A STUDY OF THE ATTITUDES OF CERTAIN STUDENTS OF MICHIGAN STATE COLLEGE TOWARD ARITHMETIC

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A STUDY OF THE ATTITUDES OF CERTAIN STUDENTS OF MICHIGAN STATE COLLEGE TOWARD ARITHMETIC

BY

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Arithmetic is one of the basic three R's that has been taught to American children for many years. Educators have usually considered this basic subject as necessary as "reading and writing" in anyone's education. Yet, the value of arithmetic has been a controversial issue. Students, teachers, and adults have been quite divided in opinion as to how valuable, necessary, enjoyable, or useful arithmetic is. Attitudes toward arithmetic have varied considerably. Many people of both sexes and all ages have stated a personal dislike for arithmetic and some of its related fields. Some children have struggled through grade school arithmetic only looking anxiously ahead to a high school course containing no mathematics. Students have purposely elected to study courses which they thought tended to shy away from the fundamentals or the applications of arithmetic. Adults who actually use arithmetic in everyday life have condemned it as being foolish, worthless, or unpractical. Many persons have attitudes toward arithmetic that are unfavorable. Still many students, teachers, and adults have had natural yearnings for arithmetic and have had highly favorable attitudes toward the subject. They have learned to like arithmetic and many of its applications. They have expended extra effort to study the more advanced

mathematical fields. They have put their knowledge of arithmetic to work and in many cases it has helped to reap or to increase profits. They have sought personal enjoyment from the applications of arithmetic to a personal interest.

As a high school teacher of mathematics, the writer has observed varied personalities which have had many diversified attitudes toward arithmetic. It is possible that many of these attitudes are carried on to college, sometimes changed and often intensified. It is a personal interest of the writer to investigate scientifically such attitudes and determine to what extent they may be modified in a favorable direction.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study (1) to determine the attitudes toward arithmetic of certain selected groups of students at Michigan State College and to compare the relationship of the attitudes of these selected groups: (2) to test the reliability and the validity of a specific attitude scale; and (3) to contribute some information that may lead to the development of an improved arithmetic attitude scale.

Importance of the study. The development of desirable attitudes is a major aim of the teachers of secondary mathematics.[1]

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[1] "The Place of Mathematics in Secondary Education" Fifteenth Yearbook of the National Council of Mathematics, (New York: Bureau of Publications, Teachers College, Columbia University, 1940) p. 26.

Despite this general objective, very little has been done in the way of measuring such attitudes.

It was desirable to know just what specific attitudes toward arithmetic were existent; to what degree these attitudes varied; how these attitudes developed or changed; and what factors had influenced these developments. It was important to know the attitudes toward arithmetic of secondary teachers who were aiming to develop desirable attitudes toward arithmetic and the attitudes toward arithmetic of the elementary teachers who were building the foundations of secondary education.

Very little information was found on the specific measurement of attitudes toward arithmetic. This study made use of a general attitude scale which was converted into a specific attitude scale to measure attitudes toward arithmetic. It was hoped that the study would justify the use of such a scale and possibly contribute information which would lead to the development of an attitude scale for arithmetic and indirectly to the development of desirable attitudes as outgrowths from the teaching of arithmetic.

II. DEFINITIONS OF TERMS USED

Attitude. An attitude was interpreted as meaning the state of mind of a person regarding some matter which was conceptual in nature. Here an attitude differed from a trait in that an attitude was more specific and less generalized. Stagner[2] has quoted Thurstone by saying: "an attitude is a generalized reaction for or against a specific psychological object." The writer felt that the definitions of the terms attitude, opinion and interest were greatly different, especially when interpreted technically and psychologically. This study has assumed for practical purposes that a person's opinion of some conceptual object very nearly expressed either his true attitude toward it or his interest in it. However, the fact was recognized that one's opinion may not always express his true attitude or interest, but in such cases it expressed the attitude or interest which the person desired other people to think he held. So for this study, attitude toward arithmetic would then reflect the opinion of or the interest in arithmetic of the individual.

Arithmetic. The term arithmetic was interpreted to mean the basic use of numbers and numerical computation

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[2] Ross Stagner, "Attitudes," The Encyclopedia of Educational Research, 1950 edition, I, 77.

below the level of algebra. In a great majority of the cases this meant all mathematics below the high school level where algebra was usually first taught. This dividing line was purposely selected because it was the point where most people either dropped all formal study of mathematics or branched out into one of its many fields. It was believed that arithmetic was a more general term than mathematics and more desirable for the purposes of this study.

CHAPTER II

REVIEW OF THE LITERATURE

Much has been written concerning attitudes in general, especially when treated as a segment of the study of personality. Literature on attitudes is rather abundant in the fields of psychology and education. However, in the very specific field of attitude measurement relatively less has been written. Following is a brief summary of the findings of some investigators who have written in various fields related to attitude measurement.

Literature on attitudes and attitude measurement. Stagner,[1] in his discussion of personality gives a detailed summarization of attitudes in general. He defines attitudes as being an integration of opinions. They are generalized tendencies to approve or to disapprove or to approach or to withdraw from a conceptual object. Attitudes are always relative to the situation and are characterized by objectivity, direction, and intensity. Attitudes are more specific than traits. He mentions a few methods of attitude measurement both objective and subjective in nature, giving references

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[1] Ross Stagner, Psychology of Personality, (New York: McGraw-Hill Book Company, 1948) p. 202.

to the writings of such authorities in the field as Thurstone, Likert, and Remmers.

Thurstone and Chave[2] in measuring attitudes toward the Church gave a good but highly technical discussion of attitudes and their measurement. They discussed theories of attitudes, gave an objective description of them, and indicated the possibilities of their measurement. They told how Thurstone selected a unit of measurement and with it devised the now famous attitude scale of equal-appearing intervals. In developing this scale, Thurstone collected a series of statements about the Church and with the help of other competent judges he arranged them in groups which appeared to be equal distances apart. A scale value was then determined for each statement. It was the work of the respondent to choose from a lot of mixed statements the statements with which he best agreed. The respondent's score was the calculated median of the total scale value of his chosen statements. Thurstone also defended this test of attitude measurement by showing various tests for its reliability and validity. He showed a method of the adjustment of this test in order to experiment on different subjects concerning attitudes toward a specific subject. Finally

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[2] L. L. Thurstone and E. J. Chave, The Measurement of Attitudes. (Chicago: University of Chicago Press, 1929), p. 1-96.

they explained the simpler method of testing attitudes through paired comparisons. In general, Thurstone and Chave have written in a highly technical nature and they are often difficult to understand.

Thurstone[3] in an address to the Midwestern Psychological Association discussed the development of the measurement of social attitudes and some of the criticisms and questions raised about this subject. He gave an example of a test of paired comparisons involving attitudes toward twenty different nationalities. The main criticism of such a test was the variance of the wording of the specific questions used. After discussing the method of paired comparisons, he branched into the method of using a statement scale. Here a series of opinions were presented to a subject for endorsement or rejection. The statements were in no classified order and each had been given a separate scale value. The subject was allowed to select those statements with which he agreed. His score was then the calculated median scale value of all of the statements he had endorsed. The meanings of the scores were then determined by the relative positions of any two or more scores. The score indicated whether one's attitude was above, equal to, or below the attitude of another individual. In

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[3] L. L. Thurstone, "The Measurement of Social Attitudes," The Journal of Abnormal and Social Psychology, 26: 249-69, October-December, 1931.

his example on attitudes toward prohibition; if x, y, and z had medians equally spaced apart, the increment in attitude difference between x and y would have been just as great as between y and z. Thurstone purposely avoided the discussion of the methods by which such scales were constructed because of the limitation of his time. He then gave several examples of the measurement of specific attitudes by the method of a statement scale. He emphasized the fact that an attitude cannot be entirely measured by any single device and, that most measurements only measure comparison of characteristics in terms of "more" or "less". He defined an attitude as being the affect for or against a psychological object. He discussed the uncertainty of using an opinion as an index of attitude. In closing he advised that attitude scales not be used to legally detect subversive attitudes toward patriotism, economic beliefs, or religion or as a means of eliminating undesirable students from institutions of higher learning.

