

A STUDY OF STUDENT ATTITUDE TOWARD TWO CONTRASTING  
PHYSICS LABORATORY DESIGNS

by

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## ABSTRACT

A study of the attitudes of students toward physics laboratory programs was hypothesized to be one method of determining the relative probability with which these laboratory programs could succeed in fulfilling two primary objectives: (1) providing a knowledge of some basic concepts and experimental techniques in physics, and (2) developing a high degree of interest in physics. This supposition was based upon the positive correlation between attitude toward a learning situation and achievement and interest in the situation, reported to have been found in previous studies investigating attitudes and their relationship to learning.

To measure the attitudes of students toward the physics laboratory, an attitude scale was developed through sound methods of scale construction. Studies were completed investigating attitudes as measured by this scale and their relationship with achievement in the laboratory and interest in physics. The results of these studies not only supported the hypothesis that the predicted relationship did exist, but also furnished evidence that the scale possessed construct validity.

The function of the attitude scale in this study was to determine which of two physics 110 laboratory programs at the University of British Columbia was more

favorably rated by students. One program was patterned upon traditional laboratory design (control program), while the other was based upon recent trends in laboratory philosophy and design (experimental program). Students worked in these programs for three months.

The attitude scale was administered before these programs commenced, and at their completion. The results of these administrations disclosed that the experimental program was rated by students to be significantly more favorable than the control program, which in view of the relationship found to exist between attitude as measured by the attitude scale, and achievement in the laboratory and interest in physics, suggested that the experimental program was more capable of providing a knowledge of some basic concepts and experimental techniques in physics, as well as developing a higher degree of interest in physics.



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## CHAPTER I

### INTRODUCTION

#### 1. Importance of the Study

In many universities in recent years there has developed an intensified effort to increase the relative effectiveness of the introductory physics laboratory. This effort has been led by the American Association of Physics Teachers and its Commission on College Physics, under the sponsorship of the National Science Foundation.<sup>1</sup> As a result, many different laboratory instructional methods and programs have been suggested, but their relative overall efficacy is difficult to gauge because reports of their success are seldom based on clearly stated objectives or supported by the results of reliable measurements on student achievement.

One behavioral objective of an introductory physics laboratory is to develop or foster, through the methods and materials presented, a good attitude toward physics.<sup>2</sup> Research has suggested that successful fulfillment of this objective will enhance the probability of two desired outcomes: (1) providing a knowledge of some basic concepts and experimental techniques in physics, and (2) developing a high degree of interest in physics, and consequently producing a desire for a

continued study of physics.<sup>3</sup> Hence, an indication of the success of the introductory physics laboratory in fulfilling these outcomes may be provided by a measurement of student attitude toward this learning situation.

In view of this stated importance of the attitude of the learner toward this learning situation, it appears worthwhile for laboratory designers to endeavour to develop or adopt laboratory methods and materials, within the realm of cognitive effectiveness, which best foster a favorable attitude in the student. Furthermore, in consideration of the present interest in the redevelopment of physics laboratories, in which the University of British Columbia is participating, the availability of an instrument capable of scaling or comparing the attitudes of students toward the new programs developed would be a significant contribution toward evaluating the extent to which the laboratory designers have succeeded in developing programs capable of fulfilling outcomes (1) and (2).

## 2. Statement of the Problem

It was the purpose of this study (1) to investigate the difference in the general attitude of students toward the University of British Columbia's Physics 110 laboratory created by three months of study patterned upon two contrasting and frequently utilized approaches in laboratory design,

the first of these being based upon the traditional laboratory philosophy and the second upon recent trends in laboratory design and philosophy; (2) to determine the reaction of students toward those specific characteristics of the laboratory which can be controlled by the laboratory designer; and (3) to develop a reliable and valid attitude scale that will accommodate the specific purposes of this and similar studies.

More generally, this study provided a comparison, from the students' point of view, of the value of the characteristics of traditional and modern laboratory philosophy.

### 3. Attitudes and Learning

The value of this and similar investigations has been in part based upon the relationship presumed to exist between student achievement in a learning situation and his attitude toward the situation. A study of the literature furnished some evidence supporting the existence of this relationship.

Numerous generalizations exist in both research reports and general texts which stress the paramount effect that attitudes have on behavior. For example, Mead, after surveying the research on attitudes, stated:

Perhaps no acquired motives influence more behavior more strongly than our attitudes. That makes them <sup>4</sup>basically and generally of maximum importance.

More specifically in relation to learning, C.E.

Skinner asserted:

One's attitude toward the work which he is about to undertake will determine his progress. If he dislikes what he is about to do, his rate of progress will be slow. When one likes the work he is interested, gives undivided attention, and makes better progress.<sup>5</sup>

Skinner's claim appears almost obvious. But studies that relate attitudes and achievement have not provided evidence of this cause-effect relationship. What these studies have provided is evidence of a significant positive correlation existing between a student's perception of or attitude toward a subject or subjects and his achievement in that subject or subjects. The cause-effect relationship mentioned is only one of several plausible explanations for the existence of a positive correlation.

Examples of studies relating attitude and achievement are Peskin's study with seventh grade arithmetic and geometry students<sup>6</sup>, Hungerman's study with sixth grade mathematics students<sup>7</sup>, and Austin's<sup>8</sup>, Brodie's<sup>9</sup>, and Malpass's<sup>10</sup> separate studies relating general scholastic success to general attitude toward school.

As a consequence of the experimental evidence available, the position has been taken that students who are satisfied with a learning situation and hold a favourable attitude toward it generally outperform dissatisfied students. However, it must be appreciated that a perfect correlation

between attitude (based upon the students' perception of the learning situation as being worthwhile and meaningful) and achievement cannot be anticipated, because other aspects of the learning situation (degree of organization of materials, instructions which identify what is to be learned, etc.) are equally, if not more important.<sup>11</sup>

Furthermore, it seemed legitimate to ask whether it was correct at all to speak of "one" attitude toward a learning situation, when it was reasonable to expect that the student might have different attitudes toward each of the dozens of properties presented by a situation. Newcomb studied this topic and concluded that "it is likely that we form a meaningful generalized attitude about any object, however complex, that we recognize as some kind of whole or unit".<sup>12</sup> On these grounds the attitudes of students toward the specific characteristics of the laboratory were considered to unite, forming a general attitude toward it.

#### 4. Definitions of Terms Used

##### 4.1 Attitude

For the purposes of this study a working definition of the nebulous term attitude was required. Thurstone, associated for many years with research in attitude scaling, provided a compact, semi-quantitative description of an

attitude, defining it as "the degree of positive or negative affect associated with some psychological object", "psychological object" referring to any symbol, phrase, slogan, person, institution, ideal or idea toward which people can differ with respect to positive or negative affect.<sup>13</sup>

More specific to this study, the attitude of the students was operationally defined as their response to the series of statements on the attitude scale. Since the purpose of the scale was to compare the attitudes of students toward two contrasting programs, these statements were chosen to pertain to those characteristics of the lab that distinguish the two approaches. These characteristics included discussion of theory, level of difficulty, equipment, instructions (open ended and brief, or step by step), reporting procedures, etc. There were also statements of a general nature regarding the overall value of the laboratory. Hence the attitude of the student as defined by the attitude scale was a synthesis of his perceptions of the virtue of those characteristics of the laboratory referred to by the attitude statements.

#### 4.2 Physics

Webster's Dictionary defines physics as "a science that deals with matter and energy and their interactions in the fields of mechanics, acoustics, optics, heat,

electricity, magnetism, radiation, atomic structure, and nuclear phenomena", where in this study the term "science" will be taken to mean "a process of inquiry".<sup>14</sup>

#### 4.3 Conventional Laboratory

The term "conventional laboratory" shall be interpreted as meaning the laboratory situation in which the student is given detailed instructions regarding the choice and setting up of apparatus, the experimental procedure, the taking of data, and the presentation of results.

#### 4.4 Free Laboratory

In extreme contrast to the "term conventional" laboratory, the term "free laboratory" shall refer to the laboratory situation in which the students are neither given instructions nor assigned experiments, but rather are expected to explore subjects of their own choosing by methods that they themselves have discovered or invented, using apparatus that they have designed, built, or assembled from available instruments and parts.

Recently, the major trend in laboratory design has been toward the free laboratory.<sup>15</sup> But because of the practical restrictions imposed by large enrollments and lack of laboratory facilities, faculty time, and finances, most institutions are striving to effect a compromise, unique to their situation, between the contrasting free and conventional design.<sup>16</sup>

## 5. The Plan of this Report

Prior to commencing the development of the attitude scale, it was necessary to survey the literature on attitude scales to weigh the advantages and disadvantages of the methods available, and study their adaptability to this situation. To appreciate the decisions underlying the design chosen, a summary of this survey on attitude scaling techniques will be given in Chapter II. The third chapter will discuss the development of the attitude scale toward the physics laboratory, Chapter IV will present the design of the attitudinal study, Chapter V will provide a statement and analysis of the results of the attitudinal study, and Chapter VI will present the summary and conclusions of this study.



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<sup>3</sup>C.E. Bensen, "Attitude of the Learner," American Educational Digest, XLV (March, 1926), 229-301, as cited by C.D. Skinner, Readings in Educational Psychology (New York: D. Appleton and Company, 1926), p. 386; L. Lafave, "Habit or Attitude as the Central Tree in Educational Theory," Educational Theory, VIII (July, 1958), 172-8.

<sup>4</sup>A.R. Mead, "Research about Attitudes," Journal of Educational Research, XLVIII (November, 1954), 233.

<sup>5</sup>C.E. Skinner, Readings in Educational Psychology (New York: D. Appleton and Company, 1926) p. 386.

<sup>6</sup>Anne S. Peskin, "Teacher Understanding and Attitude and Student Achievement and Attitude in Seventh Grade Mathematics" (unpublished Ph.D. thesis, New York University, 1964), p. 95.

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<sup>9</sup>T.A. Brodie, "Attitude toward School and Academic Achievement," Personnel and Guidance Journal, XLIII (December, 1964), 375-8.

<sup>10</sup>L.F. Malpass, "Some Relationships Between Student's Perception of School and their Achievement," Journal of Educational Psychology, XLIV (December, 1953), 475.

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<sup>13</sup>L.L. Thurstone, "Comment," American Journal of Sociology, LII (January, 1946), 39.

<sup>14</sup>"Physics," Webster's Third New International Dictionary, p. 1707. Springfield, Massachusetts: G and C Merriam Co., 1966.

<sup>15</sup>Howard Laster, "A Step Away from the Conventional Laboratory in Introductory Physics," American Journal of Physics, XXVII (March, 1959), 166-9; Leo Nedelsky, "Introductory Physics Laboratory," American Journal of Physics, XXVI (February, 1958), 51-9.

<sup>16</sup>"Laboratory Instruction in General College Physics," American Journal of Physics, XXV (October, 1957), 436-9; H.V. Neher, "The Role of Experimental Work," American Journal of Physics, XXX (March, 1962), 186-90.

## CHAPTER II

### A SURVEY OF THE LITERATURE ON THE MEASUREMENT OF ATTITUDES

#### 1. Overview of Attitude Measurement Techniques

Prior to the appearance of the supporting research available today on the importance of attitudes, there were many investigators in the early twentieth century who displayed intense interest in attitude measurement. Out of this interest arose many methods of attitude measurement, some of which have become classics and are still extensively used in opinion and attitude research.

##### 1.1 The Single Question

The most primitive and obvious manner of determining attitude was to ask a subject a single question and elicit his opinion. The logic behind the use of overt opinion to measure attitude is based on the positive correlation that exists between what people say on a subject and what they will do about it. Edwards pointed out that the correlation is, of course, not perfect, and perhaps not even high, since both opinions and actions are multiply determined.<sup>1</sup> This technique has been given thorough consideration by Remmers and has been found to contain many hazards and shortcomings. Among these are the reluctance of many individuals to give public expression of their feelings or attitudes due to felt or actual pressures toward conformity, and the fact

that some individuals may not be aware of their feelings toward a given psychological object.<sup>2</sup>

### 1.2 Summated Questionnaire

A more elaborate scheme and natural extension of the single question technique is a combination of questions on the same topic to form a summated questionnaire.<sup>3</sup> Since replication adds reliability this technique has obvious advantages over the single question.

### 1.3 Scaling Techniques

The first formal attempts to measure attitudes by use of scaling techniques appeared in the late nineteen twenties. The early techniques that are still most commonly used in attitude scaling are the method of equal-appearing intervals which was introduced by Thurstone,<sup>4</sup> and the Likert's method of summated ratings.<sup>5</sup> Through the years a multitude of minor and major variations have evolved from these basic techniques.

More recent developments in the theory and techniques of attitude scales, by Guttman, have centred around the concept of unidimensionality, a scale being unidimensional if the score derived is a measure of one factor and only one factor.<sup>6</sup> The desirability of such a scale is discussed by McNemar, who concluded that the criteria for the selection of statements in both Thurstone and Likert scales cannot be counted on to separate two or more factors which belong to

an attitude area that has been too broadly defined.<sup>7</sup>

#### 1.4 Indirect Methods of Attitude Measurement

The preceding methods measure attitudes directly in the sense that the purpose of requesting a response is usually obvious to the subject. There also exists techniques which measure attitudes indirectly. Here the individual is presented with a relatively unstructured stimulus or situation in which the real purpose of the measurement, that of determining his attitude, is not apparent to him. Among these techniques, Remmers discusses the following: Word association, a method which utilizes the subjects' response to a selected list of key words or phrases; visual stimulus, which, as the term implies, used pictures or diagrams to secure emotionally toned responses from a subject; expressive movement, a technique in which attitudes are revealed from overt behavior of the subject; intragroup attitude measurement, concerned with measuring attitudes by requiring the individual to choose within his functioning social groups either desirable or undesirable members of that group with respect to certain criteria; and rating scales, where a person is asked to rate the attributes, traits, or behavior of persons that he knows, while at the same time revealing many of his own attitudes in his ratings.<sup>8</sup>

It is apparent from the overview of attitude measures presented that it would be unrealistic to attempt to describe all these techniques. Since one purpose of this study is to develop an attitude scale, the remainder of this chapter is devoted to an examination of scaling techniques, with particular emphasis on the Thurstone and Likert techniques, which have survived much criticism, and still act as the basis for many of today's commonly applied techniques. Guttman's scale analysis will also be investigated as a possible contributor to the study.

## 2. General Description of Scaling Techniques

### 2.1 Criteria to Consider in Constructing Statements

The first step in the construction of an attitude scale is to obtain items that relate to the universe of interest or psychological object. These items are known as attitude statements. As a source of statements Edwards recommended that the examiner have individuals write a short description of their feelings about the psychological object. Statements can then be developed which express some kind of opinion about the attitude object under study. A summary of the literature on attitude statements by Edwards indicates that a person developing a scale should strive for simple, short, unambiguous statements that are relevant, not factual, refer to the present, and are unlikely

to be endorsed by everyone. The statements should not contain double negatives or universals such as "all, always, none or never". Words such as "only, just, and merely" should be used with care and moderation. Finally the statements should attempt to cover the entire attitude continuum.<sup>9</sup>

Once a set of attitude statements has been collected, there are two general methods used to develop an attitude scale. The first of these methods utilizes a judging group.

## 2.2 The Use of a Judging Group

The judging group is not asked to respond to the statements in terms of their own agreement or disagreement with them, but rather to rate the degree of favorableness or unfavorableness expressed by each statement. These judgments are used as a basis for determining scale-values of the statements upon a psychological continuum (just as the ordering of objects in terms of their measured weights is said to be on a physical continuum, the ordering of objects upon the basis of judgments is said to be on a psychological continuum). In the case of attitude, the psychological continuum extends from most unfavorable to most favorable, the units of the continuum being chosen for their convenience and suitability by the scale designer.<sup>10</sup>

Once the scale-values of the statements are known,

subjects can be asked to express their own agreement or disagreement with the individual statements. Attitude scores for these subjects can then be obtained from the scale-values of the statements endorsed.

Three methods of constructing attitude scales in this manner are outlined by Edwards. These are the methods of successive intervals, the method of paired comparisons, and the method of equal-appearing intervals. They differ only in the manner in which the judgments and scale-values of the statements are obtained.<sup>11</sup> The method of equal-appearing intervals, although extremely demanding of the respondent, is the most straight forward technique and thus the most utilized. It will be the only method of its kind considered in this survey.

### 2.3 The Direct Response Technique

The second general method used to develop an attitude scale is based upon direct responses of "agree" and "disagree" with the attitude statements by subjects from the population of interest.<sup>12</sup> Such a method does not require prior knowledge of the scale-values of the statements in any exact sense, thus a judging group is not necessary. The response methods for constructing attitude scales include Guttman's scale analysis, a technique which Suchman discussed at length<sup>13</sup>, and the Likert method of summated ratings.



Guttman's scale analysis technique is perhaps the most difficult to employ, since there is no truly effective way of selecting good items.<sup>14</sup> Much depends on the investigator's wisdom and experience in regard to the selection of statements. There has been extensive research carried out on Guttman's techniques, and from this research stems much criticism (to be discussed), notably by Festinger<sup>15</sup>, Edwards<sup>16</sup>, Edwards and Kilpatrick<sup>17</sup>, Loevinger<sup>18</sup>, and Smith.<sup>19</sup>

Likert's method of summated ratings is, like its classical counterpart, the method of equal-appearing intervals, still commonly used. Since both techniques draw considerable attention, are often compared, and may even be combined, the method of summated ratings merits consideration. Edwards supplies a complete description of this technique.<sup>20</sup>

### 3. Likert's Method of Summated Ratings

#### 3.1 Construction of the Scale

First, as with all methods, a large number of statements or propositions relating to the attitude object in question are collected. These items should be carefully edited by the investigator to eliminate ambiguous, irrelevant, and otherwise faulty items. The items are then drawn up in the form of a questionnaire

or attitude test, each item being given multiple response categories. (For example: "strongly agree, agree, undecided, disagree, strongly disagree".) The statements should be so constructed that for about half of them an "agree" response represents a favorable attitude toward the attitude object in question, and for the other half a "disagree" response represents a favorable attitude.

The experimental instrument is then administered to a reasonably large group of subjects (100 or more) who are representative of the population to which the final scale will be administered. They are asked to indicate their own attitudes by checking the response to each item which most closely expresses their feeling on that item. The questionnaires are then scored for each subject by assigning arbitrary weights of 1, 2, 3, 4, and 5 (or 0, 1, 2, 3, and 4) to the five categories of each item in such a way that the highest weight is always assigned to the response that tends toward one end of the attitude continuum (say the unfavorable end), while the lowest weight is always assigned to the response categories which tends toward the opposite end. A subject's score is the sum of the weights assigned to the responses which he made.

The items are then analyzed for their discriminating power with respect to the measurement of the attitude in question, by any one of several item-analysis procedures

available. Perhaps the simplest index is to take the top and bottom 10 percent (or 27 or any other percent) of the subjects on the distribution of total scores, and calculate the mean of the responses to each item for each of these groups separately. Those items are the most discriminating which show the greatest discrepancy in the mean response between the high and low groups. If more sensitive indices of item discriminating power are wanted, the phi coefficient, or item-test correlation procedures may be employed.<sup>21</sup>

The final attitude scale is then constructed by choosing those 20 to 25 items from the total list which show the greatest discrimination. These items are used with the same five "agree - disagree" response categories, and scored in the same previously discussed manner.

### 3.2 The Acceptance of Likert's Technique

Farnsworth asserted that in his experience the Likert technique of attitude scaling had become more popular than the older Thurstone method, due mainly to the greater work outlay inherent in the Thurstone prejudging procedure. He had discovered that many researchers felt the time demanded by this judging procedure was more than they could afford.<sup>22</sup>

### 3.3 Criticism of Likert's Technique

Farnsworth also pointed out that there are many

researchers who are somewhat loathe to lose the opportunity of prejudging, that is, of assembling item weights, which the Thurstone method alone gives.<sup>23</sup> In Remmers' words,

... the Thurstone scaling procedures give absolute meaning to scale units, and therefore to an individual score achieved on an attitude instrument constructed by these procedures. No such situation exists with the Likert technique. In the latter case, an individual's score can only be interpreted by reference to sets of norms for defined populations, since the units of the scale are not "rational" in the sense of having been defined (psychologically) as equal and equally spaced along the attitude continuum.<sup>24</sup>

The significance of this quotation will become more apparent following the discussion of Thurstone's techniques, but it should be noted at this point that this quotation outlines the main reason why the Thurstone technique is still employed in the construction of experimental attitude scales.

#### 4. Thurstone's Method of Equal-Appearing Intervals

The Thurstone technique is slightly more complex than the Likert method in that a judgment group is involved.

##### 4.1 Technique for Judging Statements

In manner similar to the Likert method, it is first necessary to collect a list of statements, following the same criteria as summarized by Edwards (section 2.1).<sup>25</sup>

The statements are mimeographed on small slips, one statement to a slip, and a set of slips is given to each subject.

The subject is also given 11 master slips of the same size lettered from A to K.

To illustrate the instructions given these subjects who are to act as the judges, the instructions from Thurstone's "Scale for Measuring Attitude toward the Church" are referred to.

1. The 130 slips contain statements regarding the value of the church. These have been made by various persons, students, and others.
2. As a first step in the making of a scale that may be used in a test of opinions relating to the church and religion we want a number of persons to sort these 130 slips into eleven piles.
3. You are given eleven slips with letters on them, A, B, C, D, E, F, G, H, I, J, K. Please arrange these before you in regular order. On slip A put those statements which you believe express the highest appreciation of the value of the church. On slip F put those expressing a neutral position. On slip K put those slips which express the strongest depreciation of the church. On the rest of the slips arrange statements in accordance with the degree of appreciation or depreciation expressed in them.
4. This means that when you are through sorting you will have eleven piles arranged in order of value-estimate from A, the highest, to K, the lowest.
5. Do not try to get the same number in each pile. They are not evenly distributed.
6. The numbers of the slips are code numbers and have nothing to do with the arrangement in piles.
7. You will find it easier to sort them if you look over a number of the slips chosen at random, before you begin to sort.
8. It will probably take you about forty-five minutes to sort them.<sup>26</sup>

#### 4.2 Criticisms of the Judging Technique

This technique of judging was attacked immediately. Thurstone had assumed that the scale-values found would be independent of the attitude distribution of the judges who rates the statements<sup>27</sup>, but many sceptics, later to include Edwards and Kenney<sup>28</sup>, pointed out that this was perhaps unjustified assumption. To test Thurstone's hypothesis, Pintner and Forlano gave the Thule and Thurstone "Scale for the Measurement of Patriotism" to four hundred and eleven students in several classes of educational psychology. The subjects marked the items according to the standard directions. Upon completion, the instructor explained briefly to the students the method of constructing such scales, and asked them to act as judges and sort the statements into 11 categories, marking each with a letter from A to K, from very much to very little patriotism. Pintner and Forlano felt that the fact that the judging followed immediately after the subject had registered his own individual attitude in regard to each item would presumably allow for the greatest "halo" influence of the individual attitude upon the item judgment.

The total group was divided into three groups on the basis of the attitude scale, an upper 27%, a middle 46%, and a lower group of 27%. Pintner and Forlano reported

When the rankings of items by the three groups were correlated, the correlations were .994 between lower and middle, .983 between middle

and upper. Also there was very little difference in the scale-values assigned by any one of the groups, and the scale-values derived by Thule and Thurstone.<sup>29</sup>

Ferguson found similar results, and so did Hinckley.<sup>30</sup> Hinckley's more elaborate study consisted of the construction of a scale measuring attitude toward the Negro. He found the correlation of the scale-values of the judges prejudiced against the Negro with those of the judges in favor of the Negro was 0.98.<sup>31</sup>

These findings which indicate that the attitudes and opinions of the judges have virtually no effect on the placement of items are in sharp conflict with the results of studies in the fields of perception and judgment. These studies indicate that judgments are greatly influenced by motivational and attitudinal factors operative at the time.<sup>32</sup>

This discrepancy prompted Sherif and Hovland to doubt the validity of the results of the Pintner and Forlano, Ferguson, and Hinckley studies. Upon investigation of these works, they felt that these previous studies failed in that they did not employ samples with a sufficiently wide range of attitudes to represent adequately the strongly involved individuals who would be most likely to show the displacements and distortions found in the field of perception and judgment.

To test this hypothesis, Sherif and Hovland used

Hinckley's original statements, and duplicated his instructions and procedures. They made every effort to secure subjects who were deeply involved with the issue at hand. Their findings were definitely in line with the predictions of judgment theory.

... individuals with strong attitudes tended to see issues in "black and white", and displaced neutral statements to the extremes. The number of statements assigned to the various categories by "average" individuals were found much more uniform.<sup>33</sup>

This behavior found in Sherif and Hovland's study was not expected to adversely affect the development of an attitude scale toward such a non-controversial topic as a physics laboratory. The range of attitude present was anticipated to be largely between indifference and mild enthusiasm, with only a few exceptions in persons who were strongly against it.

As a second criticism of the judging technique Fehrer and Farnsworth, in separate studies, found that judgment of one attitude statement is dependent upon the remaining items in the scale.<sup>34</sup> To illustrate this drawback, Fehrer constructed three scales from items of Thurstone and Peterson's "Scale of Attitude toward War". Scale C contained an equal number of Thurstone's items valued from 0 to 10 (where scale-value A corresponds to 0, B corresponds to 1, etc.). Scale M (militaristic) contained items with values 3 to 10, and scale P (pacifistic),



items with values 0 to 7. Each scale was rated by a different group of 100 equated for age and sex.

Fehrer found the median scale-values of the items common to several scales to differ significantly with content. For example, in scale M the common items were rated on the average more pacifistic than the same items were rated on the scales C and P. In general, the neutral or extreme items had the same values on all three scales, and it was the moderately pacifistic items on scale M, and the moderately militaristic items on scale P whose scale-values changed.<sup>35</sup>

This criticism can of course be kept minimal if items are chosen such that there are as many appreciation items as there are depreciation items for the judges to rate.

One last criticism of Thurstone's judging technique, investigated by Farnsworth, suggested that the scale-values may change with time. Farnsworth, utilizing the same scale as Fehrer, found that only two items had changed scale-value significantly over a period of eight years. He felt that this minor change in the scale-values on such a controversial subject as war was not serious, since the correlation between the scale-values was 0.97.<sup>36</sup>

At face value, this was considered a minor and perhaps unjust criticism, since attitudes toward controversial

topics do change with time, and consequently changes in scale-values should necessarily be expected.

#### 4.3 Development and Format of the Final Thurstone Scale

To complete the description of Thurstone's technique of attitude scale construction, reference is again made to the development of Thurstone's scale for measuring attitude toward the church. When the judging of the statements was completed, the returns were tabulated, showing for each item the frequency of response in each pile or category, and the cumulative frequency of these responses. From this cumulative frequency the scale-value, taken as the median response, and Q-value, a measure of ambiguity, were determined graphically, both values being read to one decimal point. Thurstone reasoned that the Q-value provided an objective measure of an ambiguous statement, since such a statement will be given scale-values over a wider range and the Q-value will be correspondingly high.<sup>37</sup>

From the original list of 130 statements of opinions, a final list of 45 was selected. The selection was made with consideration of the criterion of ambiguity and the scale-values. The statements were so selected that they constitute a more or less uniformly graduated series of scale-values. These statements were then arranged in random order, not in the order of their scale-values. This was done to encourage the subjects to read all of

the statements. The final list was then given to several hundred subjects, asking them to endorse those statements that express their own sentiment. The scale was scored by determining the mean scale-values of all the opinions that any individual subject endorses.<sup>38</sup>

At this stage another criterion described by Thurstone, the "criterion of irrelevance", was employed in addition to Q-value as a basis for rejecting statements. This criterion essentially demands that the greatest probability of endorsement of statements should be associated with those respondents whose attitude score on the psychological continuum is equal to the scale value of the statement.<sup>39</sup> Edwards reported that this criterion however, has not been used extensively in connection with the method of equal-appearing intervals.<sup>40</sup>

It should be noted that although Thurstone chose 45 statements for the final scale, the number of statements selected was at his discretion. From the point of view of time taken to administer the scale, fewer statements would have been convenient. But fewer statements would also have theoretically decreased the reliability of the scale.

#### 4.4 Criticism of the Final Scale

Dunlap and Kroll investigated two aspects of the format and scoring of the final list of statements. They first studied the effect of arranging the statements in

order of scale-value on mean response, variability of response, and reliability of scores, concluding that

there is evidence that arranging the statements on an attitude scale in order of scale-value neither effects the mean, the standard deviation, or the reliability. Since scoring is materially facilitated by serial arrangement, the statements should be arranged in serial order.<sup>41</sup>

But Guilford pointed out that serial order might encourage response biases, and response biases contribute to reliability while at the same time detracting from validity.<sup>42</sup> Thus he would reject the Dunlap and Kroll suggestion.<sup>43</sup>

Secondly, Dunlap and Kroll studied the effect on mean response, variability, and reliability of limiting an individual's responses to those three which best represent his attitude. Here they found that for their particular scale (concerning war), the mean was depressed, the variability of scores increased, and the reliability of the scale was slightly reduced. Dunlap and Kroll felt "in view of the savings in scoring time, and the slight loss of reliability, this method deserves favorable consideration and further investigation".<sup>44</sup> Guilford explained the greater variability of response by noting that those subjects who mark more statements tend to regress to the neutral value. He felt it was best therefore to limit a subject to marking three or five statements. He felt that when the subject has to limit his choices he

will probably concentrate marks nearest his average.<sup>45</sup>

#### 4.5 Reliability of Thurstone's Scales

Ferguson reported that Thurstone claimed reliabilities of scales constructed under his editorship all over .8, most being over .9. But Ferguson himself secured reliabilities ranging from .52 to .80 for the 20 item forms and from .68 to .89 for the 40 item forms.<sup>46</sup> Likert, Roslow, and Murphy reported reliabilities ranging from .42 to .84 for 20 item forms, and from .59 to .91 for forms of 40 items. Nystrom, Bolton, and Stouffer reported similar results.<sup>47</sup>

Edwards and Kenney, upon comparing the reliability of the Thurstone method and the Likert method, concluded that

... there is no longer any reason to doubt that the scales constructed by the method of summated ratings and containing fewer items will yield reliability coefficients as high as or higher than those obtained with scales constructed by the Thurstone method.<sup>48</sup>

This conclusion appears to be common throughout the literature.

Edwards and Kenney also did a study comparing the results obtained by the Likert and Thurstone methods, and found that even though the Likert scale was marginally more reliable than the Thurstone, the correlation between the results of the two scales was 0.92, which they felt established the fact that it is possible to construct

scales by the two methods which will yield comparable results.<sup>49</sup>

#### 4.6 Innovations Upon Thurstone's Original Technique

As previously mentioned, there have been many innovations suggested concerning the Thurstone technique. Perhaps the most radical, yet successful change was proposed by Seashore and Hevner. They suggested a method of rating the statements on a nine-point scale which is printed on the left-hand margin for each item, rather than the standard method of sorting items printed on separate slips into eleven piles. They found their rating method saves from 50 to 87 percent of the time on the various processes involved in making attitude scales by Thurstone's method, taking an amount of time comparable to that required in the construction of Likert scale.<sup>50</sup>

Seashore and Hevner had 75 subjects judge statements by the classical Thurstone technique, and 75 different subjects judge the same statements using their technique. They concluded,

The subjects find the task easier and more pleasant, and the results, when the two groups of seventy-five subjects were compared show negligible difference in the median of the scale-value of the items, and in the differences or spread of opinion (Q-value) in regard to them.<sup>51</sup>

Edwards and Kenney used the Seashore Hevner method to obtain judgments of 129 statements originally scaled by Thurstone and Chave fifteen years earlier. They found that

the scale-values of statements correlated .95 with those of Thurstone and Chave.<sup>52</sup>

It is also significant to note that Edwards and Kenney obtained this correlation by using only 72 judges, indicating that reliable scales can be obtained by relatively small groups of judges.<sup>53</sup> Similar results have been found by Uhrbrock and Rosander.<sup>54</sup> Uhrbrock obtained judgments of 279 statements from two groups of 50 judges each. The correlation between the scale-values obtained independently from the two groups of judges was .99.<sup>55</sup> Rosander reported correlations as high as .99 for scale-values obtained independently by two groups with as few as 15 judges in each group.<sup>56</sup>

#### 4.7 Validity of Thurstone's Scales

Ferguson's statement that "validity seems too obvious a requirement to mention" appears to be held by many people.<sup>57</sup> It is disturbing that most scale designers have displayed only minor consideration to this aspect of their research.

Validation of Thurstone's scales is attempted in the course of construction by retaining only those items which a sufficient number of judges allocate to the same scale position. Secondly, the items must meet, if applied, the criterion of irrelevancy.<sup>58</sup> These internal consistency methods of validating scales are of course inadequate, since

although they may aid in developing a reliable scale, reliability is a necessary but not sufficient condition for validity.

The third way in which these scales are validated is by giving them to criterion groups. Ferguson reported that although data are meagre on this point, those which have been published indicate that Thurstone's scales differentiate criterion groups fairly well.<sup>59</sup> For example, Stouffer finds a validity coefficient of .81 for the Smith scale toward prohibition when scores on it are compared to ratings based upon case history methods.<sup>60</sup>

Experimenters other than Thurstone or his students have validated their scales only by some criterion of internal consistency, or have used Thurstone's scales as a criterion. This latter method was used by Likert in the development of his technique for the measurement of attitudes.<sup>61</sup>

#### 4.8 Summary

From a survey of the literature on the Thurstone method of equal-appearing intervals, one must conclude that it is an accepted and often utilized technique. Although it has shown to be marginally less reliable than the method of summated ratings, it claims the advantage of giving item weights and absolute meaning to scale units.



## 5. Guttman's Technique of Scalogram Analysis

The Guttman technique of developing attitude scales, as previously mentioned, is somewhat more complex than the two classical methods investigated.<sup>62</sup> Due to lack of universal acceptance and application, this technique, for the purposes of this study, merited only a superficial investigation.

### 5.1 A Unidimensional Scale

The most difficult aspect of the Guttman technique is to construct a set of statements which form a unidimensional scale. Edwards reported that Guttman first proposed that this should be done by intuition and experience. If a set of statements forms a unidimensional scale, then a person with a more favorable score than another person must be at least as favorable in his response to every statement in the set as the other person.<sup>63</sup> This suggests that ideally it should be possible to reproduce from their total scores alone the responses of individuals to the various statements.

### 5.2 The Cornell Technique

There exists several means of determining whether a scale is unidimensional. The method most often described is the Cornell Technique.<sup>64</sup> A description of this technique will bring into context several important scalogram analysis terms. Edwards described this technique well by use of a

simple example.<sup>65</sup>

Edwards first considered the simplest situation in which each statement selected has only 2 response categories, agree and disagree, which are assigned item weights of 0 and 1. The weight 1 will always be assigned to the response category that indicates the more favorable attitude. These statements are given to 100 or more subjects who are asked to respond to the statements in terms of their own agreement or disagreement. A score for each subject is obtained by summing the item weights, and the papers are then ranked in order of scores from high to low.

A table similar to Table 1 is then prepared. For simplicity only 4 statements are considered.

As previously mentioned, in the case of perfect reproducibility it is possible to reproduce the response to the individual statements from knowledge of total scores. Examination of Table 1 indicates that this cannot be accomplished with the results displayed. Since perfect reproducibility cannot be realistically expected, it is desirable to know the degree of reproducibility present. This is accomplished by establishing cutting points for the response categories of each statement. These points mark the place in the rank order of subjects where the most common response shifts from one category to the other. Clark and Kriedt described the difficulties involved in

TABLE 1

THE CORNELL TECHNIQUE APPLIED TO A FOUR STATEMENT SCALE  
RESPONDED TO BY 20 SUBJECTS

SUBJECTS	STATEMENTS								SCORES
	1		2		3		4		
	1	0	1	0	1	0	1	0	
1	x		x		x		x		4
2	x			x	x		x		3
3	x		x			x	x		3
4	x		<u>x</u>			x	x		3
5	x			x	x		x		3
6	x			x	x		x		3
7	x			x	x		x		3
8	x			x	<u>x</u>		x		3
9	x			x		x	x		2
10		x	x			x	x		2
11	x			x		x	x		2
12	<u>x</u>	a		x		x	x		2
13		x	x			x	x		2
14		x		x	x		<u>x</u>		2
15		x	x			x		x	1
16		x		x		x	x		1
17		x		x		x		x	1
18		x		x	x			x	1
19		x		x		x	x		1
20		x		x		x		x	0
f	12	8	6	14	8	12	16	4	Σf=80
e	1	1	3	1	2	2	2	0	Σe=12

a The horizontal lines are the possible cutting points for the statements.

establishing the cutting points.<sup>66</sup> Guttman offered two rules to be used in locating cutting points. First, the cutting point should be located so as to minimize error, and second, no category should have more error in it than non-error (responses falling outside the category in which they theoretically belong for perfect reproducibility are counted as error).<sup>67</sup>

In Table 1, the cutting points are indicated by the horizontal lines in the body of the table. The errors are recorded at the bottom of the table. For example, for category 1 of the third statement, two responses fell below the cutting point and they should theoretically fall above it, therefore constituting two errors which are recorded in row "e" at the bottom of the table.

The errors for each category are summed, which in this case gives a total of 12 errors. The 12 errors are then expressed as a proportion of the total number of responses and this value is subtracted from unity. The number found at the end of these operations, called the coefficient of reproducibility, was considered by Guttman to indicate the percent accuracy with which responses to the various statements can be reproduced from the total scores.<sup>68</sup>

In the example, the coefficient of reproducibility

$$= 1.00 - 12/80 = .85$$

Similar methods of working out the coefficient of reproducibility for 3 response categories are described by

Edwards.<sup>69</sup> If more than 3 response categories are used, he noted that it is usually necessary to group response categories or even dichotomize the response categories to obtain a satisfactory coefficient of reproducibility.

### 5.3 Modal Categories and Minimum Marginal Reproducibility

Edwards reported that Guttman felt a coefficient of reproducibility of .90 was necessary to constitute evidence that but a single dominant variable was involved in the statements.<sup>70</sup> But Edwards and Kilpatrick pointed out that this is perhaps a necessary but not a sufficient condition, since the mean value of the modal categories (that response category containing the greatest proportion of responses) is the minimum value of the coefficient of reproducibility, and for dichotomized response categories this mean value is always greater than or equal to .50. Thus it might be possible to have a set of ten statements, each with two categories of response, and each with a very high modal frequency, and these statements would have to yield a very high coefficient of reproducibility.<sup>71</sup> The minimum value of the coefficient of reproducibility found by evaluating the mean value of the modal categories indicates the "minimal marginal reproducibility" present for a set of statements.<sup>72</sup>

It is not the intent of this study to attempt a complete analysis of Guttman's techniques. The basic

concepts of unidimensionality, cutting point, minimal marginal reproducibility, and coefficient of reproducibility have been introduced and illustrated, and can now be applied with understanding to a scaling technique devised by Edwards and Kilpatrick which incorporates both the Thurstone and Likert techniques to produce a scale which has been shown to display unidimensionality and a relatively high reliability coefficient.<sup>73</sup>

## 6. The Scale-Discrimination Technique

Edwards and Kilpatrick called their technique the "Scale-Discrimination method of attitude scale construction". It is based on investigations which showed that the cutting point of an item is related to the Thurstone scale-value of the item, and that the reproducibility of the item is related to the discriminatory power of the item.<sup>74</sup>

### 6.1 Selection of Items

The procedures involved in this technique are not new. First, a large number of statements about the attitude object are judged in the usual Thurstone manner. The median scale-value and the Q-value of each statement are then determined by graphical methods. Those statements whose Q-values fall in the top 50% of the Q-value range are rejected, and the remaining items are prepared in the form of a Likert scale, each item presenting multiple response categories. (Without explanation Edwards and Kilpatrick

chose to use six categories: strongly agree, agree, mildly agree, mildly disagree, disagree, strongly disagree).

