ties	State Colleges	State Teachers Colleges	Municipal Universities	Private Col- leges & Univers.
*(f) Sq. of Sigma xy	10.1	0.8	8.6	5.8	5.0
(g) Sigma x^2	14.7	1.7	8.5	11.4	3.7
(h) Sigma y^2	17.6	3.2	2.3	11.9	3.5
(i) Sq. Rt. of fact- ors taken sepa- rately	0.1	0.0	0.0	0.3	0.6
(j) Mult. of factors	7.4	0.0	0.0	0.0	2.8
(k) Arith. Sq. Root	0.7	0.0	1.4	0.0	0.0
(l) Sq. Rt. under radical in the denominator	1.8	0.0	7.0	0.0	2.2
13. <u>Spearman's Foot-rule and Rank Difference</u>					
(a) Process	2.8	3.3	12.4	2.3	9.1
(b) Ranking	27.7	0.0	3.0	2.2	3.1
(c) Differences	21.3	5.0	44.9	1.6	50.0
(d) Gains	27.9	0.0	58.6	22.8	58.7
(e) Sum of Squares	2.6	0.0	6.5	0.0	6.5
(f) Squares	0.0	0.0	8.8	0.0	8.8

*On preceding page

TABLE VIII

DISTRIBUTION BY COLLEGES AND UNIVERSITIES OF THE ERRORS IN AVERAGE PER CENT FOR ALL THE ITEMS OF EACH PROBLEM OF THE STATISTICAL CONCEPTS OF THE PROBLEM SECTION IN THE COMPREHENSIVE TEST.

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
I. State Universities						
1. Arizona	6.3	5.2	3.7	7.4	6.1	14.0
2. Idaho	4.1	4.1	0.0	0.0	3.2	10.7
3. Illinois	3.3	4.5	9.6	0.0	4.7	5.4
4. Indiana	4.0	5.2	11.1	5.6	4.8	12.5
5. Kansas	3.2	3.6	7.8	2.2	1.9	3.4
6. Louisiana	8.8	3.7	4.4	1.1	10.1	7.6
7. Maine	6.4	12.3	12.7	1.3	6.1	9.7
8. Maryland	6.1	3.5	4.4	13.6	14.0	11.7
9. Missouri	3.8	4.3	2.1	10.5	0.0	1.6
10. Montana	3.6	7.3	4.7	3.1	1.9	11.7
11. Nebraska	0.6	5.5	6.0	2.2	1.3	3.6
12. New Mexico	5.3	6.9	8.9	0.0	1.8	1.4
13. Ohio	3.9	3.1	9.7	2.4	0.8	6.6
14. New Jersey (Rutgers)	12.7	0.0	0.0	0.0	0.0	0.0
15. Virginia	5.4	1.6	4.2	0.0	1.1	0.0
16. Washington	2.9	4.3	8.7	3.8	4.0	8.4
17. West Virginia	4.9	4.4	3.6	0.0	3.9	8.7
18. Wyoming	4.9	7.8	16.6	6.7	5.0	10.0
Average	5.0	4.9	6.6	3.3	3.9	7.1
II. State Teachers Colleges						
1. California, San Diego	1.4	4.4	2.4	0.0	2.1	0.0

TABLE VIII (Continued)

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
II. State Teachers Colleges						
1. California, San Diego	1.4	4.4	2.4	0.0	2.1	0.0
2. Colorado, Greeley	6.2	7.0	3.3	0.0	1.6	6.7
3. District of Columbia, Ormand Wil- son	2.7	6.2	5.3	8.4	6.2	5.4
4. Indiana, Terre Haute	6.9	6.6	3.3	1.7	1.7	0.0
5. Kansas, Em- poria	6.3	4.6	10.2	0.0	3.1	5.6
6. Kansas, Pittsburg	6.6	7.4	4.8	9.6	1.3	12.5
7. Minnesota, St. Cloud	2.3	2.5	0.0	0.0	3.7	16.6
8. New Jersey, Montclair	3.3	5.1	9.0	0.0	12.9	12.9
9. Washington, Pullman	6.1	4.5	5.6	7.4	4.3	0.0
Average	4.7	5.4	4.0	3.2	4.1	6.5
III. State Colleges						
1. Manhattan	4.5	4.0	1.1	0.0	0.1	0.9
2. Miami	7.7	6.4	11.9	4.8	5.2	0.0
3. Purdue	5.5	5.5	2.7	5.0	16.7	6.1
Average	5.9	5.3	5.4	4.9	7.3	2.7