Thurstone[4] has shown that attitudes can be measured as legitimately as many concrete objects. He made use of an opinion as a verbalized expression of an attitude and consequently as a means of measuring attitudes. He discussed the uncertainty of using an opinion as an index of attitude

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[4] L. L. Thurstone, "Attitudes Can Be Measured" The American Journal of Sociology, 33: 529-54, January, 1928.

and the probabilities of the slanting of attitudes by hiding the truth. He then assumed that attitude scales would be used only on those specific situations that offered a minimum of pressure on the attitude to be measured. He realized the probable changes in attitude, and he also insisted on making use of a calculated standard error of measurement to offset errors in the measuring instrument itself. He emphasized the restriction and the limitation of the attitude to be measured and he spoke of an attitude as a point or a vicinity along the attitude continuum. Four types of description were possible by means of an attitude scale. These were (1) the average attitude of a particular individual, (2) the range of opinion he is willing to tolerate or accept, (3) the relative popularity of each attitude of the scale for a designated group, and (4) the degree of homogeneity or hetrogeneity of a designated group on a specific issue. He gave a lengthy discussion of the construction of an attitude scale by his method of equal appearing intervals and several tests for the validity of such a scale.

Attitudes are measured by presenting a list of statements about a specific issue to a subject. The subject endorses as many of these statements as he desires. His score is the average scale value of all of the statements he has endorsed. His range of tolerance is the standard

deviation of the value of all of his selected statement values. The reliability of the scale can be determined by presenting two parallel forms to the same individuals at the same time. The reliability then is indicated by the correlation coefficient between the scores of the two forms. Group attitudes can be compared by direct comparison of the group means because of the fact that a rational base line had been established. Such comparisons however are not possible when the statements' scale differences have not been measured. Changes in attitude can be measured by determining the significance of the difference in attitude scores on the same test, before and after. The most essential characteristic of the present system of attitude measurement is the fact that the steps or intervals on the scale appear or seem to most people to be equally noticeable shifts in attitude.

H. H. Remmers and Ella Belle Silance[5] discussed the merits of Thurstone's method of equal appearing intervals for the construction of an attitude measuring device. It was concluded that such a system if applied to measure very many specific psychological characteristics would encompass considerable time, labor, and expense. The possible number of variations would be nearly infinite. It was the purpose

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[5] H. H. Remmers and Ella Belle Silance, "Generalized Attitude Scales," The Journal of Social Psychology, 5: 298-312, August, 1934.

of the authors to construct a generalized scale which would make possible the measurement of more attitudes without sacrificing the theoretical rigor and precision underlying the method developed by Thurstone.

The construction of such a scale was done by Miss Silance as a part of her Master's thesis at Purdue University under the direction of H. H. Remmers. The major part of the problem was the finding of a number of verbally functional statements and the allocation of each statement to a particular point on the scale. She gathered 150 statements from (1) college freshman themes written on school subjects liked or disliked; (2) textbooks on methods of teaching and educational literature; and (3) statements composed by herself. The statements were then sorted according to Thurstone's methods by 150 college and high school students. On the basis of these sortings, two equivalent forms were constructed by selecting 45 pairs of opinions of which the medians and the interquartile ranges were as nearly as possible identical. These opinions were arranged in descending order of magnitude of the interquartile range value.

Although the scale was constructed to measure attitudes toward four different high school subjects at one time, it was hoped that it would also lend itself to measure attitudes toward college subjects and elementary-school subjects as well.

The author expressed hope of measuring the reliability

of the scale by measuring the correlation between the results of the two forms. No measure of validity had been determined, but Remmers suggested that validity be established by measuring the attitude toward a specific subject with both a specific scale and as a part of the general scale. The correlation between the two series would constitute a measure of validity of the generalized scale, using scores on the specific scale as the criterion measure.

It was this particular article that provided the writer with the basis for this entire study. The scale constructed by Miss Silance was adapted and used in obtaining most of the data for the study.

Goodenough[6] in a chapter devoted to attitude measurement explained how attitudes can differ along several coordinates such as direction, strength or intensity, breadth, and fixity or fluidity. She explained how most measuring devices measure only a specific attitude for a specific time. She discussed Thurstone's method of equal-appearing intervals for the construction of attitude scales. She gave the characteristics of good statements that make up such a scale and mentioned the process of measuring attitudes by such a scale. She advocated using the median of the scale values assigned to statements chosen as the individual score. She then

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6 Florence Goodenough, Mental Testing (New York: Rinehart and Company, 1949) p. 374-85.

explained Likert's more simplified method where the subject scores every statement according to a degree of agreement and his score is the sum of his ratings. Likert's method requires more statements to check than does Thurstone's. Thurstone has included neutral statements where Likert has not. Likert's statements are equally weighted where Thurstone's are unequally weighted according to scale values obtained through sorting in the process of constructing the scale. Although Thurstone's scales are considered more valuable, the more simplified Likert scale has been tested by self-correlations, and it is considered satisfactory enough for the purposes for which scales are likely to be used. Miss Goodenough touched upon Thurstone's method of paired comparisons mentioning that it is laborious, but that it does have a relatively small error of estimate. She noted some of the practical applications of attitude measurement in psychological research. She emphasized that the potential usefulness of attitude measurement has not been completely realized. It is not enough just to measure attitudes but more important to ascertain the general trend of those attitudes. She discussed the dependability of paper and pencil attitude tests and the sources of error in such measurements. Because of lack of evidence as to the usefulness of such scales for the prediction of actual behavior, she concluded, "It might not

be a bad idea to put a ban on the construction of further scales of this type until more has been learned about the significance that may justifiably be attached to those now available".

A. W. Graham[7] in an attempt to measure a change in democratic attitudes of students made use of an attitude scale constructed on the principles of the Thurstone method. In this study two groups of students were selected from a Portland, Oregon grade school. One group was taught by teachers who used democratic methods and whose primary concern was personality development. The other group was taught by the more traditional autocratic methods where subject matter was the primary concern. All of these eighth-grade pupils were carefully matched as to sex, intelligence, and socio-economic factors. An attitude scale was administered to the children of both groups at the beginning of the experiment and at its termination one semester later. The attitudes measured were toward six specific characteristics of democracy. At the first administration there was a very close correspondence between the two groups of pupils. There was no significant difference between the means of the groups for any of the factors measured. The second administration of the

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[7] A. W. Graham "Do Teachers Who Use Democratic Methods Develop Democratic Attitudes?" The Elementary School Journal 47: 24-27, September, 1946.

attitude scale resulted in mean differences that were small, but all in favor of the group taught by democratic methods. The differences were significant in four of the six areas measured. However the differences in attitudes toward social studies and school were not significant. It was also noted in this experiment that the attitudes of the group taught by democratic methods shifted in a positive direction while in most cases the attitudes of the other group shifted negatively. The author concluded that (1) children are usually lacking in many of the attitudes needed in a democratic society; (2) typical teaching procedures do virtually nothing to develop democratic attitudes and (3) superior teachers, using democratic methods, do have a measure of success in establishing democratic attitudes.