Subjects are instructed to check the items in the normal Likert fashion, and with item weights of 0 to 5 assigned in the appropriate manner, total scores are obtained.

The discriminating power of each item is then calculated.

Edwards and Kilpatrick used the phi coefficient (primarily because of its simplicity) to determine the discriminating power by reducing the six response categories to two by combining the original categories.<sup>75</sup>

The technique of combining response categories to determine the phi coefficient is best described by a hypothetical example (Table 2).

The rule followed in combining categories is to dichotomize so as to minimize the total of the number of subjects in the low group above the line and the number of subjects in the high group below the line.

Obviously, in Table 2, a line between response categories 2 and 3 gives  $8 + 5 + 3$  of the low group above the line and  $2 + 2 + 1$  of the high group below the line, giving a total of 21 subjects. A line drawn between any other response categories, on inspection, is found to give a total larger than 21. Therefore, for this statement, the scoring weights would be 1 for response categories previously weighed 5, 4, 3, and 0 for response categories previously weighed 2, 1, 0, as in Table 3.

TABLE 2

THE DISTRIBUTION OF RESPONSES TO AN ATTITUDE STATEMENT  
FOR THE TOP 100 SCORES (HIGH GROUP) AND LOWEST 100  
SCORES (LOW GROUP) FROM A SAMPLE OF 380.

<u>RESPONSE CATEGORY</u>	<u>LOW GROUP</u>	<u>HIGH GROUP</u>
Strongly Agree (5)	3	38
Agree (4)	5	42
Mildly Agree (3)	8	15
Mildly Disagree (2)	26	2
Disagree (1)	36	2
Strongly Disagree (0)	22	1

TABLE 3

DICHOTOMIZED RESPONSE CATEGORIES

<u>RESPONSE CATEGORY</u>	<u>LOW GROUP</u>	<u>HIGH GROUP</u>
1	16 (a)	95 (b)
0	84 (c)	5 (d)

$$\text{Phi Coefficient } r_{\phi} = \frac{bc - ad}{\sqrt{(a - b)(b - d)(a - c)(c - d)}}$$

$$= \frac{(95)(84) - (16)(5)}{\sqrt{(111)(100)(100)(89)}}$$

$$= .79$$



Tables prepared by Jurgensen enable one to obtain phi coefficients very quickly and conveniently without detailed calculation.<sup>76</sup>

Once the phi coefficients are known, the items are plotted in a bivariate distribution with the phi coefficient on the Y axis and the Thurstone scale-values on the X axis. This enables inspection of the statements available in terms of their discriminating power and scale-values. Edwards and Kilpatrick suggested selecting four items with the highest phi coefficient from each half scale interval (in their example, they chose a 9 - unit interval Thurstone continuum), where four items exist in these intervals. These items can then be assigned to two forms A and B by equating items as to Thurstone scale-values, Q-values, and phi coefficients.<sup>77</sup>

Edwards and Kilpatrick used this technique to develop an attitude scale toward Science. They found their item criteria eliminated the neutral items on the attitude continuum. Their final scale consisted of a total of 28 items on 2 forms, A and B. For A and B respectively, the mean scale-values were 3.85 and 3.91, and the mean Q-values were .90 and .92. For A, phi coefficients ranged from .58 to .78, with a median value of .65; for form B they ranged from .58 to .76 with a median value of .66.<sup>78</sup>

## 6.2 Reliability and Reproducibility of the Scale

The total test, when scored by the Likert technique

had a reliability coefficient of .89. This was estimated by the Spearman-Brown formula from the correlation of .81 between the half-tests A and B. Forms A and B had reproducibilities of 87.5% and 87.2% respectively.

Both forms A and B had a minimum marginal reproducibility of .57, thus Edwards and Kilpatrick contended that the values of the coefficients of reproducibility were sufficiently high to suggest that unidimensionality was present.<sup>79</sup>

### 6.3 Advantages of the Scale-Discrimination Technique

Thus the scale discrimination technique essentially synthesizes the methods of item selection presented by Thurstone, Likert, and Guttman. It possesses certain advantages which are not present in any one of these methods considered separately. For example, the scale discrimination technique eliminates the least discriminating items which the Thurstone procedure alone does not do, it provides scale-values which the Likert method cannot do, and its advantages over the Guttman procedure lies essentially in the fact that it provides an objective basis for the selection of a set of items which are then tested for scalability.

### 6.4 Scoring by the Method of Scale Products

Edwards and Kilpatrick assumably scored their scale by the Likert technique because it has proven more reliable

than the Thurstone technique when considering the same number of items. Research by Eysenck and Crown has suggested that the use of a combined Thurstone-Likert method of scoring might still further increase the reliability of the scale. Since Edwards and Kilpatrick have the Thurstone scale-values at their disposal, they could easily apply this technique.

Eysenck and Crown developed a scale in the usual Thurstone manner, concerning anti-Semitism. Their scale consisted of 24 items. By using 3 similar samples of 200 university students, the scale was scored first by the Thurstone technique, yielding a corrected split-half reliability coefficient of .83, then by the Likert technique, yielding a corrected split-half reliability coefficient of .90, and finally by a method of "Scale Products" which gave a split-half reliability coefficient of .94. The scale products method consisted of simply multiplying, for each item, the Likert weight by the Thurstone scale position. Thus the scale product technique takes into account both the scale position of each item and the degree of intensity with which each item is accepted or rejected. Eysenck and Crown concluded that, for their scale, this method of scoring was superior with respect to split-half reliability.<sup>80</sup>

## 7. Summary

It becomes obvious as one reads through the literature on the topic of attitude measurement that there exist scaling techniques far too numerous to discuss in this short survey. This paper presents only the most widely utilized techniques, but does so in sufficient detail to serve as a blueprint for developing a scale, utilizing one of the techniques described.

Basically, the purpose of this chapter was to ascertain whether or not suitable group techniques were available which were capable of reliably determining attitude distribution, without unreasonable expense of time. It has certainly been established that numerous techniques are available, and can be successfully applied. Whether the demand on time to develop a scale is considered reasonable must be dealt with in the light of knowledge to be gained from application of the scale.

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<sup>8</sup>Remmers, pp. 197-242.

<sup>9</sup>Edwards, pp. 13-4.

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<sup>21</sup>J.P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Co., Inc., 1965), pp. 233-8, 501-2.

<sup>22</sup>P.R. Farnsworth, "Further Data on the Obtaining of Thurstone Scale Values," Journal of Psychology, XIX (January, 1945), 69.

<sup>23</sup>Ibid.

<sup>24</sup>Remmers, p. 95.

<sup>25</sup>Edwards, Techniques of Attitude Scale Construction, pp. 13-4.

<sup>26</sup>Thurstone and Chave, p. 31.

<sup>27</sup>L.L. Thurstone, "Attitudes Can Be Measured," American Journal of Sociology, XXXIII (January, 1928), 548.

<sup>28</sup>A.L. Edwards and K.C. Kenney, "A Comparison of the Thurstone and Likert Techniques of Attitude Scale Construction," Journal of Applied Psychology, XXX (February, 1946), 75.

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<sup>31</sup>Hinckley, 292

<sup>32</sup>C.I. Hovland and M. Sherif, "Judgmental Phenomena and Scales of Attitude Measurement: Item Displacement on Thurstone Scales," Journal of Abnormal and Social Psychology, XLVII (October, 1952), 822-32.

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<sup>36</sup>Farnsworth, Journal of Psychology, XVI, 127.

<sup>37</sup>Thurstone and Chave, p. 32.

<sup>38</sup>Ibid., pp. 63-5.

<sup>39</sup>Ibid., pp. 45-56.

<sup>40</sup>Edwards, Techniques of Attitude Scale Construction, pp. 98-101.

<sup>41</sup>J.W. Dunlop and A. Kroll, "Observations on the Methodology in Attitude Scales," Journal of Social Psychology, X (November, 1939), 486-7.

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<sup>43</sup>Dunlop and Kroll, 486-7.

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<sup>54</sup>A.C. Rosander, "The Spearman-Brown Formula in Attitude Scale Construction," Journal of Experimental Psychology, XIX (August, 1936), 486-95; and R.S. Uhrbrock, "Attitudes of 4430 Employees," Journal of Social Psychology, V (August, 1934), 365-77.

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<sup>56</sup>Rosander, 495.

<sup>57</sup>Ferguson, Psychological Bulletin, XXVI, 669.

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<sup>59</sup>Ibid.



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<sup>63</sup>Edwards, Techniques of Attitude Scale Construction, pp. 172-6.

<sup>64</sup>Louis Guttman, "The Cornell Technique for Scale and Intensity Analysis," Educational and Psychological Measurement, VII (Summer, 1947), 247-80.

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<sup>68</sup>Ibid., 249-50.

<sup>69</sup>Edwards, Techniques of Attitude Scale Construction, pp. 188-91.

<sup>70</sup>Ibid., p. 191.

<sup>71</sup>Edwards and Kilpatrick, 380-2.

<sup>72</sup>Edwards, Techniques of Attitude Scale Construction, p. 192.

<sup>73</sup>Edwards and Kilpatrick, 374-84.

<sup>74</sup>Ibid., 376.

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### CHAPTER III

#### DEVELOPMENT OF AN ATTITUDE SCALE TOWARDS THE PHYSICS LABORATORY

The "Scale-Discrimination" method of attitude scale construction was chosen, upon the basis of the results of the Edwards and Kilpatrick study reported in Chapter II, sections 6.2 and 6.3, as most appropriate for this study.<sup>1</sup> The procedures employed to construct this scale followed the outline presented in Chapter II, section 6.

##### 1. Collection of the Attitude Statements

In the development of an attitude scale by the Scale-Discrimination technique it was first necessary to develop a large number of statements of opinion relating to the attitude object, in this case a physics laboratory. In order to have the statements express opinions authentically held by the students, a two hour seminar session was organized in December, 1966, during which students then enrolled in the newly developed Physics 120 lecture and laboratory course discussed the pros and cons of the laboratory as they saw them. The opinions expressed by the students provided the foundation upon which 120 statements of opinion concerning the laboratory were developed. Construction of the statements was in accordance with the suggestions summarized by Edwards (Chapter II, section 2.1).<sup>2</sup>

The statements attempted to relate to all aspects of the laboratory, with a balance of statements reflecting positive and negative attitudes, as Table 4 illustrates. Presumably neutral statements always seemed to possess a slight degree of favorableness or unfavorableness, and are entered in the appropriate column in the table.

TABLE 4

## ASPECTS OF LABORATORY COVERED BY ATTITUDE STATEMENTS

Topic of Statement	Number of Statements	
	Positive	Negative
General Attitude	17	17
Understanding	4	3
Interest	4	3
Challenge	2	1
Calculations and Formulae	1	3
Level of Difficulty	2	6
Time	5	6
Equipment	3	3
Instructor	4	4
Reference Material	4	4
Instructions (Written)	5	6
Marking	3	4
Overlap Between Laboratory and Lectures	4	4

2. Judging the 120 Statements

Once the set of original statements was contrived, it was necessary to have a group of subjects judge them as to their degree of favorableness or unfavorableness.

Thurstone's original judging technique was not applied.

Instead the time saving innovation developed by Seashore and Hevner (Chapter II, section 4.6) was adopted in which the items were judged on a nine point scale lettered "A" to "I".<sup>3</sup> The most favorable rating a judge could give a statement was "A", and the most unfavorable was "I". Scale value "E" rated the item as neutral.

The 120 statements, with instructions for judging, were presented to 200 judges in the Physics 120 class in January, 1967. The 120 statements together with the instructions given are in Appendix A. The judges were allotted 20 minutes to complete their task. Such a time limit was undesirable, but it was a product of the circumstances. In this 20 minutes 107 of the 200 judges were able to complete their evaluation of each statement. These 107 completed papers were then examined to eliminate those papers for which the judges either misunderstood the task required or lacked sincerity in completing the form. This examination involved referring to 3 items that expressed strongly favorable opinions, and 4 items that expressed strongly unfavorable opinions. If unexpected, contradictory judgments were found for any of these statements, then the entire paper was inspected to determine the extent of further judgments contrary to what would be expected. Twenty papers were eliminated by this technique, and for ease of computation, 80 out of the remaining 87 acceptable papers were chosen

to act as a basis for determining the scale-value of each statement.

Since the more conscientious judge would inevitably take longer to complete his task, disregarding the incomplete papers may have meant omitting the most valid judgments. As a check on the validity of the judgments of the 80 completed papers chosen, a comparison of responses between these papers and the 93 incomplete papers was made on 3 randomly selected statements (numbers 29, 34, 47) completed by both groups. To the first decimal place, both groups of responses yielded the same scale-value and interquartile range for a given statements, an indication that both sets of judgments were equally valid.

Finally, the response of each of the 80 chosen judges to each statement was recorded, and the results were tabulated as in Table 5, Appendix A. The first row corresponding to each item indicates the frequency of response for each scale value, while the second row is the cumulative frequency or response. Consistent with the philosophy behind this technique for developing an attitude scale, the response categories were then given equally spaced numerical values. The most favorable rating "A" was given the value "1", "B" the value "2", and so on, giving "I" the value 9.

### 3. Scale-Values and Interquartile Range

The scale-values and interquartile range ( $Q'$ ) for each statement are also listed in Table 5. They were found graphically. Scale-values 1.00 to 9.00 were taken as the abscissa of the graph, and the cumulative frequency was the ordinate. A graph was then plotted for each statement using the data in Table 5. Rather than require a separate sheet of graph paper for each statement, one piece of graph paper was appropriately labelled, and then the graphs were plotted on tracing paper laid over this one piece of graph paper, as Figure 1 and Figure 2 illustrate.

The scale-value corresponding to the median response of the judges to an item, that is, corresponding to a cumulative frequency of 40 was taken as the scale-value of the item (scale-values were read to two places of decimal, the second place being merely an approximation). This scale-value represents the degree of favorableness or unfavorableness of opinion expressed by the statement.

The  $Q'$ -value was found by taking the difference in the scale-values between the cumulative frequencies 20 and 60. The  $Q'$ -value provides an objective measure of an ambiguous statement, since an ambiguous statement will be given scale-values over a wider range, and the  $Q'$ -value will be correspondingly high. The interquartile deviation

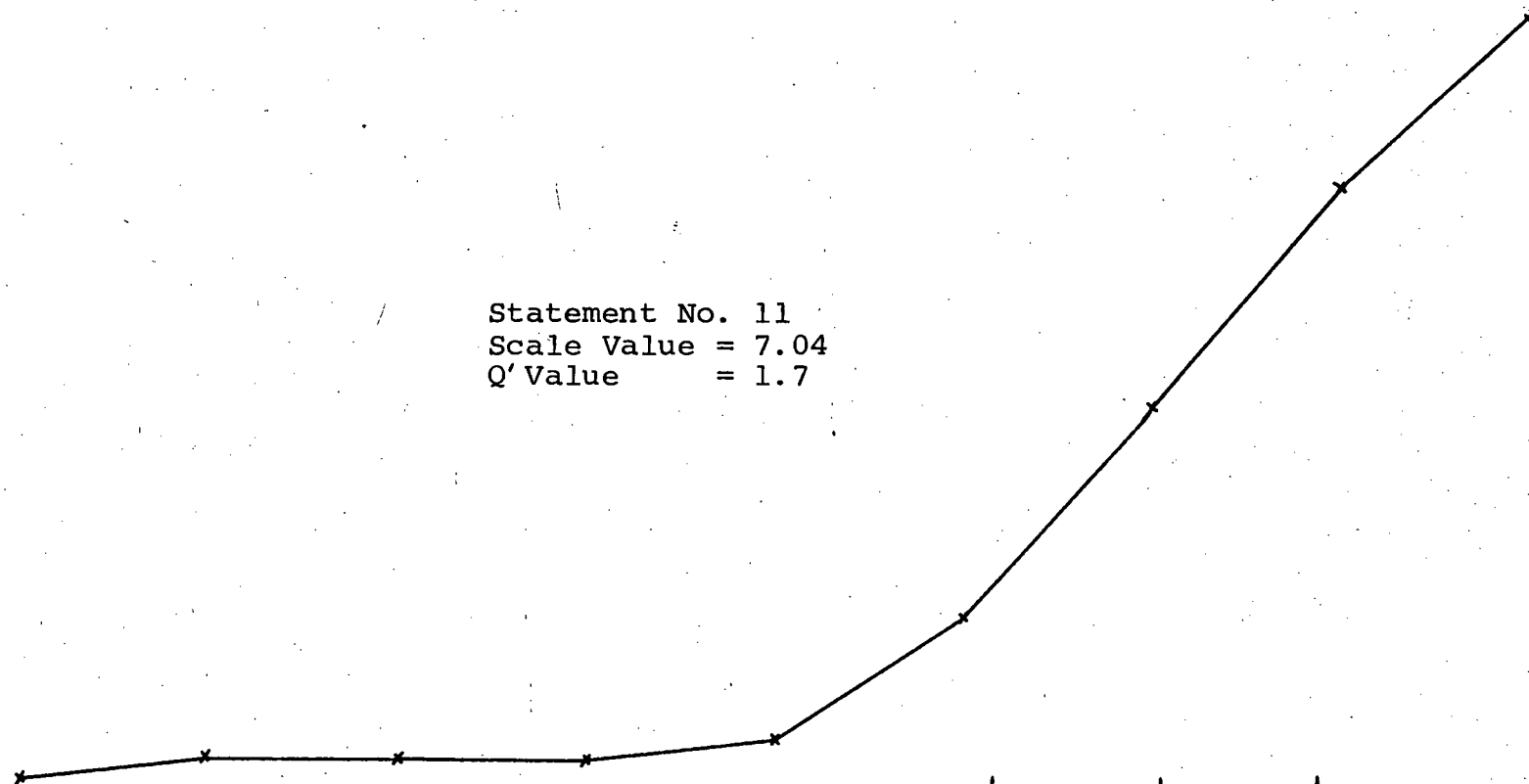


Fig. 1. An Example of an Overlay Employed to Obtain the Scale and Q' Value of a Statement.



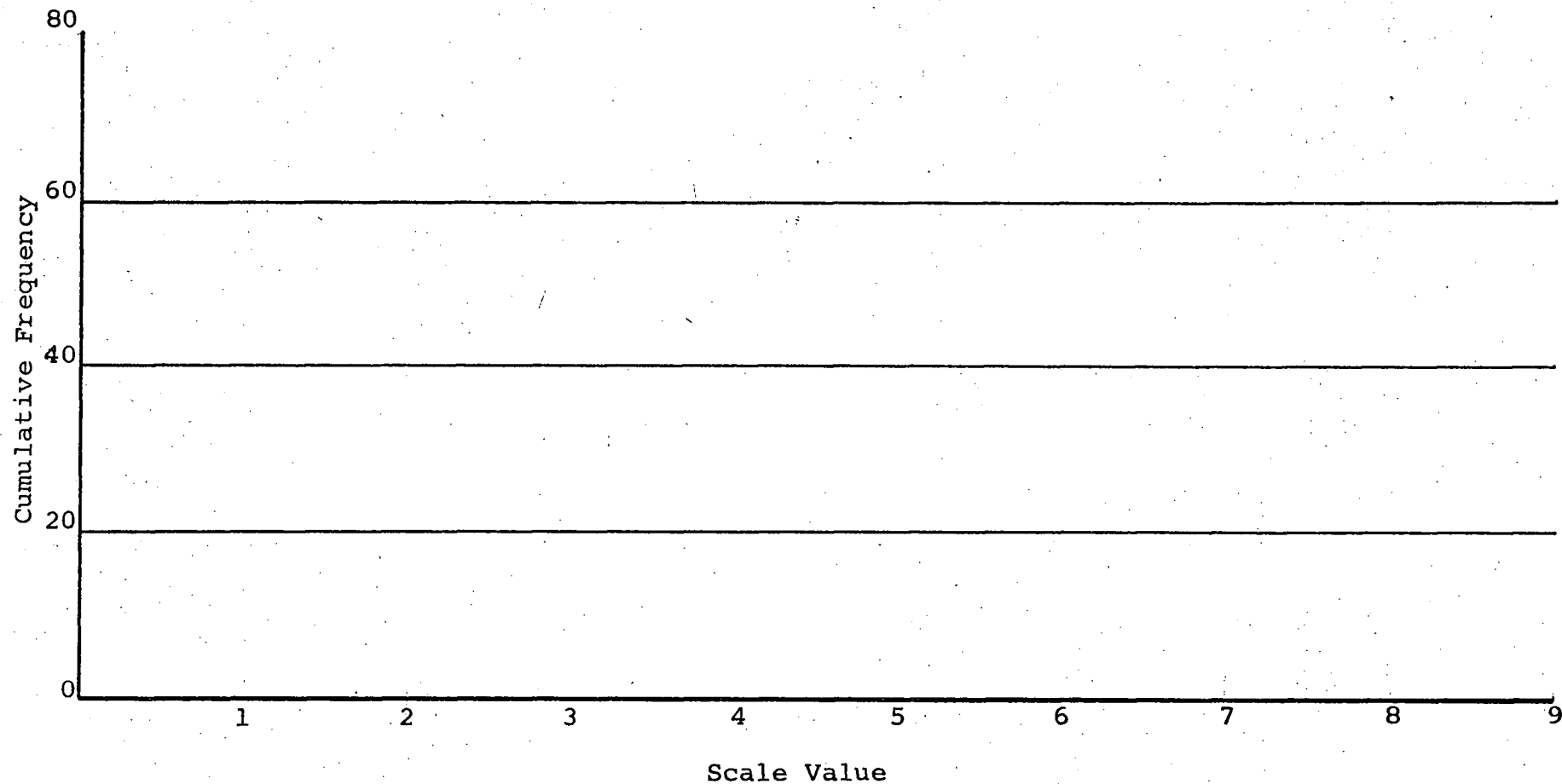


Fig. 2. The Graph Employed to Obtain the Scale and Q Value of a Statement.

has been denoted by  $Q'$  to distinguish it from the semi-interquartile deviation usually denoted by  $Q$ .

The last stage in the development of an attitude scale by the Scale-Discrimination technique is the determination of the discriminating power of that half of the original statements which have the lowest  $Q'$ -value. Before work started on this phase, an opportunity arose in March, 1967, to present the Physics 120 class with a preliminary scale.

#### 4. The Pilot Study

The opportunity to do a pilot study provided a welcome check on the entire concept of attitude measurement toward a laboratory by scaling techniques. Measurement of attitude toward a laboratory was thought to be a more difficult problem than the measurement of more openly controversial attitudes, since the range of opinion toward the lab was expected to be largely between indifference and mild enthusiasm. This limited range would clearly adversely affect the reliability of the scale produced. In contrast, measurement of opinion on the more open questions such as attitude toward the Negro, or toward pacificism, one expects to find many persons who are maintaining a strong position either for or against the question, as well as many neutral persons. In essence therefore, applying a scale to a group similar to the

1967-68 Physics 110 class to be utilized in the main study was expected to provide a reliability coefficient whose magnitude would suggest the possibility of success with the final scale.

For its ease of scoring, a pilot scale was produced in the Thurstone manner. Since this technique has proven less reliable than the Likert technique (Chapter II, section 4.5), the application of this scale was expected to provide a lower bound for future reliability coefficients.<sup>4</sup>

#### 4.1 Selection of Statements for the Pilot Scale

An attempt was made to select statements for the pilot scale so that they constituted a more or less uniformly graduated series of scale-values, and at the same time select statements which had the lowest  $Q'$ -values. To aid this operation, the statements were pictured on a graph with scale-value as the abscissa and  $Q'$ -value as the ordinate (Figure 3). This permitted the distribution of scale-values of the items to be examined the context of their  $Q'$ -value. Figure 3 illustrates that the 2 criteria of uniform distribution of scale-value, and low  $Q'$ -value could not be met simultaneously. Thus it was necessary to subjectively balance the concessions given each criterion when the final items were selected. Figure 3 also illustrates a comparative scarcity of neutral items, and where neutral items exist their  $Q'$ -values are nearly all excessively high. Thurstone,

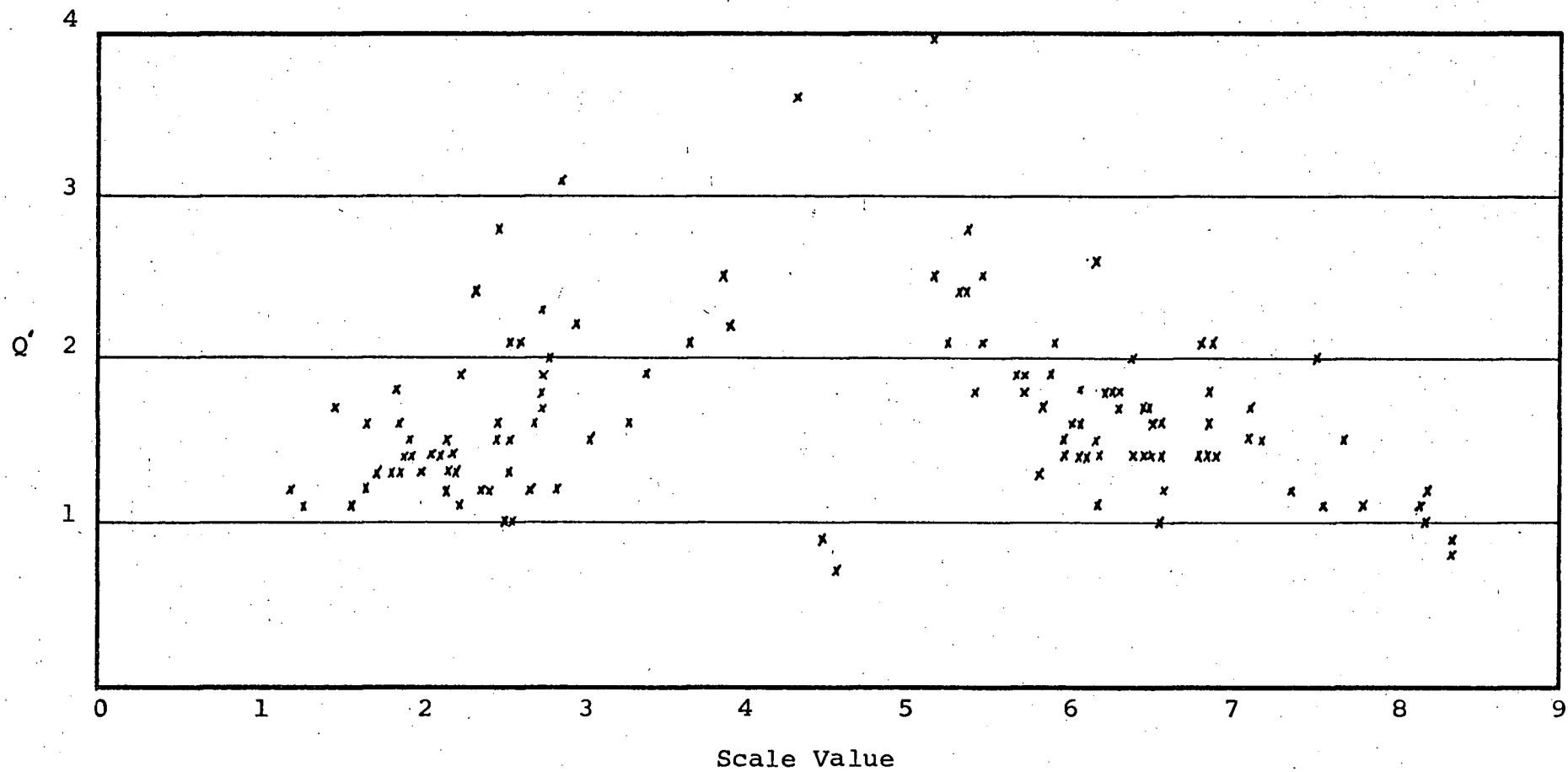


Fig. 3. The  $Q'$  Values of the 120 Original Statements as a Function of Scale Value.

Edwards and Kilpatrick, and Eysenck and Crown have found both these results to be general features of the judging technique.<sup>5</sup>

#### 4.2 The Pilot Scale

Forty items were selected for the pilot scale. To determine the reliability of this scale by a split-half technique the 40 items were divided, on the basis of scale-value, into two forms, A and B. Form A had a mean scale-value of 4.94 and Form B a mean scale-value of 4.99.

Form A and Form B, together with instructions for scoring the scale, were given to all 180 Physics 120 students as in Appendix B. The score for a student on each form was determined by adding the scale-values of the items endorsed, and then dividing this sum by the number of statements endorsed. These scores are listed in Table 6, Appendix B. A split-half coefficient of reliability was calculated using the scores on Form A and Form B available for each student. This reliability coefficient was found, using the Guttman formula, to be .912 (Figure 4, Appendix B), which compared extremely favorably with the reliability of other scales developed by any scaling technique.

Therefore, on a preliminary basis, the concept of attitude measurement toward a laboratory by a scaling technique appeared highly feasible.

### 5. Discriminating Power of the Statements

Following the pilot study, the development of the attitude scale by the Scale-Discrimination technique continued. Approximately half (68) of the original 120 statements were chosen, on the basis of low Q-value, as possible contributors to the final scale. These statements were then studied for their ability to discriminate between students of good and poor attitude toward the laboratory. The statements chosen included the 40 statements that appeared on the pilot scale, since both sets of statements were selected using the same criteria.

The 68 statements were prepared in the form of a Likert scale (Appendix C), and the scale was completed by 470 Physics 110 students in April, 1967. Rejecting response forms for which four or more statements lacked response, and those for which there existed doubt concerning sincerity, as indicated by overuse of one or two response categories or contradictory responses (statements 7, 12, 43, and 60 were examined), 411 papers remained. Two hundred and seventy-eight of the 411 were then randomly selected as the basis of the analysis.

The responses of these 278 subjects were scored in the normal Likert fashion, with weights of 0 through 5 being assigned to the six response categories. The weights were assigned so that the smallest weight was

always given to that response category that indicated the most favorable attitude. That is, the response categories "strongly agree" through "strongly disagree" were weighed 0 to 5 respectively for statements whose Thurstone scale-value was between 1.00 and 5.00, and 5 to 0 for statements with scale-values 5.01 to 9.00. A total score was obtained for each subject by adding the item weights corresponding to the responses given each statement. If a statement was not responded to, it was assigned an item weight of 3.

The papers were then arranged in order of total score, and the bottom (low group) and top (high group) 75 papers (27%) were selected. The scores in the low group ranged from 61 to 125, while those in the high group ranged from 178 to 287. For each group separately, a frequency distribution of response to each statement was tabulated as in Table 7, Appendix C, and these response categories were then dichotomized (Table 8, Appendix C), following Edwards' and Kilpatrick's criteria (Chapter II, section 6.1).<sup>6</sup> Because some subjects did not respond to all statements, the frequency distribution in Table 7 and Table 8 do not always add up to 75.

All pertinent data was now represented by two pairs of variables (Table 8), one pair being the dichotomized response distribution of students in the low scoring group,

the other being the dichotomized response distribution of students in the high scoring group. Due to its simplicity, the phi coefficient, a correlation coefficient between two pairs of variables, was employed to provide a measure of the discriminating power of each statement. The values of the phi coefficients were found in a manner analogous to the example given in Chapter II, section 6.1, and are listed in Table 9, Appendix C.

#### 6. Selection of Statements for the Final Scale

With the phi coefficients now known, the statements were represented on a new graph with Thurstone scale-value as abscissa and phi coefficient as ordinate (Figure 5). An attempt was made to select, for the final scale, those statements with a phi coefficient greater than .50 which were as equally spaced as possible across the continuum of scale-values. If two statements held similar scale-values and phi coefficients, that aspect of the laboratory to which the statement pertained was used as a criteria of selection. An attempt was made to represent all aspects of the laboratory that could theoretically be controlled by the laboratory designer, and omit those over which the designer had little or no control (i.e.; instructors).

From the 68 statements, 35 were selected as candidates for the final scale. Eight of these statements had phi coefficients of less than .50, but were selected because they related to important aspects of the laboratory.



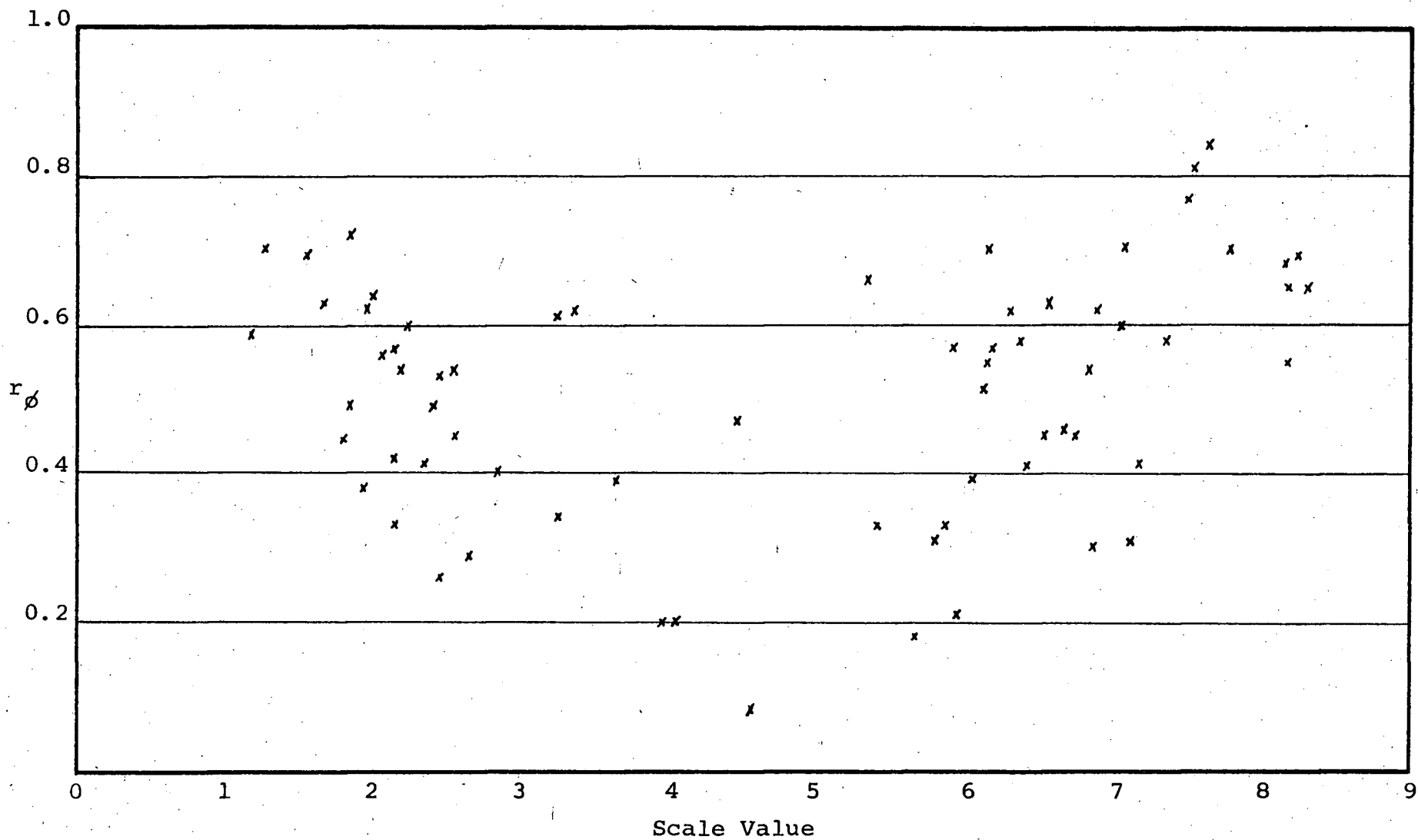


Fig. 5. The Discriminating Power of the Least Ambiguous Statements as a Function of Scale Value.

The 35 statements, together with their scale-values, Q-values and phi coefficients (Appendix D), were distributed to 3 members of the Faculty of Education (Dr. Cannon, Dr. Dennison, and Dr. McPherson) and one member of the Physics Department (Dr. Bichard) who agreed to evaluate the statements in terms of their validity as contributors to the objectives of the scale (Chapter I, section 4.1), and in terms of their clarity and lack of ambiguity. The observations of this competent judging group yielded 9 statements which were questionable and thus rejected.

#### 7. The Final Scale

The 26 remaining statements were arranged in rank order of their Thurstone scale-values, from most to least favorable. Alternate statements were then separated, forming 2 groups, one of which constituted the odd numbered statements of the final scale, and the other which formed the even numbered statements. This arrangement accommodated the calculation of an odd-even reliability coefficient. Minor variations in the separation technique were made to produce two groups of statements that were as closely equivalent in the mean and range of scale-value, Q-value, and phi coefficient as possible.

The order of selection of statements from within both groups for the final scale (Appendix E) was random, so that the items would not appear in the order of their

scale-values, and hence not encourage response biases which may detract from the validity of the scale.

For the odd and even numbered groups respectively, the mean scale-values of the 13 statements were 4.68 and 4.60, and the mean Q-values were 0.60 and 0.66. The phi coefficients for the statements in the odd group ranged from 0.36 to 0.81, with a median value of 0.58. For the even group, the range of phi coefficients was from 0.47 to 0.84, with a median value of 0.62. The scale-values, Q-values, and phi coefficients of the 26 statements are displayed in Table 10, Appendix E.

### 7.1 Scoring of the Final Scale

The final scale was scored by both the normal Likert technique and by the scale products technique proposed by Eysenck and Crown (Chapter II, section 6.4).<sup>7</sup> If the scale products scoring technique did not yield a higher reliability for the scale than that produced by the Likert scoring technique, then it was to be rejected in favor of the simpler Likert technique.

Consequently, for each attitude scale completed, two sets of data were derived, one set for each scoring technique. The elements of each set consisted of the average score on the 13 odd numbered statements, the average score on the 13 even numbered statements, and the average score for the entire 26 statements. Each set of scores

constituted the raw data necessary for the calculation of an odd-even reliability coefficient for the scale, thus permitting a comparison of the reliability of these two methods of scoring, for this particular scale with this particular sample of Physics 110 students.

## 7.2 Applications of the Final Scale

For the purposes of reporting the reliability and validity studies performed on the attitude scale, it is necessary to briefly describe the basic design of the attitudinal study. A detailed description of this design is presented in Chapter IV.

During the 1967-68 pre-Christmas term all Physics 110 students completed the same laboratory program. At the end of this program in December the attitude scale was presented to these students. This application of the scale is henceforth referred to as the first or initial application of the scale. At the beginning of the second term the Physics 110 students were separated into an experimental and control group. These groups were assigned contrasting laboratory programs. Upon completion of their respective programs in March, students were again given the attitude scale. This application of the scale is henceforth referred to as the second or final application of the scale.

### 8. Reliability of the Scale

The reliability of the scale was reported as an internal consistency coefficient, the coefficient being calculated by the Guttman formula. This formula was given preference over the combination of the Pearson product moment correlation coefficient and the Spearman Brown formula in order to remove the requirement that the odd and even groups of statements display the same variance in their total scores for any group of subjects.

The attitude scale was presented on two occasions to the control and experimental groups, hence four sets of data existed for each scoring technique from which a reliability coefficient could be calculated. These sets of data are listed in Tables 11, 12, 13, and 14, Appendix F. The sample variances of the elements in each set of data, together with the calculated reliability coefficients, found from

$$r = 2 \left( 1 - \frac{S_o^2 + S_e^2}{4S_t^2} \right)$$

are displayed in Table 15, Appendix F. In the Guttman formula above,  $S_o^2$ ,  $S_e^2$  and  $S_t^2$  are respectively the sample variances of the average scores on the 13 odd, 13 even, and entire 26 statements about their respective mean values for a given sample of students. The factor 4 is necessary to offset the fact that  $S_t^2$  is not the variance of the sum of the average scores on the odd and even numbered

statements, but rather is the variance of the mean of these two scores.