TABLE VIII (Continued)

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
IV. Municipal Universities						
1. Akron	5.8	4.9	2.0	0.0	0.8	14.8
2. Cincinnati	3.3	5.0	3.6	2.5	6.3	11.0
Average	4.6	5.0	2.8	1.3	3.6	13.4
V. Private Colleges and Universities						
1. Antioch	13.3	2.5	4.2	5.0	2.0	0.0
2. Brown	8.2	8.7	14.5	4.4	8.0	6.7
3. Bucknell	1.9	1.9	3.7	3.7	2.7	2.8
4. Chicago	6.4	2.4	6.3	5.1	4.8	3.8
5. Columbia	6.4	6.5	10.8	4.8	4.2	19.7
6. Denver	2.9	3.3	8.3	1.7	2.8	16.6
7. Duke	8.1	6.8	10.3	15.4	4.5	5.7
8. Eureka	1.5	9.3	4.8	4.8	4.2	3.6
9. Hood	5.1	6.3	8.3	16.9	2.2	0.0
10. Mills	6.0	9.4	9.7	3.5	26.0	25.2
11. Ohio Wesleyan	1.4	2.9	0.0	0.0	0.0	0.0
12. Peabody	1.5	1.1	0.0	0.0	0.0	0.0
13. Pennsylvania	7.9	6.9	8.6	7.7	2.8	1.3
14. Princeton	4.3	2.9	1.2	0.0	1.2	5.4
15. Rockford	9.6	6.6	4.8	0.0	2.0	0.0
16. Wilson	1.1	1.2	0.0	0.0	0.0	0.0
Average	5.4	4.9	6.0	4.6	4.2	5.7

APPENDIX "D"

TABLE IX

DISTRIBUTION OF THE TOTAL PER CENT OF CLASSES FAILING ON THE PROBLEMS OF THE PROBLEM SECTION OF THE COMPREHENSIVE TEST FOR THE GROUPS OF COLLEGES AND UNIVERSITIES. (The problem is regarded as the unit)

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
I. State Universities						
1. Arizona	66.7	78.7	77.8	55.5	88.9	61.1
2. Idaho	57.2	75.0	71.3	28.6	76.2	64.3
3. Illinois	25.0	42.8	64.2	35.7	50.0	53.6
4. Indiana	33.4	62.5	100.0	33.2	83.3	50.0
5. Kansas	40.0	51.7	100.0	33.3	60.0	83.4
6. Louisiana	71.7	71.5	100.0	100.0	73.4	61.2
7. Maine	58.2	73.5	100.0	52.8	25.8	19.3
8. Maryland	68.0	87.3	95.0	95.0	89.8	70.6
9. Missouri	47.0	83.0	87.6	87.6	95.8	81.3
10. Montana	54.6	65.1	100.0	81.4	55.1	64.2
11. Nebraska	24.2	54.7	95.3	38.9	74.4	65.0
12. New Mexico	36.9	64.5	100.0	42.2	80.7	83.7
13. Ohio	70.4	86.2	92.6	51.5	100.0	83.4
14. New Jersey (Rutgers)	62.4	100.0	100.0	100.0	100.0	100.0
15. Virginia	68.8	90.6	100.0	100.0	100.0	100.0
16. Washington	46.6	68.3	95.6	91.0	59.0	77.3
17. West Virginia	39.1	67.4	95.7	82.6	87.0	82.7
18. Wyoming	40.0	55.0	100.0	20.0	26.7	70.0
Average	52.2	70.9	92.5	62.7	57.6	59.5
II. State Teachers Colleges						
1. Colorado, Greeley	46.7	68.3	86.7	53.3	77.8	80.5
2. Indiana, Terre Haute	45.0	58.8	100.0	80.0	73.3	37.5