Engle[8] in a discussion of social problems and attitudes stresses the point that many attitudes are based on very limited experience. He defines a prejudice as any attitude that prevents one from considering or evaluating certain new evidence. He mentions that an individual's attitudes in general cannot be measured, but that indidividual attitudes on specific social questions can. To measure specific social attitudes, an attitude scale is first constructed by competent

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[8] T. L. Engle, Psychology Principles and Applications. (Yonkers-on-Hudson, New York: World Book Company, 1945) p. 432-35.

personnel. The scale usually consists of a series of statements that have been given numerical values according to their relative position with one another. A subject is asked to select all of the statements with which he agrees. The sum total of the relative values of all of his selected statements is the individual's score. Then this score indicates his attitude toward the specific social question and it can be compared with the scores of other individuals or with any group.

Corey and Beery[9] attempted to measure the effect of teacher popularity upon attitude toward school subjects. College freshmen were asked to write the names of their high school teachers who were liked best and least and to include the high school subjects which each teacher had taught. A month later they were asked to list only the high school subjects liked best or least. These school subjects listed were followed by a check indicating whether they were being followed at the University and whether it was required or elected. The authors compiled their data in a chart containing eight different combinations of answers. They gave no statistical treatment of it, not even percentage calculations; but, they concluded that there were twice as many popular

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[9] Stephen M. Corey and G. S. Beery, "The Effect of Teacher Popularity Upon Attitude Toward School Subjects" The Journal of Educational Research, 29: 665-70, December, 1938.

teachers teaching popular academic subjects as there were popular academic subjects taught by unpopular teachers. If the teacher was not liked, the attitude was very apt to be carried over to the school subject. They concluded with the following quotation by John Dewey:[10] "With the young, the influence of the teacher's personality is intimately fused with that of the subject; the child does not separate or even distinguish the two."

Rose[11] discussed the major requirements and uses of the questionnaire for the process of attitude measurement and the opinion poll. He emphasized the importance of the minimum of ambiguity in the individual sentences or words. All questionnaires should be pretested before being allowed to be used. Individual subjects to be measured must be approached in the "right way" depending on the various situations. Care must be taken to get the best possible representative sample of a population. He suggests a few ways of getting the best possible sample according to the population being measured. He told how attitude measurers must boil down their data into a comprehensible reading form by the processes of "coding" and "analysis". He showed how attitude measurement

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[10] John Dewey, How We Think, (New York: D. C. Heath and Company, 1933) p. 59.

[11] Arnold M. Rose "Attitude Measurement and the Questionnaire Survey" The Scientific Monthly, 68: 97-101, February, 1949.

has now broadened out to detect attitudes and to reveal expectations, wishes, activities, facts, and estimations. He showed how such questionnaires were used to measure changes in attitudes in social studies. He also discussed questionnaires that were used to predict marital adjustment, future consumers' markets, and election results. He finally explained that periodical literature in the field is somewhat behind and that the field promised to have a most interesting future.

Katz and Allport[12] in a report of the Syracuse University Reaction Study made use of several methods of attitude measurement. They wrote in detail about different measurements of attitudes toward religious beliefs, cribbing, moral standards, etc.. In the latter section of their book they gave a good summary of attitudes and their measurement. They discussed the techniques of yes-no tests, multiple choice tests, rating scales, ranking scales, and attitude scales. They showed how each developed from a preceding one and briefly discussed the advantages and disadvantages of each and their uses at Syracuse University. They then discussed and evaluated the methods of Thurstone especially showing the advantages over the a priori, logical scales. They question the possible discrimination of the judges

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[12] Daniel Katz and F. H. Allport, Students' Attitudes (Syracuse, New York: The Craftsman Press, Inc., 1931) p. 353-73.

even though Thurstone and his associates have found this element to be of little practical consequence. Allport's scales at Syracuse differed from Thurstones on one main issue. Thurstone's statements were expressions which reflect the underlying attitudes while Allport's statements were thought to represent the attitudes themselves. Katz and Allport gave a few techniques of the administration of attitude surveys. They mentioned the importance of the arousing of interest, the role of the personality of the administrator, and the value of an added subjective device. In general this book represented a sound practical application of the principles of attitude measurement.

Literature on attitudes toward arithmetic. Plank,[13] observed the attitudes of young children toward mathematics. Twenty children who varied in ages from 5.2 to 11.4 years were studied. Their backgrounds were first investigated as to their level of educational attainment, their arithmetic acceleration or retardation, their socio-economic levels, and their past school attendance. This was done through school records and interviews with the children, teachers, and parents. The children were divided into three groups according to their mathematical abilities which were determined by several standardized tests and their chronological ages.

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[13] Emma N. Plank, "Observations of the Attitudes of Young Children Toward Mathematics," The Mathematics Teacher, 43-263, October, 1950.

Each group then was observed in a classroom. The observer first established rapport with the children and led them to select and to make use of the materials that were present. These materials were sets of the Montessori mathematical material for elementary schools which basically were objects that offered young children a chance for individual experimentation on quantitative and spatial relationships. Such a test explores the reaction of a child when faced with a baffling problem. The test denotes such qualities as fluidity, flexibility, rigidity and persistence. The author went into detail about each of the twenty subjects. She told about the child's background and the results of the various tests, interviews, and her direct observations. She gave interpretations of the results of the work with the Montessori materials and many direct quotations from the children which expressed specific attitudes toward arithmetic. She attempted to explain the specific cases of retardation in arithmetic by the comparison of certain personality factors that were noticed in her observations. Some of her conclusions were interesting. They were:

General ability is not always attended by mathematical ability.

There is less relation between intelligence and achievement in arithmetic than in either reading or spelling.

Failure in arithmetic is traced to school absences and defects in the educational process rather than in the child's innate mental makeup.

Continual failure makes many children dislike arithmetic.

Some children fail in arithmetic because they dislike speed.

In her review of the literature she mentioned that very little was avilable on the relations between personality and success or failure in arithmetic.

Young[14] in discussing the aims of mathematical instruction, listed the following paragraph as one of the aims.

> The Acquisition of mental habits and attitudes which will make mathematical training effective in the life of an individual. Among such habitual reactions are the following: a seeking for relations and their precise expression; an attitude of inquiry; a desire to understand, to get to the bottom of a situation; concentration and persistance; a love for precision, accuracy, thoroughness, and clearness, and a distaste for vagueness and incompleteness; a desire for orderly and logical organization as an aid to understanding and memory.

These represent specific attitudes that an educator thought ought to be developed in secondary mathematical instruction. He did not offer a way of measuring these attitudes.

An outlook in attitude measurement. This review has presented only a few of the many publications in the field of attitude measurement. It was unfortunate that so few articles

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[14] John W. Young, The Reorganization of Mathematics in Secondary Education. (New York: Houghton Mifflin Co., 1927) 171 pp.

were found in the specific field of attitudes toward arithmetic. The whole field of attitude measurement is still controversial and unlimited in its opportunities for contributions. The trend in the construction of attitude scales is toward simplification and the uses of these scales are gaining popularity. It would be of extreme importance if a valid scale could be constructed through which attitudes toward arithmetic and the changes in such attitudes could be measured. It is possible that achievement in arithmetic could be promoted indirectly through the development of attitudes more favorable to arithmetic. But first, some better means of measuring such attitudes and their changes is in demand.

CHAPTER III

THE MATERIALS USED AND GROUPS STUDIED

After considerable investigation of the published literature of attitude measurement, the attitude scale was selected as the most appropriate measuring device for this particular study. A general subject matter attitude scale was adapted to measure a specific attitude and a subjective supplement was added to it.