The reliability coefficients displayed in Table 15 illustrate that either method of scoring yields very reliable results, but the simpler Likert technique produces the same or marginally better coefficients. For this reason the scores derived through the Likert scoring technique were used in the main study.

A complete description of reliability should also include a coefficient of stability for the scale. The scale could have been administered to a group of Physics 110 students immediately following the Christmas break, which would have been six weeks after the first application of the scale. This would have been ideal experimental design, as there was no exposure to the laboratory during that time.

This administration of the scale was not carried out. It was generally felt that another application of the scale, added to the two applications already needed for the main study, may place a strain on both the good rapport assumed to exist between the students and the interviewer, and the interest of the student toward the scale. Hence, information about the scale was sacrificed for the sake of the validity of the main study.

#### 9. Validity of the Scale

Evidence of the construct validity of the scale

was gathered by utilizing four general approaches: (1) the statements on the scale were examined by a competent group of judges, (2) the attitudes of three groups were compared, which, on a priori grounds, should differ, (3) a comparison was made with another measure of attitude, and (4) the accuracy of prediction of behavior based upon the measurement of the attitudes by the scale was studied.

In the two latter approaches, the criteria used were considered weak, either in terms of their relevance as criteria or in terms of their reliability. But these studies were completed upon the belief that any indication of validity was superior to no indication.

The first approach has been discussed previously and will be given no further consideration. However, the latter three approaches will be discussed in detail.

#### 9.1 Validity Study Utilizing Criterion Groups

The second approach at establishing validity involved mailing copies of the scale, together with stamped, self-addressed, return envelopes to 200 randomly selected students who had taken Physics 110 in the year 1966-67. Responses were received from 122 of these students. These responses were divided into 3 categories representing those students who enrolled in pure physics (38 students) in their second year (1967-68), those who went into applied physics (36 students), and those who elected no physics

courses (48 students). It was anticipated that those students who continued in physics would have held a better attitude toward the laboratory than those who elected no physics courses. The "t" statistic was employed to compare the mean attitude scores of students electing pure physics or applied physics with those electing no physics courses.

The attitude scores for the three groups of students and derived data necessary for calculation of the "t" statistic are presented in Tables 16, 17, and 18, Appendix G.

The calculation of the "t" values is displayed in Figure 6, Appendix G.

The mean scores of students electing no physics, pure physics, and applied physics were respectively 2.9999, 2.8005, and 2.7050, where a lower score indicates a more favorable attitude. The calculations in Figure 6 illustrate that the difference between the mean scores of the no physics and applied physics group is significant at the .005 level, while the difference in the mean scores between the no physics and pure physics groups is significant at the .05 level. These results are commensurate with expectations, and hence provide evidence supporting the contention that the scale is measuring what it purports to measure.

## 9.2 Student Attitude as Interpreted by the Teaching Assistants

The third approach at establishing validity involved a comparison of the attitude score of a student on the



attitude scale, and an attitude score of the same student as given by his teaching assistant in the laboratory.

In March, 1968, all teaching assistants were given the form displayed in Figure 7, Appendix G, asking them to judge their students' attitude toward the laboratory. Twenty-two teaching assistants completed this task and of these, the responses of seventeen of the more conscientious teaching assistants provided judgments upon 257 students. These scores, as given by the teaching assistants, were then correlated with the students' scores on the final application (March, 1968) of the attitude scale. Both sets of scores are listed in Table 19, Appendix G, and the calculation of a Pearson product moment correlation coefficient is illustrated in Figure 8, Appendix G. The coefficient of .03 obtained indicated that no relationship existed between the two sets of data.

This result provided no support for the validity of the scale. A possible, and very probable explanation for this apparent lack of agreement may be the unreliability of the criterion measure. Seventeen people making subjective evaluations concerning students about whom they know very little provides a weak criterion measure.

### 9.3 Attitudes and Achievement

Inasmuch as the literature on the topic of attitudes and learning has established that a relationship exists

between these two concepts, a positive correlation was expected to exist between the students' attitudes toward the laboratory and their laboratory marks. To test this hypothesis a correlation coefficient was calculated between the attitude scores on the final application of the attitude scale, and the sum of the marks achieved on the second terms laboratory experiments. The final application of the attitude scale measured the attitudes of students toward these experiments only.

However, these laboratory grades were unfortunately believed to be quite unreliable, since they were assigned by 26 teaching assistants whose marking techniques varied greatly. Consequently, correlations were also desirable between the final attitude scores and the final exam mark, the total lab mark from both terms, the total course mark and a composite mark prior to the final exam derived from the students' lab mark, weekly assignments, mid-term tests, and Christmas exam. Although these scores were less relevant because they were not derived from the experiments to which the final attitude scores referred, they were considered to be more reliable estimates of achievement, either because they were a composite of a greater number of individual evaluations, as in the case of the total laboratory mark, the final course mark, and the composite mark prior to the final exam, or because, as in the case

of the final exam, the score was obtained through a more standardized procedure.

The final attitude scores, together with the five marks with which these scores were correlated are displayed in Table 20. Only the scores of the experimental group were employed for this study. The instructions given to the teaching assistants for scoring the experimental group's second term's experiments, in comparison to the instructions given for scoring the control group's second term's experiments, were more detailed and explicit, and hence the results were considered more reliable.

The results of the correlations, as observed in Table 21, indicate that a definite relationship existed between the attitude scores, and the lab mark in the second term, the total lab mark, and the final exam mark. The respective correlations of .3791 and .2213 between attitude scores and the lab mark in the second term and the total lab mark are highly significant at the one percent level of confidence. The correlation of .1667 between the attitude scores and the final exam mark is significant at the five percent level of confidence.

These results, particularly the most significant correlation existing between attitude scores and the lab mark in the second term, provide further evidence supporting the validity of the scale.

TABLE 21

CORRELATION COEFFICIENTS DENOTING THE RELATIONSHIP BETWEEN  
ATTITUDES AND ACHIEVEMENT

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Correlation Coefficients <sup>a</sup>	
	Final Attitude Score
Lab Mark -- Second Term	-.3791**
Lab Mark -- Total	-.2213**
Final Exam Mark	-.1667*
Final Course Mark	-.1342
Course Mark Prior to Final Exam	-.0924

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<sup>a</sup> All coefficients are negative because a low attitude score indicates a favorable attitude.

n = 200, \*\* is significant at .01  
when r = .181

\* is significant at .05  
when r = .138

## 10. Summary

This chapter described the development of the attitude scale toward the Physics laboratory. The scale was shown to possess an average internal reliability coefficient of .942 based upon two applications of the scale to two groups of Physics 110 students, each group having in excess of 200 members.

The function of the attitude scale in this study was to determine which laboratory program the Physics 110 students perceived as being most worthwhile and meaningful. The importance of this information rested upon the presence of the relationship presumed to exist between the attitudes of students toward the laboratory as measured by the scale and their achievement in the laboratory. A relationship was also postulated to exist between attitude as measured by the scale and the student's desire to continue his study of physics. The results of the validity studies investigating these relationships were in the predicted directions, hence supporting not only the construct validity of the scale but also the hypothesis that these relationships do exist.

Footnote References -- Chapter III

<sup>1</sup>A.L. Edwards and F.P. Kilpatrick, "A Technique for the Construction of Attitude Scales," Journal of Applied Psychology, XXXII (August, 1948), 374-84.

<sup>2</sup>A.L. Edwards, Techniques of Attitude Scale Construction (New York: Appleton-Century-Crofts, Inc., 1957), pp. 13-4.

<sup>3</sup>R.H. Seashore and K.A. Hevner, "A Time-Saving Device for the Construction of Attitude Scales," Journal of Social Psychology, IV (August, 1933), 366-72.

<sup>4</sup>A.L. Edwards and K.C. Kenney, "A Comparison of the Thurstone and Likert Techniques of Attitude Scale Construction," Journal of Applied Psychology, XXX (February, 1946), 82.

<sup>5</sup>L.L. Thurstone and E.J. Chave, The Measurement of Attitude (Chicago: The University of Chicago Press, 1929), pp. 1-96; Edwards and Kilpatrick, 378; and H.J. Eysenck and S. Crown, "An Experimental Study in Opinion-Attitude Methodology," International Journal of Opinion and Attitude Research, III (1949), 77.

<sup>6</sup>Edwards and Kilpatrick, 379.

<sup>7</sup>Eysenck and Crown, 47-86.

## CHAPTER IV

### THE DESIGN OF THE ATTITUDINAL STUDY

#### 1. The Programs Presented to the Experimental and Control Groups

Students were presented with two modes of laboratory instruction based on two contrasting philosophies in laboratory design. Since this change in instructional design was made at the end of the first term, it is most convenient to consider the first term and second term programs separately.

##### 1.1 Laboratory Program -- First Term

The pre-Christmas laboratory program, taken from the 1966-67 edition of the Physics 110 Laboratory Manual, can be classified as "strictly conventional". Students were given a three hour laboratory period on alternate weeks. During this three hour period they were expected to complete an experiment and an accompanying write-up, which was to be handed in prior to leaving the laboratory. Students completed a total of six discrete experiments in this manner.

The instructions given in the experiment regarding equipment, use of formula, taking of data, etc., were explicit. The object of the experiment, as given to the student, was to verify or demonstrate some fact or law previously introduced in the lecture. Reports of the

experiment were to be written in the traditional manner, using the conventional headings of object, theory, method, data, calculations, conclusions, and sources of error.

Following an introductory exercise on measuring instruments, significant figures, and errors, the topics considered in the experiments were Boyle's Law for an ideal gas, Fletcher's Trolley (Newton's Second Law), the period of oscillation of a simple pendulum, the velocity of standing waves in a string, and the moment of inertia of a disc. The entire population of students in this study completed these experiments.

### 1.2 The Experimental and Control Groups

Two distinctive programs, henceforth referred to as the control program and experimental program, were presented in the second term. Since students were given a laboratory period on alternate weeks only, it was possible to present the control program on one set of alternate weeks, and the experimental program on the intervening weeks. In this manner the control and experimental groups were defined.

The assignment of the 1000 Physics 110 students to a particular set of alternate weeks was based upon the first initial of their last name (A-L in the experimental group, M-Z in the control group). This assignment was made in September, 1967, at the general registration session of all university students. As a result of this impartial



selection technique, these groups were considered to be equivalent in those attributes external to the laboratory programs which may effect their attitude toward the laboratory.

Scheduling the control and experimental programs on an alternate week basis was particularly convenient, because the laboratory teaching assistants instructed every week, and consequently both the experimental and control group had the same teaching assistants. This arrangement eliminated the necessity of considering a variable whose effects would be difficult to gauge.

### 1.3 Laboratory Program -- Second Term

1.3.1 Program of the Control Group. The control group was so named because, apart from the topics of the experiments, the members of the group were presented with a continuation of the design of the first term's laboratory program. The experiments were again taken from the 1966-67 edition of the Physics 110 Manual. The topics considered were Ohm's Law, the potentiometer, magnetism, the spectrometer, the cathode ray oscilloscope (2 experiments), and radioactivity.

1.3.2 Program of the Experimental Group. This group of students was presented a set of experiments recently prepared for incorporation into the 1968-69 Physics 110 Laboratory Manual. Although the topics of the experiments

were similar to those outlined for the control group, the main differences in the two programs lay in the areas of stress and methodology. This program, a compromise between the free and conventional laboratory approaches, was intended to expose the students to some of the spirit of the free laboratory (Chapter I, section 4.4), but within a framework which placed reasonable demands on the laboratory facilities and staff available.

Since this was part of the program proposed for adoption in the next university calendar year, it was the attitude of students toward this program and its characteristics, in relation to their attitude toward the conventional program that was of importance. For completeness, a more detailed description of the characteristics of this experimental program will be given.

## 2. Characteristics of the Experimental Program

### 2.1 Scheduling of Experiments

Students were presented with only three experiments (Ohm's Law, The Cathode Ray Oscilloscope, and Radioactivity). This permitted approximately one month for each experiment. Each experiment consisted of a series of related studies which as a unit required at least twice as much time to complete as did an experiment in the control program. To retain some ease in administering the lab, students were allotted two regularly scheduled laboratory periods on

alternate weeks for each experiment.

On the basis of one scheduled laboratory period every two weeks, laboratory time could be scheduled for all students in such a manner that only six of the ten available mornings or afternoons were utilized. To accommodate those students who desired additional time for a more free and perhaps more sophisticated study in the areas under investigation, optional lab time was made available by opening the laboratory on three of the four remaining mornings or afternoons.

## 2.2 Laboratory Reports

Students were not presented with a rigid formal outline to follow in writing up their report. Instead, they were given the following instructions.

You are to consider your book as an experimental record book containing a statement of the title, object, and date of the experiment (recorded each time you add new data), plus clear circuit diagrams where applicable, all relevant data (neatly tabulated and/or plotted where possible), and calculations. There should be some comments on the results, their accuracy, and the estimated errors. Do not waste time copying out given instructions and theory, but when you are required to initiate your own method of achieving a result, you should outline what you did and why you did it in the manner chosen.

Students are permitted to write their lab reports outside of the laboratory. This procedure allowed the student more time for experimental activities in the laboratory, provided a greater opportunity for analysis of data, and such a practice accommodated the proposal of free lab time.

### 2.3 Instructions

The students were given as few specific instructions as possible, so that they would have to employ their imagination and ingenuity. That is, where practical, the students were handed the responsibility of deciding which theory was relevant, what data were required, and which methods would best provide that data.

### 3. Application of the Scale

The population of students completed the attitude scale at the end of both the first and second terms' laboratory program. The first application was necessary to detect any initial differences in attitude between the control and experimental groups before they became acquainted with the second term's laboratory program.

The purpose of the second application of the scale was to detect any differences in attitude between the control and experimental groups after they had completed the two contrasting experimental programs. On this application, students were instructed to respond to the statements with specific reference to the second term's laboratory program only.

### 4. The Collection and Treatment of the Data

Rather than consider the two samples from the population of Physics 110 students as being random, the

groups were studied for their equivalence by gathering, for each student, data upon which his attitude may depend. The influence of the sets of data obtained on the final attitude score was margined out by treating each factor as an independent variable in an analysis of covariance, the dependent variable being the final attitude score.

#### 4.1 The Independent Variables (Covariates)

Information was collected on those characteristics of the student which may have affected his attitude toward the experimental or control laboratory program. As a result, eight independent variables were defined. These were the verbal, quantitative, and total scores on the School and College Ability Tests, the attitude score on the initial application of the scale, the mark in the last high school physics course taken, the high school graduating average, the number of high school physics courses taken, and the number of laboratory courses elected concurrently with Physics 110.

The School and College Ability Tests' scores were obtained from the University of British Columbia counselling office, and the remaining information was collected at the first Physics 110 lecture in September, 1967. The card in Figure 9 was developed for this purpose.

#### 4.2 Restrictions Imposed by Incomplete Data

To adopt the analysis of covariance technique it

Fig. 9.--The Card Employed to Obtain Information Required in the Analysis of Covariance.

PHYSICS 110 LABORATORY			
NAME _____		REG. NO. _____	S.C.A.T. Verbal _____
Surname Given Names			Quant. _____
			Total _____
School Last Attended _____		Graduating Average _____	
Math and Science courses completed in Secondary School (Circle appropriate No. and indicate final mark)		Laboratory Science Courses taken this year.	
		_____	
		_____	
		_____	
COURSES		RESPECTIVE MARKS	
Physics	91, 11, 12	_____	_____
Chemistry	91, 11, 12	_____	_____
Biology	91, 11, 12	_____	_____
Math	91, 11, 12	_____	_____
OTHER (indicate where taken)			
_____			
_____			
INTENDED PHYSICS PROGRAM			
Major in Physics (Accompanying Major)		<input type="checkbox"/>	_____
Honors in Physics (Accompanying Honor)		<input type="checkbox"/>	_____
Physics 110 Only		<input type="checkbox"/>	_____
Undecided		<input type="checkbox"/>	_____

was necessary to have a complete set of data on each student, consisting of the dependent variable (final score), and the eight independent variables described. The members of the control and experimental groups originally consisted of those students in the appropriate set of alternate weeks who completed the initial application of the scale. Using this criterion there were initially 353 students in the control group and 370 students in the experimental group. It became apparent, on tabulating the information on each of these students, that some had not written the School and College Ability Tests, and others were not present at the first Physics 110 lecture to complete the card in Figure 9. Furthermore, many of these students did not complete the final application of the scale. Tables 22 and 23 in Appendix H display the data collected for the original control and experimental groups. In these tables  $Y$  is the student's score on the final application of the attitude scale, and  $X_1$  through  $X_9$  are respectively his score on the initial application of the attitude scale, his total, verbal, and quantitative scores on the School and College Ability Tests, the mark obtained in his last high school physics course, the number of high school physics courses taken, his high school graduating average, the number of laboratory sciences taken concurrently with Physics 110, and his Physics 110 mark at the time of writing the final application of the scale.

The high school physics mark and high school graduating average in Tables 22 and 23 were coded in the following manner: A (86% - 100%) was given the value 1, B (72% - 85%) the value 2, C+ (65% - 71%) the value 3, C (57% - 64%) the value 4, C- (50% - 56%) the value 5, and D (40% - 49%) the value 6. The final column of these tables, the Physics 110 mark in March, was not included in the analysis of covariance, but was used in a validity study described in Chapter III.

Of the original numbers, there remained 201 and 209 in the control and experimental groups respectively for which a complete set of data was available. These subjects constituted the final control and experimental groups upon which the analysis of covariance was run.

#### 4.3 Responses to Individual Statements

A second function of this study was to compare the reaction of the students in the control and experimental groups toward specific aspects of the two laboratory designs, as elicited by the individual attitude statements. This was accomplished by tabulating, for each group separately, the frequency with which each response category for a single statement was utilized. Then, for each statement, two histograms displaying these distributions of response were constructed. One histogram was based upon the response distribution of the control group for that



statement, while the other was constructed from the response distribution of the experimental group. A comparison of these histograms yielded, in a qualitative manner, the information required concerning the particular aspect of the laboratory to which that statement pertained.

These histograms were constructed for both the initial and final applications of the scale. It was anticipated that the control and experimental groups would display the same response distribution for each statement on the initial application, since both groups completed the same program. Consequently, any differences between the histograms of the two groups found in the second application could be attributed to the different treatments given the groups.

#### 4.4 Limitations of the Data

The grouping of students upon the basis of the first initial of their last name may introduce a bias in the results which is not accounted for by the covariance technique.

Furthermore, since the experimental group will know that they are involved in a new and different program, there is a possibility that the results obtained may in part be a reflection of the "Hawthorne Effect".

## CHAPTER V

### ANALYSIS OF THE DATA

The purpose of this chapter is to study the results of the analysis of covariance, and also to investigate the differences in responses as given by the experimental group and control group to each individual attitude statement.

#### 1. General Attitudinal Differences of the Control and Experimental Groups

The results of the analysis of covariance, as seen in Table 24, illustrate that the difference in the mean attitude scores of the experimental group and control group was statistically significant. An F value of 42.272 with 1 and 400 degrees of freedom is well beyond the one tenth of one percent level of significance. The adjusted mean attitude scores in Table 25 reveal that the experimental group held the lower mean score, and hence displayed the more favorable attitude.

#### 2. Attitudinal Differences of the Control and Experimental Groups on the Individual Attitude Statements

A separate histogram displaying the response distribution of each group to each statement was constructed for both applications of the scale. Tables 26 and 27

TABLE 24  
ANALYSIS OF COVARIANCE TABLE

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F
Total (adj.)	401	102.1303		
Between Groups (adj.)	1	9.7616	9.7616	42.272 ( $p < .001$ )
Within Groups (adj.)	400	92.3687	0.2309	

TABLE 25  
MEAN ATTITUDE SCORES

Treatment	Treatment Mean <sup>a</sup>	
	Not Adjusted	Adjusted
Experimental	2.4343	2.4618
Control	2.8019	2.7733

<sup>a</sup> The low score denotes the more favourable attitude.

in Appendix H respectively display the response distributions on the initial and final applications. Using the data for statement number 14, Figures 10, 11, 12, and 13 in Appendix H provide an example of the four histograms plotted for a given statement.

An examination of the histograms based upon the responses of the experimental and control groups on the first application of the scale revealed that on 17 statements the response distributions were the same for both groups, while on 9 statements (numbers 1, 3, 5, 7, 8, 9, 23, 25, and 26) the responses of the experimental group were marginally more favorable than those of the control group. These differences were not attributable to any treatment given the groups, since both groups completed the same program under the same instructors.

An examination of the histograms based upon the responses of the control and experimental groups on the second application yielded two qualitative observations: (1) the responses to each statement by the experimental group were more favorable than those given by the control group, with the exception of statements 13 and 21, for which the response distributions were similar (as they were on the initial application); and (2) the degree to which the more favorable responses of the experimental group surpassed those of the control group on the second

application of the scale exceeded the degree of any differences existing in the initial application, with the exception of statements 5, 13, 21, 25, and 26, where the differences, if they existed, were the same.

In summary therefore, the responses obtained on the two applications of the attitude scale suggested that the experimental program was perceived by students to be as good as or superior to the control program in all aspects of the laboratory alluded to by the attitude statements. The aspects referred to were understanding promoted, level of difficulty, clarity of instructions, opportunity for individual initiative, generation of interest, and demands on time.

## CHAPTER VI

### SUMMARY AND CONCLUSIONS

#### 1. Restatement of the Problem

The purpose of this study was (1) to compare the attitudes of students toward two contrasting introductory physics laboratory designs, and (2) to develop a reliable and valid attitude scale capable of measuring these attitudes. Knowledge of these attitudes was considered important in view of the relationships hypothesized to exist between attitude toward the physics laboratory and achievement in it, and attitude toward the laboratory and the likelihood of a continued study in physics.

Attitude toward the laboratory was defined as the student's perception of the value and meaningfulness of the laboratory, as developed through their perceptions of its specific characteristics as measured by the attitude scale.

#### 2. Summary of Results

##### 2.1 The Attitude Scale

An attitude scale toward the physics laboratory was constructed using the Scale-Discrimination technique. It consists of 26 attitude statements whose average scale-value on a nine point Thurstone continuum (scale-values

1 to 9) is 4.64, and whose mean semi-interquartile range is 0.63. The phi coefficients, employed as a measure of the discriminating power of each statement, range from 0.36 to 0.84, with a median value of 0.60.

The reliability of the scale, reported as a Guttman internal consistency coefficient, was 0.942. This coefficient was the average of four coefficients secured through two applications of the scale to the control and experimental groups of Physics 110 students, each containing in excess of 200 members.

Evidence that the scale possessed construct validity was pursued in three separate approaches. The first approach, utilizing criterion groups of past Physics 110 students who elected pure, applied, or no physics courses in their second year, established that the difference between the mean attitude scores of the applied physics group and no physics group toward the Physics 110 laboratory was significant at the one percent level, while the difference between the scores on the pure and no physics groups was significant at the five percent level.

In the second validity study, the laboratory achievement scores of students were correlated with their attitude scores. The correlation coefficient of .3791 obtained was well beyond the one percent level of significance.

The third approach at establishing evidence of construct validity correlated the attitude scores of students

with estimates of student attitude provided by the teaching assistants in the laboratory. A significant correlation was not found. The unreliability of the teaching assistants' estimate of a student's attitude was considered responsible for the apparent lack of agreement.

## 2.2 Attitudinal Differences Possessed by the Experimental and Control Groups

2.2.1 General Attitudinal Difference. The technique employed to detect a general attitudinal difference between the experimental and control group was an analysis of covariance. The resulting F ratio of 42.272 with 1 and 400 degrees of freedom which was highly significant at the .001 level, and the respective adjusted mean scores of 2.3618 and 2.7733 for the experimental and control groups indicated that students viewed the experimental program as superior to the control program.

2.2.2 Specific Attitudinal Differences. The histograms drawn from the response distributions of the control and experimental groups to each statement disclosed that students found the experimental program as good as or superior to the control program in all aspects of the laboratory programs referred to by the attitude statements.



### 3. Conclusions

#### 3.1 Development of an Attitude Scale

An attitude scale was developed, capable of objectively scaling students' attitudes toward a physics laboratory. This conclusion was based upon the sound methods of scale construction utilized (Chapter III), the high coefficient of reliability obtained for the scale (Chapter III, section 8), and the success in establishing some manifestation of validity (Chapter III, section 9).

The findings of the validity studies supported not only the construct validity of the scale, but also the theory concerning the nature of attitudes as measured by the scale and their correlates in actual behavior.

#### 3.2 The Attitudinal Study

A review of the data obtained in the attitudinal study lead to the formulation of some tentative but suggestive conclusions. These conclusions are contingent upon the scale's validity as an attitude measuring device.

3.2.1 Immediate Conclusions. As an integral unit, the experimental program, in contrast to the control program, was perceived by students as having been more worthwhile and meaningful (Chapter V, section 1). Furthermore, the individual characteristics of the experimental program were perceived by students as having had as much or more

merit than those of the control group (Chapter V, section 2), in so far as student responses toward these characteristics were measured by the attitude scale.

3.2.2 General Conclusions. The results of the validity studies, in conjunction with the results of the attitudinal study imply that the experimental program should be more conducive in promoting better achievement in the laboratory, and also more likely to produce a desire for a continued study in physics.

#### 4. Discussion

A comparison of the characteristics of the experimental and control laboratory programs, in view of the conclusions stated in section 3.2.1, yielded some interesting observations and inferences.

In contrast to the control program, the experimental program demanded more time, the topics were studied in greater depth, and the instructions given were less explicit. However, an examination of the responses to the individual statements on the attitude scale determined that the experimental group rated (1) the instructions in their laboratory as being less confusing (statements 5, 6, and 12), (2) the level of difficulty as being lower and more appropriate (statements 2, 10, 17, and 24), and (3) the time required as being more commensurate with the benefit derived (statements

9 and 19). These responses were considered to be partially the result of student participation in more worthwhile and meaningful experiences which were conducive to the development of desirable attitudes, and were also considered to reflect the greater freedoms and responsibilities given students in the less structured experimental program, even though this program was more demanding. These freedoms and responsibilities required the application of more imagination and ingenuity, and provided the opportunity for greater involvement in the activities required to meet the immediate objectives of the laboratory program as seen by the students.

A study of the responses to all the attitude statements revealed that the experimental program, in relation to the control program, was perceived by students as: (1) being more effective in promoting understanding, (2) providing more opportunity for individual initiative, (3) generating more interest, (4) having a more appropriate level of difficulty, (5) providing clearer instructions, and (6) demanding an amount of time more commensurate with the benefit derived.

## 5. Recommendations

### 5.1 Achievement in the Laboratory

Since the value of this study in part depends upon the relationship between attitude toward the laboratory

as determined by the attitude scale and achievement in the laboratory, a more reliable and valid measurement of achievement is required to determine to what extent this relationship does exist. This could perhaps be obtained through the development of a written and practical exam whose questions are constructed in view of the objectives of the laboratory program, with the assistance of Bloom's Taxonomy.

## 5.2 Future Studies

The attitude scale developed could be equally valid and applicable to the other laboratory sciences at levels of instructions ranging from junior secondary school to university, if it was utilized in a manner similar to the one reported. The only modification required for the application of this scale to laboratory sciences other than physics would be the replacement of the work "physics", which appears in some statements on the scale, with the name of the appropriate science.

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APPENDIX A

ANALYSIS OF THE ORIGINAL  
120 ATTITUDE STATEMENTS

THE FORM OF THE ORIGINAL ATTITUDE STATEMENTS AND INSTRUCTIONS  
FOR JUDGING THE STATEMENTS AS PRESENTED TO THE JUDGES

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Name (if you wish) \_\_\_\_\_

Explanation and Instructions

1. The following statements express various opinions about the Physics 120 laboratory. Some of them will be used in making a scale to measure the attitude of students toward the laboratory.
2. As a first step in making this scale, it is necessary that a number of persons rate these statements by assigning them to nine different classes.
3. These classes will be called A, B, C, D, E, F, G, H, and I, and you will find these letters directly to the left of each statement. If you find a statement which you believe expresses the highest appreciation of the laboratory, circle the letter A. For a statement which seems neutral circle E, while for those statements which express strongest depreciation of the laboratory, circle I. Other degrees of appreciation or depreciation may be indicated by circling one of the other possible letters to represent intermediate ratings.
4. Note:
  - (a) You will find it easier to rate the statements if you first read a few statements chosen at random before you begin to rate.
  - (b) Do not attempt to get the same number of statements under each rating, as the statements are not evenly distributed.
  - (c) Your own opinions about the laboratory are not asked for, and should not enter into your ratings of the statements given.
  - (d) It will probably take you about forty (40) minutes to rate the statements.

- ABCDEF GHI 1. I have found no value in the laboratory.
- ABCDEF GHI 2. In most instances I feel the labs aid me in my understanding of physics.
- ABCDEF GHI 3. Some experiments are all right, but most have no value.
- ABCDEF GHI 4. I find the laboratory instructor gives me all the aid I require.
- ABCDEF GHI 5. I have trouble with experiments because their theoretical basis is insufficiently discussed in lectures.
- ABCDEF GHI 6. I feel our laboratory is as good a way as any to learn physics.
- ABCDEF GHI 7. Even though I obtain a passing mark on most experiments, I really don't understand them.
- ABCDEF GHI 8. I find I usually have ample time in the laboratory to complete the required (B) experiments.
- ABCDEF GHI 9. I do not regard our laboratory as essential to obtaining a true understanding of physics.
- ABCDEF GHI 10. I feel my instructor is incapable of giving assistance when required.
- ABCDEF GHI 11. To me the laboratory is more or less boring.
- ABCDEF GHI 12. I like the stress the lab gives to the proper use of instruments.
- ABCDEF GHI 13. I feel the mark I receive for an experiment as a rule reflects my actual understanding of the experiment.
- ABCDEF GHI 14. My experience is that the experiments are hopelessly above my comprehension level.
- ABCDEF GHI 15. I think our lab raises this course to a higher standard than it could achieve without it.
- ABCDEF GHI 16. I feel the laboratory is an adherent of true physics because it stresses understanding.

- ABCDEFGHI 17. Experiments would be more effective if there was not such a stress on calculations.
- ABCDEFGHI 18. I enjoy the laboratory, but see no need for it.
- ABCDEFGHI 19. I am glad laboratory marks count as only one-third of the final grade because I find the experiments difficult.
- ABCDEFGHI 20. I feel the lack of common ground between lectures and labs leads to nothing but confusion and hours of unrewarding work.
- ABCDEFGHI 21. I find it disturbing that our experiments require us to use formulae whose basis or derivation we do not yet know.
- ABCDEFGHI 22. I believe the laboratory successful in promoting understanding.
- ABCDEFGHI 23. I feel our experiments tend to skim topics too shallowly.
- ABCDEFGHI 24. I hate the laboratory.
- ABCDEFGHI 25. The laboratory's good and bad points balance each other.
- ABCDEFGHI 26. The laboratory's custom of giving extra marks for optional (C) experiments provides me with added incentive.
- ABCDEFGHI 27. Occasionally I feel I have truly benefitted from an experiment, but in most instances I doubt it.
- ABCDEFGHI 28. I find our laboratory most efficient in developing an understanding of physics.
- ABCDEFGHI 29. I believe the laboratory has value in that it stimulates my interest in physics.
- ABCDEFGHI 30. Quite often I believe the laboratory is a fruitless chore.
- ABCDEFGHI 31. I regard the laboratory instructor as fully competent.

- ABCDEF GHI 32. I think there are too many students in the laboratory.
- ABCDEF GHI 33. Some experiments are too briefly explained.
- ABCDEF GHI 34. The laboratory to me is synonymous with frustration.
- ABCDEF GHI 35. I feel the laboratory provides a very stimulating and well presented opportunity to learn.
- ABCDEF GHI 36. The laboratory succeeds in providing an understanding of the application of modern instruments.
- ABCDEF GHI 37. I feel that the theoretical basis of experiments is discussed sufficiently in lectures.
- ABCDEF GHI 38. Quite often I find I do not have sufficient time in the laboratory to complete the required (B) experiments.
- ABCDEF GHI 39. I believe our experiments are mere recipes to follow rather than true investigations.
- ABCDEF GHI 40. I feel the laboratory is essential for learning physics.
- ABCDEF GHI 41. Our laboratory is superior because it does not waste time simply justifying material covered in lectures.
- ABCDEF GHI 42. I find that the instructor's time is in such demand that I cannot obtain adequate assistance.
- ABCDEF GHI 43. This laboratory has killed any desire I might have had to take future physics laboratories.
- ABCDEF GHI 44. I find the experiments an organized situation in which I can learn on my own.
- ABCDEF GHI 45. The laboratory outline seems to explain any ideas previously foreign to me.

- ABCDEFGHI 46. I find the laboratory's stress on use of instruments has greatly advanced my understanding of them.
- ABCDEFGHI 47. I feel much time is wasted because the instructors do not provide enough aid.
- ABCDEFGHI 48. Through lack of understanding, I believe most things I do are by trial and error.
- ABCDEFGHI 49. I find the marks I obtain appear to be based on understanding displayed, rather than perfect numerical results.
- ABCDEFGHI 50. My experience is that the experiments are at the right level of difficulty.
- ABCDEFGHI 51. Due to lack of laboratory time, I find I am seldom able to attempt an optional (C) experiment.
- ABCDEFGHI 52. I sometimes find equipment so complex I do not understand what I am trying to accomplish.
- ABCDEFGHI 53. I feel the lack of common ground between laboratory and lectures is an efficient way to learn more physics.
- ABCDEFGHI 54. Many calculations have little significance to me since I do not understand the basis upon which the formulae were derived.
- ABCDEFGHI 55. I regard the laboratory as an extremely beneficial activity.
- ABCDEFGHI 56. I like the laboratory because it offers opportunity for individual initiative.
- ABCDEFGHI 57. Although I concede the laboratory may serve a useful purpose, I hate it.
- ABCDEFGHI 58. The awarding of extra marks for optional (C) sections is unfair.
- ABCDEFGHI 59. The amount of time demanded by the laboratory is justified by the tremendous benefit I receive from it.

- ABCDEFGHI 60. I find it a pleasure to work with such fine equipment.
- ABCDEFGHI 61. I think the course would be improved if the laboratory were scrapped.
- ABCDEFGHI 62. I feel we are presented with apparatus too far beyond our present level of understanding.
- ABCDEFGHI 63. Some experiments are good, but in others I see no value.
- ABCDEFGHI 64. A few experiments have doubtful value, but most are excellent.
- ABCDEFGHI 65. I find that most experiments are too difficult for me.
- ABCDEFGHI 66. I have found the laboratory presents me with a reasonable challenge.
- ABCDEFGHI 67. I feel my lab instructor is incompetent.
- ABCDEFGHI 68. I have found that any reference material I require is always readily available.
- ABCDEFGHI 69. I find I seldom understand how to use the equipment without the aid of the instructor.
- ABCDEFGHI 70. I feel the experiments may be providing worthwhile experiences but they do not interest me.
- ABCDEFGHI 71. I believe that the instructions provided explain the experiments in sufficient detail.
- ABCDEFGHI 72. Our laboratory fails in that it does not relate to lecture material.
- ABCDEFGHI 73. I regard the laboratory as essential, but I am disappointed in ours.
- ABCDEFGHI 74. My laboratory instructor appears able to give good explanations when I require them.
- ABCDEFGHI 75. I feel the need for a laboratory program, and am pleased with ours.



- ABCDEFGHI 76. I learn much from the experiments, but I feel they do not help some people.
- ABCDEFGHI 77. The lab to me is primarily a waste of time.
- ABCDEFGHI 78. The experiments in general are quite easy.
- ABCDEFGHI 79. I like our laboratory because the experiments demand we think, rather than providing us with a step by step procedures.
- ABCDEFGHI 80. Reference material I have obtained is very readable and a great aid.
- ABCDEFGHI 81. The instructor seems to have sufficient time to help everyone.
- ABCDEFGHI 82. I have found this laboratory the most interesting aspect of any of my courses.
- ABCDEFGHI 83. I usually find it necessary to just fumble my way through experiments.
- ABCDEFGHI 84. I find the experiments assume we know more than we actually do.
- ABCDEFGHI 85. The laboratory certainly stimulates an interest in physics.
- ABCDEFGHI 86. I think our instructor looks mainly for correct numerical results when marking.
- ABCDEFGHI 87. I think the laboratory is a hindrance to true physics because one still must "cook results".
- ABCDEFGHI 88. I like the experiments because the instructions are general enough to provide an opportunity for us to display our own initiative.
- ABCDEFGHI 89. Through lack of guidance I find most things I do are by trial and error.
- ABCDEFGHI 90. Considering the time demanded by the laboratory, I feel the laboratory mark does not count enough toward the final grade.

- ABCDEFGHI 91. I find no particular like or dislike toward the laboratory.
- ABCDEFGHI 92. I actually believe the experiments have taught me some basic ideas of physics far better than books could.
- ABCDEFGHI 93. Almost without exception I find I am able to obtain references on ideas which I am not familiar with.
- ABCDEFGHI 94. I regard the laboratory as a futile, time-wasting activity, and as such it should be deleted from the course.
- ABCDEFGHI 95. To adequately write up a report, I find the time given us outside the laboratory is not sufficient.
- ABCDEFGHI 96. I believe our laboratory is a powerful agency for presenting an undistorted picture of what physics truly is.
- ABCDEFGHI 97. I enjoy the experiments because they are fairly easy.
- ABCDEFGHI 98. I feel our experiments attempt to cover too many ideas in too short a time.
- ABCDEFGHI 99. I like the stress our experiments place on the importance of errors.
- ABCDEFGHI 100. I think too much time is demanded by the laboratory for the benefit that is being derived.
- ABCDEFGHI 101. I can seldom get any aid from the laboratory instructor.
- ABCDEFGHI 102. With reasonable effect, I regard the ideas presented in the laboratory well within my reach.
- ABCDEFGHI 103. I feel the laboratory would be more valuable if it demonstrated ideas presented in the lectures.
- ABCDEFGHI 104. I find the laboratory does far more for projecting knowledge of physics than lectures.

- ABCDEFGHI 105. I find I can seldom obtain outside references.
- ABCDEFGHI 106. The experiments to me are merely a demonstration of something I already know.
- ABCDEFGHI 107. Without the aid of the instructor I would be unable to set up most circuits.
- ABCDEFGHI 108. I find working in the laboratory both inspiring and enjoyable.
- ABCDEFGHI 109. This laboratory has killed my interest in physics.
- ABCDEFGHI 110. Reference books I manage to obtain are, as a rule, unreadable at my level, and of little use.
- ABCDEFGHI 111. I think of the laboratory as a necessary evil.
- ABCDEFGHI 112. I find the time allotted to prepare a write-up for handing in is ample.
- ABCDEFGHI 113. I think our lab is a valuable educational experience, even though physics is not my major interest.
- ABCDEFGHI 114. I find the instructions in the laboratory manual confusing.
- ABCDEFGHI 115. I feel the experiments are justified in having us use formulae that we could not derive.
- ABCDEFGHI 116. I believe it makes little difference whether or not lectures and laboratories are based on common ideas.
- ABCDEFGHI 117. My experience is that the laboratory is a hopeless turmoil of confusion.
- ABCDEFGHI 118. I believe some experiments attempt to cover a topic too deeply at this level.
- ABCDEFGHI 119. I find many problems I have are answered by referring to the reference books found in the laboratory.

ABCDEFGHI 120. I feel the laboratory would be more effective if I had more time to work on one set of experiments.