TABLE IX (Continued)

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
*3. Kansas, Emporia	69.5	54.4	88.9	38.9	83.0	77.8
4. Kansas, Pittsburg	57.1	74.1	64.3	71.4	100.0	83.1
5. New Jersey, Montclair	51.4	61.6	100.0	100.0	100.0	77.0
6. California, San Diego	23.6	56.5	100.0	73.7	79.0	60.5
7. Minnesota, St. Cloud	16.7	66.6	100.0	66.7	72.2	84.0
8. Washington, Pullman	27.8	50.0	88.9	66.6	58.5	38.9
9. District of Columbia, Ormand Wilson	46.5	70.4	96.5	71.5	76.2	40.2
Average	41.7	62.3	91.7	69.1	80.0	64.4
III. State Colleges						
1. Manhattan	19.3	66.4	100.0	92.4	65.5	84.6
2. Miami	42.9	70.4	85.7	78.6	64.3	64.3
3. Purdue	60.0	80.0	90.0	30.0	73.3	95.0
Average	37.4	72.4	91.9	67.0	67.7	81.3
IV. Municipal Universities						
1. Akron	23.5	65.5	100.0	17.6	100.0	73.5
2. Cincinnati	28.1	53.1	38.6	52.4	66.1	40.0
Average	25.8	59.3	69.3	35.0	83.5	56.8

*On preceding page

TABLE IX (Continued)

Type of School	Measures of Central Tendency	Measures of Dispersion	Percentile Rank	Random Sample	Correlation	Straight Line
V. Private Colleges and Universities						
1. Antioch	82.5	90.0	100.0	100.0	88.3	75.0
2. Brown	46.7	48.3	80.1	53.3	71.1	13.3
3. Bucknell	16.7	86.1	100.0	22.2	66.7	16.7
4. Duke	65.4	71.2	100.0	46.7	84.6	69.3
5. Eureka	42.9	82.2	100.0	57.2	57.0	50.1
6. Hood	45.0	40.0	90.0	90.0	30.0	5.0
7. Chicago	19.3	66.4	100.0	92.4	65.5	84.6
8. Columbia	42.9	70.4	85.7	78.6	64.3	64.3
9. Mills	47.4	67.2	100.0	63.1	61.3	71.5
10. Ohio Wesleyan	34.1	73.9	100.0	100.0	100.0	61.5
11. Denver	20.8	50.3	83.0	0.0	44.4	58.2
12. Peabody	34.0	96.3	100.0	100.0	100.0	100.0
13. Princeton	53.5	82.2	100.0	71.4	88.0	63.6
14. Rockford	42.9	100.0	100.0	28.6	76.2	78.0
15. Pennsylvania	70.6	88.5	100.0	100.0	86.3	75.0
16. Wilson	12.5	81.3	100.0	50.0	61.7	55.4
Average	49.2	83.9	95.2	72.1	76.3	60.4

APPENDIX "E"

LIST OF PUBLISHERS OF STATISTICS TEXTS

TO WHOM INQUIRIES WERE SENT

1. Century Company, 353 Fourth Ave., New York
2. Ginn and Company, Chicago, Illinois
3. C. A. Gregory Company, Cincinnati, Ohio
4. Charles Griffin and Company, Ltd., London, England
5. D. C. Heath and Company, Boston, Massachusetts
6. Henry Holt and Company, New York
7. Houghton Mifflin Company, Chicago, Illinois
8. Longmans, Green and Company, New York
9. Macmillan and Company, New York
10. McGraw-Hill Book Company, New York
11. Prentice-Hall Book Company, New York
12. Charles Scribner and Son, New York
13. A. W. Shaw Company, Chicago, Illinois
14. Silver, Burdett and Company, Chicago, Illinois
15. The University of Chicago Press, Chicago, Illinois
- ✓ 16. World Book Company, Yonkers, New York.

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