I. THE ATTITUDE SCALE

The objective attitude scale. An adapted form of a scale designed to measure attitudes toward general academic school subjects was used in this study. It had been constructed on the basis of Thurstone's method of equal appearing intervals by Miss Elle Belle Silance[1] as a part of her Master's Thesis at Purdue University in 1934. The construction of this scale has been described in the survey of the literature. The scale consisted of two forms which were comparable in content. Silance constructed the scale for the purpose of measuring several specific attitudes at

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[1] H. H. Remmers and Ella Belle Silance, "Generalized Attitude Scales" The Journal of Social Psychology, 5: 306-10, August, 1934.

a single sitting with one measuring instrument. She gave no evidence of the degree of reliability or validity of the scale. It was a purpose of this study to test an adaptation of this scale for those qualities.

The general pattern of Miss Silance's attitude scale was retained for use in this study. There were two individual scales, each a list of forty-five statements labeled Form A and Form B. The statements were arranged in the same logical order from expressions that were unfavorable to those that were highly favorable. The statements had been revised chiefly by substituting the word "arithmetic" for any word or group of words that originally had referred to the general subject in Miss Silance's attitude scale. Basically a general scale was converted into a specific one which was designed to measure only attitudes toward arithmetic. The scale was then entitled An Arithmetic Interest Scale. The two forms were printed on separate sheets of paper and each contained the identical specific instructions for self administration.

The subjective supplement. Along with the two objective scales was an answer sheet which permitted easier administration and scoring of both of the forms. On this answer sheet was a space for the subjective supplement. This space was preceded by instructions which asked for any reasons

why the individual subject may have liked or disliked arithmetic. This answer sheet also contained general instructions, a limitation of the term "arithmetic", and lines for such information as name, class, date, etc., which the writer may have desired in specific instances for other studies which grew out of this one. A copy of the complete attitude scale appears in the appendix of this study.

Scoring of the scale. The subjects were asked to select five statements rather than one because a single response is not necessarily a reliable index of attitude, while several responses tend more to indicate the presence of an attitude.[2] In order to avoid unnecessary and cumbersome totals of numbers, the average of the five numbers of the selected statements was used as the individual score for each form of the objective attitude scale. No range of tolerance was computed because the subjects had been limited to five choices rather than being unlimited as in Thurstone's scoring technique.[3] The average of the averages for each group was computed also. The standard deviations of the frequency distributions for each group was computed as a measure of variability in group attitude. The standard

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[2] I. D. MacCrone, Race Attitudes in South Africa, (London: Oxford University Press, 1937), p. 114.

[3] L. L. Thurstone "Attitudes Can Be Measured" The American Journal of Sociology, 33: 534, January, 1928.

error of the mean of each group was also calculated in order to determine the significance of the differences in mean attitudes for the various groups.

No scoring was applied to the subjective statements given by the subjects but these statements were used to provide further specific attitudes toward arithmetic and to establish the validity of the objective scales.

II. THE GROUPS STUDIED

It was desired to have several groups of subjects whose ranges of formal mathematical training were quite varied. It was suspected that arithmetic attitudes may have corresponded to arithmetic ability, achievement, or attainment. Five such distinct groups were selected from the students who were in attendance at Michigan State College during the winter quarter of 1951.

The first group consisted of thirty students who were in the Arithmetic Clinic. These students were unable to pass a simple standardized arithmetic test taken at the beginning of their freshman year in college. The clinic had been set up to help those students learn the fundamentals of arithmetic below the level of algebra. These students were given periodic examinations which if passed satisfactorily would release them from the clinic. No students were ever compelled to leave the clinic at any time. The students received no

credit for this course. This first group then was rather obviously weak in arithmetic.

Next was a group of thirty-one students who were studying high school algebra at the College without receiving college credit for it. These students were exempt from the Arithmetic Clinic because of their scores on the entrance tests. The course was voluntary and the group consisted of individuals who were eager either to improve their knowledge of mathematics or to study algebra for the first time. It was thought that this group as a whole would be a step higher in arithmetic attainment than the group comprising the Arithmetic Clinic.

A third group consisted of 111 students who were majoring in elementary education. They were students who had studied at various levels of arithmetic training. They were future teachers who were going to have to teach elementary arithmetic whether they liked it or not. They did not take the arithmetic entrance test since they entered college before the Arithmetic Clinic was established. This large group was studying a common course in the methodology of teaching elementary arithmetic. It was thought that this group might be about average for college students in arithmetic attainment.

A fourth group was composed of 112 secondary education majors. In this group were students who had taken little

or no mathematics on the college level. In addition there were students who had teaching majors that had required many courses in mathematics on the college level. It was thought that this group would be about average in mathematical attainment.

Finally, a small group of ten mathematic majors comprised the fifth group. These students were studying college calculus which indicated mathematical attainment. They were taking majors in some science, engineering, or business which involved complicated mathematics. This group was considered to be above average in mathematical attainment.

CHAPTER IV

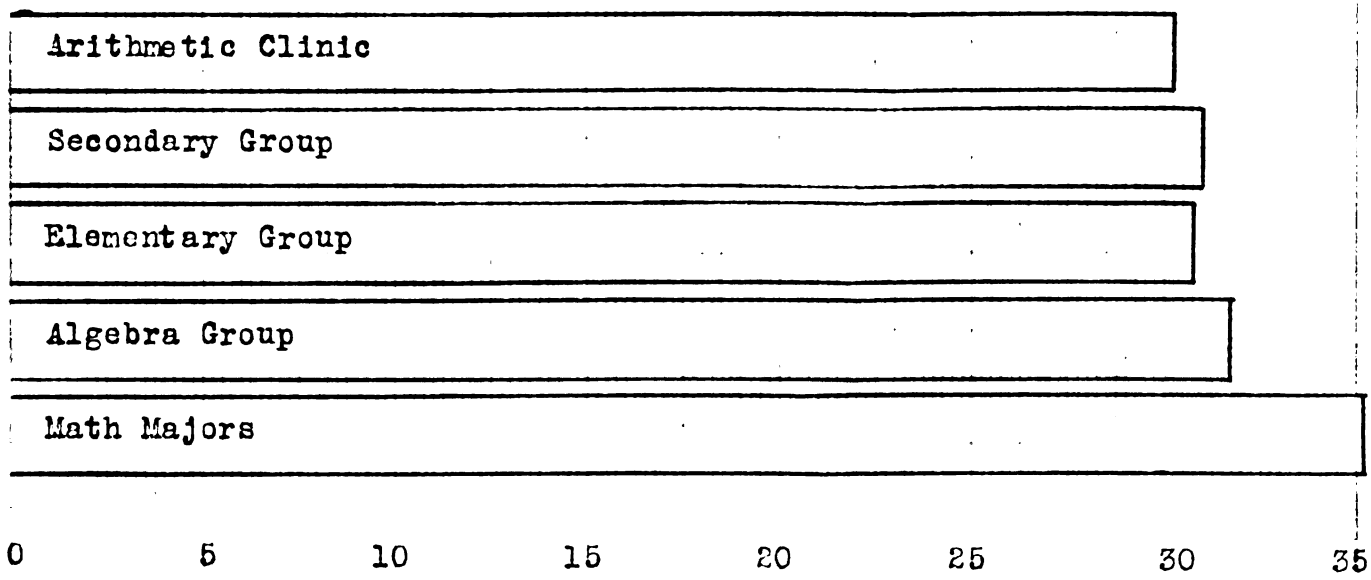
FINDINGS OF THE STUDY

It was the purpose of this study to determine the different levels of attitude of five specific groups of students, to test the objective attitude scale used, and to obtain statements of attitudes from college students toward arithmetic. Data was collected from 294 students.