TABLE 5  
THE RESPONSE DISTRIBUTION OF 80 JUDGES TOWARD THE 120  
ATTITUDE STATEMENTS, AND THE SCALE VALUE AND INTERQUARTILE  
RANGE OF EACH STATEMENT.<sup>a</sup>

Statement No.	Scale Value	Q'- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
1	7.78	1.1	0 0	0 0	0 0	0 0	0 0	1 1	10 11	37 48	32 80
2	2.13	1.2	7 7	29 36	37 73	6 79	1 80	0 80	0 80	0 80	0 80
3	6.50	1.6	0 0	1 1	1 2	3 5	9 14	10 24	34 58	16 74	6 80
4	2.46	2.8	7 7	27 34	15 49	8 57	11 68	4 72	5 77	3 80	0 80
5	4.28	3.6	8 8	10 18	12 30	7 37	15 52	10 62	11 73	5 78	2 80
6	3.85	2.5	1 1	17 18	14 31	12 43	26 69	5 74	2 76	3 79	1 80
7	5.43	2.4	1 1	9 10	1 11	5 16	15 31	21 52	12 64	14 78	2 80
8	2.31	2.4	15 15	22 37	11 48	16 64	9 73	4 77	1 78	1 79	1 80
9	6.90	1.4	1 1	0 1	0 1	0 1	6 7	9 16	27 43	27 70	10 80
10	7.10	1.7	1 1	2 3	5 8	2 10	2 12	7 19	19 38	29 67	13 80
11	7.04	1.7	0 0	1 1	0 1	0 1	2 3	13 16	23 39	23 62	18 80
12	2.48	2.1	7 7	23 30	23 53	11 64	11 75	2 77	3 80	0 80	0 80
13	2.85	3.1	9 9	19 28	13 41	6 47	18 65	7 72	4 76	3 79	1 80

TABLE 5--Continued

Statement No.	Scale Value	Q'- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
14	6.79	2.1	1	0	2	4	7	12	18	26	10
			1	1	3	7	14	26	44	70	80
15	2.05	1.4	10	30	29	6	5	0	0	0	0
			10	40	69	75	80	80	80	80	80
16	1.83	1.8	12	33	14	12	6	2	1	0	0
			12	45	59	71	77	79	80	80	80
17	5.81	1.7	0	0	6	7	7	26	20	8	6
			0	0	6	13	20	46	66	74	80
18	6.15	2.6	0	0	0	7	21	10	16	13	13
			0	0	0	7	28	38	54	67	80
19	5.70	1.8	0	1	4	3	13	28	17	10	4
			0	1	5	8	21	49	66	76	80
20	6.84	1.8	0	3	5	2	2	10	23	26	9
			0	3	8	10	12	22	45	71	80
21	5.12	4.0	8	8	8	8	7	12	17	7	5
			8	16	24	32	39	51	68	75	80
22	2.67	1.7	5	19	35	13	5	0	1	2	0
			5	24	59	72	77	77	78	80	80
23	5.47	2.1	4	4	6	5	9	29	20	3	0
			4	8	14	19	28	57	77	80	80
24	8.32	0.8	0	0	0	0	0	1	2	19	58
			0	0	0	0	0	1	3	22	80
25	4.47	0.9	0	4	9	7	43	7	9	1	0
			0	4	13	20	63	70	79	80	80
26	2.51	2.1	11	21	20	17	3	2	4	1	1
			11	32	52	69	72	74	78	79	80
27	5.32	2.4	0	3	5	12	13	25	19	3	0
			0	3	8	20	33	58	77	80	80

TABLE 5--Continued

Statement No.	Scale Value	Q- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
28	2.14	1.5	7 7	31 38	26 64	10 74	2 76	1 77	2 79	0 79	1 80
29	2.00	1.3	7 7	33 40	29 69	6 75	4 79	1 80	0 80	0 80	0 80
30	7.09	1.5	0 0	1 1	0 1	2 3	2 5	8 13	26 39	27 66	14 80
31	1.92	1.5	6 6	38 44	18 62	10 72	4 76	0 76	2 78	1 79	1 80
32	5.70	1.9	0 0	0 0	1 1	5 6	21 27	19 46	22 68	7 75	5 80
33	5.44	2.5	2 2	9 11	4 15	7 22	7 29	27 56	22 78	2 80	0 80
34	7.34	1.2	0 0	0 0	0 0	3 3	1 4	3 7	20 27	39 66	14 80
35	1.87	1.6	19 19	26 45	23 68	7 75	5 80	0 80	0 80	0 80	0 80
36	2.34	1.2	4 4	25 29	36 65	9 74	3 77	1 78	0 78	2 80	0 80
37	2.96	2.2	1 1	10 11	32 43	14 57	7 64	4 68	7 75	2 77	3 80
38	6.00	1.6	0 0	0 0	2 2	2 4	9 13	28 41	23 64	14 78	2 80
39	6.51	1.6	1 1	1 2	2 4	2 6	2 8	18 26	29 55	20 75	5 80
40	1.70	1.3	17 17	34 51	23 74	4 78	1 79	0 79	1 80	0 80	0 80
41	2.21	1.9	12 12	25 37	22 59	7 66	5 71	0 71	7 78	2 80	0 80
42	5.88	1.9	1 1	0 1	4 5	6 11	11 22	20 44	23 67	11 78	2 80

TABLE 5--Continued

Statement No.	Scale Value	Q-Value	Response Categories								
			A	B	C	D	E	F	G	H	I
43	8.19	1.2	0	0	0	1	0	2	8	25	44
			0	0	0	1	1	3	11	36	80
44	2.17	1.4	4	33	25	9	5	0	3	1	0
			4	37	62	71	76	76	79	80	80
45	2.42	1.3	2	24	33	14	1	4	1	1	0
			2	26	59	73	74	78	79	80	80
46	2.16	1.2	3	32	35	5	3	0	2	0	0
			3	35	70	75	78	78	80	80	80
47	6.42	1.4	0	0	3	3	5	14	35	17	3
			0	0	3	6	11	25	60	77	80
48	6.45	1.7	0	1	2	3	6	15	30	17	6
			0	1	3	6	12	27	57	74	80
49	2.79	2.0	3	15	29	12	12	4	2	3	0
			3	18	47	59	71	75	77	80	80
50	2.72	1.8	3	23	21	21	9	3	0	0	0
			3	26	47	68	77	80	80	80	80
51	5.67	1.9	0	1	2	5	17	26	16	11	2
			0	1	3	8	25	51	67	78	80
52	6.38	2.0	1	2	5	3	7	13	26	18	5
			1	3	8	11	18	31	57	75	80
53	2.74	2.3	2	17	25	14	8	3	5	6	0
			2	19	44	58	66	69	74	80	80
54	6.38	1.4	0	2	5	2	5	13	36	11	6
			0	2	7	9	14	27	63	74	80
55	1.27	1.1	30	39	10	1	0	0	0	0	0
			30	69	79	80	80	80	80	80	80
56	1.65	1.2	15	50	19	3	1	1	1	0	0
			15	55	74	77	78	79	80	80	80
57	7.50	2.0	0	1	2	2	9	4	10	26	26
			0	1	3	5	14	18	28	54	80



TABLE 5--Continued

Statement No.	Scale Value	Q-Value	Response Categories								
			A	B	C	D	E	F	G	H	I
58	6.88	1.4	0 0	0 0	0 0	0 0	3 3	12 15	28 43	29 72	8 80
59	1.44	1.7	29 29	26 55	14 69	6 75	2 77	0 77	3 80	0 80	0 80
60	1.92	1.4	9 9	36 45	19 64	11 75	4 79	1 80	0 80	0 80	0 80
61	8.15	1.1	0 0	0 0	0 0	0 0	1 1	1 2	5 7	26 33	47 80
62	6.57	1.2	0 0	1 1	3 4	3 7	2 9	10 19	38 57	17 74	6 80
63	5.40	1.8	1 1	1 2	2 4	5 9	23 32	22 54	19 73	7 80	0 80
64	2.52	1.5	5 5	20 25	30 55	21 76	4 80	0 80	0 80	0 80	0 80
65	6.14	1.5	0 0	0 0	1 1	2 3	10 13	23 36	29 65	14 79	1 80
66	2.57	1.0	2 2	14 16	42 58	18 76	4 80	0 80	0 80	0 80	0 80
67	7.16	1.5	0 0	0 0	0 0	0 0	4 4	7 11	24 35	29 64	16 80
68	2.69	1.6	4 4	14 18	33 51	12 63	13 76	2 78	2 80	0 80	0 80
69	6.06	1.8	0 0	1 1	3 4	7 11	12 23	16 39	33 72	7 79	1 80
70	5.88	2.1	0 0	0 0	2 2	9 11	14 25	18 43	26 69	8 77	3 80
71	2.83	1.2	1 1	7 8	40 48	22 70	6 76	1 77	2 79	1 80	0 80
72	6.19	1.4	1 1	0 1	1 2	4 6	3 9	25 36	29 65	12 77	3 80

TABLE 5--Continued

Statement No.	Scale Value	Q-Value	Response Categories								
			A	B	C	D	E	F	G	H	I
73	6.30	1.8	0 0	0 0	2 2	5 7	10 17	14 31	30 61	16 77	3 80
74	2.46	1.2	5 5	18 23	37 60	14 74	4 78	2 80	0 80	0 80	0 80
75	1.83	1.3	7 7	40 47	23 70	7 77	3 80	0 80	0 80	0 80	0 80
76	3.36	1.9	1 1	9 10	23 33	21 54	19 73	5 78	1 79	1 80	0 80
77	7.54	1.1	0 0	0 0	0 0	0 0	1 1	1 2	17 19	38 57	23 80
78	3.95	2.2	2 2	9 11	13 24	18 42	19 61	12 73	6 79	1 80	0 80
79	1.81	1.3	15 15	33 48	25 73	4 77	2 79	0 79	1 80	0 80	0 80
80	2.15	1.3	8 8	28 36	32 68	5 73	7 80	0 80	0 80	0 80	0 80
81	2.46	1.5	5 5	22 27	30 57	17 74	6 80	0 80	0 80	0 80	0 80
82	1.19	1.2	35 35	30 65	10 75	3 78	2 80	0 80	0 80	0 80	0 80
83	6.54	1.4	0 0	0 0	1 1	1 2	2 4	18 22	33 55	19 74	6 80
84	5.93	1.5	0 0	2 2	4 6	2 8	8 16	25 41	28 69	9 78	2 80
85	2.21	1.1	5 5	27 32	39 71	7 78	2 80	0 80	0 80	0 80	0 80
86	6.00	1.6	0 0	0 0	6 6	2 8	11 19	21 40	28 68	11 79	1 80
87	6.82	1.4	0 0	0 0	0 0	2 2	3 5	9 14	33 47	23 70	10 80

TABLE 5--Continued

Statement No.	Scale Value	Q'- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
88	2.05	1.4	10 10	29 39	31 70	6 76	1 77	3 80	0 80	0 80	0 80
89	6.52	1.0	0 0	1 1	2 3	1 4	2 6	13 19	42 61	14 75	5 80
90	5.34	2.8	1 1	8 9	9 18	4 22	14 36	16 52	21 73	5 78	2 80
91	4.57	0.7	0 0	0 0	0 0	4 4	66 70	6 76	4 80	0 80	0 80
92	1.96	1.4	12 12	30 42	27 69	8 77	3 80	0 80	0 80	0 80	0 80
93	2.72	1.9	3 3	22 25	22 47	18 65	8 73	2 75	3 78	2 80	0 80
94	8.30	0.9	0 0	0 0	0 0	0 0	0 0	0 0	4 4	18 22	58 80
95	6.20	1.8	1 1	1 2	8 10	2 12	7 19	16 35	27 62	16 78	2 80
96	1.65	1.6	21 21	31 52	14 66	10 76	3 79	1 80	0 80	0 80	0 80
97	3.62	2.1	0 0	5 5	19 24	27 51	10 61	12 73	5 78	1 79	1 80
98	5.80	1.3	0 0	2 2	2 4	3 7	9 16	30 46	31 77	3 80	0 80
99	2.67	1.2	1 1	13 14	40 54	16 70	9 79	1 80	0 80	0 80	0 80
100	6.17	1.1	0 0	0 0	1 1	2 3	2 5	27 32	42 74	4 78	2 80
101	6.67	1.4	0 0	0 0	0 0	2 2	5 7	15 22	31 53	22 75	5 80
102	2.52	1.0	2 2	18 20	40 60	12 72	7 79	1 80	0 80	0 80	0 80

TABLE 5--Continued

Statement No.	Scale Value	Q'- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
103	5.13	2.5	5 5	3 8	8 16	12 28	10 38	26 64	13 77	3 80	0 80
104	2.14	1.3	5 5	31 36	30 66	7 73	3 76	2 78	1 79	1 80	0 80
105	5.95	1.4	0 0	0 0	0 0	4 4	8 12	30 42	28 70	5 75	5 80
106	6.27	1.7	0 0	0 0	3 3	2 5	12 17	16 33	31 64	12 76	4 80
107	6.23	1.8	0 0	1 1	4 5	6 11	7 18	15 33	30 63	15 78	2 80
108	1.55	1.1	20 20	38 58	17 75	4 79	0 79	0 79	1 80	0 80	0 80
109	8.18	1.0	0 0	0 0	0 0	0 0	0 0	1 1	4 5	27 32	48 80
110	6.82	1.6	0 0	1 1	1 2	0 2	5 7	15 22	23 45	30 75	5 80
111	6.86	2.1	1 1	0 1	0 1	3 4	8 12	13 25	17 42	26 68	12 80
112	3.24	1.6	2 2	10 12	23 35	26 61	14 75	4 79	0 79	1 80	0 80
113	2.39	1.2	7 7	19 26	37 63	14 77	3 80	0 80	0 80	0 80	0 80
114	6.11	1.4	0 0	0 0	1 1	1 2	6 8	29 37	29 66	13 79	1 80
115	3.42	1.7	0 0	6 6	20 26	32 58	5 63	6 69	5 74	3 77	3 80
116	4.01	1.4	0 0	0 0	11 11	19 30	34 64	8 72	6 78	2 80	0 80

TABLE 5--Continued

Statement No.	Scale Value	Q- Value	Response Categories								
			A	B	C	D	E	F	G	H	I
117	7.67	1.5	0	0	0	0	0	3	19	28	30
			0	0	0	0	0	3	22	50	80
118	6.05	1.4	0	0	3	6	7	21	38	4	1
			0	0	3	9	16	37	75	79	80
119	3.01	1.5	0	12	28	26	8	5	1	0	0
			0	12	40	66	74	79	80	80	80
120	5.21	2.1	2	5	6	10	11	31	13	1	1
			2	7	13	23	34	65	78	79	80

<sup>a</sup> For each item, the first line is the frequency distribution, the second line is the cumulative frequency distribution.

## APPENDIX B

### THE PILOT STUDY

## THE THURSTONE SCALE DEVELOPED FOR THE PILOT STUDY

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### ATTITUDE TOWARD THE LABORATORY

This is an experimental study of the distribution of attitude toward your laboratory. You will be asked to read a list of statements about your laboratory and endorse those that express your own sentiment. Let your own experience with the laboratory determine your endorsements.

1. Name \* \_\_\_\_\_
2. High School Physics courses completed -
  - Physics 11 \_\_\_\_\_
  - Physics 12 \_\_\_\_\_
  - Physics 91 \_\_\_\_\_
  - Others (specify) \_\_\_\_\_
3. Indicate your future intentions with regard to physics.
  - a. To not continue in physics \_\_\_\_\_
  - b. To continue in physics: Honors \_\_\_\_\_  
 Major \_\_\_\_\_  
 Undecided \_\_\_\_\_
  - c. Undecided \_\_\_\_\_
4. Write an X somewhere on the line below to indicate where you think you belong.
 

Strongly favorable  
to the laboratory

Neutral

Strongly against  
the laboratory
5. In form A and B that follow circle the numbers of the statements that most closely express your sentiment towards the laboratory. Interpret the statements in accordance with your own experience.

\* (optional)

Form A

1. I have found no value in the laboratory.
2. I think our lab raises this course to a higher standard than it could achieve without it.
3. The laboratory's good and bad points balance each other.
4. Due to lack of laboratory time, I find I am seldom able to attempt an optional (C) experiment.
5. The laboratory to me is synonymous with frustration.
6. I feel we are presented with apparatus too far beyond our present level of understanding.
7. Some experiments are good, but in others I see no value.
8. I find that most experiments are too difficult for me.
9. I feel my lab instructor is incompetent.
10. I feel the need for a laboratory program, and am pleased with ours.
11. I learn much from the experiments, but I feel they do not help some people.
12. I have found this laboratory the most interesting aspect of any of my courses.
13. I think the laboratory is a hindrance to true physics because one still must "cook results".
14. I regard the laboratory as a futile, time-wasting activity, and as such it should be deleted from the course.
15. I think too much time is demanded by the laboratory for the benefit that is being derived.
16. With reasonable effect, I regard the ideas presented in the laboratory well within my reach.
17. I find the time allotted to prepare a write-up for handing in is ample.
18. I think our lab is a valuable educational experience, even though physics is not my major interest.



19. I believe it makes little difference whether or not lectures and laboratories are based on common ideas.
20. My experience is that the laboratory is a hopeless turmoil of confusion.

Form B

1. To me the laboratory is more or less boring.
2. Occasionally I feel I have truly benefitted from an experiment, but in most instances I doubt it.
3. Quite often I believe the laboratory is a fruitless chore.
4. I feel the laboratory is essential for learning physics.
5. I find that the instructor's time is in such demand that I cannot obtain adequate assistance.
6. This laboratory has killed any desire I might have had to take future physics laboratories.
7. Although I concede the laboratory may serve a useful purpose, I hate it.
8. I think the course would be improved if the laboratory were scrapped.
9. I have found the laboratory presents me with a reasonable challenge.
10. I believe that the instructions provided explain the experiments in sufficient detail.
11. I regard the laboratory as essential, but I am disappointed in ours.
12. The lab to me is primarily a waste of time.
13. I usually find it necessary to just fumble my way through experiments.
14. I find the experiments assume we know more than we actually do.
15. The laboratory certainly stimulates an interest in physics.
16. I find no particular like or dislike toward the laboratory.
17. I enjoy the experiments because they are fairly easy.

18. I find the laboratory does far more for projecting knowledge of physics than lectures.
19. I find working in the laboratory both inspiring and enjoyable.
20. I feel the experiments are justified in having us use formulae that we could not derive.

TABLE 6

THE SCORES OF THE PHYSICS 120 STUDENTS WHO PARTICIPATED IN  
THE PILOT STUDY, ACCOMPANIED BY THE STATISTICS REQUIRED IN  
THE CALCULATION OF A SPLIT-HALF CORRELATION COEFFICIENT  
USING THE GUTTMAN FORMULA

Student No.	Total Scale Score A + B	Form A Score A	Form B Score B	$(A + B)^2$	$A^2$	$B^2$
1	4.13	2.16	1.97	17.05	4.66	3.88
2	4.25	2.10	2.15	18.06	4.41	4.62
3	4.28	2.14	2.14	18.31	4.56	4.56
4	4.30	2.14	2.16	18.49	4.56	4.66
5	4.32	2.16	2.16	18.66	4.66	4.66
6	4.41	2.65	1.76	19.44	7.02	3.09
7	4.43	1.87	2.56	19.62	3.50	6.57
8	4.43	1.80	2.63	19.62	3.25	6.89
9	4.48	2.18	2.30	20.07	4.75	5.31
10	4.50	1.90	2.60	20.25	3.61	6.76
11	4.55	2.55	2.00	20.70	6.51	4.00
12	4.53	2.38	2.15	20.52	5.66	4.62
13	4.58	2.58	2.00	20.97	6.65	4.00
14	4.61	2.45	2.16	21.25	6.00	4.66
15	4.62	2.37	2.25	21.34	5.62	5.08
16	4.65	2.18	2.47	21.62	4.75	6.10
17	4.73	2.57	2.16	22.37	6.61	4.66
18	4.78	2.68	2.10	22.84	7.18	4.41
19	4.78	2.46	2.32	22.84	6.05	5.38
20	4.80	2.40	2.40	23.04	5.76	5.76
21	4.83	2.53	2.30	23.32	6.40	5.29
22	4.88	2.45	2.43	23.81	6.00	5.90
23	4.87	2.55	2.32	23.71	6.51	5.39
24	4.88	1.85	3.03	23.81	3.43	9.20
25	4.96	2.40	2.56	24.60	5.76	6.55
26	4.99	2.54	2.45	24.90	6.45	6.00
27	5.05	3.05	2.00	25.50	9.30	4.00
28	5.08	2.58	2.50	25.80	6.65	6.25
29	5.12	2.56	2.56	26.21	6.55	6.55
30	5.12	2.17	2.95	26.21	4.71	8.70
31	5.14	2.06	3.08	26.41	4.24	9.48
32	5.16	2.66	2.50	26.62	7.07	6.25
33	5.15	2.37	2.78	26.51	5.62	7.72
34	5.26	2.94	2.32	27.66	8.64	5.38
35	5.25	2.72	2.53	27.56	7.39	6.40

TABLE 6--Continued

Student No.	Total Scale Score A + B	Form A Score A	Form B Score B	(A + B) <sup>2</sup>	A <sup>2</sup>	B <sup>2</sup>
36	5.35	2.95	2.40	28.62	8.70	5.76
37	5.39	2.53	2.86	29.05	6.41	8.17
38	5.42	2.55	2.87	29.37	6.51	8.24
39	5.44	2.82	2.62	29.59	7.95	6.86
40	5.51	3.35	2.16	30.36	11.22	4.66
41	5.54	3.88	2.16	30.69	11.42	4.66
42	5.54	3.08	2.46	30.69	9.48	6.05
43	5.53	2.43	3.10	30.58	5.91	9.61
44	5.55	2.95	2.60	30.80	8.70	6.76
45	5.57	3.27	2.30	31.02	10.69	5.29
46	5.61	3.05	2.56	31.47	9.30	6.55
47	5.71	2.95	2.76	32.60	8.70	7.61
48	5.70	2.74	2.96	32.49	7.50	8.76
49	5.73	2.95	2.78	32.83	8.70	7.72
50	5.88	2.85	3.03	34.57	8.12	9.18
51	5.90	3.30	2.60	34.81	10.89	6.76
52	5.99	3.33	2.66	35.88	11.08	7.07
53	6.00	2.86	3.14	36.00	8.18	9.85
54	6.03	3.10	2.93	36.36	9.61	8.58
55	6.10	3.22	2.88	37.21	10.36	8.29
56	6.18	2.82	3.36	38.19	7.95	11.28
57	6.20	3.45	2.75	38.44	11.90	7.56
58	6.20	3.00	3.20	38.44	9.00	10.24
59	6.22	3.10	3.12	38.68	9.61	9.73
60	6.21	2.96	3.25	38.56	8.76	10.56
61	6.23	3.45	2.78	38.81	11.90	7.72
62	6.30	2.70	3.60	39.69	7.29	12.96
63	6.30	2.90	3.40	39.69	8.41	11.56
64	6.33	2.83	3.50	40.06	8.00	12.25
65	6.37	2.97	3.40	40.57	8.82	11.56
66	6.38	2.88	3.50	40.70	8.29	12.25
67	6.41	2.95	3.46	41.08	8.70	11.97
68	6.45	3.44	3.01	41.60	11.83	9.06
69	6.48	3.68	2.80	41.99	13.54	7.84
70	6.54	3.43	3.11	42.77	11.76	9.67
71	6.55	3.20	3.35	42.90	10.24	11.22
72	6.61	2.75	3.86	43.69	7.56	14.89
73	6.63	3.40	3.23	43.95	11.56	10.43
74	6.63	3.33	3.30	43.95	11.08	10.89
75	6.73	2.73	4.00	45.29	7.45	16.00
76	6.75	3.77	2.98	45.56	14.21	8.88

TABLE 6--Continued

Student No.	Total Scale Score A + B	Form A Score A	Form B Score B	(A + B) <sup>2</sup>	A <sup>2</sup>	B <sup>2</sup>
77	6.75	2.75	4.00	45.56	7.56	16.00
78	6.82	4.02	2.80	46.51	16.16	7.84
79	6.82	3.30	3.52	46.51	10.89	12.39
80	6.87	3.47	3.40	47.19	12.04	11.56
81	6.95	3.33	3.62	48.30	11.08	13.10
82	6.97	3.20	3.77	48.58	10.24	14.21
83	7.04	3.84	3.20	49.56	14.74	10.24
84	7.03	3.27	3.76	49.42	10.96	14.13
85	7.08	3.85	3.23	50.12	14.82	10.43
86	7.08	3.38	3.70	50.12	11.42	13.69
87	7.09	3.21	3.88	50.26	10.30	15.05
88	7.16	4.23	2.93	51.26	17.89	8.58
89	7.18	3.00	4.18	51.55	9.00	17.47
90	7.21	3.85	3.36	51.98	14.82	11.28
91	7.22	3.46	3.76	52.12	11.97	14.13
92	7.24	3.44	3.80	52.41	11.83	14.44
93	7.25	3.70	3.55	52.56	13.69	12.60
94	7.26	3.55	3.71	52.70	12.60	13.76
95	7.31	3.60	3.71	53.43	12.96	13.76
96	7.32	3.10	4.22	53.58	9.61	17.80
97	7.37	4.14	3.23	54.31	17.13	10.43
98	7.38	3.52	3.86	54.46	12.39	14.89
99	7.46	3.80	3.66	55.65	14.44	13.39
100	7.49	3.93	3.56	56.10	15.44	12.67
101	7.49	3.47	4.02	56.10	12.04	16.16
102	7.49	3.41	4.08	56.10	11.62	16.64
103	7.63	4.33	3.30	58.21	18.74	10.89
104	7.60	4.00	3.60	57.76	16.00	12.96
105	7.61	3.94	3.67	57.91	15.52	13.46
106	7.65	3.63	4.02	58.52	13.17	16.16
107	7.72	3.80	3.92	59.59	14.44	15.36
108	7.72	3.76	3.96	59.59	14.13	15.68
109	7.98	3.52	4.46	63.68	12.39	19.89
110	7.97	3.86	4.11	63.52	14.89	16.89
111	7.98	3.98	4.00	63.68	15.84	16.00
112	7.98	3.54	4.44	63.68	12.53	19.71
113	8.04	4.30	3.74	64.64	18.49	13.98
114	8.09	3.92	4.17	65.44	15.36	17.38
115	8.12	3.47	4.65	65.93	12.04	21.62
116	8.21	3.36	4.85	67.40	11.28	23.52
117	8.42	3.60	4.82	70.89	12.96	23.23

TABLE 6--Continued

Student No.	Total Scale Score A + B	Form A Score A	Form B Score B	$(A + B)^2$	$A^2$	$B^2$
118	8.43	4.57	3.86	71.06	20.88	14.89
119	8.44	4.36	4.08	71.23	19.00	16.64
120	8.47	3.90	4.57	71.74	15.21	20.88
121	8.50	4.00	4.50	72.25	16.00	20.25
122	8.51	4.35	4.16	72.42	18.92	17.30
123	8.55	4.20	4.35	73.10	17.64	18.92
124	8.57	4.27	4.30	73.44	18.23	18.49
125	8.60	4.00	4.60	73.96	16.00	21.16
126	8.63	3.97	4.64	74.47	15.76	21.25
127	8.69	4.66	4.03	75.51	21.71	16.24
128	8.72	4.12	4.60	76.03	16.97	21.16
129	8.71	4.20	4.51	75.86	17.64	20.34
130	8.75	4.40	4.35	76.56	19.36	18.92
131	8.90	4.20	4.70	79.21	17.64	22.09
132	8.96	4.15	4.81	80.28	17.22	23.13
133	9.00	4.05	4.95	81.00	16.40	24.50
134	9.03	4.46	4.57	81.54	19.89	20.88
135	9.10	4.80	4.30	82.81	23.04	18.49
136	9.16	4.60	4.56	83.90	21.16	20.79
137	9.18	4.38	4.80	84.27	19.18	23.04
138	9.19	3.93	5.26	84.45	15.44	27.66
139	9.27	4.20	5.07	85.93	17.64	25.70
140	9.38	4.58	4.80	87.98	20.97	23.04
141	9.40	4.10	5.30	88.36	16.81	28.09
142	9.42	5.52	3.90	88.73	30.47	15.21
143	9.45	4.85	4.60	89.30	23.52	21.16
144	9.48	5.04	4.44	89.87	25.40	19.71
145	9.62	4.82	4.80	92.54	23.23	23.04
146	9.63	4.73	4.90	92.73	22.37	24.01
147	9.92	4.41	5.51	98.40	19.44	30.30
148	10.05	4.70	5.35	101.00	22.09	28.62
149	10.09	5.17	4.92	101.80	26.72	24.20
150	10.18	4.23	5.95	103.63	17.89	35.40
151	10.20	5.02	5.18	104.04	25.20	26.83
152	10.28	4.90	5.38	105.67	24.01	28.94
153	10.37	5.01	5.36	107.53	25.10	28.72
154	10.37	4.65	5.72	107.53	21.62	32.71
155	10.40	5.80	4.60	108.16	33.64	21.16
156	10.58	4.68	5.90	111.93	21.90	34.81
157	10.66	4.83	5.83	113.63	23.32	33.98
158	10.88	5.40	5.48	118.37	29.16	30.03

TABLE 6--Continued

Student No.	Total Scale Score A + B	Form A Score A	Form B Score B	(A + B) <sup>2</sup>	A <sup>2</sup>	B <sup>2</sup>
159	10.88	5.33	5.55	118.37	28.40	30.80
160	10.89	5.62	5.62	118.59	31.58	27.77
161	10.95	5.50	5.45	119.90	30.25	29.70
162	10.97	4.82	6.15	120.34	23.23	37.82
163	11.10	5.80	5.30	123.21	33.64	28.09
164	11.09	5.08	6.01	122.98	25.80	36.12
165	11.16	4.93	6.23	124.54	24.30	38.81
166	11.25	5.25	5.90	126.56	28.62	34.81
167	11.30	5.30	6.00	127.69	28.09	36.00
168	11.37	6.12	5.25	129.27	37.45	25.56
169	11.44	5.81	5.63	130.87	33.75	31.69
170	11.49	5.67	5.82	132.02	32.14	33.87
171	11.80	6.08	5.72	139.24	36.96	32.71
172	11.88	5.96	5.92	141.13	35.52	35.04
173	12.04	5.56	6.48	144.93	30.91	41.99
174	12.12	5.80	6.32	146.89	33.64	39.94
175	12.32	6.10	6.22	151.78	37.21	38.68
176	12.59	6.07	6.52	158.50	36.84	42.51
177	12.83	6.60	6.23	164.60	43.56	38.81
178	14.00	6.55	7.45	196.00	42.90	55.50
179	14.22	7.02	7.20	202.20	49.28	51.84
180	15.80	7.80	8.00	249.64	60.84	64.00
Totals	1367.10	673.68	693.24	11360.72	2741.90	2971.78



Fig. 4.--Calculation of the Reliability Coefficient

Variance of scores on Form A

$$\sigma_A^2 = \frac{\sum A^2 - \frac{(\sum A)^2}{N}}{N} = 1.22$$

Variance of scores on Form B

$$\sigma_B^2 = \frac{\sum B^2 - \frac{(\sum B)^2}{N}}{N} = 1.67$$

Variance of the total scores

$$\sigma_{A+B}^2 = \frac{\sum (A+B)^2 - \frac{(\sum A+B)^2}{N}}{N} = 5.32$$

The Guttman correlation coefficient for the scale is

$$r_{(A+B)(A+B)} = 2 \left( 1 - \frac{\sigma_A^2 + \sigma_B^2}{\sigma_{A+B}^2} \right)$$

$$= .912$$

## APPENDIX C

### ANALYSIS OF STATEMENTS FOR THEIR DISCRIMINATING POWER

THE LIKERT SCALE DEVELOPED TO DETERMINE THE DISCRIMINATING  
POWER OF THOSE 68 OF THE ORIGINAL 120 STATEMENTS WITH  
LOWEST Q VALUE

ATTITUDE TOWARD THE LABORATORY

This is an experimental study of the distribution of attitude toward your laboratory. You are asked to read each statement in the following list, and place an X in one of the six response categories provided for each statement. Your choice of category for a statement is to be based on the degree of agreement or disagreement you find with the statement. The six categories are clearly labelled.

Name: \*

	Strongly Agree	Agree	Mildly Agree	Mildly Disagree	Disagree	Strongly Disagree		Strongly Agree	Agree	Mildly Agree	Mildly Disagree	Disagree	Strongly Disagree		Strongly Agree	Agree	Mildly Agree	Mildly Disagree	Disagree	Strongly Disagree
1.							24.							47.						
2.							25.							48.						
3.							26.							49.						
4.							27.							50.						
5.							28.							51.						
6.							29.							52.						
7.							30.							53.						
8.							31.							54.						
9.							32.							55.						
10.							33.							56.						
11.							34.							57.						
12.							35.							58.						
13.							36.							59.						
14.							37.							60.						
15.							38.							61.						
16.							39.							62.						
17.							40.							63.						
18.							41.							64.						
19.							42.							65.						
20.							43.							66.						
21.							44.							67.						
22.							45.							68.						
23.							46.													

\* optional

1. I have found no value in the laboratory.
2. In most instances I feel the labs aid me in my understanding of physics.
3. I do not regard our laboratory as essential to obtaining a true understanding of physics.
4. I feel my instructor is incapable of giving assistance when required.
5. To me the laboratory is more or less boring.
6. I think our lab raises this course to a higher standard than it could achieve without it.
7. I hate the laboratory.
8. The laboratory's good and bad points balance each other.
9. Occasionally I feel I have truly benefitted from an experiment, but in most instances I doubt it.
10. I find our laboratory most efficient in developing an understanding of physics.
11. I believe the laboratory has value in that it stimulates my interest in physics.
12. Quite often I believe the laboratory is a fruitless chore.
13. The laboratory to me is synonymous with frustration.
14. The laboratory succeeds in providing an understanding of the application of modern instruments.
15. I feel the laboratory is essential for learning physics.
16. I find that the instructor's time is in such demand that I cannot obtain adequate assistance.
17. This laboratory has killed any desire I might have had to take future physics laboratories.
18. I find the experiments an organized situation in which I can learn on my own.

19. The laboratory outline seems to explain any ideas previously foreign to me.
20. I feel much time is wasted because the instructors do not provide enough aid.
21. Due to lack of laboratory time, I find I am seldom able to attempt an optional (C) experiment.
22. Many calculations have little significance to me since I do not understand the basis upon which the formulae were derived.
23. I regard the laboratory as an extremely beneficial activity.
24. I like the laboratory because it offers opportunity for individual initiative.
25. Although I concede the laboratory may serve a useful purpose, I hate it.
26. The awarding of extra marks for optional (C) sections is unfair.
27. I find it a pleasure to work with such fine equipment.
28. I think the course would be improved if the laboratory were scrapped.
29. I feel we are presented with apparatus too far beyond our present level of understanding.
30. Some experiments are good, but in others I see no value.
31. I find that most experiments are too difficult for me.
32. I have found the laboratory presents me with a reasonable challenge.
33. I feel my lab instructor is incompetent.
34. I believe that the instructions provided explain the experiments in sufficient detail.
35. Our laboratory fails in that it does not relate to lecture material.

36. I regard the laboratory as essential, but I am disappointed in ours.
37. My laboratory instructor appears able to give good explanations when I require them.
38. I feel the need for a laboratory program, and am pleased with ours.
39. I learn much from the experiments, but I feel they do not help some people.
40. The lab to me is primarily a waste of time.
41. The experiments in general are quite easy.
42. I like our laboratory because the experiments demand we think, rather than providing us with a step by step procedure.
43. I have found this laboratory the most interesting aspect of any of my courses.
44. I usually find it necessary to just fumble my way through experiments.
45. I find the experiments assume we know more than we actually do.
46. The laboratory certainly stimulates an interest in physics.
47. I think the laboratory is a hindrance to true physics because one still must "cook results".
48. Through lack of guidance I find most things I do are by trial and error.
49. I find no particular like or dislike toward the laboratory.
50. I actually believe the experiments have taught me some basic ideas of physics far better than books could.
51. I regard the laboratory as a futile, time-wasting activity, and as such it should be deleted from the course.

52. I enjoy the experiments because they are fairly easy.
53. I feel our experiments attempt to cover too many ideas in too short a time.
54. I like the stress our experiments place on the importance of errors.
55. I think too much time is demanded by the laboratory for the benefit that is being derived.
56. I can seldom get any aid from the laboratory instructor.
57. With reasonable effort, I regard the ideas presented in the laboratory well within my reach.
58. I find the laboratory does far more for projecting knowledge of physics than lectures.
59. I find I can seldom obtain outside references.
60. I find working in the laboratory both inspiring and enjoyable.
61. This laboratory has killed my interest in physics.
62. I find the time allotted to prepare a write-up for handing in is ample.
63. I think our lab is a valuable educational experience, even though physics is not my major interest.
64. I find the instructions in the laboratory manual confusing.
65. I feel the experiments are justified in having us use formulae that we could not derive.
66. I believe it makes little difference whether or not lectures and laboratories are based on common ideas.
67. My experience is that the laboratory is a hopeless turmoil of confusion.
68. I believe some experiments attempt to cover a topic too deeply at this level.