Group variances. The individual scores for both forms of the objective attitude scale were compiled into their appropriate groups. The arithmetic mean was computed for both forms of each group as the major measure of central tendency. This measure was the basis by which the various groups were compared for corresponding levels of attitudes toward arithmetic. This comparison is best shown by the bar graphs in Figure 1.

Because these groups varied considerably in size, the standard deviation of the scores of each form for each group was computed as the measure of dispersion. With these data, it was possible to compute the standard error of each arithmetic mean. These in turn were used to test the significance of the differences between the means of the various groups and to determine the critical ratios for the differences between the means.

FORM A



FORM B

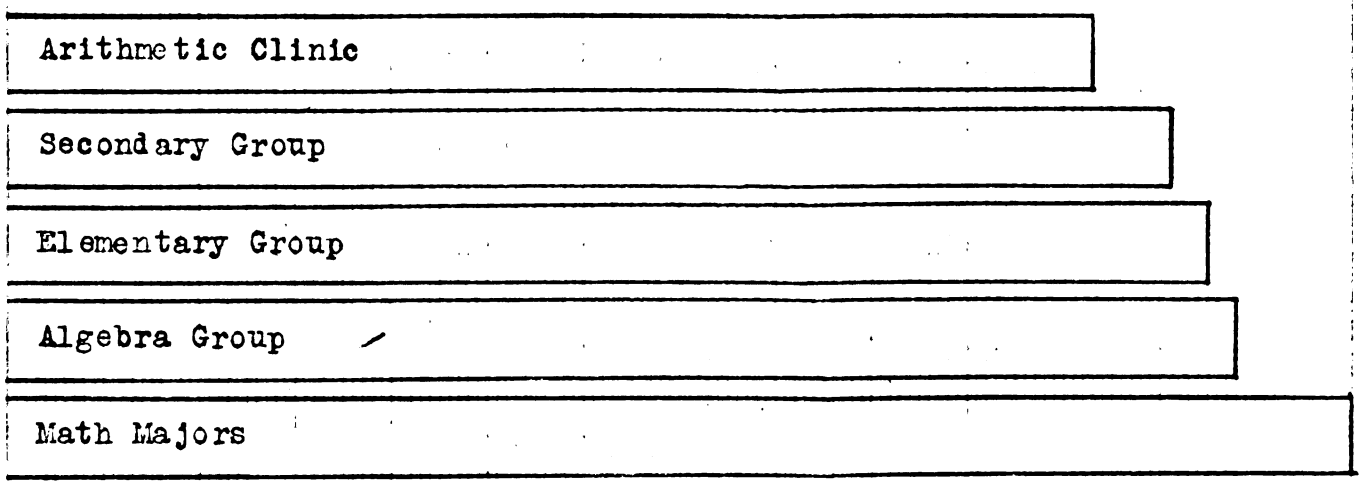


FIGURE 1

A comparison of the means of the group scores.

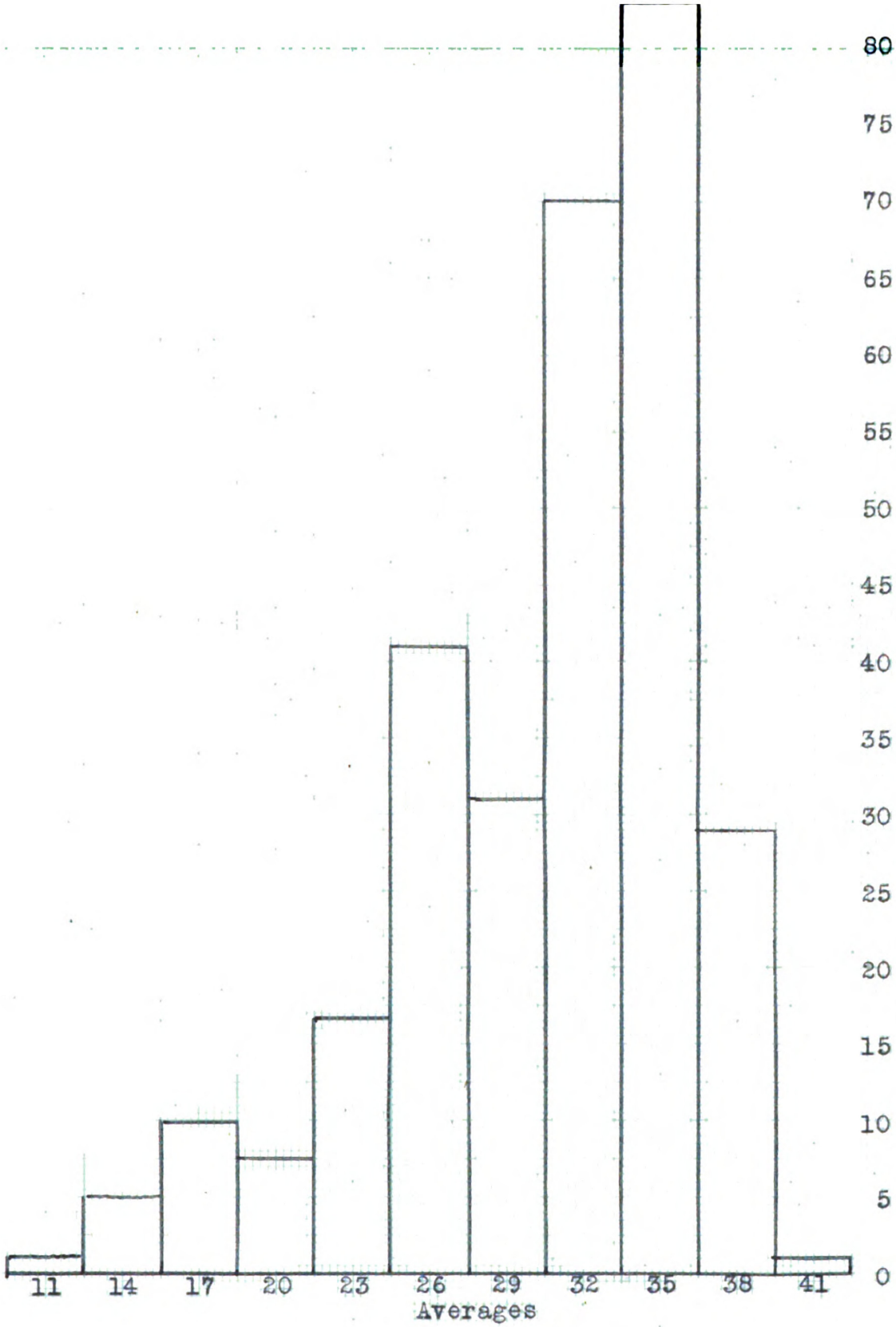


FIGURE 2

INDIVIDUAL AVERAGES OF FORM A ARRANGED IN INTERVALS OF WIDTH THREE

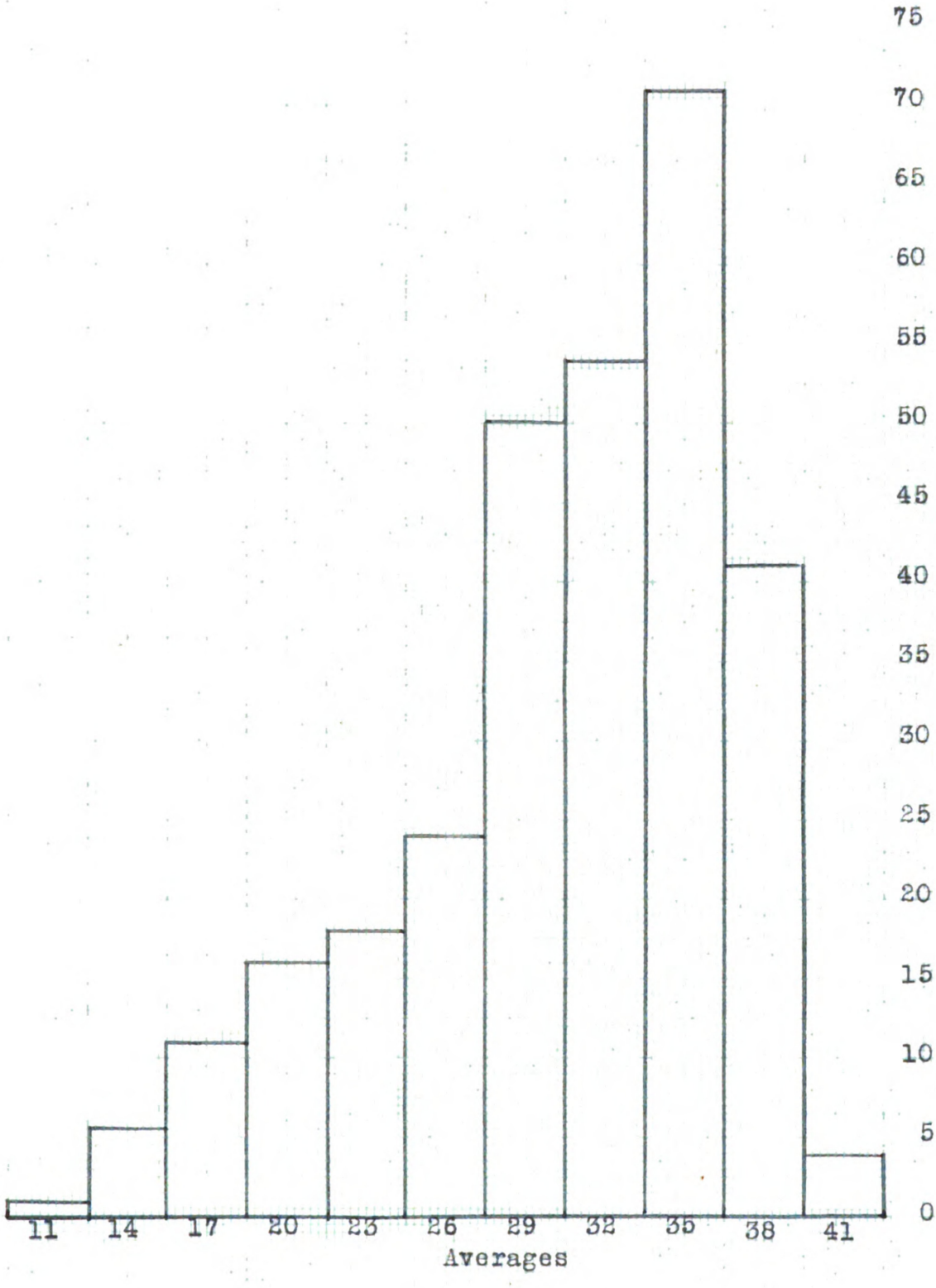


FIGURE 3

INDIVIDUAL AVERAGES OF FORM B ARRANGED IN INTERVALS OF WIDTH THREE

Figure 1 shows how the groups compared according to their arithmetic means without any consideration for measures of dispersion or standard error. The graphs show a distinct difference between the means of the math majors and of the other groups. They also show that the means of the other four groups were comparatively close together, with the mean of the Arithmetic Clinic being the lowest. With these means, the score of any individual can be compared with the group average and the average of the group can be compared with that of another group or any combination of groups. A score of twenty-one would have represented a neutral attitude toward arithmetic. All of the group scores were above this neutral point on the scale. They differed in degree even though they were all favorable toward arithmetic.

In Tables I and II the group means and variabilities in attitude are presented for comparison and with indication of the significance of differences in means for the various groups. The critical ratios were computed by dividing the actual difference between the means by the standard error of that difference. The significance of the difference between the averages of any pair of groups then depended upon the value of this critical ratio. When this ratio was greater than 1.96, the difference was significant at the five per cent level, meaning that such a difference would have been due to chance about five times in one hundred. If the critical ratio were

TABLE I

MEANS AND STANDARD DEVIATIONS OF ARITHMETIC ATTITUDE SCORES

GROUP		Form A			Form B		
	N	$\bar{X}$	σ	$\sigma_{\bar{x}}$	$\bar{X}$	σ	$\sigma_{\bar{x}}$
Math Majors	10	35.2	1.3	.43	35.0	2.09	.96
Algebra Group	31	31.8	3.8	.69	32.2	5.5	1.00
Elementary Group	111	31.0	4.8	.46	31.3	5.1	.49
Secondary Group	112	31.2	7.1	.67	30.1	6.7	.64
Arithmetic Group	30	30.5	5.2	.98	28.2	5.4	1.00
Total	294	30.7	5.8	.34	30.6	6.2	.36

N = Number of subjects in group

$\bar{X}$ = Arithmetic mean of group

σ = Standard deviation of the group

$\sigma_{\bar{x}}$ = Standard error of the mean

TABLE II

CRITICAL RATIOS OF THE DIFFERENCE BETWEEN GROUP MEANS AND THE STANDARD ERROR OF THE DIFFERENCE

	Algebra Group	Elementary Group	Secondary Group	Arithmetic Clinic
Math Majors	2.03*	3.43**	4.26**	4.89**
Algebra Group		.81	1.76	2.84**
Elementary Group			1.49	2.79**
Secondary Group				1.60

* Significant at the five per cent level.

** Significant at the one per cent level.

greater than 2.58, such a difference was significant at the one per cent level and would have been due to chance once in one hundred occurances. All levels greater than the five per cent level are considered to be negligible. Table II shows that the group of math majors have attitudes that are significantly different from the attitudes of the other four groups. The Arithmetic Clinic group has attitudes that are significantly different from all groups excepting the secondary education group. Any other combination of pairs of groups has differences that are insignificant.

Relationship of the two objective forms. The two objective attitude scales used on each subject were assumed to be very similar in structure, appearance, and order. It was a purpose of the study to compare these two different forms and to call attention to any relationship that may exist between them.

The scores of all 294 subjects were totaled and treated exactly as were the scores for each group as previously mentioned. Form A has a slightly higher arithmetic mean and a slightly lower standard deviation and standard error of the mean than Form B. Table I shows that these differences were exceedingly small. When tested statistically, the actual difference between these means was .10, while the standard error of this difference was .49 . The critical

ratio for this difference is .20. Such a difference is insignificant.

The difference between the standard deviations when divided by the standard error of that difference gives a critical ratio of 1.15. This difference in the variability between the two forms is insignificant. On the basis of these two measures the two forms appear to be comparable.

The frequency distributions of the two forms were tested for goodness of fit by a chi square comparison. This determines the significance of the difference between the actual distribution of the data and the theoretical normal distribution based on the actual mean and standard deviation. The chi square value for Form A was 115.6 while that for Form B was 51.8. For 12 degrees of freedom such a chi square value will exceed 26.2 only one percent of the time. Therefore, it can be said that each of the distributions differed significantly from normality.

On the basis of the chi square values Form B may be considered more normal than Form A. The chi square value for Form A is twice as great as for Form B. This is illustrated in the histograms in Figures 2 and 3.

Another means of showing a relationship is the computation of a product moment coefficient of correlation. Such a coefficient was computed on the basis of individual scores which consisted of the mean of the five numbered statements

for each subject on each form of the scale. This particular product moment coefficient was .78. For the number of scores involved, the standard error of this coefficient was .04. It was thought that the median of the three scores appearing closest together would yield a more reliable attitude score for any given individual. These median scores for individuals yielded a correlation of .65 $\pm$ .05 between Form A and Form B. The difference between this correlation and the one obtained for the mean scores was found to be significant at the five per cent level. From this it would appear that the median score is not superior to the mean score. There is a probable advantage in favor of the mean score.