TABLE 7

THE FREQUENCY DISTRIBUTION OF RESPONSE TO EACH OF THE 68 STATEMENTS ON THE LIKERT SCALE BY THE LOW SCORING AND HIGH SCORING GROUPS OF STUDENTS<sup>a</sup>

No.	L.G. <sup>b</sup>	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.
1.	0	4	2.	2	3	3.	0	7	4.	1	6
	0	15		0	24		2	22		1	8
	0	20		1	15		2	19		5	4
	3	15 <sup>c</sup>		15	19		12	10		5	15
	40	17		44	14		33	12		28	29
	30	4		10	0		26	4		34	13
5.	1	5	6.	2	12	7.	0	11	8.	5	11
	3	22		3	26		1	13		22	20
	2	18		4	21		2	21		0	30
	8	11		18	15		3	12		12	11
	34	14		35	9		23	16		28	3
	26	5		11	1		45	2		4	0
9.	3	14	10.	3	14	11.	1	13	12.	0	9
	6	40		3	34		2	31		3	38
	10	13		18	15		5	11		3	11
	13	4		25	12		15	15		13	11
	36	3		22	0		38	4		39	5
	6	0		4	0		14	0		16	1
13.	1	12	14.	2	6	15.	0	10	16.	1	5
	3	20		3	22		3	18		4	10
	7	20		4	10		7	14		6	19
	10	12		19	21		17	12		6	8
	37	9		37	14		29	12		42	25
	15	1		9	2		18	8		16	8
17.	2	6	18.	4	14	19.	0	11	20.	0	5
	1	8		9	22		4	24		0	9
	4	16		8	25		7	16		6	21
	3	19		14	12		38	12		11	13
	39	19		34	1		24	11		44	25
	25	5		5	1		2	1		12	2
21.	21	34	22.	2	19	23.	0	16	24.	2	11
	18	15		6	29		2	31		3	26
	15	17		16	18		4	10		7	22
	5	5		12	6		25	13		25	12
	9	3		30	5		31	2		31	4
	4	1		8	0		12	2		6	0



TABLE 7--Continued

No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.
25.	0	7	26.	5	14	27.	2	11	28.	0	5
	0	13		9	16		5	20		0	9
	2	27		9	15		14	12		3	15
	9	13		10	9		24	20		3	27
	35	13		16	11		22	10		28	14
	26	1		9	2		5	0		41	5
29.	0	0	30.	4	13	31.	0	1	32.	0	7
	1	9		16	36		1	5		1	11
	5	16		19	18		1	21		1	9
	5	18		8	3		10	25		18	27
	41	17		25	4		41	15		41	20
	23	14		0	1		20	7		11	0
33.	0	6	34.	0	17	35.	1	22	36.	1	20
	1	3		6	14		4	23		2	12
	4	9		12	15		21	13		5	21
	4	18		19	16		19	9		16	13
	33	27		27	12		21	5		42	8
	33	10		7	1		9	3		7	0
37.	0	2	38.	0	13	39.	1	6	40.	2	14
	2	11		2	27		4	23		0	13
	2	9		4	20		6	28		0	26
	13	14		22	13		33	12		5	14
	40	29		38	2		24	5		38	6
	17	10		6	0		5	0		30	1
41.	2	8	42.	4	15	43.	7	37	44.	0	8
	11	19		4	14		13	26		4	25
	20	20		14	27		19	7		3	20
	19	11		20	15		18	5		16	12
	16	12		27	1		15	0		37	9
	4	4		4	0		2	0		12	1
45.	0	6	46.	1	14	47.	0	10	48.	0	2
	9	30		3	24		4	12		3	13
	18	25		8	19		9	26		6	24
	17	7		29	13		9	15		12	16
	28	6		30	5		38	12		45	19
	3	0		4	0		13	0		9	21

TABLE 7--Continued

No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.
49.	7	11	50.	0	12	51.	1	6	52.	3	13
	34	26		4	27		1	6		18	33
	17	16		6	18		2	20		17	21
	8	16		24	15		3	24		22	5
	8	4		26	3		20	17		10	2
	1	2		12	0		43	2		1	1
53.	1	11	54.	4	11	55.	1	20	56.	0	5
	2	15		12	27		3	19		0	4
	19	16		16	13		5	18		3	7
	13	16		19	16		12	7		2	20
	25	11		15	7		41	4		35	28
	6	2		5	1		7	1		32	11
57.	0	0	58.	1	13	59.	0	7	60.	1	18
	3	10		12	31		8	11		2	32
	3	13		17	18		12	19		12	15
	10	34		24	7		18	15		25	6
	44	18		13	2		27	17		29	1
	13	0		5	4		4	5		4	1
61.	0	7	62.	7	31	63.	1	12	64.	0	10
	0	8		22	18		7	18		1	17
	4	20		17	8		9	14		13	18
	3	20		7	10		11	21		14	20
	35	15		18	7		35	9		37	7
	30	5		2	1		9	1		7	2
65.	2	29	66.	16	29	67.	0	5	68.	3	5
	4	19		29	19		2	11		0	19
	14	19		14	19		1	29		13	21
	24	4		5	4		2	20		12	11
	31	3		8	3		39	8		37	15
	0	1		3	0		30	2		10	4

<sup>a</sup> The responses for each statement are quoted such that the first number in the column corresponds to the response weight 5, and the last number corresponds to the response weight 0. In terms of response categories, responses are listed in the order "strongly disagree" through "strongly agree" for items whose Thurstone scale values are 0 to 5.00, and "strongly agree" through "strongly disagree" for items with scale values 5.00 to 9.

TABLE 7--Continued

- b "L.G." is the low group of students on the total score, and "H.G." is the high group of students. These groups were defined respectively by taking the bottom and top 27% of the scores.
- c The lines drawn between two response categories for a given item dichotomize the response categories by minimizing the sum of the number of subjects in the low group above the line and the number of subjects in the high group below the line.

TABLE 8

DICHOTOMIZED RESPONSE DISTRIBUTION OF THE HIGH SCORING AND LOW SCORING GROUPS ON THE LIKERT SCALE<sup>a</sup>

No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.H.	H.G.
1.	3 70	54 21	2.	18 54	61 14	3.	4 71	48 26	4.	40 34	62 13
5.	14 60	56 19	6.	9 64	50 25	7.	6 68	57 18	8.	27 44	61 14
9.	19 55	67 7	10.	6 69	48 27	11.	8 66	55 19	12.	6 68	58 17
13.	21 52	64 10	14.	28 46	59 16	15.	10 64	42 32	16.	17 58	42 33
17.	10 64	49 33	18.	21 64	61 24	19.	11 53	51 14	20.	17 64	48 24
21.	21 51	34 41	22.	24 50	66 11	23.	6 68	57 17	24.	12 62	59 16
25.	11 61	60 14	26.	23 35	45 22	27.	7 65	33 42	28.	6 69	56 19
29.	11 64	43 31	30.	20 52	49 26	31.	12 61	52 22	32.	20 52	54 20
33.	9 66	36 37	34.	18 53	46 29	35.	5 70	45 30	36.	8 65	53 21
37.	17 57	36 39	38.	6 66	60 15	39.	11 62	57 17	40.	7 68	67 7
41.	13 59	27 49	42.	22 51	58 16	43.	20 54	63 12	44.	7 65	53 22
45.	27 48	61 13	46.	12 63	57 18	47.	22 51	63 12	48.	21 54	55 20
49.	7 68	11 64	50.	12 63	57 18	51.	7 63	56 19	52.	38 33	67 8

TABLE 8--Continued

No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.	No.	L.G.	H.G.
53.	35	58	54.	16	38	55.	9	57	56.	5	36
	31	13		55	37		60	12		67	39
57.	16	57	58.	30	62	59.	20	37	60.	15	65
	57	18		42	13		49	37		58	8
61.	7	55	62.	7	31	63.	28	65	64.	28	65
	65	20		66	44		43	10		44	9
65.	20	67	66.	16	29	67.	5	65	68.	28	56
	55	8		59	45		69	10		47	19

<sup>a</sup> These dichotomized scores were obtained by grouping the responses above and below the line in the response distributions in Table 6. Consequently, for an arbitrary statement whose response categories are of the form

$$\begin{array}{cc} a & b \\ c & d \end{array} \quad \text{then,}$$

$$r_{\phi} = \frac{cb - ad}{\sqrt{(a + b)(b + d)(a + c)(c + d)}}$$

where  $r_{\phi}$  is the phi coefficient.

TABLE 9

PHI COEFFICIENTS FOR THE 68 STATEMENTS ON THE LIKERT SCALE

No.	$r_{\phi}$	No.	$r_{\phi}$	No.	$r_{\phi}$	No.	$r_{\phi}$
1.	.70	18.	.54	35.	.57	52.	.39
2.	.57	19.	.53	36.	.62	53.	.31
3.	.62	20.	.41	37.	.26	54.	.29
4.	.31	21.	.18	38.	.72	55.	.70
5.	.60	22.	.58	39.	.62	56.	.46
6.	.56	23.	.70	40.	.81	57.	.54
7.	.69	24.	.63	41.	.20	58.	.42
8.	.47	25.	.77	42.	.41	59.	.21
9.	.66	26.	.30	43.	.59	60.	.69
10.	.33	27.	.38	44.	.63	61.	.65
11.	.64	28.	.68	45.	.47	62.	.36
12.	.70	29.	.45	46.	.60	63.	.49
13.	.58	30.	.33	47.	.54	64.	.51
14.	.41	31.	.55	48.	.45	65.	.61
15.	.45	32.	.45	49.	.08	66.	.20
16.	.33	33.	.41	50.	.62	67.	.84
17.	.55	34.	.40	51.	.65	68.	.39

APPENDIX D

THE STATEMENTS JUDGED FOR THEIR  
VALIDITY

THE 35 STATEMENTS SELECTED ON THE BASIS OF HIGH PHI COEFFICIENT  
AS PRESENTED TO FOUR FACULTY MEMBERS TO BE JUDGED FOR THEIR  
VALIDITY AS POSSIBLE CANDIDATES FOR THE FINAL SCALE

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These statements have been chosen from the original 120 in the light of the objectives of the study, as the most desirable possibilities for the final draft of the scale. From these, 25 to 30 must be selected. Numbers 28 - 35 have a low  $r_{\phi}$  value (to be expected since many have a central scale-value), but are included because they relate to important aspects of the laboratory.

	Q Value	Scale Value	$r_{\phi}$	
1.	0.70	6.11	.51	I find the instructions in the laboratory manual confusing.
2.	0.55	1.55	.69	I find working in the laboratory both inspiring and enjoyable.
3.	0.55	1.27	.70	I regard the laboratory as an extremely beneficial activity.
4.	0.40	8.32	.69	I hate the laboratory.
5.	0.60	1.19	.59	I have found this laboratory the most interesting aspect of any of my courses.
6.	0.60	1.65	.63	I like the laboratory because it offers opportunity for individual initiative.
7.	0.60	2.13	.57	In most instances I feel the labs aid me in my understanding of physics.
8.	0.70	6.19	.57	Our laboratory fails in that it does not relate to lecture material.
9.	0.55	7.54	.81	The lab to me is primarily a waste of time.
10.	0.70	2.17	.54	I find the experiments an organized situation in which I can learn on my own.
11.	0.60	7.34	.58	The laboratory to me is synonymous with frustration.



	Q Value	Scale Value	$r_{\phi}$	
12.	0.75	6.14	.55	I find that most experiments are too difficult for me.
13.	0.70	6.54	.63	I usually find it necessary to just fumble my way through experiments.
14.	0.70	1.96	.62	I actually believe the experiments have taught me some basic ideas of physics far better than books could.
15.	0.70	6.82	.54	I think the laboratory is a hindrance to true physics because one still must "cook results".
16.	0.50	8.18	.65	This laboratory has killed my interest in physics.
17.	0.50	2.52	.54	With reasonable effort, I regard the ideas presented in the laboratory well with my reach.
18.	0.75	7.09	.70	Quite often I believe the laboratory is a fruitless chore.
19.	0.85	7.04	.60	To me the laboratory is more or less boring.
20.	0.55	6.17	.70	I think too much time is demanded by the laboratory for the benefit that is being derived.
21.	1.20	5.32	.66	Occasionally I feel I have truly benefitted from an experiment, but in most instances I doubt it.
22.	0.85	3.24	.61	I feel the experiments are justified in having us use formulae that we could not derive.
23.	0.65	2.00	.64	I believe the laboratory has value in that it stimulates my interest in physics.
24.	0.55	7.78	.70	I have found no value in the laboratory.
25.	0.75	7.67	.84	My experience is that the laboratory is a hopeless turmoil of confusion.

	Q Value	Scale Value	$r_{\phi}$	
26.	0.65	1.83	.72	I feel the need for a laboratory program, and am pleased with ours.
27.	0.65	2.42	.53	The laboratory outline seems to explain any ideas previously foreign to me.
28.	0.60	2.39	.49	I think our lab is a valuable educational experience even though physics is not my major interest.
29.	0.65	1.81	.49	I like our laboratory because the experiments demand we think, rather than providing us with a step by step procedure.
30.	0.75	5.93	.47	I find the experiments assume we know more than we actually do.
31.	0.45	4.47	.47	The laboratory's good and bad points balance each other.
32.	0.60	6.75	.45	I feel we are presented with apparatus too far beyond our present level of understanding.
33.	0.65	1.70	.45	I feel the laboratory is essential for learning physics.
34.	0.80	3.24	.36	I find the time allotted to prepare a write-up for handing in is ample.
35.	0.35	4.57	.08	I find no particular like or dislike toward the laboratory.

## APPENDIX E

### THE FINAL ATTITUDE SCALE

ATTITUDE TOWARD THE PHYSICS LABORATORY

This scale represents a controlled study to determine the success of the laboratory program as the student sees it. The statements on the scale represent opinions put forth by previous physics students.

You are presented with 5 response categories for each statement: (1) strongly agree, (2) agree, (3) neutral (4) disagree, and (5) strongly disagree. The numbers (1) to (5) correspond to the numbers of the columns found on the accompanying answer sheet. Choose the response category which best expresses your degree of agreement or disagreement with each statement.

Your responses to the statements will undergo a programmed statistical analysis, and the results will be used to aid in redesigning the present laboratory.

NOTE: Statistical analysis by computer requires that every statement be responded to.

1. In most instances I feel the labs aid me in my understanding of physics.
2. I find that most experiments are too difficult.
3. The lab to me is primarily a waste of time.
4. I regard the laboratory as an extremely beneficial activity.
5. I find the instructions in the laboratory manual confusing.
6. I usually find it necessary to just fumble my way through experiments.
7. I feel the laboratory is essential for learning physics.
8. This laboratory has killed my interest in physics.
9. I think too much time is demanded by the laboratory for the benefit that is being derived.
10. I find the experiments assume we know more than we actually do.

11. I like the laboratory because it offers opportunity for individual initiative.
12. The laboratory outline seems to explain ideas previously foreign to me.
13. The laboratory's good and bad points balance each other.
14. I feel the need for a laboratory program, and am pleased with ours.
15. I hate the laboratory.
16. I have found no value in the laboratory.
17. The laboratory to me is synonymous with frustration.
18. I have found this laboratory the most interesting aspect of any of my courses.
19. I find the time allotted to prepare a write-up for handing in is ample.
20. I actually believe the experiments have taught me some basic ideas of physics far better than books could.
21. I feel we are presented with apparatus too far beyond our present level of understanding.
22. I like our laboratory because the experiments demand we think, rather than providing us with a step by step procedure.
23. I believe the laboratory has value in that it stimulates my interest in physics.
24. My experience is that the laboratory is a hopeless turmoil of confusion.
25. With reasonable effort, I regard the ideas presented in the laboratory well within my reach.
26. To me the laboratory is more or less boring.

TABLE 10

THE SCALE-VALUES, Q-VALUES, AND PHI COEFFICIENTS OF THE 26  
STATEMENTS ON THE FINAL ATTITUDE SCALE

No.	Scale- Value	Q- Value	$r_{\phi}$	No.	Scale- Value	Q- Value	$r_{\phi}$
1.	2.13	.60	.57	2.	6.14	.75	.55
3.	7.54	.55	.81	4.	1.27	.55	.70
5.	6.11	.70	.51	6.	6.54	.70	.63
7.	1.70	.65	.45	8.	8.18	.50	.65
9.	6.17	.55	.70	10.	5.93	.75	.47
11.	1.65	.60	.63	12.	2.42	.65	.53
13.	4.47	.45	.47	14.	1.83	.65	.72
15.	8.32	.40	.69	16.	7.78	.55	.70
17.	7.34	.60	.58	18.	1.19	.60	.59
19.	3.24	.80	.36	20.	1.96	.70	.62
21.	6.75	.60	.45	22.	1.81	.65	.49
23.	2.00	.65	.64	24.	7.67	.75	.84
25.	2.52	.50	.54	26.	7.04	.85	.60

APPENDIX F

DATA REQUIRED FOR THE RELIABILITY STUDY  
ON THE FINAL ATTITUDE SCALE

TABLE 11

THE ATTITUDE SCORES OF THE EXPERIMENTAL GROUP IN DECEMBER  
THAT WERE REQUIRED IN THE CALCULATION OF GUTTMAN'S INTERNAL  
CONSISTENCY RELIABILITY COEFFICIENT

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total <sup>a</sup>	Odd	Even	Total
0071670	2.154	3.077	3.115	13.046	12.454	12.750
0081662	3.846	4.231	4.038	18.192	19.317	18.755
0081671	2.077	2.154	2.115	9.036	9.742	9.389
0119671	4.385	3.846	4.115	20.686	16.687	18.687
0324673	2.154	2.462	2.308	8.962	9.093	9.028
0396670	2.692	2.538	2.615	11.106	9.371	10.238
0405671	2.769	2.385	2.577	11.817	9.948	10.882
0409670	1.769	2.692	2.231	7.357	10.678	9.017
0416672	3.462	3.615	3.538	15.643	16.195	15.919
0432671	2.923	2.923	2.923	12.844	12.656	12.750
0566672	2.538	2.615	2.577	10.465	10.766	10.615
0763672	4.462	4.308	4.385	20.108	19.068	19.588
0765670	1.692	1.769	1.731	6.710	6.918	6.814
0768672	2.538	2.615	2.577	12.167	11.019	11.593
0794671	2.692	2.846	2.769	11.968	11.882	11.925
0795672	2.077	2.462	2.269	9.658	10.535	10.097
0819673	2.462	2.769	2.615	10.715	11.067	10.891
0834678	3.615	4.000	3.808	16.503	17.032	16.767
0843674	4.077	3.846	3.962	19.419	18.186	18.803
0871671	2.692	3.154	2.923	12.407	14.492	13.449
0880671	3.385	3.538	3.462	14.759	14.798	14.778
0913671	2.538	2.538	2.538	10.962	10.119	10.540
0918674	2.923	3.308	3.115	12.906	14.907	13.907
0920671	2.615	2.769	2.692	11.157	11.441	11.299
0921672	2.538	2.923	2.731	12.292	13.842	13.067
0944671	2.846	2.615	2.731	12.692	9.115	10.904
0974672	3.231	3.231	3.231	14.278	13.874	14.076
0988673	2.692	3.308	3.000	12.727	13.488	13.107
0995671	2.615	2.692	2.654	11.565	10.962	11.264
1001676	3.308	2.846	3.077	15.205	12.552	13.879
1030672	3.538	3.692	3.615	15.352	15.554	15.453
1043673	2.385	2.308	2.346	10.445	9.268	9.857
1047671	2.923	2.846	2.885	13.498	12.992	13.245
1058673	2.154	2.385	2.269	9.582	9.948	9.765
1074670	1.923	2.000	1.962	8.549	7.798	8.174
1075672	1.923	1.846	1.885	8.197	7.296	7.747
1081672	3.385	3.462	3.423	16.166	15.319	15.743



TABLE 11--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
1103674	2.846	3.308	3.077	11.734	13.830	12.782
1112673	2.154	2.462	2.308	9.239	10.362	9.801
1147673	2.308	2.385	2.346	9.698	9.178	9.438
1149671	1.846	1.769	1.808	8.737	7.973	8.355
1164671	2.769	2.769	2.769	12.632	11.213	11.923
1171672	2.692	2.769	2.731	12.465	10.969	11.717
1253672	4.077	3.923	4.000	18.895	18.486	18.690
1302662	2.385	2.231	2.308	10.562	10.015	10.288
1322670	2.154	2.385	2.269	7.866	8.956	8.411
1358672	3.000	3.000	3.000	12.670	12.345	12.507
1358675	2.308	2.615	2.462	10.287	10.812	10.549
1373671	2.308	2.385	2.346	10.621	10.830	10.725
1389671	2.385	2.692	2.538	11.607	10.652	11.130
1397678	2.846	2.846	2.846	12.166	12.528	12.347
1405670	2.385	2.231	2.308	10.625	10.351	10.488
1424672	2.154	1.923	2.038	9.766	8.411	9.088
1465673	2.385	2.538	2.462	10.072	10.418	10.245
1466674	3.077	2.615	2.846	13.421	9.730	11.575
1492671	2.769	2.923	2.846	13.399	13.372	13.386
1492673	2.154	2.231	2.192	9.602	9.345	9.473
1537673	1.846	1.692	1.769	7.926	5.915	6.920
1558673	2.538	2.385	2.462	11.421	9.194	10.307
1567672	2.000	1.692	1.846	8.765	7.324	8.045
1573673	2.846	2.615	2.731	13.178	9.813	11.496
1575670	1.538	1.846	1.692	6.978	7.146	7.062
1579660	4.000	4.462	4.231	19.408	21.619	20.514
1580676	1.769	1.462	1.615	7.377	6.099	6.738
1584671	2.692	2.692	2.692	11.388	9.935	10.662
1604671	2.692	3.154	2.923	12.579	13.810	13.195
1613671	2.923	2.923	2.923	13.522	13.358	13.440
1719670	2.769	3.385	3.077	12.652	14.980	13.816
1719671	2.462	2.615	2.538	10.265	11.139	10.702
1727670	2.077	2.385	2.231	9.782	10.792	10.287
1765671	2.615	3.308	2.962	10.789	13.461	12.125
1786671	2.846	3.077	2.962	13.082	12.671	12.877
1789671	3.000	2.769	2.885	15.010	12.015	13.512
1802671	2.077	1.923	2.000	8.861	7.654	8.257
1806672	2.231	2.077	2.154	10.049	8.700	9.375
1808674	2.769	2.231	2.500	10.925	8.928	9.927
1812661	2.385	2.385	2.385	10.703	8.772	9.737
1812672	3.385	2.846	3.115	14.931	11.887	13.409
1844671	2.923	2.769	2.846	11.661	11.597	11.629
1896675	2.846	2.769	2.808	12.085	10.825	11.455

TABLE 11--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
1896676	2.385	2.615	2.500	10.123	10.548	10.335
1901673	2.923	3.308	3.115	12.299	13.520	12.910
1929671	1.692	1.692	1.692	8.293	8.235	8.264
1954672	2.385	2.769	2.577	10.338	11.955	11.147
1954673	2.769	2.923	2.846	12.616	13.678	13.147
1966670	2.000	2.000	2.000	8.984	9.060	9.022
2073671	2.385	2.462	2.423	10.035	8.671	9.353
2114672	1.615	2.154	1.885	6.710	9.664	8.187
2333672	3.077	3.308	3.192	14.036	14.297	14.167
2361671	2.769	2.615	2.692	12.180	10.092	11.136
2390671	2.692	2.385	2.538	11.247	7.875	9.561
2390673	3.308	3.385	3.346	15.102	15.387	15.244
2391672	2.308	2.000	2.154	8.827	7.378	8.103
2392672	2.000	2.538	2.269	7.856	10.089	8.973
2586671	2.692	2.769	2.731	11.525	11.233	11.379
2586672	2.231	2.308	2.269	9.699	10.289	9.994
2587672	3.231	3.154	3.192	14.782	14.273	14.528
2734672	3.077	3.000	3.038	13.706	13.272	13.489
2734673	2.231	2.462	2.346	9.972	10.368	10.170
2738672	2.308	2.615	2.462	9.602	10.182	9.892
2738673	3.385	3.923	3.654	16.374	17.773	17.073
2754671	2.615	2.692	2.654	11.070	10.610	10.840
2776674	2.538	2.769	2.654	9.898	11.225	10.561
2826673	3.692	3.769	3.731	17.554	16.926	17.240
2844670	2.000	2.077	2.038	8.476	7.886	8.181
2855675	2.538	2.231	2.385	11.438	9.691	10.565
2858674	2.462	2.538	2.500	9.382	10.962	10.172
2894671	3.000	2.769	2.885	12.648	10.528	11.588
2905661	3.462	3.769	3.615	15.862	16.829	16.346
2908671	2.692	3.231	2.962	12.274	12.930	12.602
2937672	2.462	2.615	2.538	11.054	10.738	10.896
2937675	3.154	3.385	3.269	15.797	15.126	15.462
2937677	3.000	3.308	3.154	13.772	13.783	13.778
2937678	2.154	2.000	2.077	9.242	8.128	8.685
3023671	2.538	2.308	2.423	11.205	9.242	10.223
3027672	3.462	3.231	3.346	14.992	13.635	14.313
3042675	2.231	2.077	2.154	9.611	8.338	8.974
3043672	2.154	2.231	2.192	9.982	9.528	9.755
3136672	3.769	3.385	3.577	17.005	14.908	15.957
3146670	1.846	2.154	2.000	7.550	7.588	7.569
3201671	2.769	2.538	2.654	13.330	10.096	11.713
3201672	2.538	2.923	2.731	11.398	13.259	12.329
3209673	2.462	2.077	2.269	9.928	8.389	9.159

TABLE 11--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
3210678	1.769	2.462	2.115	7.995	10.437	9.216
3285671	1.769	1.692	1.731	8.287	6.923	7.605
3315673	2.154	2.538	2.346	8.860	10.590	9.725
3385671	2.385	2.615	2.500	10.611	10.958	10.784
3409660	2.692	3.308	3.000	12.901	14.409	13.655
3409674	2.462	2.692	2.577	12.071	13.075	12.573
3432670	2.615	3.000	2.808	11.210	11.154	11.182
3438670	2.615	2.769	2.692	11.556	12.030	11.793
3442673	2.923	2.538	2.731	12.734	10.092	11.413
3445670	3.154	3.385	3.269	14.392	13.147	13.769
3477672	2.769	2.615	2.692	12.507	11.025	11.766
3498672	2.923	2.923	2.923	13.761	12.904	13.332
3545671	2.923	3.231	2.077	13.179	14.300	13.740
3552671	2.154	2.231	2.192	9.413	9.097	9.255
3567670	2.077	2.231	2.154	9.155	8.789	8.972
3568670	3.615	3.923	3.769	16.327	16.115	16.221
3573671	2.538	2.462	2.500	12.198	10.487	11.342
3672671	2.385	2.385	2.385	10.446	10.378	10.412
3731673	3.077	2.692	2.885	13.376	10.998	12.187
3734670	3.23	3.308	3.269	14.368	14.840	14.554
3744673	2.462	2.615	2.538	11.821	10.829	11.325
3765670	3.308	3.462	3.385	15.560	16.297	15.928
3843673	2.154	2.615	2.385	9.425	10.706	10.066
3845672	3.385	3.462	3.423	15.053	15.822	15.438
3849670	2.692	3.000	2.846	11.615	12.028	11.821
4144670	2.385	2.154	2.269	11.090	8.893	9.992
4569672	3.231	3.769	3.500	13.999	16.476	15.238
4575669	3.308	3.154	3.231	15.010	13.233	14.122
4575672	2.846	2.846	2.846	12.180	11.735	11.957
4576678	2.846	2.000	1.923	8.742	8.385	8.563
4671671	2.692	2.846	2.769	11.851	11.575	11.713
4673670	2.846	2.231	2.538	13.092	9.236	11.164
4694670	2.077	2.615	2.346	8.077	11.032	9.555
4694671	3.385	2.769	3.077	17.112	13.092	15.102
4713672	2.462	2.538	2.500	10.677	11.657	11.167
4741672	2.538	2.538	2.538	11.041	10.765	10.903
4815670	2.692	2.615	2.654	12.246	11.218	11.732
4831671	2.846	2.692	2.769	13.116	12.455	12.786
4839670	2.692	2.615	2.654	12.008	10.201	11.105
4852670	2.846	2.846	2.846	13.069	12.478	12.773
4866671	2.231	2.308	2.269	10.839	9.825	10.332
4875670	3.462	3.077	3.269	15.594	13.038	14.316

TABLE 11--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
4884670	2.769	2.538	2.654	11.583	11.095	11.339
4888674	2.231	2.462	2.346	9.224	10.268	9.746
4891672	1.923	2.077	2.000	8.207	8.258	8.232
4897670	1.846	2.000	1.923	8.259	7.898	8.079
4899672	1.615	2.077	1.846	6.468	7.589	7.028
4925672	2.077	2.231	2.154	8.858	9.179	9.018
4932670	2.538	2.154	2.346	11.311	8.929	10.120
4960672	2.462	2.692	2.577	11.115	11.506	11.311
4964670	2.538	2.538	2.538	10.638	11.128	10.883
4983671	2.000	2.154	2.077	8.215	8.638	8.427
4983672	3.000	3.077	3.038	13.923	13.342	13.633
4984670	1.923	2.231	2.077	8.260	9.151	8.705
4999672	2.538	2.462	2.500	11.442	9.933	10.688
5016670	1.769	2.000	1.885	8.392	8.572	8.482
5021670	2.615	2.231	2.423	11.222	9.518	10.370
5035675	2.769	3.077	2.923	12.082	12.615	12.349
5042674	2.692	2.923	2.808	12.458	12.533	12.496
5116673	4.000	4.231	4.115	18.678	18.632	18.655
5151672	2.385	2.923	2.654	11.022	12.265	11.644
5187671	3.154	2.308	2.731	13.918	10.095	12.006
5192676	2.538	2.769	2.654	10.951	12.366	11.658
5304673	2.308	2.154	2.231	10.497	9.430	9.963
5326622	2.615	2.462	2.538	11.065	10.227	10.646
5337673	2.385	2.462	2.423	11.252	11.265	11.258
5406674	2.462	2.462	2.462	10.425	10.053	10.239
5425677	2.154	2.231	2.192	8.748	8.634	8.691
5438671	2.538	2.769	2.654	12.514	11.690	12.102
5449670	2.385	2.154	2.269	11.008	8.966	9.987
5469674	2.077	2.385	2.231	9.929	10.768	10.348
5585674	3.538	3.385	3.462	16.419	14.045	15.232
5622670	3.077	3.231	3.154	14.020	13.415	13.718
5662671	2.462	2.308	2.385	11.583	9.162	10.373
5835670	2.769	2.923	2.846	13.309	12.965	13.137
5897670	2.692	3.692	3.192	12.339	16.785	14.562
6019670	4.077	4.000	4.038	18.010	17.318	17.664
6041676	3.462	3.769	3.615	16.374	16.949	16.662
6215670	1.462	1.615	1.538	6.295	7.407	6.851
6507670	2.615	2.923	2.769	11.337	13.248	12.292
6901675	1.692	1.692	1.692	7.525	7.285	7.405
6985676	2.692	2.615	2.654	12.126	12.010	12.068
7036673	1.538	1.538	1.538	6.730	7.035	6.883
7082674	2.385	2.923	2.654	11.801	10.728	11.264
7189670	2.231	2.154	2.192	9.699	9.372	9.536

TABLE 11--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
7198672	2.615	2.538	2.577	11.387	10.103	10.745
7400675	2.846	3.000	2.923	13.168	14.285	13.727
7522672	1.769	1.769	1.769	6.903	6.188	6.545
7535674	3.000	3.154	3.077	13.217	12.735	12.976
7549670	2.000	2.231	2.115	9.006	8.851	8.928
7555675	3.077	3.000	3.038	13.441	12.585	13.013
7593671	2.000	2.154	2.077	8.482	8.120	8.301
7695675	2.231	2.154	2.192	10.468	10.246	10.357
7704674	2.538	2.308	2.423	11.099	9.708	10.404
771670	3.769	4.000	3.885	17.580	18.043	17.812
7742672	2.077	2.308	2.192	9.045	8.472	8.759
7783672	2.231	2.154	2.192	10.148	9.492	8.820
7807671	2.538	2.615	2.577	11.548	10.014	10.781
7813673	2.308	2.462	2.385	9.015	9.118	9.067
7827678	2.462	2.615	2.538	10.788	10.688	10.738
7924676	2.385	2.615	2.500	9.965	10.988	10.477
7927672	3.231	3.308	3.269	12.852	13.517	13.184
8040671	2.154	2.538	2.346	9.814	10.372	10.093
8041671	3.769	3.692	3.731	16.730	15.710	16.220
8186672	1.846	1.923	1.885	9.018	8.452	8.735
8321673	2.231	2.308	2.269	10.027	9.749	9.888
8390675	2.385	2.615	2.500	11.018	12.040	11.529
9227679	1.846	1.769	1.808	8.208	7.138	7.673
9287670	3.385	3.538	3.462	13.778	13.488	13.633
9303674	2.538	3.846	3.692	11.042	12.828	11.935
9430671	2.846	3.231	3.038	13.707	15.505	14.606
9465672	3.538	3.143	3.346	15.713	14.324	15.018
9513673	2.462	2.385	2.423	10.598	9.022	9.810
9513674	2.385	2.077	2.231	11.016	7.002	9.009
9513676	2.308	2.769	2.538	11.632	11.233	11.433
9526675	2.615	2.538	2.577	12.164	10.392	11.278
9716672	2.231	2.462	2.346	9.892	10.204	10.048
9725672	3.231	3.462	3.346	13.521	14.634	14.077
9912673	2.385	2.000	2.192	10.479	7.874	9.177

<sup>a</sup> The terms odd, even, and total, for either scoring technique, refer respectively to the average score on the 13 odd numbered statements, the average score on 13 even numbered statements, and the average score on the entire 26 statements.

TABLE 12

THE ATTITUDE SCORES OF THE CONTROL GROUP IN DECEMBER THAT WERE REQUIRED IN THE CALCULATION OF GUTTMAN'S INTERNAL CONSISTENCY RELIABILITY COEFFICIENT

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total <sup>a</sup>	Odd	Even	Total
0363671	2.538	2.231	2.385	10.472	9.708	10.090
0403673	2.385	2.615	2.500	10.311	10.910	10.610
0437671	3.077	3.538	3.308	13.433	15.199	14.316
0812670	2.077	2.385	2.231	8.312	9.163	8.737
0813672	1.692	1.462	1.577	7.090	6.120	6.605
0898671	3.231	3.077	3.154	12.884	11.439	12.162
0966676	2.846	2.769	2.808	12.608	12.222	12.415
0982670	2.000	2.000	2.000	9.052	8.751	8.901
1047673	3.846	3.769	3.808	17.784	15.698	16.741
1127672	2.231	2.308	2.269	9.099	9.565	9.332
1241671	2.308	2.538	2.423	9.880	10.186	10.033
1376676	2.462	2.231	2.346	11.396	9.390	10.393
1387662	3.154	3.154	3.154	14.144	13.391	13.767
1407673	2.462	2.462	2.462	10.238	9.232	9.735
1459671	2.692	2.692	2.692	11.483	10.598	11.040
1496672	2.538	2.154	2.346	10.339	9.080	9.710
1534662	2.846	2.462	2.654	12.248	10.764	11.506
1536672	2.462	2.615	2.538	10.930	10.897	10.913
1762672	2.462	2.538	2.500	11.046	10.492	10.769
1838675	2.308	2.615	2.462	10.237	11.465	10.851
1839660	2.692	2.923	2.808	11.824	11.415	11.619
1843672	2.615	2.692	2.654	11.360	11.101	11.230
2109663	1.538	1.538	1.538	6.857	6.253	6.555
2127674	2.154	2.231	2.192	8.161	8.135	8.148
2191670	2.154	2.308	2.231	9.593	10.355	9.974
2854673	2.154	2.692	2.423	8.965	11.051	10.008
2889674	3.385	2.615	3.000	15.965	11.598	13.782
2905671	3.308	3.462	3.385	14.558	14.518	14.538
2921677	2.154	2.154	2.154	9.178	8.591	8.885
3081670	3.615	2.692	2.654	17.002	17.608	17.305
3127670	2.077	2.692	2.385	9.512	11.719	10.615
3289672	2.692	3.077	2.885	12.495	13.653	13.074
3391671	2.923	2.846	2.885	12.082	11.168	11.625
3460651	3.077	3.538	3.308	12.839	15.795	14.317
3475673	1.923	1.846	1.885	7.553	7.318	7.435
3615672	2.385	2.462	2.423	9.476	9.437	9.457
3698672	3.846	3.923	3.885	17.495	18.807	18.151

TABLE 12--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
3720672	3.692	3.462	3.577	16.631	14.455	15.543
3793670	3.462	3.538	3.500	15.203	15.344	15.273
3817673	2.462	2.385	2.423	10.557	8.876	9.717
3841670	1.769	1.846	1.808	7.035	6.491	6.763
4049670	3.308	3.000	3.154	14.938	13.475	14.207
4412670	2.615	2.769	2.692	11.775	10.712	11.243
4616670	2.000	2.000	2.000	7.825	6.675	7.250
4671676	3.077	2.769	2.923	14.795	11.957	13.376
4739672	2.538	2.308	2.423	10.698	9.902	10.300
5009670	1.769	1.692	1.731	7.306	7.315	7.310
5121670	3.077	2.615	2.846	13.816	11.566	12.691
5122663	3.462	3.154	3.308	16.692	14.200	15.446
5148670	1.846	2.308	2.077	8.268	8.832	8.550
5148672	2.692	2.385	2.538	12.570	10.655	11.613
5192673	2.308	2.308	2.308	9.848	9.456	9.652
5206670	3.615	3.538	3.577	15.395	15.052	15.223
5207670	1.692	2.077	1.885	7.438	8.155	7.797
5211670	2.846	2.385	2.615	14.727	11.282	13.005
5215672	3.462	3.462	3.462	14.692	14.952	14.822
5250675	3.462	3.154	3.308	15.600	12.697	14.148
5304675	3.154	3.308	3.231	14.755	14.358	14.557
5314670	2.769	2.846	2.808	12.780	12.630	12.705
5338672	3.462	3.308	3.385	14.752	14.648	14.700
5402670	2.077	2.231	2.154	8.098	8.597	8.348
5417674	3.000	2.692	2.846	11.445	10.552	10.998
5417677	2.077	2.462	2.269	8.957	10.798	9.877
542;679	2.923	2.769	2.846	13.314	11.787	12.550
5422671	3.462	3.615	3.538	16.149	15.545	15.847
5422674	2.231	2.000	2.115	9.758	8.483	9.121
5423674	2.769	3.308	3.038	12.992	14.495	13.744
5423675	2.538	2.615	2.577	10.628	10.766	10.697
5424679	3.077	3.000	3.038	13.378	12.411	12.895
5428674	2.615	2.846	2.731	11.968	12.603	12.286
5445672	3.615	3.308	3.462	16.885	13.618	15.252
5459673	2.923	2.538	2.731	12.375	10.842	11.608
5467675	4.077	4.077	4.077	16.387	17.258	16.823
5468672	3.231	3.231	3.231	14.659	13.081	13.870
5470672	2.462	2.692	2.577	10.445	11.235	10.840
5480673	2.385	2.846	2.615	10.350	11.697	11.023
5486671	2.615	2.615	2.615	12.065	11.554	11.809
5499670	2.462	2.923	2.692	10.255	12.461	11.358
5505673	3.923	3.615	3.769	17.218	14.511	15.865
5514672	2.308	2.231	2.269	10.767	9.522	10.145

TABLE 12--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
5517673	3.000	2.846	2.923	13.006	12.265	12.636
5567641	2.692	2.538	2.615	12.424	9.654	11.039
5567672	2.308	2.308	2.308	10.236	9.675	9.955
5567674	3.154	3.000	3.077	14.635	13.477	14.056
5584650	2.846	2.769	2.808	12.048	11.263	11.655
5584670	1.692	2.077	1.885	7.387	7.706	7.547
5605670	3.000	2.846	2.923	12.813	11.853	12.333
5606670	2.231	2.538	2.385	8.675	10.443	9.559
5607672	3.462	3.231	3.346	15.917	12.599	14.258
5608657	2.692	2.846	2.769	11.985	12.815	12.400
5616673	1.846	1.615	1.731	7.645	6.371	7.008
5618671	1.923	1.769	1.846	8.493	7.021	7.757
5619672	2.308	2.615	2.462	10.442	11.085	10.764
5619673	2.923	2.231	2.577	13.055	9.098	11.077
5633670	2.154	2.385	2.269	9.315	9.795	9.555
5637670	2.692	3.154	2.923	12.755	15.519	14.137
5642671	2.385	3.000	2.692	10.174	13.142	11.658
5679674	3.692	3.538	3.615	17.475	16.264	16.870
5705670	2.692	2.538	2.615	12.965	10.764	11.865
5712672	2.231	2.462	2.346	9.010	9.352	9.181
5734671	2.077	1.923	2.000	8.610	8.225	8.417
5739673	3.769	4.000	3.885	16.865	17.339	17.102
5753676	2.385	2.231	2.308	10.877	10.064	10.470
5779670	3.923	3.308	3.615	18.195	13.292	15.744
5833673	3.308	3.615	3.462	15.782	15.946	15.864
5836670	2.077	2.077	2.077	8.837	9.335	9.086
5842670	2.462	3.077	2.769	10.604	12.174	11.389
5887671	2.538	3.000	2.769	10.765	12.122	11.444
5890670	2.538	2.462	2.500	11.316	10.995	11.156
5928672	2.538	2.538	2.538	11.308	10.624	10.966
5964670	3.231	3.385	3.308	14.144	13.804	13.974
5975671	2.000	2.462	2.231	8.529	9.242	8.886
5982670	2.538	2.923	2.731	10.770	11.796	11.283
6008670	2.462	3.000	2.731	11.063	12.838	11.951
6041672	2.385	2.846	2.615	10.305	11.496	10.901
6065671	2.846	2.846	2.846	12.219	12.145	12.182
6085670	2.769	3.000	2.885	12.420	12.443	12.432
6159670	2.308	2.462	2.385	10.413	10.573	10.493
6180671	3.077	3.154	3.115	14.831	13.358	14.095
6240673	3.462	3.077	3.269	15.072	13.116	14.094
6528671	2.000	2.154	2.077	8.715	8.124	8.420
6665670	2.923	2.923	2.923	12.404	12.974	12.689
6885670	2.231	2.154	2.192	9.663	8.616	9.140