A quantitative analysis of the objective scale. An attitude scale gives material and data that can be treated quantitatively.[1] Many statements, especially at the extreme ends of the objective scale, were not selected by any of the subjects. Again certain more general statements were very frequently chosen. For these and other reasons the average of the five numbers of the statements was used as the individual score for each subject. This does not mean that this score corresponds to the attitude expressed by that

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[1] L. L. Thurstone and E. J. Chave, The Measurement of Attitudes. (Chicago: University of Chicago Press, 1929), p. 10.

statement which is equal to the individual's average or score. This score is a point on the scale which is relative to scores associated with the other statements chosen by an individual. A person whose score is thirty-seven has a more favorable attitude toward arithmetic than a person whose score is thiry-six or anything lower than thirty-seven. The statements in each form were arranged in a logical order from low to high. The average score on each form for the entire 294 subjects is 31. An individual score could have been compared with this score to determine whether the subject's attitude toward arithmetic was above or below the group average. The averages for each group were computed as shown in Table I. These group means were used in making comparisons in attitude for the different groups.

A quantitative analysis of the subjective section. The subjective section consisted of a request for a written response to the question of why one may have liked or disliked arithmetic. Instructions were printed on the answer sheet for such a response and the request was to have been stated orally by the person who administered the attitude scale. However, the response was not mandatory and consequently a small percentage of these responses were obtained. Of the 294 subjects who completed the objective scale, only 104 responded with a written reason for liking or not liking

arithmetic. This represented thirty-five per cent participation. Of these 104 written responses, five were completely neutral. Fifty-two subjects stated that they liked arithmetic for some reason or another while forty-seven subjects expressed reasons for disliking it. This gives a total of ninety-nine who responded positively or negatively.

For each of these ninety-nine subjects the median of the three closest scores was determined for both Form A and Form B. Using these as the measures of central tendency, it was possible to compare the specific cases with the averages of the different groups and with that of the entire group. Of the fifty-two who stated a liking for arithmetic, eleven had median scores below the group average while forty-one had median scores above the group average on both forms of the scale. For those who stated a dislike for arithmetic, thirty-three had median scores below the group average and fourteen were above on both forms of the scale. These figures were used in making a comparison of individuals above or below average on the attitude scale for both the "likes" and "dislikes". A test of significance was applied to these results which yielded a chi square value of 22.16. With a single degree of freedom as was this case, such a chi square value is significant at the one per cent level when it exceeds 6.63. This test then shows that the group stating a liking for arithmetic had objective attitude scores that were significantly

different from the objective attitude scores of the group which stated a disliking for arithmetic. Such a difference would occur by chance alone far less than once in one hundred times. A tetrachoric correlation of .70 with a standard error of .14 was computed from the percentages of the total which were above and below the group average for both the "likes" and the "dislikes". This showed that those who gave reasons for disliking arithmetic tended to choose unfavorable statements on the attitude scale, and those who expressed reasons for liking arithmetic tended to choose statements on the attitude scale which were favorable to arithmetic.

A qualitative analysis of the subjective section.

These subjective responses were not only valuable for evaluating the attitude scale, but they have given many additional verbal expressions of attitudes toward arithmetic. Many of these statements could be useful in the improvement or the development of a specific arithmetic attitude scale. In fact, they have already been considered by another investigator for such a purpose. Several of these specific individual expressions indirectly offer a severe challenge to the teachers of arithmetic. The statements are listed in the order of the frequency of their occurence. The number in parentheses at the end of each statement represents the number of times the statement (or one nearly the same in content) was mentioned.

The following statements were expressed by those students who said they disliked arithmetic:

The teachers of arithmetic were never interesting. Their methods were wrong. They progressed too fast. (16)

I do not understand arithmetic. (9)

I had a weak arithmetic foundation. (8)

Arithmetic was always too difficult. (8)

I am weak in arithmetic. (7)

Arithmetic has always been forced upon me. (7)

It requires too much work and time. (6)

I met constant failure in grade school arithmetic. (4)

It is a dry subject. (3)

It does not fascinate me. (2)

Arithmetic is boring. (2)

Arithmetic teachers have humiliated me before the class. (2)

Arithmetic requires unnecessary accuracy. (1)

I had too much long division forced upon me. (1)

I went to several different schools; the levels of arithmetic were not standardized. (1)

The following were expressed by those who said they liked arithmetic:

I have a feeling of satisfaction and accomplishment when I work a problem. (9)

Arithmetic is useful in everyday life. (8)

Arithmetic is concrete. It is objective, being either right or wrong with no subjective scoring of problems. (8)

It helps me to develop more accurate thinking. (7)

It is based on facts. (6)

I just enjoy arithmetic as pure fun. (5)

I enjoy solving arithmetic problems and puzzles. (5)

It is necessary for ordinary business transactions. (5)

Arithmetic is essential for my future work. (5)

It is a pleasant subject. (4)

Arithmetic is practical. (4)

It has many useful applications. (4)

Arithmetic was always taught in an interesting fashion. (4)

I like the logical order of arithmetic reasoning. (4)

I was given a good arithmetic foundation in grade school. (4)

Arithmetic is essential in everything we do. (3)

Arithmetic is interesting. (3)

It is of use to the normal person. (2)

It fascinates me. (2)

I have excelled in it. (2)

It is the basis for abstract thinking and scientific interpretation. (1)

I enjoy computing bowling averages. (1)

I enjoy computing baseball batting and fielding averages. (1)

I like it only because my present teacher is sympathetic and very patient with me. (1)

An evaluation of the scale. Since the general scale had been constructed with no reported evaluation, the writer felt that an investigation of the reliability and validity of the scale as applied specifically to arithmetic should be made as a part of this study.

The test for reliability was the significance of the relationship between the scoring on forms A and B. As has been previously mentioned, two different coefficients of correlation were found between these two forms. That based upon the corresponding averages was .78. That based upon the corresponding medians of the three closest choices was only .65. Correlation coefficients for good attitude scales, such as those of Thurstone, Remmers and Allport, are .80 and above.[2] The findings of this study therefore indicate fair reliability for the arithmetic attitude scale that was used. The critical ratio of the actual difference between these correlations of .78 and .65 and the standard error of this difference was 2.22. This means that the difference between these two correlation coefficients was significant at the five per cent level but insignificant at the one per cent level. Or, roughly speaking, such a difference would occur by chance only about three times in one hundred.

On the basis of this significance, it appears that the

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[2] Ross Stagner, "Attitudes," The Encyclopedia of Educational Research, 1950 Edition, Walter S. Monroe, Editor, (New York: The Macmillan Company, 1950), p. 82.

averages are superior to the medians for the measures of central tendency. The writer feels that reliability coefficients of .78 and .65 with standard errors of .04 and .05 and based on a population of 294 are not reliable enough for predictive usage. But, these results tend to point in a direction favoring the mean scores for individuals. A reliability coefficient of .80 would have been considered good. Consequently, the reliability of the scale has been considered to be fair. The scale may be considered useful for the comparison of group attitudes toward arithmetic.

Such a scale would be valid only if it measured what it purported to measure. The scale attempts to identify the attitudes toward arithmetic and to determine the differences in such attitudes for five specific groups.

No effort to disguise the scale was made. Although it was called an Interest Scale, the subjects were told that it was an attitude scale.