TABLE 12--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
6897674	2.308	2.385	2.346	10.750	10.951	10.850
6905673	3.308	3.154	3.231	13.948	13.006	13.477
6930671	2.769	2.846	2.808	11.195	12.347	11.771
6932673	2.538	2.769	2.654	10.853	11.096	10.975
6934671	3.615	3.538	3.577	16.427	15.863	16.145
6934673	3.077	3.154	3.115	13.802	13.867	13.834
6950672	2.538	2.615	2.577	11.065	11.323	11.194
6977672	2.923	2.769	2.846	12.895	11.887	12.391
6996671	1.651	1.231	1.423	6.334	5.712	6.023
7005670	2.231	2.615	2.423	9.989	11.819	10.904
7024676	3.154	3.615	3.385	14.205	16.438	15.322
7026660	2.692	3.077	2.885	11.907	13.512	12.710
7026673	2.769	2.923	2.846	11.995	12.264	12.130
7062672	2.000	1.846	1.923	9.402	8.528	8.965
7082672	1.692	2.077	1.885	6.522	9.191	7.857
7104650	2.385	2.615	2.500	10.321	10.505	10.413
7104670	2.385	2.308	2.346	10.131	9.220	9.675
7104674	2.077	2.000	2.038	9.058	8.553	8.805
7121670	3.462	3.231	3.346	15.328	13.176	14.252
7139670	1.769	1.923	1.846	8.068	8.321	8.195
7149673	2.846	2.692	2.769	12.983	10.625	11.804
7176670	3.000	3.000	3.000	14.342	13.989	14.165
7177672	2.615	2.846	2.731	11.177	12.326	11.752
7194673	2.308	2.538	2.423	10.006	10.615	10.310
7300671	2.077	2.000	2.038	9.015	8.244	8.629
7324670	2.231	2.692	2.462	10.664	11.356	11.010
7347672	2.692	2.538	2.615	12.320	9.770	11.045
7347675	3.538	4.231	3.885	17.420	18.522	17.971
7347676	3.231	2.154	3.192	14.001	13.333	13.667
7399673	2.385	2.077	2.231	10.909	8.890	9.900
7441675	2.846	2.692	2.769	12.165	11.079	11.622
7467663	2.154	2.308	2.231	9.900	9.623	9.762
7491670	3.846	3.769	3.808	17.176	15.362	16.269
7544672	3.154	3.077	3.115	14.318	13.360	13.839
7555673	2.462	2.538	2.500	10.999	10.391	10.695
7576672	3.385	3.846	3.615	13.775	16.747	15.261
7619650	2.385	2.692	2.538	10.788	13.750	12.269
6788673	2.000	2.154	2.077	9.042	8.924	8.983
7691672	3.000	2.923	2.962	13.192	12.666	12.930
7697678	4.231	3.923	4.077	19.688	17.232	18.460
7701671	2.538	2.462	2.500	9.989	9.451	9.720
7701676	3.000	2.077	3.038	13.026	11.699	12.363
7707672	3.538	3.308	3.423	16.822	16.013	16.418

TABLE 12--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
7713671	2.692	2.538	2.615	12.894	10.711	11.802
7713674	3.154	3.615	3.385	15.078	16.135	15.607
7713675	2.154	2.231	2.192	8.332	8.825	8.579
7715674	2.692	3.077	2.885	12.208	12.763	12.486
7716671	2.615	2.615	2.615	12.641	12.213	12.427
7733676	3.077	3.231	3.154	13.556	13.595	13.576
7801670	3.000	2.615	2.808	13.439	9.505	11.472
7807673	1.462	1.462	1.462	6.536	6.295	6.416
7824670	2.538	2.769	2.654	11.165	11.046	11.105
7868672	2.462	2.077	2.269	10.587	9.252	9.920
7918650	3.462	3.077	3.269	15.656	13.322	14.489
7918671	2.462	2.308	2.385	10.203	9.910	10.057
7961671	2.769	2.923	2.846	11.935	12.130	12.032
7980673	2.923	2.846	2.885	12.804	11.864	12.334
7990676	2.846	2.769	2.808	13.162	11.619	12.390
7994674	3.385	3.231	3.308	15.115	14.584	14.849
7997670	2.231	2.385	2.308	9.617	10.245	9.931
8020671	2.308	2.231	2.269	10.104	9.755	9.929
8050670	3.231	2.769	3.000	13.902	11.952	12.927
8117672	3.308	3.231	3.269	15.216	14.522	14.869
8121671	2.077	2.308	2.192	8.528	9.218	8.873
8124673	2.231	2.077	2.154	9.587	8.286	8.937
8125672	2.308	2.462	2.385	9.255	10.064	9.659
8127660	3.538	3.615	3.577	15.520	15.691	15.605
8151674	3.077	3.154	3.115	14.596	12.849	13.723
8160671	2.615	2.692	2.654	11.257	12.458	11.857
8161673	2.000	1.923	1.962	7.976	8.058	8.017
8189670	2.538	2.923	2.731	11.313	13.488	12.401
8219671	3.615	3.308	3.462	15.698	14.788	15.243
8220673	2.923	2.923	2.923	12.571	11.741	12.156
8232674	1.385	1.308	1.346	6.050	5.208	5.629
8238672	2.308	2.615	2.462	10.385	10.997	10.691
8286672	3.462	3.462	3.462	15.594	15.292	15.443
8315671	2.077	2.154	2.115	9.692	8.816	9.254
8316670	2.231	2.077	2.154	9.343	10.472	9.907
8321674	2.615	2.846	2.731	12.018	13.514	12.766
8348672	2.615	2.462	2.538	11.221	9.858	10.539
8367671	2.692	2.923	2.808	12.148	13.483	12.815
8373674	2.154	2.308	2.231	9.107	8.494	8.800
8415674	2.462	2.615	2.538	10.980	11.816	11.398
8423670	2.846	3.308	3.077	12.282	13.147	12.715
8427671	2.846	2.769	2.808	13.298	11.938	12.618
8432670	2.231	2.154	2.192	9.905	8.756	9.330

TABLE 12--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
8432671	3.538	3.538	3.538	15.689	14.868	15.279
8532671	2.769	3.154	2.962	11.809	12.281	12.045
8563672	3.000	3.154	3.077	12.818	13.371	13.095
8568670	3.000	2.923	2.962	14.108	14.267	14.188
8947671	1.462	1.692	1.577	5.952	5.962	5.957
8957670	1.615	2.154	1.885	7.048	8.417	7.733
9010672	1.769	2.000	1.885	7.674	7.888	7.781
9166670	2.615	2.538	2.577	12.213	11.000	11.607
9179671	2.000	2.000	2.000	8.998	8.112	8.555
9235676	2.769	2.769	2.769	12.162	11.290	11.726
9274670	2.692	2.769	2.731	10.525	10.791	10.658
9303672	2.385	2.154	2.269	10.862	8.990	9.926
9379673	2.385	2.769	2.577	10.475	12.034	11.254
9452670	3.154	3.538	3.346	14.062	14.980	14.521
9457671	2.692	2.615	2.654	11.842	10.601	11.222
9464672	2.615	3.077	2.846	11.036	12.487	11.762
9481672	2.923	2.846	2.885	13.032	12.486	12.759
9512674	3.615	3.923	3.769	16.268	17.345	16.807
9513672	3.077	3.231	3.154	14.208	14.460	14.334
9513677	2.154	2.231	2.192	10.272	9.968	10.120
9515676	2.846	2.923	2.885	13.461	12.118	12.790
9554671	2.538	2.385	2.462	11.630	10.062	10.846
9627670	3.000	3.077	3.038	13.227	12.602	12.914
9700672	1.692	1.769	1.731	7.586	7.891	7.738
9718650	3.615	3.538	3.577	16.500	15.940	16.220
9749675	2.615	2.615	2.615	10.942	10.082	10.512
9774673	2.462	2.154	2.308	10.537	8.946	9.742
9796672	3.000	3.615	3.308	12.738	14.493	13.615
9810670	2.231	2.077	2.154	9.666	9.493	9.580

<sup>a</sup> The terms odd, even, and total, for either scoring technique, refer respectively to the average score on the 13 odd numbered statements, the average score on the 13 even numbered statements, and the average score on the entire 26 statements.

TABLE 13

THE ATTITUDE SCORES OF THE EXPERIMENTAL GROUP IN MARCH THAT  
WERE REQUIRED IN THE CALCULATION OF GUTTMAN'S INTERNAL  
CONSISTENCY RELIABILITY COEFFICIENT

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total <sup>a</sup>	Odd	Even	Total
0071670	2.231	2.077	2.154	9.307	8.754	9.030
0081662	4.231	4.308	4.269	19.660	19.729	19.695
0081671	1.923	1.846	1.885	9.034	8.949	8.992
0119671	2.385	2.692	2.538	10.752	11.592	11.172
0324673	1.923	2.231	2.077	8.032	7.904	7.968
0396670	4.077	4.077	4.077	18.697	18.488	18.593
0405671	2.923	2.923	2.923	13.037	12.214	12.625
0409670	2.154	2.769	2.462	9.657	11.260	10.458
0416672	2.231	2.385	2.308	10.208	10.123	10.165
0432671	2.385	2.308	2.346	10.924	9.668	10.296
0566672	2.462	2.154	2.308	11.840	10.111	10.975
0763672	4.231	4.462	4.346	19.895	18.980	19.437
0765670	1.923	1.692	1.808	7.688	6.413	7.050
0768672	3.000	3.385	3.192	13.450	14.115	13.783
0794671	3.000	3.000	3.000	13.825	13.791	13.808
0795672	2.077	2.077	2.077	9.561	8.767	9.164
0819673	2.308	2.308	2.308	9.127	10.542	9.835
0834678	4.000	4.231	4.115	18.392	18.522	18.457
0843674	4.462	4.077	4.269	21.158	20.430	20.794
0871671	1.923	2.154	2.038	8.143	9.655	8.899
0880671	2.692	2.846	2.769	12.767	12.302	12.534
0913671	2.077	2.000	2.038	9.521	8.555	9.038
0918674	1.923	1.846	1.885	8.478	7.897	8.187
0920671	2.462	2.538	2.500	10.682	10.408	10.545
0921672	2.385	2.231	2.308	10.921	10.926	10.923
0944671	1.769	1.692	1.731	7.345	6.218	6.782
0974672	3.615	3.692	3.654	16.644	16.182	16.413
0988673	2.538	2.308	2.423	11.597	9.582	10.590
0995671	1.846	1.769	1.808	8.012	7.044	7.528
1001676	1.615	1.692	1.654	7.404	7.795	7.600
1030672	1.923	1.538	1.731	8.065	6.674	7.369
1043673	2.308	2.231	2.269	10.233	9.565	9.894
1047671	2.154	1.846	2.000	10.511	8.587	9.549
1058673	2.000	2.077	2.038	8.974	8.748	8.861
1074670	2.231	2.077	2.154	9.946	8.793	9.370
1075672	2.077	1.846	1.962	9.371	7.620	8.495
1081672	3.462	3.615	3.538	16.692	16.413	16.552
1103674	4.308	4.538	4.423	19.850	21.188	20.519

TABLE 13--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
1112673	2.077	2.308	2.192	8.129	8.862	8.496
1147673	1.846	1.462	1.654	8.146	5.718	6.932
1149671	2.154	2.231	2.192	10.017	9.944	9.980
1164671	2.769	2.538	2.654	12.422	10.688	11.555
1171672	2.077	1.769	1.923	9.522	7.376	8.449
1253672	3.769	3.769	3.769	17.724	16.445	17.085
1302662	2.308	2.308	2.308	10.079	10.472	10.275
1322670	2.385	2.615	2.500	10.289	10.339	10.314
1358672	2.615	2.692	2.654	11.322	11.335	11.328
1358675	2.462	2.692	2.577	10.830	11.438	11.134
1365679	2.308	3.538	3.423	14.236	17.426	15.831
1373671	2.000	2.077	2.038	10.095	10.078	10.086
1389671	2.615	2.769	2.692	12.298	11.851	12.074
1397678	3.615	3.769	3.692	17.193	17.348	17.271
1405670	2.385	2.231	2.308	10.257	10.148	10.202
1424672	2.077	1.923	2.000	9.452	8.595	9.024
1465673	2.308	2.538	2.423	10.309	10.138	10.224
1466674	2.154	2.385	2.269	9.064	9.812	9.438
1492671	2.615	2.692	2.654	13.429	13.386	13.408
1492673	1.846	1.692	1.769	7.952	7.443	7.697
1537673	1.769	1.846	1.808	8.078	7.221	7.650
1558673	2.308	2.538	2.423	10.982	11.865	11.423
1567672	1.615	1.308	1.462	8.059	6.184	7.122
1573673	2.769	2.769	2.769	11.762	11.188	11.475
1575670	1.462	1.923	1.692	6.776	8.188	7.482
1579660	2.923	2.846	2.885	14.770	11.238	13.004
1580676	1.538	1.385	1.462	6.710	6.262	6.486
1582671	2.462	2.769	2.615	10.883	10.465	10.674
1604671	2.615	3.154	2.885	13.232	14.658	13.945
1613671	1.615	1.846	1.731	7.381	8.821	8.101
1719670	2.231	2.538	2.385	10.277	10.818	10.547
1719671	2.923	3.154	3.038	13.018	13.682	13.350
1727670	2.385	2.308	2.346	10.426	9.615	10.021
1765671	2.154	2.692	2.423	9.259	10.744	10.002
1786671	2.308	2.308	2.308	9.942	10.092	10.017
1789671	3.154	3.231	3.192	14.439	14.125	14.282
1802671	2.846	3.000	2.923	13.486	12.938	13.212
1806672	2.077	1.846	1.962	8.925	7.700	8.313
1808674	1.308	1.462	1.385	6.277	6.445	6.361
1812661	1.846	1.462	1.654	8.404	7.038	7.721
1812672	3.231	3.077	3.154	14.542	13.135	13.838
1844671	2.308	2.385	2.346	10.455	10.616	10.536
1896675	2.077	1.692	1.885	8.685	6.537	7.611

TABLE 13--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
1896676	2.385	2.692	2.538	10.234	10.998	10.616
1901673	2.231	2.231	2.231	9.040	9.465	9.252
1929671	1.923	2.000	1.962	9.246	8.369	8.808
1954672	2.385	2.462	2.423	10.967	10.047	10.507
1954673	4.077	4.000	4.038	18.664	19.052	18.858
1966670	2.000	2.462	2.231	9.585	9.798	9.692
2073671	2.231	2.692	2.462	10.454	11.122	10.788
2114672	1.692	1.769	1.731	7.499	7.211	7.355
2333672	2.615	2.846	2.731	12.413	12.982	12.698
2361671	2.000	2.000	2.000	9.649	8.648	9.148
2390672	1.923	1.923	1.923	8.799	8.288	8.544
2390673	2.923	3.231	3.077	14.367	14.342	14.354
2391672	2.154	2.077	2.115	8.958	8.568	8.763
2392672	2.692	3.231	2.962	11.119	12.950	12.035
2586671	1.769	1.923	1.846	7.067	7.741	7.404
2586672	3.231	3.769	3.500	15.480	17.935	16.707
2587672	2.538	2.692	2.615	11.489	12.683	12.086
2734672	2.538	2.692	2.615	11.285	11.102	11.193
2734673	2.077	2.154	2.115	9.351	10.842	10.096
2738672	3.231	3.000	3.115	14.824	12.665	13.745
2738673	2.769	2.769	2.769	12.101	12.095	12.098
2754671	2.308	2.538	2.423	10.113	11.029	10.571
2776674	1.538	1.462	1.500	6.436	6.429	6.433
2826673	2.385	2.462	2.423	9.996	10.410	10.203
2844670	2.231	2.154	2.192	8.592	8.563	8.578
2855675	3.231	3.154	3.192	14.757	14.030	14.393
2858674	2.308	2.923	2.615	10.836	12.862	11.849
2894671	2.385	2.308	2.346	11.119	9.425	10.272
2905661	2.615	3.077	2.846	11.534	12.578	12.056
2908671	2.000	1.769	1.885	9.797	8.574	9.185
2937672	2.692	2.846	2.769	11.254	11.775	11.514
2937675	3.385	3.615	3.500	16.081	15.968	16.025
2937677	2.538	2.846	2.692	11.042	12.490	11.766
2937678	1.923	2.077	2.000	8.553	8.807	8.680
3023671	3.231	3.385	3.308	15.359	14.561	14.960
3027672	2.077	2.231	2.154	9.174	9.438	9.306
3042675	2.923	2.154	2.538	12.734	8.735	10.734
3043672	1.769	2.154	1.962	8.360	11.205	9.783
3136672	2.077	2.462	2.269	9.308	7.998	8.653
3146670	1.846	1.846	1.846	7.552	7.642	7.597
3201671	2.231	2.846	2.538	9.826	10.815	10.321
3201672	2.538	2.462	2.500	11.596	10.051	10.823
3209673	1.923	2.154	2.038	8.731	9.041	8.886

TABLE 13--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
3210678	2.385	2.692	2.538	11.409	11.469	11.439
3285671	1.769	1.615	1.692	7.748	6.412	7.080
3315673	1.615	1.769	1.692	7.065	7.522	7.293
3385671	2.538	2.615	2.577	11.374	11.712	11.543
3409660	3.615	3.077	3.346	16.849	14.141	15.495
3409674	2.308	2.462	2.385	11.272	11.359	11.315
3432670	3.308	3.000	3.154	16.272	12.684	14.478
3438670	2.692	2.769	2.731	13.442	11.816	12.629
3442673	2.154	2.462	2.308	8.868	10.212	9.540
3445670	2.154	2.308	2.231	9.418	9.673	9.545
3477672	2.308	2.154	2.231	10.640	10.047	10.343
3498672	2.385	2.692	2.538	11.135	11.644	11.389
3545671	1.846	1.923	1.885	7.819	8.058	7.938
3552671	2.692	2.846	2.769	11.466	11.767	11.617
3567670	2.000	2.231	2.115	9.302	9.718	9.510
3568670	2.077	2.231	2.154	9.400	9.277	9.338
3573671	2.000	1.769	1.885	9.280	8.044	8.662
3672671	2.231	2.538	2.385	9.577	10.605	10.091
3731673	2.077	2.231	2.154	9.348	9.475	9.411
3734670	2.692	3.308	3.000	12.272	14.946	13.609
3744673	2.231	2.846	2.538	9.972	11.681	10.827
3765670	2.538	2.462	2.500	10.993	10.528	10.761
3843673	2.308	2.385	2.346	10.592	10.809	10.701
3845672	2.615	2.385	2.500	11.824	9.713	10.768
3849670	3.231	3.077	3.154	14.977	14.462	14.720
4144670	2.308	2.308	2.308	10.405	10.390	10.397
4569672	3.462	3.615	3.538	18.096	18.112	18.104
4575669	1.846	1.846	1.846	8.099	7.364	7.732
4575672	1.769	1.923	1.846	7.935	7.654	7.795
4576678	1.846	1.846	1.846	8.405	7.802	8.103
4671671	2.923	3.000	2.962	13.291	12.803	13.047
4672670	2.154	1.923	2.038	9.895	8.122	9.008
4694670	1.846	2.000	1.923	8.258	8.052	8.155
4694671	2.846	2.538	2.692	12.911	11.835	12.373
4713672	1.231	1.154	1.192	5.985	5.690	5.837
4741672	2.308	2.231	2.269	10.103	9.524	9.813
4815670	2.462	2.692	2.577	11.477	12.547	12.012
4821671	2.692	2.538	2.615	13.605	12.091	12.848
4839670	2.000	2.231	2.115	8.918	9.569	9.244
4852670	2.385	2.615	2.500	10.448	10.828	10.638
4866671	2.000	2.077	2.038	9.491	8.662	9.077
4875670	2.154	2.000	2.077	9.172	9.039	9.106
4884670	2.231	2.538	2.385	9.989	10.672	10.330

TABLE 13--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
4888674	2.231	2.615	2.423	9.816	11.015	10.415
4891672	1.846	1.846	1.846	8.208	7.175	7.691
4897670	2.769	2.538	2.654	12.898	10.656	11.777
4899672	1.846	1.923	1.885	6.972	6.736	6.854
4925672	2.231	2.308	2.269	9.467	9.316	9.392
4932670	2.538	3.077	2.808	12.129	12.691	12.410
4960672	2.923	3.154	3.038	12.665	12.634	12.644
4964670	2.462	2.769	2.615	11.010	11.917	11.463
4983671	2.000	1.769	1.885	8.492	7.129	7.811
4983672	2.846	3.000	2.923	13.208	13.295	13.252
4984670	2.615	2.615	2.615	13.045	10.632	11.838
4999672	2.462	2.308	2.385	10.875	10.563	10.719
5016670	2.000	2.077	2.038	9.590	9.408	9.499
5021670	2.308	2.231	2.269	11.282	9.252	10.267
5035675	2.385	2.692	2.538	10.312	10.323	10.317
5042674	2.538	2.923	2.731	11.758	12.693	12.226
5116673	2.000	1.846	1.923	8.742	7.985	8.364
5151672	1.923	2.000	1.962	8.577	7.719	8.148
5187671	2.462	2.462	2.462	10.591	11.128	10.860
5192676	2.923	2.846	2.885	12.952	12.375	12.663
5304673	2.385	2.231	2.308	11.012	9.518	10.265
5326622	2.385	2.308	2.346	10.436	9.661	10.048
5337673	2.615	2.923	2.769	13.001	14.124	13.562
5406674	2.231	2.154	2.192	10.640	9.788	10.214
5425677	2.077	2.538	2.308	8.831	10.601	9.716
5438671	1.846	1.615	1.731	9.576	7.359	8.468
5449670	2.154	2.846	2.500	10.398	12.385	11.392
5468674	2.538	2.385	2.462	12.143	11.248	11.696
5585674	2.923	2.462	2.692	12.477	9.949	11.213
5622670	2.385	2.308	2.346	11.108	10.390	10.749
5662671	1.846	1.769	1.808	7.613	6.574	7.093
5825670	2.538	2.462	2.500	11.678	11.352	11.515
5897670	2.846	4.000	3.423	13.946	18.925	16.435
6019670	4.538	4.385	4.462	20.842	19.023	19.932
6215670	1.615	1.846	1.731	7.668	8.015	7.841
6507670	3.923	4.538	4.231	18.240	20.472	19.356
6901675	1.923	1.692	1.808	8.782	6.870	7.826
6985676	2.692	2.462	2.577	12.413	10.907	11.660
7036673	2.077	1.769	1.923	9.051	7.683	8.367
7082674	2.154	3.077	2.615	10.832	14.658	12.745
7189670	2.615	2.846	2.731	12.571	13.156	12.863
7198672	2.231	2.077	2.154	9.820	9.238	9.529
7400675	2.769	3.231	3.000	13.288	14.870	14.079



TABLE 13--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
7522672	1.308	1.615	1.462	5.633	5.914	5.773
7525674	2.538	2.692	2.615	11.769	10.831	11.300
7549670	2.000	2.385	2.192	9.462	10.431	9.947
7555675	2.923	2.923	2.923	13.461	12.442	12.952
7593671	1.923	2.462	2.192	7.748	9.101	8.424
7695675	2.231	2.385	2.308	10.288	10.434	10.361
7704674	2.538	3.000	2.769	10.981	12.421	11.701
7710670	2.846	3.077	2.962	13.555	13.094	13.324
7742672	2.385	2.769	2.577	10.867	10.818	10.842
7783672	2.385	2.385	2.385	11.252	10.345	10.798
7807671	1.692	1.923	1.808	7.602	7.016	7.309
7813673	2.538	2.538	2.538	11.532	10.550	11.041
7827678	3.000	2.923	2.962	13.750	13.262	13.506
7924676	2.769	3.154	2.962	12.233	13.556	12.895
7927672	1.923	2.077	2.000	7.762	8.101	7.932
8040671	2.308	2.769	2.538	11.167	12.282	11.725
8041671	2.538	2.538	2.538	11.699	10.764	11.232
8186672	1.385	1.692	1.538	6.934	7.861	7.397
8321673	2.231	2.154	2.192	9.729	8.612	9.171
8390675	2.231	2.231	2.231	11.102	10.426	10.764
9227679	1.923	2.000	1.962	8.572	8.060	8.316
9287670	2.923	3.231	2.077	12.558	13.086	12.822
9303674	2.231	2.231	2.231	10.699	10.263	10.481
9430671	1.923	2.385	2.154	9.270	10.570	9.920
9465672	2.154	2.154	2.154	10.100	8.212	9.156
9513673	2.615	2.846	2.731	11.548	12.095	11.822
9513674	2.231	2.077	2.154	9.572	8.866	9.219
9513676	1.846	1.692	1.769	8.862	8.962	8.912
9536675	2.154	1.615	1.885	9.580	7.577	8.578
9716672	2.692	3.154	2.923	13.108	13.800	13.454
9725672	2.692	2.769	2.731	12.762	12.412	12.587

<sup>a</sup> The terms odd, even, and total, for either scoring technique, refer respectively to the average score on the 13 odd numbered statements, the average score on the 13 even numbered statements, and the average score on the entire 26 statements.

TABLE 14

THE ATTITUDE SCORES ON THE CONTROL GROUP IN MARCH THAT WERE  
REQUIRED IN THE CALCULATION OF GUTTMAN'S INTERNAL CONSISTENCY  
RELIABILITY COEFFICIENT

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total <sup>a</sup>	Odd	Even	Total
0363671	2.462	2.615	2.538	10.428	11.295	10.862
0403673	2.385	2.385	2.385	10.555	9.805	10.180
0437671	2.923	3.231	3.077	13.348	13.662	13.505
0812670	1.692	1.923	1.808	6.278	27.364	6.821
0813672	2.308	1.923	2.115	10.809	8.104	9.457
0898671	2.846	2.615	2.731	11.829	10.418	11.123
0966676	3.462	3.000	3.231	16.379	12.779	14.579
0982670	2.231	2.385	2.308	9.949	10.255	10.102
1047672	2.846	2.462	2.654	14.198	10.993	12.596
1241671	2.231	2.538	2.385	9.432	10.127	9.779
1376676	2.385	2.538	2.462	10.889	10.397	10.643
1387662	3.077	3.308	3.192	13.632	13.307	13.470
1407673	2.692	2.769	2.731	11.075	11.306	11.191
1459671	2.385	2.462	2.423	10.288	9.452	9.870
1496672	2.462	2.538	2.500	10.213	10.377	10.295
1534662	2.615	2.615	2.615	11.827	11.715	11.771
1536672	2.615	2.615	2.615	11.536	10.105	10.816
1762672	2.692	3.077	2.885	12.022	12.825	12.423
1838675	1.923	2.077	2.000	8.075	7.944	8.010
1839660	3.538	3.923	3.731	15.960	18.390	17.175
1843672	3.462	3.538	3.500	16.366	15.308	15.837
2109663	1.692	1.385	1.538	7.224	5.897	6.560
2127674	2.231	2.308	2.269	9.025	9.538	9.282
2191670	2.154	2.154	2.154	9.808	9.758	9.783
2854673	3.000	2.154	2.077	13.399	14.122	13.760
2889674	2.077	2.231	2.154	9.292	10.091	9.691
2905671	3.000	3.000	3.000	13.825	13.791	13.808
2921677	2.308	2.615	2.462	10.252	10.378	10.315
3081670	2.692	3.000	2.846	12.222	12.437	12.329
3127670	2.692	2.462	2.577	11.653	11.066	11.360
3289672	2.615	2.692	2.654	12.190	12.099	12.145
3391671	2.923	3.538	3.231	12.609	14.629	13.619
3460651	3.692	3.846	3.769	16.932	16.472	16.702
3475673	2.154	2.000	2.077	8.582	8.035	8.308
3615672	3.385	3.077	3.231	14.633	13.346	13.990
3698672	2.462	2.692	2.577	9.057	11.470	10.263
3720672	3.923	3.846	3.885	18.090	17.489	17.790
3793670	3.462	3.462	3.462	15.583	15.366	15.475
3817673	2.692	2.692	2.692	12.128	11.055	11.591

TABLE 14--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
3841670	1.769	2.077	1.923	8.364	8.705	8.534
4049670	2.846	2.846	2.846	12.096	13.105	12.601
4412670	2.462	2.308	2.385	10.348	9.055	9.702
4616670	2.385	3.385	2.885	10.392	12.380	11.386
4671676	2.923	3.000	2.962	13.075	13.237	13.156
4739672	2.462	2.462	2.462	10.790	9.462	10.126
5009670	1.692	1.769	1.731	7.179	7.508	7.343
5121670	3.154	2.923	3.038	14.238	12.766	13.502
5122663	3.000	2.769	2.885	14.245	12.310	13.278
5148670	2.538	3.308	2.923	10.983	13.418	12.200
5148672	2.769	2.923	2.846	13.175	12.376	12.775
5192673	2.538	2.231	2.385	11.034	8.994	10.014
5206670	2.846	3.154	3.000	12.054	14.128	13.091
5207670	1.692	2.462	2.077	7.247	11.062	9.155
5211670	2.769	2.692	2.731	12.713	11.136	11.925
5215672	2.615	2.538	2.577	12.451	10.114	11.282
5250675	2.846	3.231	3.038	12.745	14.737	13.741
5304675	2.923	3.231	3.077	13.882	13.623	13.753
5314670	2.462	2.231	2.346	12.163	10.262	11.212
5338672	2.692	2.538	2.615	11.988	10.350	11.169
5423674	3.077	3.231	3.154	14.003	14.042	14.022
5402670	2.154	2.308	2.231	8.837	9.022	8.929
5417674	3.615	4.077	3.846	16.878	17.218	17.048
5417677	2.846	2.846	2.846	11.816	11.438	11.627
5421679	2.538	2.462	2.500	11.755	10.587	11.171
5422671	3.154	3.077	3.115	14.912	12.517	13.714
5422674	3.308	2.846	3.077	14.637	12.007	13.322
5423675	2.538	2.462	2.500	10.982	10.162	10.572
5424679	3.308	3.385	3.346	14.688	14.459	14.573
5428674	2.923	2.769	2.846	13.494	11.754	12.624
5445672	2.692	2.692	2.962	12.106	10.318	11.212
5459673	3.538	3.462	3.500	15.159	14.558	14.858
5467675	3.231	3.846	3.538	15.115	15.723	15.419
5468672	3.692	4.308	4.000	17.845	19.398	18.622
5470672	2.846	2.692	2.769	11.962	11.943	11.952
5480673	2.231	1.615	1.923	9.995	6.388	8.192
5499670	2.923	2.846	2.885	11.952	11.378	11.665
5505673	4.000	3.462	3.731	17.367	13.811	15.589
5514672	2.385	2.385	2.385	10.714	10.664	10.689
5517673	3.538	3.385	3.462	16.707	15.081	15.894
5567641	2.692	2.923	2.808	12.938	11.960	12.449
5567672	2.462	2.000	2.231	11.052	9.021	10.037
5567674	2.692	2.846	2.769	11.802	11.386	11.594

TABLE 14--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
5584650	2.615	2.769	2.692	12.148	11.643	11.895
5584670	1.846	1.846	1.846	8.414	7.552	7.983
5605670	3.077	2.923	3.000	15.049	12.357	13.703
5606670	2.769	2.846	2.808	11.698	11.324	11.511
5607672	3.923	3.923	3.923	17.737	18.532	18.135
5608657	2.923	3.077	3.000	13.629	13.762	13.695
5616673	1.615	1.846	1.731	7.122	6.807	6.964
5618671	2.692	2.462	2.577	12.635	11.614	12.125
5619672	2.231	2.385	2.308	9.847	10.749	10.298
5619673	2.308	2.769	2.538	9.532	11.915	10.724
5633670	2.692	2.000	2.346	11.369	8.751	10.060
5637670	3.077	3.308	3.192	14.490	15.580	15.035
5642671	2.769	2.538	2.654	12.126	10.528	11.327
5679674	2.615	2.923	2.769	11.518	12.632	12.075
5705670	2.615	2.385	2.500	12.073	10.109	11.091
5712672	3.231	3.308	3.269	14.722	12.789	13.755
5739673	4.000	4.615	4.308	18.795	20.522	19.658
5753676	2.462	2.077	2.269	11.167	9.254	10.210
5779670	2.615	3.000	2.808	11.455	11.818	11.637
5833673	3.000	3.154	3.077	13.580	13.922	13.751
5836670	2.385	2.769	2.577	10.127	10.558	10.342
5842670	2.692	2.538	2.615	12.128	9.219	10.673
5887671	2.923	3.385	3.154	13.728	14.858	14.293
5890670	2.462	2.538	2.500	10.587	10.759	10.673
5928672	2.692	3.077	2.885	12.493	12.779	13.636
5964670	3.308	3.462	3.385	14.132	14.273	14.203
5975671	2.000	2.154	2.077	8.562	8.062	8.312
5982670	2.308	2.692	2.500	9.461	10.048	9.755
6008670	2.615	2.846	2.731	12.123	12.838	12.481
6041672	2.385	2.615	2.500	11.037	11.210	11.123
6065671	2.923	2.769	2.846	12.572	11.873	12.223
6085670	2.462	2.615	2.538	10.135	10.266	10.201
6159670	3.077	3.538	3.308	13.933	14.878	14.406
6180671	2.846	2.769	2.808	13.114	11.428	12.271
6240673	3.154	2.846	3.000	13.588	13.894	13.741
6528671	2.308	2.462	2.385	10.222	10.444	10.333
6665670	3.000	3.615	3.308	13.134	15.757	14.445
6885670	2.692	2.692	2.692	12.575	11.185	11.880
6897674	2.154	2.000	2.077	11.142	10.050	10.596
6905673	3.923	3.846	3.885	18.270	17.571	17.920
6930671	3.231	3.538	3.385	14.178	15.690	14.934
6932673	2.538	2.308	2.423	10.682	9.537	10.110
6934671	3.308	3.154	3.231	14.720	13.506	14.113

TABLE 14--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
6934673	2.385	2.769	2.577	10.545	12.605	11.575
6950672	3.462	3.615	3.538	15.148	16.336	15.742
6977672	2.308	2.692	2.500	10.660	11.368	11.014
6996671	2.154	2.231	2.192	8.105	9.054	8.580
7005670	2.462	1.846	2.154	11.222	7.233	9.227
7024676	3.308	4.000	3.654	15.783	20.077	17.930
7026660	3.000	3.385	3.192	12.565	14.588	13.576
7026673	2.769	3.154	2.962	12.247	14.023	13.135
7062672	1.769	1.692	1.731	7.943	7.562	7.753
7082672	2.077	2.154	2.115	8.958	8.382	8.670
7104650	2.231	2.077	2.154	9.315	8.706	9.011
7104670	2.692	2.538	2.615	11.998	10.542	11.270
7104674	2.538	2.462	2.500	11.572	10.602	11.087
7121670	3.923	3.692	3.808	17.915	16.914	17.414
7139670	2.462	2.538	2.500	11.273	11.955	11.614
7149673	4.462	4.385	4.423	20.643	20.051	20.347
7176670	2.923	3.462	3.192	13.475	14.690	14.083
7177672	2.615	2.462	2.538	11.406	10.270	10.838
7194673	3.385	3.385	3.385	16.255	15.055	15.655
7300671	2.923	2.923	2.923	13.152	11.768	12.460
7324670	2.462	2.538	2.500	10.608	10.186	10.397
7347672	2.692	2.385	2.538	12.228	9.465	10.847
7347675	2.462	3.077	3.769	10.171	12.393	11.282
7347676	2.615	2.538	2.577	11.745	10.579	11.162
7399673	2.231	2.154	2.192	10.290	9.789	10.040
7441675	2.846	3.000	2.923	13.170	12.798	12.984
7467663	1.923	2.077	2.000	8.166	7.661	7.913
7491670	3.692	3.923	3.808	16.874	17.158	17.016
7544672	3.231	3.077	3.154	14.141	13.389	13.765
7555673	3.308	3.538	3.423	14.625	13.682	14.153
7576672	2.923	2.615	2.769	11.814	10.110	10.962
7619650	3.385	3.615	3.500	15.732	16.855	16.293
7688673	2.462	2.538	2.500	10.725	10.123	10.424
7691672	3.538	3.615	3.577	16.930	15.786	16.358
7697678	4.385	4.692	4.538	20.277	21.954	21.090
7701671	3.000	3.077	3.038	14.468	13.287	13.878
7701676	3.077	3.077	3.077	13.135	12.090	12.613
7707672	3.923	3.846	3.885	19.208	18.170	18.689
7713671	3.308	3.231	3.269	14.771	13.522	14.146
7713674	3.000	3.385	3.192	13.992	14.757	14.374
7713675	3.000	2.923	2.962	12.307	11.794	12.500
7715674	3.000	3.615	3.308	12.915	15.785	14.350
7716671	3.769	3.692	3.731	17.448	17.562	17.505

TABLE 14--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
7733676	2.077	2.154	2.115	9.769	8.656	9.213
7801670	3.308	3.769	3.538	13.578	15.988	14.783
7807673	1.462	1.923	1.692	6.181	8.162	7.172
7824670	2.615	2.615	2.615	12.019	11.538	11.779
7868672	2.462	2.308	2.385	10.605	9.651	10.128
7918650	3.846	4.000	3.923	17.668	17.998	17.833
7918671	2.615	2.385	2.500	11.967	10.809	11.388
7961671	3.000	3.154	3.077	12.919	12.931	12.925
7980673	2.538	2.231	2.385	10.388	8.843	9.615
7990676	2.846	3.077	2.962	13.878	14.247	14.063
7994674	3.538	3.923	3.731	16.552	16.882	16.717
7997670	2.923	2.462	2.692	13.462	10.117	11.789
8020671	2.769	3.077	2.923	12.538	13.677	13.108
8050670	3.231	3.154	3.192	15.802	13.835	14.818
8117672	3.462	3.462	3.462	15.846	15.712	15.779
8121671	3.000	2.385	3.692	13.658	10.960	12.309
8124673	2.769	3.000	2.885	13.509	13.498	13.504
8125672	2.923	2.923	2.923	12.864	12.588	12.726
8127660	3.385	3.385	3.385	14.548	14.150	14.349
8151674	2.846	3.077	2.962	12.326	13.726	13.026
8160671	2.385	2.692	2.538	10.945	11.205	11.075
8161673	2.769	2.077	1.923	7.525	8.064	7.794
8189670	3.000	3.385	3.192	13.308	14.692	14.000
8219671	3.000	2.769	2.885	14.871	12.907	13.889
8220673	3.538	3.154	3.346	16.250	13.782	15.016
8232674	2.077	2.308	2.192	8.453	8.822	8.637
8238672	2.615	2.615	2.615	12.105	11.714	11.910
8286672	3.077	3.308	3.192	14.022	14.634	14.328
8315671	2.000	2.231	2.115	8.495	9.609	9.052
8316670	2.231	2.846	2.538	10.435	12.907	11.671
8321674	2.308	2.285	2.346	10.538	10.364	10.451
8348672	2.462	2.385	2.423	11.521	10.505	11.013
8367671	2.769	2.538	2.654	12.436	11.946	12.191
8373674	2.077	2.077	2.077	8.996	8.253	8.625
8415674	2.692	2.538	2.615	12.412	11.908	12.160
8423670	2.231	2.692	2.462	9.812	9.997	9.904
8427671	2.538	2.923	2.731	10.962	12.581	11.772
8432670	1.923	2.000	1.962	8.458	8.646	8.552
8432671	2.385	2.769	2.577	10.649	11.335	10.992
8532671	3.231	2.846	3.038	14.722	11.659	13.190
8563672	3.308	3.615	3.462	16.088	16.004	16.046
8568670	3.077	3.385	3.231	14.035	15.623	14.829
8947671	1.692	1.769	1.731	7.272	6.418	6.845

TABLE 14--Continued

Student No.	Likert Score			Scale Products Score		
	Odd	Even	Total	Odd	Even	Total
8957670	2.231	1.923	2.077	10.138	8.142	9.140
9010672	2.077	2.308	2.192	8.748	9.165	8.956
9166670	1.923	1.769	1.846	8.725	7.433	8.079
9179671	2.308	2.615	2.462	9.768	10.776	10.272
9235676	3.000	2.769	2.885	13.675	10.996	12.335
9274670	3.846	3.769	3.808	17.199	15.231	16.215
9303672	2.846	3.000	2.923	13.949	13.594	13.772
9379673	3.462	3.308	3.385	16.927	14.430	15.678
9452670	3.231	3.231	3.231	14.866	13.341	14.103
9457671	2.692	2.923	2.808	12.388	12.404	12.396
9464672	3.231	3.615	3.423	13.475	14.539	14.007
9481672	2.615	3.154	2.885	11.902	13.368	12.635
9512674	3.077	3.154	3.115	13.357	14.703	14.030
9513672	2.538	2.538	2.538	11.973	11.173	11.573
9513677	2.308	2.538	2.423	10.446	10.472	10.459
9515676	2.231	2.538	2.385	9.920	10.445	10.182
9554671	2.231	1.923	2.077	9.595	7.508	8.552
9627670	1.923	2.231	2.077	8.331	8.724	8.527
9700672	2.077	1.923	2.000	9.273	8.209	8.741
9718650	3.231	3.077	3.154	15.235	13.505	14.370
9749675	3.154	3.231	3.192	13.758	13.145	13.452
9774673	2.538	2.231	2.385	11.079	9.118	10.099
9796672	2.462	2.846	2.654	10.532	11.532	11.032
9810670	2.308	2.154	2.231	10.483	8.732	9.608

<sup>a</sup> The terms odd, even, and total, for either scoring technique, refer respectively to the average score on the 13 odd numbered statements, the average score on the 13 even numbered statements, and the average score on the entire 26 statements.

TABLE 15

STATISTICS REQUIRED FOR THE CALCULATION OF A GUTTMAN INTERNAL  
CONSISTENCY RELIABILITY COEFFICIENT

Statistics of Scores Obtained by the Likert Technique					
Date	Group	$S_o^2$	$S_e^2$	$S_t^{2a}$	$r^b$
December 1967	Control	.3192	.3091	.2970	.942
	Experimental	.3136	.3294	.3025	.937
March 1968	Control	.3003	.3576	.3102	.937
	Experimental	.3352	.4032	.3516	.950

Statistics of Scores Obtained by the Scale Products Technique

Date	Group	$S_o^2$	$S_e^2$	$S_t^2$	r
December 1967	Control	7.529	6.912	6.760	.932
	Experimental	7.530	7.947	7.241	.932
March 1968	Control	7.447	8.486	7.469	.933
	Experimental	8.082	9.229	8.288	.956

a  $S_o^2$ ,  $S_e^2$ , and  $S_t^2$  are respectively the sample variances of the average scores on the 13 odd, 13 even, and the entire 26 statements about their respective mean values for a given sample of students.

b r is Guttman's internal consistency reliability coefficient, calculated from

$$r = 2(1 - \frac{S_o^2 + S_e^2}{4S_t^2})$$

For each application there were 238 students in the control group, and 242 in the experimental group.



## APPENDIX G

### DATA REQUIRED IN THE VALIDITY STUDIES ON THE FINAL ATTITUDE SCALE

TABLE 16

ATTITUDE SCORES AND DERIVED DATA PERTAINING TO STUDENTS WHO  
ELECTED NO PHYSICS COURSES IN THEIR SECOND YEAR

No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>
1.	2.769	7.667	17.	3.077	9.467	33.	2.885	8.323
2.	3.115	9.703	18.	4.038	16.305	34.	3.346	11.195
3.	4.077	16.056	19.	2.500	6.250	35.	2.346	5.503
4.	2.923	8.543	20.	3.654	13.351	36.	2.231	4.977
5.	2.846	8.099	21.	3.769	14.205	37.	2.731	7.458
6.	2.538	6.441	22.	3.808	14.500	38.	2.769	7.667
7.	3.692	13.690	23.	2.423	5.870	39.	3.077	9.467
8.	3.231	10.439	24.	3.038	14.103	40.	2.538	6.441
9.	3.077	9.042	25.	2.962	8.773	41.	2.192	4.804
10.	3.308	10.942	26.	1.885	3.553	42.	2.500	6.250
11.	2.154	9.947	27.	2.308	5.326	43.	3.231	10.439
12.	3.885	15.093	28.	3.885	15.093	44.	3.000	9.000
13.	3.038	9.229	29.	2.392	7.246	45.	3.654	13.351
14.	2.038	4.153	30.	3.885	15.093	46.	2.846	8.099
15.	2.769	7.669	31.	2.423	5.870	47.	2.808	7.884
16.	2.846	8.099	32.	3.538	12.517	48.	2.615	11.093

$$\sum X = 143.969$$

$$\bar{X} = 2.9999$$

$$\sum X^2 = 443.638$$

$$s^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N} = .2463$$

TABLE 17

ATTITUDE SCORES AND DERIVED DATA PERTAINING TO STUDENTS WHO  
ELECTED PURE PHYSICS COURSES IN THEIR SECOND YEAR

No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>
1.	3.769	14.205	14.	2.423	5.870	27.	3.385	11.458
2.	2.692	7.246	15.	3.000	9.000	28.	3.077	9.467
3.	2.000	4.000	16.	2.769	7.667	29.	2.846	8.099
4.	2.846	8.099	17.	2.500	6.250	30.	2.308	5.326
5.	2.615	6.838	18.	2.077	4.313	31.	3.231	10.439
6.	4.115	16.933	19.	3.231	10.439	32.	2.115	4.473
7.	3.269	10.689	20.	2.346	5.503	33.	2.423	5.870
8.	3.385	11.458	21.	2.308	5.326	34.	2.654	7.043
9.	3.038	9.229	22.	2.769	7.667	35.	2.192	4.804
10.	2.731	7.458	23.	3.808	14.500	36.	2.038	4.153
11.	2.423	5.870	24.	2.577	6.640	37.	3.154	9.947
12.	2.615	6.838	25.	3.000	9.000	38.	3.231	10.439
13.	2.577	6.538	26.	2.885	8.323			

$$\sum X = 106.422$$

$$\bar{X} = 2.8005$$

$$\sum X^2 = 307.327$$

$$s^2 = \sum X^2 - \frac{(\sum X)^2}{N} = .2442$$

TABLE 18

ATTITUDE SCORES AND DERIVED DATA PERTAINING TO STUDENTS WHO  
ELECTED APPLIED PHYSICS COURSES IN THEIR SECOND YEAR

No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>	No.	X	X <sup>2</sup>
1.	3.269	10.686	13.	2.654	7.043	25.	2.654	7.043
2.	2.654	7.043	14.	3.077	9.467	26.	2.962	8.773
3.	2.846	8.099	15.	3.115	9.703	27.	3.269	10.686
4.	2.538	6.441	16.	2.962	8.773	28.	2.346	5.503
5.	2.154	4.639	17.	2.115	4.473	29.	2.000	4.000
6.	2.192	4.804	18.	2.885	8.323	30.	2.192	8.902
7.	1.885	3.553	19.	2.500	6.250	31.	3.077	9.467
8.	8.385	11.458	20.	2.308	5.326	32.	3.269	10.686
9.	2.192	4.804	21.	3.231	10.439	33.	2.615	6.838
10.	3.346	11.195	22.	3.038	9.229	34.	3.115	9.703
11.	3.423	11.716	23.	2.462	6.061	35.	2.462	6.061
12.	2.115	4.473	24.	3.462	11.985	36.	1.615	2.608

$$\sum X = 97.381$$

$$\bar{X} = 2.7050$$

$$\sum X^2 = 272.155$$

$$s^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N} = .2426$$

Fig. 6.--The Significance of Differences Existing in the Mean Attitude Scores Toward the Physics 110 Laboratory of Past Physics 110 Students Electing Applied Physics, Pure Physics, or No Physics in Their Second Year.

A. Applied Physics (2) Versus No Physics (1)

$$\begin{aligned}
 t &= \frac{X_1 - X_2}{\sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}} \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}} \\
 &= \frac{2.9999 - 2.7050}{\sqrt{\frac{(47)(.2463) + (35)(.2426)}{82}} \sqrt{\frac{1}{48} + \frac{1}{36}}} \\
 &= 2.748
 \end{aligned}$$

$t = 2.748$  is significant at the .005 level  
 $(t_{.005, \infty} = 2.576)$

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B. Pure Physics (2) Versus No Physics (1)

$$\begin{aligned}
 t &= \frac{2.9999 - 2.8005}{\sqrt{\frac{(47)(.2463) + (37)(.2442)}{84}} \sqrt{\frac{1}{48} + \frac{1}{38}}} \\
 &= 1.854
 \end{aligned}$$

$t = 1.854$  is significant at the .05 level  
 $(t_{.05, \infty} = 1.645)$



TABLE 19

STUDENTS' ATTITUDE SCORES ON THE ATTITUDE SCALE AND THE  
ATTITUDE SCORES GIVEN THEM BY THEIR TEACHING ASSISTANTS

Student No.	X <sup>a</sup>	Y	Student No.	X	Y
0081662	2	4.3	0081671	3	1.9
0119671	3	2.5	0416672	3	2.3
0432671	1	2.3	0463672	4	4.3
0768672	4	3.2	0794671	3	3.0
0834678	2	4.1	0871671	2	2.0
0880671	2	2.8	0920671	1	2.5
0944671	3	1.7	0995671	2	1.8
1001676	3	1.7	1030672	2	1.7
1043673	2	2.3	1058673	1	2.0
1074670	2	2.1	1075672	1	2.0
1081672	2	3.5	1103674	3	4.4
1112673	3	2.2	1147673	1	1.6
1149671	1	2.2	1164671	2	2.7
1253672	4	3.8	1302662	2	2.3
1322670	2	2.5	1358672	3	2.7
1397678	3	3.7	1465673	3	2.4
1492671	3	2.7	1492673	3	1.8
1573673	2	2.8	1613671	1	1.7
1719670	2	2.4	1719671	2	3.0
1727670	2	2.3	1765671	2	2.4
1789671	2	3.2	1802671	1	2.9
1808674	2	1.4	1812661	3	1.7
1812672	3	3.2	1844671	3	2.3
1896675	2	1.9	1929671	2	2.0
1954672	1	2.4	1954673	3	4.0
2073671	1	2.5	2114672	2	1.7
2361671	2	2.0	2391672	1	2.1
2392672	1	3.0	2586672	2	3.5
2734672	2	2.6	2734673	1	2.1
2738672	3	3.1	2754671	2	2.4
2776674	2	1.5	2858674	2	2.6
2905661	3	2.8	2908671	3	1.9
2937672	2	2.8	2937677	2	2.7
2937678	2	2.0	3043672	1	2.0
3201671	3	2.5	3285671	1	1.7
3315673	2	1.7	3385671	3	2.6
3409660	3	3.3	3432670	2	3.1
3438670	3	2.7	3445670	1	2.3
3477672	1	2.2	3567670	2	2.1

TABLE 19--Continued

Student No.	X	Y	Student No.	X	Y
3573671	3	1.9	3731673	3	2.2
3843673	2	2.3	3845672	2	2.5
3849670	2	3.2	4671671	2	3.0
4694670	1	1.9	4713672	2	1.2
4852670	1	2.5	4866671	1	2.0
4891672	1	1.8	4932670	2	2.8
4960672	2	3.0	4984670	2	2.6
4999672	3	2.4	5021670	2	2.3
5042674	3	2.7	5116673	3	1.9
5151672	3	1.9	5326622	2	2.3
5406674	3	2.2	5585674	3	2.7
5622670	3	2.3	5662671	2	1.8
5835670	1	2.5	6019670	2	4.5
6215670	3	1.7	6901675	3	1.8
7082674	2	2.6	7189670	3	2.7
7522672	3	1.5	7549670	2	2.2
7593671	1	2.2	7695675	3	2.3
7704674	3	2.8	7710670	3	3.0
7742672	3	2.6	7783672	1	2.4
7807671	3	1.8	7827678	1	3.0
7927672	2	2.0	8186672	1	1.5
9227679	1	2.0	9465672	2	2.2
9513673	3	2.7	9513676	2	1.8
9536675	2	1.9	9912673	3	3.3
0363671	2	2.5	0813672	1	2.1
0898671	2	2.7	0966676	3	3.2
0982670	2	2.3	1241671	3	2.4
1376676	1	2.5	1387662	3	3.2
1407673	3	2.7	1534662	3	2.6
1536672	2	2.6	2109663	2	1.5
2191670	2	2.2	2889674	1	2.2
2905671	2	3.0	2921677	1	2.5
3081670	2	2.8	3127670	3	2.6
3289672	3	2.7	3391671	3	3.2
3460651	3	3.7	3475673	1	2.0
3698672	2	2.6	3793670	2	3.5
3817673	2	2.7	4049670	2	2.8
4412670	2	2.4	4671676	2	3.0
5009670	3	1.7	5121670	1	3.0
5122663	3	2.9	5148670	3	2.9
5211670	2	2.7	5250675	3	3.0
5417677	2	2.8	5421679	3	2.5
5422674	2	3.0	5423675	3	2.5
5424679	2	3.3	5445672	2	2.7



TABLE 19--Continued

Student No.	X	Y	Student No.	X	Y
5459673	2	3.5	5470672	1	2.8
5480673	1	1.9	5499670	3	2.9
5514672	2	2.4	5517673	3	3.5
5567672	3	2.2	5567674	4	2.8
5607672	3	3.9	5616673	2	1.7
5618671	3	2.6	5619673	3	2.5
5633670	2	2.4	5637670	2	3.2
5642671	3	2.6	5739673	2	4.3
5753676	1	2.3	5779670	2	2.8
5833673	2	3.0	5887671	3	3.2
5890670	4	2.5	5964670	1	3.4
6008670	2	2.7	6065671	3	2.9
6159670	3	3.3	6528671	2	2.4
6665670	2	3.3	6905673	3	3.9
6930671	2	3.4	6932673	3	2.4
6950672	2	3.5	6977672	3	2.5
6996671	3	2.2	7005670	1	2.2
7024676	2	3.7	7026660	4	3.2
7026673	2	3.0	7062672	3	1.7
7082672	4	2.1	7104670	3	2.6
7104674	2	2.5	7139670	2	2.5
7149673	3	4.4	7176670	2	3.2
7177672	2	2.5	7324670	2	2.5
7347672	2	2.5	7347676	1	2.6
7467663	3	2.0	7491670	1	3.8
7555673	2	3.4	7619650	2	3.5
7713671	2	3.3	7713674	2	3.2
7713675	1	3.0	7715674	1	3.3
7716671	2	3.7	7733674	2	2.1
7807673	1	1.7	7824670	3	2.6
7918650	4	3.9	7918671	2	2.5
7961671	2	3.0	7980673	2	2.4
8020671	3	2.9	8121671	3	2.7
8125672	2	3.0	8127660	3	3.4
8160671	2	2.5	8161673	2	1.9
8189670	2	3.2	8219671	3	2.9
8232674	1	2.2	8315671	1	2.1
8321674	3	2.3	8348672	3	2.4
8367671	3	2.6	8415674	2	2.6
8423670	2	2.4	8947671	4	1.7
8957670	2	2.0	9179671	1	2.5
9235676	2	2.9	9464672	3	3.4
9481672	2	2.9	9515676	3	2.4
9554671	2	2.0	9700672	1	2.0
9718650	3	3.2	9774673	3	2.4
9796672	1	2.7	9810670	2	2.2

TABLE 19--Continued

- <sup>a</sup> "X" is the students' attitude score given by the teaching assistant, and "Y" is the score achieved on the attitude scale.

Fig. 8.--The Correlation of Students' Attitude Scores on the Attitude Scale With the Attitude Scores Given Them By Their Teaching Assistants.

Y - Attitude Score obtained on Attitude Scale

X - Attitude Score given by Teaching Assistant

$$\begin{array}{lll} \sum X = 583 & \sum X^2 = 1473 & \sum XY = 1521.8 \\ \sum Y = 670.6 & \sum Y^2 = 1834.5 & N = 257 \end{array}$$

$$\begin{aligned} r_{xy} &= \frac{\sum XY - \frac{(\sum X)(\sum Y)}{N}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{N}\right) \left(\sum Y^2 - \frac{(\sum Y)^2}{N}\right)}} \\ &= \frac{(1521.8) - \frac{(583)(670.6)}{257}}{\sqrt{\left(1473 - \frac{(583)^2}{257}\right) \left(1834.5 - \frac{(670.6)^2}{257}\right)}} \\ &= 0.032 \end{aligned}$$

TABLE 20

THE DATA UTILIZED IN THE VALIDITY STUDY RELATING STUDENT  
ATTITUDE AND ACHIEVEMENT<sup>a</sup>

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
0081671	1.885	70	46	115	103	23
0119671	2.538	57	36	93	100	20
0416672	2.308	80	33	113	100	24
0432671	2.346	73	30	103	110	26
0324673	2.077	80	53	113	100	25
0566672	2.308	55	24	79	97	22
0768672	3.192	43	35	78	74	19
0794671	3.000	73	47	120	88	21
0795672	2.077	47	25	75	81	20
0834678	3.115	64	16	85	78	21
0843674	4.269	39	4	43	68	16
0871671	2.038	79	45	124	118	28
0880671	2.769	66	29	95	93	24
0913671	2.038	43	11	54	97	21
0918674	1.885	70	31	101	77	21
0921672	2.308	59	26	85	80	18
0944671	1.731	51	52	103	97	21
0974672	3.654	72	32	104	103	24
0988673	2.423	64	26	90	95	22
0995671	1.808	75	31	106	115	27
1001676	1.654	84	51	135	100	25
1030672	1.731	84	48	132	114	26
1043673	2.269	71	51	122	100	24
1047671	2.000	63	42	105	91	20
1058673	2.038	67	45	112	102	25
1074670	2.154	61	36	97	82	19
1075672	1.962	63	31	94	108	26
1081672	3.538	70	33	103	102	23
1103674	4.423	53	18	71	96	22
1112673	2.192	54	40	94	100	23
1149671	2.192	72	38	110	92	23
1164671	2.654	48	21	69	89	20
1171672	1.923	72	32	104	102	24
1302662	2.308	61	32	93	95	21
1322670	2.500	73	25	98	98	24
1358672	3.000	63	8	71	96	21
1373671	2.038	68	32	100	87	22
1389671	2.393	69	40	109	90	21
1397678	3.692	86	43	129	107	26

TABLE 20--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
1405670	2.308	75	38	113	112	25
1424672	2.000	65	32	98	88	20
1465673	2.423	64	41	111	80	21
1466674	2.269	74	50	124	93	24
1492671	2.654	71	26	97	110	24
1492673	1.769	80	57	137	110	27
1537673	1.808	50	29	79	89	22
1567672	1.462	79	47	126	91	23
1573673	2.769	75	40	115	102	25
1575670	1.692	63	33	96	107	20
1579660	2.885	72	39	111	94	21
1580676	1.462	72	19	94	107	25
1584671	2.615	62	24	86	78	21
1604671	2.885	67	38	105	102	23
1613671	1.731	97	55	152	142	32
1719670	2.384	74	50	126	91	23
1719671	3.038	61	25	86	92	23
1727670	2.346	53	26	79	84	21
1765671	2.432	55	10	65	79	21
1786671	2.308	73	36	109	85	20
1789671	3.192	83	47	120	107	26
1802671	2.923	73	34	107	108	25
1808674	1.385	56	10	66	123	24
1812672	3.154	60	28	88	82	19
1844671	2.346	66	33	99	107	24
1896676	2.538	69	30	99	109	27
1901673	2.231	79	50	129	108	25
1929671	1.962	68	25	93	108	26
1954672	2.423	53	22	75	84	22
1954673	4.038	73	31	104	82	21
1966670	2.231	57	33	90	94	20
2073671	2.462	84	47	131	110	28
2114672	1.732	52	29	81	102	22
2333672	2.731	67	50	117	86	21
2390672	1.923	80	51	131	125	27
2390673	3.077	64	43	107	90	23
2391672	2.115	69	39	108	109	26
2392672	2.962	37	23	60	77	19
2586671	1.846	65	32	98	95	20
2586672	3.500	70	38	108	93	22
2587672	2.615	70	40	110	85	22
2734672	2.615	65	37	102	105	23
2734673	2.115	76	43	119	100	24

TABLE 20--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
2738672	3.115	55	34	89	92	22
2738673	2.769	60	27	87	84	21
2754671	2.423	71	30	101	104	25
2776674	1.500	57	41	98	97	22
2826673	2.423	35	20	55	84	17
2844670	2.192	59	20	79	85	20
2855675	3.192	75	49	124	79	21
2858674	2.615	57	20	77	93	23
2894671	2.346	59	18	77	102	22
2905661	2.846	64	48	112	79	20
2908671	1.885	68	37	94	111	25
2937672	2.769	67	31	98	95	23
2937675	3.500	51	23	89	111	24
2937678	2.000	57	25	82	106	22
3023671	3.308	62	38	100	97	25
3027672	2.154	55	33	87	99	22
3042675	2.538	58	32	90	97	21
3136672	2.269	76	47	123	112	24
3146670	1.846	54	57	148	112	27
3201671	2.538	62	31	93	97	22
3201672	2.500	67	39	106	92	21
3209673	2.038	55	29	84	104	23
3210678	2.538	56	18	74	99	23
3285671	1.692	66	46	112	97	23
3315673	1.692	58	32	90	111	24
3385671	2.577	67	27	94	98	23
3409660	3.346	61	32	93	77	20
3438670	2.731	78	52	130	104	26
3445670	2.231	92	51	143	135	30
3477672	2.231	74	29	103	140	30
3498672	2.538	48	37	85	88	18
3545671	1.885	63	40	103	109	24
3552671	2.769	68	33	101	87	19
3567670	2.115	42	33	96	93	21
3568670	2.154	63	53	132	110	24
3573671	1.885	71	45	116	112	23
3672671	2.385	71	47	118	102	22
3731673	2.154	64	40	104	96	23
3734670	3.000	62	30	92	84	19
3744673	2.538	73	40	113	105	25
3765670	2.500	73	31	104	101	22
3843673	2.346	69	34	103	106	22

TABLE 20--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
3845672	2.500	68	36	104	104	23
3849670	3.154	68	33	92	92	21
4144670	2.308	81	50	131	97	24
4569672	3.538	71	34	105	105	22
4575669	1.846	53	22	75	106	22
4575672	1.846	66	40	106	117	24
4671671	2.962	63	29	92	88	22
4673670	2.038	71	36	107	94	21
4694670	1.923	49	37	86	103	22
4694671	2.692	54	25	79	92	20
4713672	1.192	68	38	106	106	24
4741672	2.269	62	31	93	102	22
4815670	2.577	65	32	98	109	23
4831671	2.615	56	20	80	90	21
4839670	2.115	67	38	105	107	24
4852670	2.500	71	37	108	110	25
4866671	2.038	61	37	98	119	25
4875670	2.077	53	17	70	102	21
4888674	2.423	56	39	95	83	21
4891672	1.846	78	37	115	107	25
4897670	2.654	78	52	140	93	24
4899672	1.885	69	40	109	96	22
4925672	2.269	51	14	65	102	23
4932670	2.808	65	36	101	97	22
4960672	3.038	68	42	110	90	24
4999672	2.385	48	23	71	86	19
5016670	2.038	55	24	79	91	22
5021670	2.269	73	42	115	123	27
5116673	1.923	59	16	75	94	21
5151672	1.962	67	39	106	101	22
5187671	2.462	70	48	118	98	24
5192676	2.885	63	22	85	88	20
5304673	2.308	84	34	118	107	26
5326622	2.346	58	34	92	114	26
5337673	2.769	47	30	77	85	20
5406674	2.192	55	32	87	102	22
5449670	2.500	84	58	142	97	21
5468674	2.462	74	31	105	103	19
5585674	2.692	46	30	76	108	23
5622670	2.346	54	25	79	105	23
5662671	1.808	87	55	142	111	26
5835670	2.500	45	14	59	99	22

TABLE 20--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
6019670	4.462	72	31	103	94	23
6215670	1.731	41	14	55	98	20
6507670	4.231	43	29	72	79	21
6901675	1.808	50	8	60	81	19
6985676	2.577	42	18	60	93	21
7082674	2.615	68	36	104	92	23
7189670	2.731	53	33	86	85	20
7198672	2.154	80	80	51	92	22
7522672	1.462	61	27	88	98	21
7549670	2.192	57	27	84	79	19
7555675	2.923	58	44	102	89	19
7593671	2.192	76	42	117	105	25
7695675	2.308	58	30	88	97	23
7704674	2.769	43	24	67	87	21
7710670	2.962	62	38	100	99	22
7742672	2.577	62	13	75	87	21
7813673	2.538	79	42	121	93	22
7827678	2.962	65	13	78	105	25
7927672	2.000	89	55	144	117	26
8040671	2.538	52	24	76	80	20
8041671	2.538	61	35	96	106	24
8186672	1.538	61	35	96	96	22
8321673	2.192	59	22	82	103	23
8390675	2.231	49	4	53	104	23
9227679	1.962	87	47	134	109	25
9287670	3.077	65	23	88	71	19
9303674	2.231	73	43	116	98	24
9430671	2.154	69	46	115	104	25
9465672	2.154	75	48	123	103	23
9513676	1.769	65	34	99	102	21
9536675	1.885	56	22	78	104	23
9716672	2.923	66	20	86	108	25
9725672	2.731	69	35	104	104	24
9912673	3.346	73	44	114	93	24

<sup>a</sup> Y is the student's score on the final application of the attitude scale, and X<sub>1</sub> through X<sub>5</sub> are respectively the course mark prior to the final exam, the final exam mark, the final course mark, the lab mark in the second term, and the total lab mark.



## APPENDIX H

### THE DATA USED IN THE ANALYSIS OF THE ATTITUDINAL STUDY

TABLE 22

THE FINAL ATTITUDE SCORE FOR EACH STUDENT IN THE CONTROL GROUP, TOGETHER WITH THOSE FACTORS UPON WHICH THIS SCORE MAY DEPEND

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub> <sup>a</sup>
0348673	-	2.346	89	43	46	3	1	3	0	-
0363671	2.538	2.385	63	29	34	2	1	3	1	60
0403673	2.385	2.500	96	49	47	2	1	2	2	73
0437671	3.077	3.308	80	34	46	3	1	3	1	51
0591670	-	2.615	58	22	36	4	2	3	0	-
0768670	-	1.962	86	36	50	3	1	3	0	-
0802660	-	2.923	79	37	42	5	1	4	2	-
0812670	1.808	2.231	-	-	-	3	1	-	2	-
0813672	2.115	1.577	77	33	44	4	2	4	2	74
0898671	2.731	3.154	99	51	48	2	2	1	1	73
0926673	-	2.923	87	40	47	1	1	2	1	-
0966676	3.231	2.808	82	33	49	3	2	3	1	75
0982670	2.308	2.000	97	49	48	3	2	2	1	73
1032672	-	3.538	87	42	45	2	2	2	1	-
1047673	4.000	3.808	77	32	45	3	2	3	1	81
1127672	2.654	2.269	64	35	29	3	1	4	1	60
1241671	2.385	2.423	86	40	46	2	2	1	2	83
1363675	-	2.269	77	31	46	4	2	2	1	-
1376676	2.462	2.346	93	46	47	1	2	1	1	84
1387662	3.192	3.154	75	38	37	3	1	3	3	20
1407673	2.731	2.462	80	43	37	5	1	3	1	56
1459671	2.423	2.692	82	36	46	3	2	3	1	55
1496672	2.500	2.346	75	32	43	3	2	3	1	66
1534662	2.615	2.654	67	31	36	5	1	4	2	45
1536672	2.615	2.538	72	31	41	5	2	4	1	54
1580677	-	3.154	80	37	43	6	2	3	1	-
1653670	-	2.692	93	44	49	5	2	2	1	-
1762672	2.885	2.500	73	37	36	2	2	2	1	81
1838675	2.000	2.462	77	38	39	3	2	3	1	56
1839660	2.731	2.808	-	-	-	3	1	3	1	52
1843672	3.500	2.654	81	35	46	2	1	3	0	63
1860670	-	3.000	75	38	37	5	1	4	1	-
1931672	-	2.731	77	32	45	4	2	3	2	-
2109663	1.538	1.538	80	40	40	-	1	-	2	-
2127674	2.269	2.192	86	44	42	2	1	2	1	72
2191670	2.154	2.231	82	38	44	2	2	1	1	84
2358672	-	2.808	93	48	45	4	1	2	0	-
2527660	-	2.538	-	-	-	-	-	-	-	-
2788670	-	3.538	101	55	46	3	1	3	1	-

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
2854673	3.077	2.423	79	31	48	3	2	3	1	79
2855672	-	2.769	75	33	42	3	2	4	1	-
2889672	-	2.077	85	38	47	2	2	3	1	-
2889674	2.154	3.000	92	46	46	4	2	3	1	69
2905671	3.000	3.385	70	31	39	4	2	3	1	57
2921677	2.462	2.154	89	42	47	1	1	1	2	82
2935661	-	4.269	86	40	46	1	2	2	0	-
3081670	2.846	3.654	57	24	33	5	2	4	1	59
3127670	2.577	2.385	77	41	36	2	1	2	1	54
3289672	2.654	2.885	77	36	41	3	2	3	1	62
3391671	3.231	2.885	79	39	40	-	1	1	1	65
3460651	3.769	3.308	-	-	-	6	1	3	2	-
3475673	2.077	1.885	85	44	41	1	1	3	1	48
3515674	-	2.500	77	34	43	-	-	-	-	-
3615672	3.231	2.423	65	26	39	2	1	3	1	47
3676671	-	3.577	83	44	39	4	2	4	2	-
3698672	2.577	3.885	89	44	45	4	1	3	2	60
3720672	3.885	3.977	73	33	40	2	1	2	2	81
3744660	-	2.231	98	50	48	-	-	-	-	-
3793670	3.462	3.500	97	51	46	3	1	3	1	65
3817673	2.692	2.423	78	31	47	-	-	-	-	-
3841670	1.923	1.808	83	37	46	4	2	3	1	64
4049670	2.846	3.154	76	35	41	3	1	2	2	63
4412670	2.385	2.692	78	31	47	4	2	4	2	62
4545671	-	1.769	74	30	44	4	2	3	2	-
4616670	2.885	2.000	-	-	-	-	1	-	2	-
4671672	-	2.462	73	36	37	3	1	3	1	-
4671676	2.962	2.923	71	32	39	2	1	4	1	58
4739672	2.462	2.423	94	50	44	-	-	-	-	-
4825660	-	3.615	77	38	39	4	1	6	0	-
4889671	-	3.000	76	32	44	3	1	2	1	-
5011672	-	2.808	99	54	45	-	-	-	-	-
5009670	1.731	1.731	63	26	37	4	1	2	1	67
5019660	-	2.654	102	53	49	2	1	2	2	-
5074670	-	2.500	69	36	33	2	1	2	1	-
5121670	3.038	2.846	91	45	46	3	2	4	1	56
5122663	2.885	3.308	75	38	37	2	1	2	2	49
5123670	-	3.231	71	34	37	4	2	4	1	-
5140672	-	3.769	87	42	45	4	1	2	1	-
5148670	2.923	2.077	94	48	46	4	2	3	1	64
5148672	2.846	2.538	90	41	49	3	1	2	1	59
5149673	-	2.923	75	37	38	2	1	3	1	-
5158670	-	2.038	78	40	38	2	2	2	1	-
5190671	-	2.731	-	-	-	-	-	-	-	-
5192673	2.385	2.308	86	38	48	3	2	3	1	67

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
5206670	3.000	3.577	75	31	44	3	2	2	1	52
5207670	2.077	1.885	83	41	42	5	1	2	2	35
5211670	2.731	2.615	61	26	35	4	1	4	1	61
5215672	2.577	3.462	82	36	46	-	-	-	-	-
5232670	-	2.462	87	40	47	4	1	4	1	-
5250675	2.028	2.208	80	35	45	3	1	2	2	70
5254670	-	1.962	84	34	50	3	2	2	1	-
5304675	2.077	3.231	71	30	41	3	1	3	1	55
5314670	2.346	2.808	63	23	40	5	2	4	1	59
5338672	2.615	3.385	95	46	49	1	2	1	1	85
5359671	-	2.962	88	45	43	2	1	4	2	-
5402670	2.231	2.154	90	42	48	2	2	2	1	87
5415673	-	2.577	67	31	36	5	2	4	1	-
5417674	2.846	2.846	-	-	-	-	-	-	-	-
5417677	2.846	2.269	87	41	46	1	1	2	2	75
5419672	-	3.769	84	39	45	3	2	2	2	-
5421679	2.500	2.846	63	37	26	3	1	3	0	58
5422671	3.115	3.538	96	52	44	4	1	3	1	69
5422673	-	3.923	90	48	42	4	1	4	0	-
5422674	3.077	2.115	82	37	45	2	2	3	1	62
5422678	-	2.192	91	41	50	2	2	1	1	-
5423674	3.154	3.038	97	52	45	-	-	-	-	-
5423675	2.500	2.577	73	32	41	5	1	3	1	72
5423678	-	2.231	90	43	47	3	2	3	2	-
5424679	3.346	3.038	92	48	44	4	1	2	2	54
5428674	2.846	2.731	78	35	43	1	1	1	1	85
5430670	-	2.885	72	36	36	3	1	2	1	-
5445672	2.692	3.462	71	30	41	3	1	3	2	63
5459673	3.500	2.731	103	53	50	1	1	1	0	86
5467675	3.538	4.077	81	39	42	2	2	3	1	72
5468672	4.000	3.231	107	57	50	1	2	1	2	91
5470672	2.769	2.577	87	46	41	4	2	3	1	73
5480673	1.923	2.615	90	42	48	-	-	-	-	-
5486671	-	2.615	-	-	-	-	0	4	1	-
5499670	2.885	2.692	77	37	40	4	2	3	2	58
5505673	3.731	3.659	96	49	47	4	2	3	2	74
5514672	2.385	2.269	93	48	45	4	1	3	1	56
5517673	3.462	2.923	83	36	47	-	-	-	-	-
5535670	-	2.462	75	34	41	2	2	3	1	-
5548662	-	2.615	-	-	-	4	1	4	1	-
5567641	2.808	2.615	74	31	43	3	1	3	1	70
5567672	2.231	2.308	98	52	46	4	2	3	1	57
5567674	2.769	3.077	85	43	42	2	1	2	2	51
5570676	-	3.500	80	36	44	2	2	3	1	-
5583671	-	3.654	72	30	42	2	1	3	0	-

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
5584650	2.692	2.808	-	-	-	4	1	2	2	-
5584670	1.846	1.885	-	-	-	2	2	3	1	-
5595673	-	1.346	88	41	47	4	2	3	2	-
5600679	-	3.192	-	-	-	4	2	3	1	-
5605670	3.000	2.923	89	47	42	3	2	3	1	56
5606670	2.808	2.385	89	40	49	3	2	2	1	80
5607672	3.923	3.346	73	32	41	4	2	3	1	73
5608657	3.000	2.769	63	37	26	-	-	-	-	-
5608670	-	3.115	102	55	47	4	1	3	1	-
5616673	1.731	1.731	68	30	38	4	2	4	1	51
5618671	2.577	1.846	86	41	45	2	2	2	1	76
5619672	2.308	2.362	67	26	41	3	2	4	2	67
5619673	2.538	2.577	91	45	46	3	2	2	2	75
5620672	-	2.423	86	49	37	1	1	3	1	-
5626592	-	3.654	77	44	33	4	1	4	1	-
5629674	-	3.308	82	43	39	3	2	3	2	-
5633670	2.346	2.269	74	33	41	4	2	4	2	61
5637670	3.192	2.923	75	30	45	4	1	4	0	34
5639674	-	2.692	65	23	42	3	1	3	1	-
5642671	2.654	2.962	-	-	-	-	-	-	-	-
5648670	-	2.577	92	46	46	1	1	2	1	-
5679674	2.769	3.615	90	42	48	3	2	1	1	68
5705670	2.500	2.615	105	55	50	2	2	1	1	86
5712672	3.269	2.346	96	54	42	3	2	3	2	70
5734671	-	2.000	100	50	50	1	1	1	1	-
5739671	-	1.731	83	38	45	4	2	3	1	-
5739673	4.308	3.885	99	55	44	2	1	3	2	74
5752660	-	3.385	87	38	49	4	1	3	2	-
5753676	2.269	2.308	66	32	34	4	2	4	1	63
5767670	-	2.154	52	12	40	4	1	4	2	-
5779670	2.808	3.615	78	37	41	2	2	2	1	84
5833673	3.077	3.462	78	41	37	3	1	3	1	61
5836670	2.577	2.077	78	31	47	2	2	3	1	66
5842670	2.615	2.769	88	39	49	3	2	3	0	64
5887671	3.154	2.769	97	52	45	-	-	-	-	-
5890670	2.500	2.500	87	40	47	3	1	2	2	55
5928672	2.885	2.538	84	38	46	2	1	2	1	65
5964670	3.385	3.308	86	40	46	3	1	3	1	68
5975671	2.077	2.231	77	31	46	2	2	2	1	78
5982670	2.500	2.731	74	30	44	3	1	2	2	75
6008670	2.731	2.731	72	28	44	-	-	-	-	-
6041672	2.500	2.615	76	35	41	3	1	3	1	73
6065671	2.846	2.846	85	39	46	3	1	2	0	45
6078670	-	-	96	58	38	5	2	4	1	-
6085670	2.538	2.885	88	39	49	2	2	3	1	55

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
6115671	-	3.000	98	50	48	1	1	2	1	-
6159670	3.308	2.385	97	49	48	4	2	2	1	66
5180671	2.808	3.115	87	45	42	2	2	3	1	63
6240673	3.000	3.269	89	43	46	2	1	2	1	79
6493672	-	1.962	94	48	46	2	1	2	2	-
6511674	-	2.346	-	-	-	-	0	4	1	-
6528671	2.385	2.077	70	32	38	4	2	3	1	65
6665670	3.308	2.923	86	45	41	4	2	3	1	65
6717661	-	3.462	81	37	44	4	1	4	1	-
6882672	-	2.885	83	35	48	1	2	2	2	-
6885670	2.692	2.192	45	9	36	1	1	2	1	85
6897674	2.077	3.346	82	49	33	3	1	4	2	72
6905671	-	2.885	100	50	50	1	1	1	2	-
6905673	3.885	3.231	-	-	-	-	-	-	-	-
6924677	-	2.385	68	34	34	2	1	2	2	-
6926672	-	2.615	85	47	38	4	2	3	2	-
6930671	3.385	2.808	96	47	49	2	1	2	1	73
6932673	2.423	2.654	81	38	43	3	1	2	0	63
6934671	3.231	3.577	103	55	48	1	1	2	2	62
6934673	2.577	3.115	66	29	37	4	2	3	2	66
6950672	3.538	2.577	63	25	38	3	1	2	1	54
6965661	-	3.115	103	56	47	-	1	-	0	-
6972671	-	2.615	68	40	28	3	2	3	1	-
6977672	2.500	2.846	69	31	38	5	1	3	2	52
6996671	2.192	1.423	70	38	32	3	1	3	1	54
7005670	2.154	2.423	81	42	39	4	2	4	2	63
7024676	3.654	3.385	84	39	45	1	1	2	1	48
7026660	3.192	2.885	74	31	43	3	1	3	2	52
7026673	2.962	2.846	87	43	44	4	2	4	1	71
7062672	1.731	1.923	38	19	19	-	1	-	2	-
7082672	2.115	1.885	72	29	43	3	0	3	2	55
7085671	-	2.385	85	40	45	3	2	2	1	-
7104650	2.154	2.500	86	41	46	3	1	4	1	62
7104670	2.615	2.346	66	29	37	3	2	3	1	66
7104674	2.500	2.038	59	22	37	4	1	4	1	47
7121670	2.808	3.346	85	35	50	3	1	2	1	78
7139670	2.500	1.846	95	45	50	1	1	1	2	89
7139673	-	3.654	88	51	37	5	2	4	2	-
7149673	4.423	2.769	83	43	40	2	1	2	1	50
7176670	3.192	3.000	104	55	49	2	1	2	1	74
7177672	2.538	2.731	100	53	47	4	1	3	1	54
7183673	-	2.423	92	43	49	2	1	4	1	-
7194673	3.385	2.423	86	40	46	-	-	-	-	-
7300671	2.923	2.038	76	29	47	1	1	1	1	63