It was realized that people can easily hide or falsify a true attitude in such a written response. It was hoped that such a practice did not occur in this study. A special emphasis was made to assure the subjects that all data would be handled in a confidential manner. The subjects were given both verbal and printed guarantees that their results would not affect their grade in the course in which the scale was administered. The attitude scale did not require a name or

any mark of personal identification. The subjects were also told the purposes of the study and the importance of their participation.

Only one-third of the subjects responded to the requested subjective question. Of these responses, those who stated a definite liking or a disliking for arithmetic tended to choose statements corresponding generally in attitude on the attitude scale. The significance of the relationship of the objective and subjective sections was beyond the one per cent level. The validity coefficient as shown by the tetrachoric correlation coefficient might have been somewhat higher if the mean score rather than the median score for individuals were used in this comparison. Application of the scale indicated significant differences between the average attitudes of groups differing in level of training in mathematics. Two extreme groups were obviously different in levels of mathematical attainment from the other three groups. Correspondingly, these groups showed differences in arithmetic attitude that were significantly different from those of all other groups except in a single case as shown in Table II. Therefore it can be stated that for the comparison of group attitudes the scale is valid.

This study shows which statements on the attitude scale seem to represent attitudes toward arithmetic of students with various school background.

The writer suggests that some statements on the scale be eliminated since they were not chosen by any of the subjects used in this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study was a survey of the existing attitudes toward arithmetic of five selected groups of Michigan State College students during the winter quarter of 1951 and an evaluation of a specific attitude scale.

The subjects who provided the data for the study were the following five specific groups: an Arithmetic Clinic group, a group studying high school algebra, a group studying elementary education, a group studying secondary education, and a group studying calculus.

A general subject-matter attitude scale was adapted for particular use with arithmetic. This attitude scale with a subjective supplement was used in obtaining the data for the study. The subjects were given standardized instructions and allowed fifteen minutes to select statements on the scale and to write reasons for liking or disliking arithmetic.

The distribution of the selections of the objective scale indicated which of the statements best expressed the subjects' attitudes toward arithmetic. The responses to the request for attitude reasons provided additional interesting opinions of arithmetic.

The study shows that the average attitude score for all five groups studied was favorable toward arithmetic. These

scores differed in their degree of favorableness. It was found that those who had taken the more advanced courses in college mathematics had attitudes which were more favorable toward arithmetic than those who had not studied advanced college mathematics.

The general attitude scale adapted for this study was shown to be satisfactorily valid and reliable for use in measuring group attitudes toward arithmetic. Suggestions for the improvement of the scale were given.

The study has led to the following problems: (1) by what means and to what extent can changes in attitudes toward arithmetic be measured, (2) how can teachers influence changes in attitudes toward arithmetic at various age levels, (3) can achievement in arithmetic be improved by improving attitudes toward arithmetic.

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APPENDIX

An Arithmetic Interest Scale

Following is a list of statements about arithmetic. They refer to simple arithmetic or numerical computation below the level of algebra. Choose the five statements with which you agree. Your score will in no way affect your grade in any course.

1. I hate arithmetic.
2. Arithmetic is the most undesirable subject taught.
3. I detest arithmetic.
4. I look forward to arithmetic with horror.
5. Arithmetic is disliked by all students.
6. It is a punishment for anybody to take arithmetic.
7. Arithmetic is a waste of time.
8. Arithmetic is based on "fogy" ideas.
9. I would not advise any one to take arithmetic.
10. I have seen no value in arithmetic.
11. I have no desire for arithmetic.
12. Arithmetic reminds me of Shakespeare's play--"Much Ado About Nothing."
13. Arithmetic is very dry.
14. Arithmetic does not teach you to think.
15. I am not interested in arithmetic.
16. The minds of students are not kept active in arithmetic.
17. Mediocre students never take arithmetic so it should be eliminated from schools.
18. I could do very well without arithmetic.
19. My parents never had arithmetic, so I see no merit in it.
20. Arithmetic will benefit only the brighter students.
21. I haven't any definite like or dislike for arithmetic.
22. I am careless in my attitude toward arithmetic, but I would not like to see this attitude become general.
23. I don't believe arithmetic will do anybody any harm.
24. Arithmetic is a good pastime.
25. Arithmetic is not a bore.
26. Arithmetic saves time.
27. Arithmetic is not receiving its due in public high schools.
28. I am willing to spend my time studying arithmetic.
29. Arithmetic is O.K..
30. All lessons and all methods used in arithmetic are clear and definite.
31. Arithmetic is a cultural subject.
32. All of our great men studied arithmetic.
33. Arithmetic is a good subject.
34. Arithmetic is a universal subject.
35. Arithmetic teaches me to be accurate.
36. Any student who takes arithmetic is bound to be benefited.
37. Arithmetic is very practical.
38. Arithmetic develops good reasoning ability.
39. Arithmetic is profitable to everybody who takes it.
40. I really enjoy arithmetic.
41. Arithmetic has an irresistable attraction for me.
42. Arithmetic is of great value.
43. I love to study arithmetic.
44. I would rather study arithmetic than eat.
45. No matter what happens, arithmetic comes first.

Following is a list of statements about arithmetic. They refer to simple arithmetic or numerical computation below the level of algebra. Choose the five statements with which you agree. Your score will in no way affect your grade in any course.

1. Arithmetic is the worst subject taught in school.
2. Words can't express my antagonism toward arithmetic.
3. No sane person would take arithmetic.
4. Arithmetic is all bunk.
5. Arithmetic is more like a plague than a study.
6. Nobody likes arithmetic.
7. Arithmetic has no place in the modern world.
8. Arithmetic can't benefit me.
9. All of the material in arithmetic is very uninteresting.
10. The average student gets nothing worth having out of arithmetic.
11. Arithmetic does not hold my interest at all.
12. Arithmetic seems to be a necessary evil.
13. Arithmetic is dull.
14. Arithmetic interferes with developing.
15. Arithmetic has numerous limitations and defects.
16. Arithmetic does not motivate the pupil to do better work.
17. No definite results are evident in arithmetic.
18. To me arithmetic is more or less boring.
19. No student should be concerned with the way arithmetic is taught.
20. Arithmetic is all right, but I would not take any more of it.
21. My likes and dislikes for arithmetic balance one another.
22. Arithmetic does not worry me in the least.
23. Arithmetic might be worth while if it were taught right.
24. Arithmetic has its drawbacks, but I like it.
25. I think arithmetic is amusing.
26. Arithmetic is not based on untried theories.
27. Arithmetic aims mainly at power of execution or application.
28. Every year more students are taking arithmetic.
29. Arithmetic has its merits and fills its purpose quite well.
30. All methods used in arithmetic have been thoroughly tested in the classroom by experienced teachers.
31. Arithmetic serves the needs of a large number of boys and girls.
32. Arithmetic teaches methodical reasoning.
33. Arithmetic is interesting.
34. There are more chances for development of high ideals in arithmetic.
35. Arithmetic makes me efficient in school work.
36. Arithmetic will help pupils socially as well as intellectually.
37. Arithmetic gives pupils the ability to interpret situations they will meet later in life.
38. The merits of arithmetic far outweigh the defects.
39. Arithmetic fascinates me.
40. Arithmetic is one subject that all young Americans should know.
41. I believe arithmetic is the basic one for all high school courses.
42. Arithmetic is one of the most useful subjects I know.
43. If I had my way, I would compel everybody to study arithmetic.
44. The very existence of humanity depends upon this subject.
45. I am "crazy" about arithmetic.

Instructions:

Circle five of the numbers which correspond to the five numbers of the statements you have selected which best compare with your opinion(s) of arithmetic.

Form A	Form B
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45

In the space below, write any reason(s) why you like or dislike arithmetic.