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
7324670	2.500	2.462	81	37	44	2	2	2	1	72
7332673	-	2.346	93	53	40	3	2	2	1	-
7347672	2.538	2.615	78	43	35	2	1	2	2	78
7347675	2.769	3.885	91	46	45	4	2	3	0	53
7347676	2.577	3.192	86	43	43	3	2	2	1	79
7366676	-	3.923	53	22	31	4	1	4	1	-
7399673	2.192	2.231	77	39	38	4	2	4	1	65
7441675	2.923	2.769	89	50	39	4	2	4	1	54
7442673	-	2.269	92	49	43	1	1	1	1	-
7467663	2.000	2.231	72	32	40	2	1	3	0	48
7489671	-	3.192	89	43	46	3	2	3	1	-
7491670	3.808	3.808	95	50	45	1	1	2	2	68
7544672	3.154	3.115	81	32	49	3	2	3	1	75
7555673	3.423	2.500	92	45	47	3	2	3	2	70
7576672	2.769	3.615	81	39	42	2	1	2	2	74
7593672	-	3.769	81	36	45	3	2	3	1	-
7619650	3.500	2.538	78	39	39	2	1	2	3	60
7659670	-	1.654	90	42	48	1	1	2	1	-
7688673	2.500	2.077	96	47	49	1	2	1	1	80
7691672	3.577	2.962	81	41	40	3	1	2	1	51
7694671	-	-	46	16	30	-	-	-	1	-
7697678	4.538	4.077	78	43	35	2	2	3	2	73
7700677	-	2.962	81	37	44	2	1	3	1	-
7701671	3.038	2.500	83	35	48	3	2	3	1	74
7701676	3.077	3.038	77	37	40	2	2	3	1	58
7707672	3.885	3.423	85	39	46	2	1	2	2	58
7710672	-	2.192	83	34	49	2	2	2	1	-
7713671	3.269	2.615	77	32	45	3	2	3	1	67
7713674	3.192	3.385	73	41	32	3	1	3	2	56
7713675	2.962	2.192	103	55	48	1	1	1	1	81
7715674	3.308	2.885	80	40	40	4	1	4	1	64
7716671	3.731	2.615	61	14	47	2	1	2	1	69
7733674	-	3.115	92	46	46	4	2	4	1	-
7733676	2.115	3.154	77	35	42	4	2	3	1	55
7767631	-	2.731	75	36	39	-	0	2	1	-
7767671	-	2.692	108	58	50	3	2	2	2	-
7801670	3.538	3.808	86	40	46	3	1	2	2	88
7807673	1.692	1.462	76	29	47	3	2	3	1	68
7824670	2.615	2.654	62	23	39	2	1	3	2	72
7842670	-	2.538	84	43	41	3	2	3	2	-
7868672	2.385	2.269	102	58	44	-	-	-	-	-
7900670	-	-	-	-	-	1	1	2	0	-
7918650	3.923	3.269	-	-	-	3	1	3	4	-
7918671	2.500	2.385	83	34	49	3	2	3	1	61

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
7961671	3.077	2.846	101	54	47	1	1	2	2	81
7980673	2.385	2.885	92	49	43	3	2	3	1	79
7983671	-	2.385	92	50	42	-	-	-	-	-
7988671	-	2.308	77	32	45	-	-	-	-	-
7989672	-	2.346	82	34	48	3	1	3	1	-
7990660	2.962	3.269	97	54	43	-	1	-	0	56
7990676	-	2.808	89	41	48	2	2	3	1	-
7994674	3.731	3.308	90	40	50	2	1	2	1	92
7997670	2.692	2.308	-	-	-	-	1	-	1	-
8009672	-	2.769	91	45	46	4	2	3	1	-
8020671	2.923	2.296	84	34	50	2	2	3	1	74
8050670	3.192	3.000	76	27	49	2	1	2	2	81
8109661	-	2.423	82	46	36	6	2	3	3	-
8117672	3.462	3.269	86	39	47	3	1	2	1	70
8121671	2.692	2.192	71	23	48	3	1	3	2	57
8125672	2.885	2.154	69	24	45	3	1	2	1	71
8125672	2.923	2.385	102	52	49	2	2	1	1	77
8127660	3.385	3.577	-	-	-	4	1	3	1	-
8151674	2.962	3.115	82	42	40	4	2	4	1	34
8160671	2.538	2.654	100	52	48	2	1	2	2	69
8161673	1.923	1.962	98	50	48	3	2	3	1	61
8189670	3.192	2.731	78	42	36	3	1	4	3	58
8219671	2.885	3.462	82	43	39	4	2	3	1	74
8220673	3.346	2.923	92	53	39	3	1	3	2	59
8232674	2.192	1.346	94	47	47	2	1	3	2	58
8238672	2.615	2.462	88	48	40	2	1	2	2	53
8286672	3.192	3.462	68	27	41	4	2	3	1	55
8315671	2.115	2.115	67	28	39	-	-	-	-	-
8316670	2.538	2.154	42	11	31	-	-	-	-	-
8321674	2.346	2.731	84	40	44	4	1	3	1	62
8348672	2.432	2.538	61	29	32	3	1	2	2	80
8367671	2.654	2.808	85	37	48	4	1	3	1	56
8368673	-	2.692	-	-	-	2	2	2	1	-
8373674	2.077	2.231	83	36	47	3	2	3	1	44
8415674	2.615	2.538	78	38	40	3	1	3	1	57
8423670	2.462	3.077	90	42	48	2	1	1	1	70
8427671	2.731	2.808	72	29	43	4	1	2	2	59
8432670	1.962	2.192	93	44	49	1	1	3	1	62
8432671	2.577	3.538	89	42	47	3	2	2	1	85
8437670	-	3.154	95	46	49	4	2	2	1	-
8498671	-	2.923	72	24	48	3	2	2	1	-
8508672	-	1.692	102	54	48	4	1	3	1	-
8528662	-	2.308	83	42	41	2	1	3	2	-
8532671	3.038	2.962	-	-	-	1	1	1	2	-



TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
8540678	-	2.231	83	39	44	2	2	2	1	-
8563672	3.462	3.077	103	53	50	2	2	3	1	75
8568670	3.231	2.962	92	47	45	5	1	3	0	48
8568672	-	2.808	81	34	47	2	2	2	1	-
8571670	-	2.423	86	44	42	4	1	3	1	-
8582671	-	2.692	88	44	44	3	1	3	1	-
8947671	1.731	1.577	-	-	-	3	2	3	1	-
8957670	2.077	1.885	82	38	44	5	0	4	2	46
8959672	-	2.769	-	-	-	3	2	4	1	-
9010672	2.192	1.885	84	39	45	2	2	2	1	69
9044670	-	2.923	82	40	42	3	1	2	2	-
9082670	-	2.115	-	-	-	-	-	-	-	-
9166670	1.846	2.557	75	29	46	3	2	3	1	75
9179671	2.462	2.000	79	30	49	4	2	3	1	67
9215674	-	1.808	98	52	46	-	1	2	2	-
9235676	2.885	2.769	100	51	49	1	1	1	1	78
9242671	-	2.462	81	37	44	3	2	3	2	-
9273671	3.808	1.808	95	46	49	3	2	1	1	79
9274670	-	2.731	94	46	48	1	1	2	2	-
9293671	-	2.692	90	43	47	4	2	3	1	-
9303672	2.923	2.269	92	46	46	2	1	2	2	74
9304678	-	2.462	84	39	45	4	2	4	1	-
9368670	-	2.846	93	47	46	7	1	3	2	-
9379673	3.385	2.577	88	40	48	2	1	1	1	86
9452670	3.231	3.346	90	41	49	3	1	-	0	-
9457671	2.808	2.654	91	53	38	4	2	3	1	68
9457673	-	2.577	88	39	49	4	2	3	1	-
9464672	3.423	2.846	83	41	42	5	1	3	1	63
9481672	2.885	2.885	73	35	38	5	1	4	2	45
9512674	3.115	3.769	75	31	44	3	1	2	1	61
9513671	-	1.500	85	40	45	4	1	4	1	-
9513672	2.538	3.154	83	39	44	2	1	2	0	62
9513677	2.423	2.192	71	25	46	3	2	2	1	70
9515676	2.385	2.885	72	27	45	2	2	2	0	44
9515678	-	2.308	64	23	41	4	2	3	2	-
9533672	-	1.923	98	57	41	4	2	3	1	-
9554671	2.077	2.462	83	38	45	4	2	3	1	69
9570670	-	2.1769	88	42	46	2	1	2	2	-
9627670	2.077	3.038	72	35	37	1	1	2	0	56
9696672	-	2.154	89	41	48	1	2	1	1	-
9700672	2.000	1.731	-	-	-	3	2	3	0	73
9718650	3.154	3.577	79	25	44	-	0	-	1	55
9749675	3.192	2.615	91	44	47	2	1	2	2	68
9750671	-	3.231	72	29	43	3	1	2	2	-

TABLE 22--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
9774673	2.385	2.308	78	35	43	4	1	4	1	56
9796672	2.654	3.308	80	39	41	3	2	2	1	73
9810670	2.231	2.154	80	43	47	-	1	-	1	57

- <sup>a</sup> Y is the student's score on the final application of the attitude scale, and X<sub>1</sub>, through X<sub>9</sub> are respectively his score on the initial application of the attitude scale, his total, verbal and quantitative scores on the School and College Ability Tests, the mark obtained in his last high school physics course, the number of high school physics courses taken, his high school graduating average, the number of laboratory sciences taken concurrently with Physics 110, and his Physics 110 mark at the time of writing the final application of the scale.

The high school physics mark and high school graduating average were coded in the following manner: A (86% - 100%) was given the value 1, B (72% - 85%) the value 2, C+ (65% - 71%) the value 3, C (57% - 64%) the value 4, C- (50% - 56%) the value 5, and D (40% - 49%) the value 6.

TABLE 23

THE FINAL ATTITUDE SCORE FOR EACH STUDENT IN THE EXPERIMENTAL GROUP, TOGETHER WITH THOSE FACTORS UPON WHICH THIS SCORE MAY DEPEND

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub> <sup>a</sup>
0071670	2.154	3.115	77	31	46	5	2	3	2	69
0071671	-	3.077	68	27	41	4	2	3	1	-
0081662	4.269	4.038	-	-	-	-	1	3	4	-
0081671	1.885	2.115	98	52	46	3	1	2	2	70
0119671	2.538	4.115	71	33	38	2	2	3	1	57
0324673	2.077	2.308	90	41	49	1	2	1	1	80
0393672	-	3.692	95	52	43	2	1	3	2	49
0396670	4.077	2.615	101	52	49	-	-	-	-	-
0400673	-	1.923	88	47	41	3	1	2	1	-
0405671	2.923	2.577	87	45	42	-	-	-	-	-
0409670	2.462	2.231	90	47	43	-	-	-	-	-
0416672	2.308	3.538	73	35	38	3	2	3	1	80
0432671	2.346	2.923	90	47	43	4	2	3	1	73
0519674	-	2.269	87	39	48	-	-	-	-	-
0566672	2.308	2.577	80	42	38	5	1	4	2	55
0623660	-	2.423	93	46	47	3	1	3	2	-
0713670	-	2.538	86	40	46	1	1	2	1	-
0713671	-	2.346	75	35	40	3	2	3	1	-
0763672	4.346	4.385	83	45	38	-	-	-	-	-
0765670	1.808	1.731	85	49	36	-	-	-	-	-
0768672	3.192	2.577	75	37	38	5	1	2	2	43
0794671	3.000	2.769	87	41	46	4	2	2	1	73
0795672	2.077	2.269	77	33	44	5	0	3	1	47
0819673	2.308	2.615	77	35	42	-	-	-	-	-
0819675	-	3.115	80	41	39	2	1	3	1	-
0823672	-	2.808	73	31	42	3	2	3	1	-
0834678	4.115	3.808	98	52	46	3	2	4	1	64
0843674	4.269	3.962	96	51	45	6	0	4	1	39
0871671	2.038	2.923	78	33	45	2	1	2	1	79
0880671	2.769	3.462	77	30	47	2	1	3	1	66
0913671	2.038	2.538	85	38	47	4	2	3	1	43
0913673	-	2.231	-	-	-	2	2	2	1	-
0918674	1.885	3.115	80	34	46	4	2	4	2	70
0920671	2.500	2.692	90	44	46	-	-	-	-	-
0921672	2.308	2.731	53	21	32	4	1	3	2	59
0944671	1.731	2.731	83	44	39	2	1	2	1	51
0962664	-	3.346	79	40	39	2	1	2	2	-
0974672	3.654	2.231	70	26	44	2	1	2	0	72
0975673	-	3.231	67	33	34	4	2	3	0	-

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
0988673	2.423	3.000	89	41	48	3	1	3	2	64
0995671	1.808	2.654	78	33	45	3	2	2	0	75
1001676	1.654	3.077	88	42	46	2	2	2	2	84
1030672	1.731	3.615	74	30	44	-	0	2	2	84
1034673	-	3.615	65	32	33	3	1	3	1	-
1039672	-	2.308	82	39	43	4	2	2	1	-
1043673	2.269	2.346	94	46	48	2	2	2	1	71
1047671	2.000	2.885	96	49	47	5	1	3	1	63
1058673	2.038	2.269	99	51	48	1	1	2	1	67
1072677	-	1.185	64	36	38	5	2	4	1	-
1074670	2.154	1.962	74	26	48	5	2	4	1	61
1075672	1.962	1.885	80	35	45	3	2	3	1	63
1081672	3.538	3.423	72	30	42	3	2	3	1	70
1088670	-	2.500	76	42	34	3	1	3	1	-
1092671	-	2.538	81	43	38	3	2	3	1	-
1103674	4.423	3.077	55	21	34	3	1	3	1	53
1112673	2.192	2.308	72	36	36	5	1	4	0	54
1132673	-	2.538	88	42	46	3	2	3	1	-
1147673	1.654	2.346	-	-	-	2	1	2	2	-
1149671	2.192	1.808	75	33	42	3	2	3	1	72
1164671	2.654	2.769	77	30	47	4	2	4	0	48
1171672	1.923	2.731	74	33	41	2	2	2	1	72
1253662	3.769	3.346	-	-	-	5	1	3	2	-
1253672	-	4.000	79	46	33	-	-	-	-	-
1264675	-	2.346	88	51	37	4	2	2	1	-
1283670	-	2.462	86	41	45	2	2	2	1	-
1286673	-	2.346	77	34	43	4	2	4	1	-
1300670	-	2.154	92	47	45	1	2	1	1	-
1302662	2.308	2.308	84	44	40	4	2	3	1	61
1302673	-	3.692	89	45	44	2	2	2	2	-
1322670	2.500	2.269	87	40	47	2	2	2	1	73
1358672	2.654	3.000	67	30	37	4	2	3	0	63
1358675	2.577	2.462	-	-	-	2	2	2	1	-
1365674	-	3.000	97	48	49	1	1	1	2	-
1365679	3.423	-	40	7	33	-	-	2	1	-
1368672	-	3.577	91	49	42	2	2	2	2	-
1373671	2.038	2.346	93	49	44	3	1	2	2	68
1384673	-	2.308	81	41	40	3	1	3	1	-
1387673	-	2.885	76	33	43	4	1	4	1	-
1389671	2.692	2.538	65	22	43	4	2	4	1	69
1397671	-	3.769	-	-	-	-	-	-	-	-
1397678	3.692	2.846	75	31	44	3	2	2	2	86
1397679	-	2.423	60	24	36	5	1	3	2	-
1405670	2.308	2.308	55	15	40	5	2	3	1	75
1424672	2.000	2.038	85	42	43	4	1	5	2	65

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
1449671	-	2.615	82	38	44	3	1	3	1	-
1453673	-	3.038	96	51	45	2	2	2	2	-
1465661	-	-	75	36	39	5	1	3	1	-
1465673	2.423	2.462	73	36	37	3	1	2	1	64
1466674	2.269	2.846	98	51	47	3	2	2	2	74
1469673	-	3.269	86	39	47	3	1	2	2	-
1492671	2.654	2.846	92	47	45	2	1	1	0	71
1492673	1.769	2.192	92	46	46	1	2	1	1	80
1537673	1.808	1.769	100	52	48	3	2	2	2	50
1558673	2.423	2.462	-	-	-	3	2	3	1	-
1567672	1.462	1.846	86	38	48	1	2	2	2	79
1573673	2.769	2.731	89	39	50	3	2	2	1	75
1575670	1.692	1.692	86	48	38	2	2	2	1	63
1579660	2.885	4.231	88	43	45	2	1	1	3	72
1580676	1.462	1.615	88	42	46	3	2	3	1	72
1584671	2.615	2.692	71	30	41	2	1	2	1	62
1604671	2.885	2.923	89	45	44	4	2	4	1	67
1613671	1.731	2.923	98	52	46	1	1	1	3	97
1624674	-	1.962	86	43	43	2	1	2	1	-
1652672	-	2.731	72	34	38	3	2	3	1	-
1719670	2.385	3.077	76	43	33	4	1	4	2	74
1719671	3.038	2.538	80	35	45	-	0	3	1	61
1727670	2.346	2.231	57	26	31	3	1	4	1	53
1765671	2.423	2.962	80	34	46	4	2	4	1	55
1786671	2.308	2.962	89	53	36	3	2	3	1	73
1789671	3.192	2.885	79	32	47	2	1	2	1	83
1802671	2.923	2.000	97	47	50	4	2	3	1	73
1806672	1.962	2.154	77	32	45	-	-	-	-	-
1808674	1.385	2.500	68	33	35	5	2	4	2	56
1812661	1.654	2.385	-	-	-	4	1	4	3	-
1812672	3.154	3.115	64	30	34	3	2	3	2	60
1820671	-	2.269	81	38	43	3	2	4	1	-
1841670	-	2.115	67	33	34	4	2	4	0	-
1844671	2.346	2.846	85	46	39	3	2	3	2	66
1896675	1.885	2.808	-	-	-	2	2	3	2	-
1896676	2.538	2.500	100	51	49	3	2	2	2	69
1901673	2.231	3.115	106	58	48	1	2	1	2	78
1901675	-	4.346	67	27	40	4	1	3	1	-
1910675	-	2.231	86	43	43	3	1	4	1	-
1925673	-	3.731	77	35	42	4	2	2	1	-
1929671	1.962	1.692	83	37	46	1	1	2	1	68
1940670	-	3.615	53	22	31	3	2	4	1	-
1954672	2.423	2.577	96	55	41	3	1	3	2	53
1954673	4.038	2.846	77	31	46	3	1	3	1	73
1966670	2.231	2.000	86	45	41	4	0	4	2	57

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
2073671	2.462	2.423	98	54	44	2	2	2	1	84
2114672	1.732	1.885	93	54	39	3	1	2	1	52
2333672	2.731	3.192	98	56	42	1	2	2	1	67
2361671	2.000	2.692	71	29	42	-	-	-	-	-
2387671	-	2.885	99	50	49	1	1	2	1	-
2390671	-	2.538	86	40	46	2	2	2	1	-
2390672	1.923	2.308	91	44	47	2	2	1	2	80
2390673	3.077	3.346	74	27	47	3	2	2	2	64
2391672	2.115	2.154	91	44	47	2	1	2	1	69
2392672	2.962	2.269	66	32	34	4	1	3	2	37
2586671	1.846	2.731	82	34	48	4	2	2	1	65
2586672	3.500	2.269	83	41	42	2	1	2	2	70
2587672	2.615	3.192	86	40	46	2	2	2	2	70
2649671	-	1.846	76	34	42	2	2	3	1	-
2734672	2.615	3.038	76	33	43	2	1	2	2	65
2734673	2.115	2.346	85	42	43	3	2	2	1	76
2738672	3.115	2.462	89	41	48	3	2	3	1	55
2738673	2.769	3.654	91	46	45	2	1	3	1	60
2754671	2.423	2.654	103	57	46	2	1	1	3	71
2768671	-	2.231	76	36	40	2	1	1	1	-
2776674	1.500	2.654	74	42	32	4	1	3	2	57
2788678	-	1.962	84	41	43	1	1	1	2	-
2816673	-	3.192	69	28	41	3	1	3	1	-
2826673	2.423	3.731	89	55	34	4	1	4	2	35
2836674	-	2.346	69	37	32	2	1	2	1	-
2844670	2.192	2.038	70	33	37	4	1	3	0	59
2855675	3.192	2.385	97	50	47	2	1	2	2	75
2858674	2.615	2.500	75	34	41	3	2	3	1	57
2892673	-	3.192	57	31	26	3	1	3	2	-
2894671	2.346	2.885	68	34	34	3	1	3	1	59
2905661	2.846	3.615	94	49	45	3	2	2	4	64
2908671	1.885	2.962	83	39	44	3	1	2	2	68
2922671	-	2.462	78	31	47	-	-	-	-	-
2937672	2.769	2.538	77	39	38	4	2	3	1	67
2937675	3.500	3.269	70	45	45	4	2	2	2	51
2937677	2.692	3.154	83	37	46	-	-	-	-	-
2937678	2.000	2.077	87	43	44	3	2	3	0	57
3012672	-	2.192	86	42	44	1	2	1	1	-
3023671	3.308	2.423	89	46	43	2	1	3	1	62
3027672	2.154	3.346	73	41	32	4	2	4	2	55
3042675	2.538	2.154	63	24	39	5	1	4	2	58
3043672	1.962	2.192	66	24	42	-	-	-	-	-
3103671	-	2.808	80	41	39	2	1	2	0	-
3136672	2.269	3.577	86	43	44	4	2	4	0	76
3146670	1.846	2.000	91	43	48	2	2	1	1	54

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
3160670	-	3.000	77	34	43	4	1	2	2	-
3160671	-	2.923	67	37	30	4	1	4	2	-
3192671	-	2.500	100	52	48	2	1	1	1	-
3201671	2.538	2.654	76	41	35	4	2	4	1	62
3201672	2.500	2.731	84	35	49	3	1	3	1	67
3209673	2.038	2.269	74	38	36	5	2	4	1	55
3210678	2.538	2.115	78	40	38	4	2	4	2	56
3220672	-	3.500	91	46	45	4	1	4	1	-
3260673	-	2.269	71	26	45	5	2	3	1	-
3285671	1.692	1.731	81	34	47	3	2	2	1	66
320672	-	1.885	85	38	47	1	2	2	1	-
3315673	1.692	2.346	88	49	39	3	1	2	1	58
3378670	-	2.462	88	39	49	4	1	3	1	-
3385671	2.577	2.500	92	47	45	3	2	3	1	67
3409660	3.346	3.000	70	31	39	3	1	3	1	61
3409672	-	2.423	68	27	41	6	2	4	1	-
3409674	2.385	2.577	-	-	-	4	1	4	1	-
3410670	-	3.115	90	52	48	1	1	1	1	-
3432670	3.154	2.808	76	30	46	-	-	-	-	-
3438670	2.731	2.692	99	52	47	2	2	2	1	78
3442673	2.308	2.731	-	-	-	4	1	4	2	-
3445670	2.231	3.269	92	47	45	2	1	2	1	92
3458670	-	2.808	94	53	41	-	-	-	-	-
3475671	-	3.615	82	46	36	4	2	3	1	-
3477672	2.231	2.692	73	32	41	3	2	3	1	74
3482676	-	3.115	-	-	-	-	-	-	-	-
3498672	2.538	2.923	81	43	38	3	2	4	2	48
3522670	-	3.231	65	17	48	3	2	3	1	-
3522672	-	1.923	95	46	49	1	1	1	2	-
3530650	-	3.500	70	32	38	2	1	-	2	-
3545671	1.885	3.077	76	35	41	3	2	2	1	63
3552671	2.769	2.192	73	34	39	4	2	2	1	68
3556671	-	2.423	-	-	-	-	2	4	0	-
3567670	2.115	2.154	83	36	47	3	2	3	1	42
3568670	2.154	3.769	81	33	48	1	1	1	2	63
3573671	1.885	2.500	88	43	45	-	0	3	1	71
3581676	-	3.231	94	49	45	1	2	1	1	-
3615673	-	2.846	74	32	42	2	1	3	1	-
3616671	-	3.462	77	33	44	3	1	3	0	-
3672671	2.385	2.385	80	35	45	3	2	3	2	71
3674672	-	3.500	95	47	48	3	2	3	1	-
3679671	-	2.231	95	48	47	2	1	1	1	-
3726671	-	3.615	-	-	-	5	2	5	2	-
3731673	2.154	2.885	74	32	42	4	1	2	1	64
3733673	-	2.308	85	37	48	3	2	3	2	-

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
3734670	3.000	3.269	55	24	31	2	1	3	0	62
3739670	-	2.192	48	14	34	1	1	2	1	-
3744673	2.538	2.538	66	26	40	2	1	2	0	73
3765670	2.500	3.385	80	39	41	3	2	3	1	73
3843673	2.346	2.385	85	46	39	4	2	4	1	69
3845672	2.500	2.423	81	38	43	3	2	2	1	68
3849670	2.154	2.846	82	33	49	1	1	2	1	68
4144670	2.308	2.269	77	32	45	4	2	3	1	81
4569672	3.538	3.500	79	39	40	3	2	3	1	71
4575669	1.846	3.231	75	35	40	2	1	2	3	53
4575672	1.846	2.846	93	45	48	2	1	2	2	66
4575678	-	3.000	93	43	50	3	2	2	1	-
4576678	1.846	1.923	53	24	29	-	1	-	0	-
4580671	-	2.308	91	44	47	2	1	2	2	-
4626671	-	3.000	73	35	38	3	1	3	1	-
4671671	2.962	2.769	85	40	45	3	1	3	1	63
4673670	2.038	2.538	70	29	41	3	2	2	1	71
4694670	1.923	2.346	71	24	47	3	1	3	2	49
4694671	2.692	3.077	85	40	45	6	2	3	2	54
4713672	1.192	2.500	84	42	42	4	2	4	1	68
4726670	-	3.731	88	43	45	4	1	3	1	-
4741672	2.269	2.538	85	39	46	4	1	2	1	62
4815670	2.577	2.654	83	41	42	4	1	3	2	65
4831671	2.615	2.769	87	40	47	3	2	3	1	56
4839670	2.115	2.654	75	33	42	1	2	2	1	67
4847670	-	2.885	78	37	41	2	1	3	1	-
4852670	2.500	2.846	80	43	37	1	1	2	2	71
4866671	2.038	2.269	95	53	42	2	1	2	2	61
4866672	-	2.846	83	44	39	4	2	2	2	-
4875670	2.077	3.269	86	43	43	3	2	4	1	53
4884670	2.385	2.654	92	43	49	2	2	2	1	57
4888674	2.423	2.346	92	48	44	2	1	3	2	56
4891672	1.846	2.000	76	36	40	4	2	2	2	78
4897670	2.654	1.923	104	55	49	1	1	1	2	78
4897674	-	2.115	80	36	44	3	2	2	1	-
4899672	1.846	1.846	80	35	45	2	2	2	1	69
492-67-	-	2.615	74	31	43	3	2	3	2	-
4925672	2.269	2.154	63	27	36	5	0	3	0	51
4932670	2.808	2.346	66	25	41	4	2	2	1	65
4933672	-	3.077	-	-	-	-	0	3	2	-
4960672	3.038	2.577	86	40	46	3	2	2	1	68
4964670	2.615	2.538	83	37	46	2	1	2	1	76
4983671	1.885	2.077	-	-	-	3	1	3	2	-
4983672	2.923	3.038	70	27	43	-	-	-	-	-
4984670	2.615	2.077	99	49	50	-	-	-	-	-



TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
4986670	-	-	56	24	32	4	2	4	0	-
4999672	2.385	2.500	83	36	47	4	2	4	1	48
5004670	-	2.385	76	29	47	4	2	3	1	-
5016670	2.038	1.885	76	27	49	3	2	3	1	55
5021670	2.269	2.423	89	41	48	2	1	2	2	73
5035675	2.538	2.923	-	-	-	2	1	2	1	-
5042671	2.731	2.538	87	42	45	3	1	3	1	20
5042674	-	2.808	87	47	40	4	2	2	1	-
5116673	1.923	4.115	92	49	43	2	2	2	0	59
5151672	1.962	2.654	90	44	46	4	2	3	0	67
5187671	2.462	2.731	69	37	32	1	2	3	1	70
5192676	2.885	2.654	78	37	41	3	2	2	1	63
5292671	-	3.077	83	41	42	5	2	4	1	-
5304673	2.308	2.231	107	57	50	1	1	1	1	84
5321676	-	2.346	94	47	47	1	1	1	1	-
5326622	2.346	2.538	87	40	47	3	1	4	3	58
5329673	-	3.385	78	30	48	3	1	3	2	-
5337673	2.769	2.423	76	28	48	4	1	4	1	47
5406674	2.192	2.462	91	48	45	3	1	3	1	55
5425677	2.308	2.192	-	-	-	2	1	3	2	-
5438671	1.731	2.654	-	-	-	2	2	2	1	-
5449670	2.500	2.269	95	47	48	2	1	1	1	84
5468674	2.462	2.231	68	25	43	2	1	2	1	74
5585674	2.692	3.462	91	47	44	2	1	2	1	46
5599671	-	2.731	84	40	44	5	1	4	2	-
5622670	2.346	3.154	85	39	46	5	2	4	1	54
5662671	1.808	2.385	76	34	42	2	2	2	1	87
5835670	2.500	2.846	74	31	43	4	1	4	1	45
5896670	-	2.692	84	45	39	2	1	3	1	-
5897670	3.423	3.192	84	33	51	-	-	-	-	-
6019670	4.462	4.438	81	37	44	2	1	2	1	72
6041676	-	3.615	55	19	36	4	2	4	1	-
6215670	1.731	1.538	81	42	39	4	2	3	1	41
6264671	-	2.538	71	28	43	4	1	3	1	-
6507670	4.231	2.769	75	34	41	3	2	2	1	43
6542670	-	2.962	80	34	46	3	1	3	2	-
6707672	-	2.500	90	42	48	2	2	2	2	-
6901671	-	2.923	83	39	44	3	2	2	2	-
6901675	1.808	1.692	74	33	41	3	1	4	1	50
6981674	-	3.769	91	43	48	3	1	2	2	-
6985676	2.577	2.654	74	34	40	5	2	4	1	42
7036673	1.923	1.538	91	44	47	3	1	4	2	45
7082674	2.615	2.654	94	45	49	3	2	3	1	68
7150673	-	1.500	88	43	45	4	2	3	1	-
7189670	2.731	2.192	69	40	29	4	1	3	2	53

TABLE 23--Continued

Student No.	Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>
7198672	2.154	2.577	82	35	47	3	2	2	1	80
7400675	3.000	2.933	74	31	43	3	1	4	1	36
7522672	1.462	1.769	68	33	35	4	2	3	2	61
7535674	2.615	3.077	88	41	47	3	2	4	2	65
7549670	2.192	2.115	85	38	47	4	2	3	1	57
7555675	2.923	3.038	88	45	43	3	2	2	2	58
7593671	2.192	2.077	72	28	44	3	2	2	1	76
7695675	2.308	2.192	60	28	32	4	2	3	1	58
7696679	-	3.000	84	38	46	4	2	3	1	-
7704674	2.769	2.423	86	47	39	3	2	3	1	43
7709676	-	2.500	104	54	50	-	-	-	-	-
7710670	2.962	3.885	71	29	42	2	2	3	1	62
7742672	2.577	2.192	85	42	43	3	2	4	1	62
7783672	2.385	2.192	68	32	36	4	2	3	1	60
7807671	1.808	2.577	59	23	36	-	-	-	-	-
7813673	2.538	2.385	75	35	40	2	2	3	1	79
7827678	2.962	2.538	86	43	43	2	2	2	1	65
7924676	2.962	2.500	-	-	-	-	-	-	-	-
7927672	2.000	3.269	91	53	38	1	1	2	1	89
8040671	2.538	2.346	76	33	43	4	1	4	1	52
8041671	2.538	3.731	80	38	42	2	1	2	1	61
8145670	-	3.308	84	41	43	-	1	3	1	-
8170673	-	2.768	96	49	47	-	-	-	-	-
8186672	1.538	1.885	73	32	41	3	2	3	1	61
8290672	-	-	73	35	38	3	2	3	2	-
8321673	2.192	2.269	79	39	40	5	2	3	1	59
8390675	2.231	2.500	82	37	45	2	1	3	1	49
8499674	-	3.192	70	32	38	2	1	4	1	-
8501673	-	-	98	50	48	2	2	1	1	-
9220675	-	3.192	90	45	45	4	2	3	1	-
9227679	1.962	1.808	90	43	47	1	2	2	1	87
9287670	3.077	3.462	79	30	49	3	1	3	1	65
9303674	2.231	2.692	85	40	45	3	2	3	1	73
9430671	2.154	3.038	92	46	46	2	2	2	1	69
9467672	2.154	3.346	77	35	42	1	1	1	1	75
9513673	2.731	2.423	74	29	45	2	2	2	2	63
9513674	2.154	2.231	89	40	49	-	-	-	-	-
9513676	1.769	2.538	80	34	46	4	2	3	1	65
9515671	-	3.385	88	43	45	4	1	4	1	-
9536675	1.885	2.577	80	37	43	4	2	3	2	56
9566671	-	3.038	84	92	42	3	1	3	2	-
9700670	-	2.269	75	33	42	1	2	2	1	-
9716672	2.923	2.340	53	14	39	3	2	3	1	66
9725672	2.731	3.346	66	20	46	3	2	3	1	69
9774660	-	3.269	89	39	50	3	1	2	-	-
9912673	3.346	2.192	81	33	48	4	2	3	1	70

TABLE 23--Continued

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- a Y is the student's score on the final application of the attitude scale, and  $X_1$  through  $X_9$  are respectively his score on the initial application of the attitude scale, his total, verbal and quantitative scores on the School and College Ability Tests, the mark obtained in his last high school physics course, the number of high school physics courses taken, his high school graduating average, the number of laboratory sciences taken concurrently with Physics 110, and his Physics 110 mark at the time of writing the final application of the scale.

The high school physics mark and high school graduating average were coded in the following manner: A (86% - 100%) was given the value 1, B (72% - 85%) the value 2, C+ (65% - 71%) the value 3, C (57% - 64%) the value 4, C- (50% - 56%) the value 5, and D (40% - 49%) the value 6.

TABLE 26

THE FREQUENCY DISTRIBUTION OF RESPONSE TO EACH STATEMENT BY  
THE CONTROL AND EXPERIMENTAL GROUPS ON THE INITIAL  
APPLICATION OF THE ATTITUDE SCALE<sup>a</sup>

Statement No.	Response Category				
	1	2	3	4	5
1	24	115	59	37	3
	32	122	51	28	9
2	5	23	74	123	13
	6	29	71	122	14
3	6	28	49	110	45
	13	17	43	118	51
4	9	74	83	63	9
	18	77	81	54	12
5	12	44	69	93	20
	16	45	62	99	20
6	9	34	51	117	27
	9	32	49	127	25
7	26	101	44	55	12
	50	86	42	49	15
8	3	14	51	93	77
	5	13	44	99	81
9	24	59	47	83	25
	25	44	57	97	19
10	18	67	65	76	12
	19	78	51	81	13
11	9	50	83	74	22
	12	56	86	74	14
12	1	76	83	68	10
	9	79	86	62	6
13	6	70	93	60	9
	5	79	96	52	10

TABLE 26--Continued

Statement No.	Response Category				
	1	2	3	4	5
14	9	69	82	58	20
	8	78	78	57	21
15	5	17	47	94	75
	13	9	41	98	81
16	3	20	34	136	45
	7	14	30	139	52
17	7	44	66	88	33
	16	37	65	93	31
18	12	21	54	99	52
	5	26	50	114	47
19	10	49	26	95	58
	12	62	29	63	76
20	14	91	70	53	10
	14	99	59	58	12
21	0	9	34	148	47
	3	9	34	152	44
22	8	70	102	46	12
	3	77	94	53	15
23	11	70	77	71	9
	14	79	89	51	9
24	3	18	52	131	34
	7	17	47	132	39
25	25	149	48	15	1
	33	167	30	11	1
26	5	26	73	106	28
	7	24	53	113	45

<sup>a</sup> For each statement, the first line is the frequency distribution of the experimental group, the second line the frequency distribution of the control group.

TABLE 27

THE FREQUENCY DISTRIBUTION OF RESPONSE TO EACH STATEMENT BY  
THE CONTROL AND EXPERIMENTAL GROUPS ON THE FINAL APPLICATION  
OF THE ATTITUDE SCALE<sup>a</sup>

Statement No.	Response Category				
	1	2	3	4	5
1	37	142	37	21	5
	20	110	72	25	9
2	7	18	59	132	26
	1	25	78	120	12
3	8	21	29	120	64
	14	31	61	97	33
4	25	94	72	41	10
	9	57	81	70	19
5	18	53	71	86	14
	8	59	77	84	8
6	9	27	50	132	24
	13	45	49	106	23
7	47	91	52	38	14
	31	75	55	64	11
8	5	10	24	122	81
	10	14	69	95	48
9	20	40	50	111	21
	18	66	48	94	10
10	13	66	57	93	13
	12	70	67	78	9
11	26	71	95	36	14
	6	43	93	69	25
12	15	92	74	56	5
	2	70	82	70	12
13	5	67	101	61	8
	6	65	91	66	8

TABLE 27--Continued

Statement No.	Response Category				
	1	2	3	4	5
14	28	103	75	27	9
	6	62	83	68	17
15	9	11	30	97	95
	14	30	53	81	58
16	5	14	22	129	72
	8	18	38	139	33
17	10	18	53	132	29
	7	41	64	95	29
18	12	49	61	88	32
	4	32	55	90	55
19	79	128	23	5	7
	11	68	41	72	44
20	38	102	60	34	8
	15	92	59	57	13
21	5	15	51	133	38
	6	20	50	125	35
22	19	114	76	26	7
	2	49	107	60	18
23	20	99	84	24	15
	4	58	96	64	14
24	8	16	38	132	48
	7	19	57	120	33
25	51	148	31	11	1
	37	137	44	17	1
26	14	27	36	122	43
	16	39	64	97	20

<sup>a</sup> For each statement, the first line is the frequency distribution of the experimental group, the second line the frequency distribution of the control group.

Fig. 10.--The Response Distribution to Statement 14 By the Experimental Group on the Initial Application of the Attitude Scale.

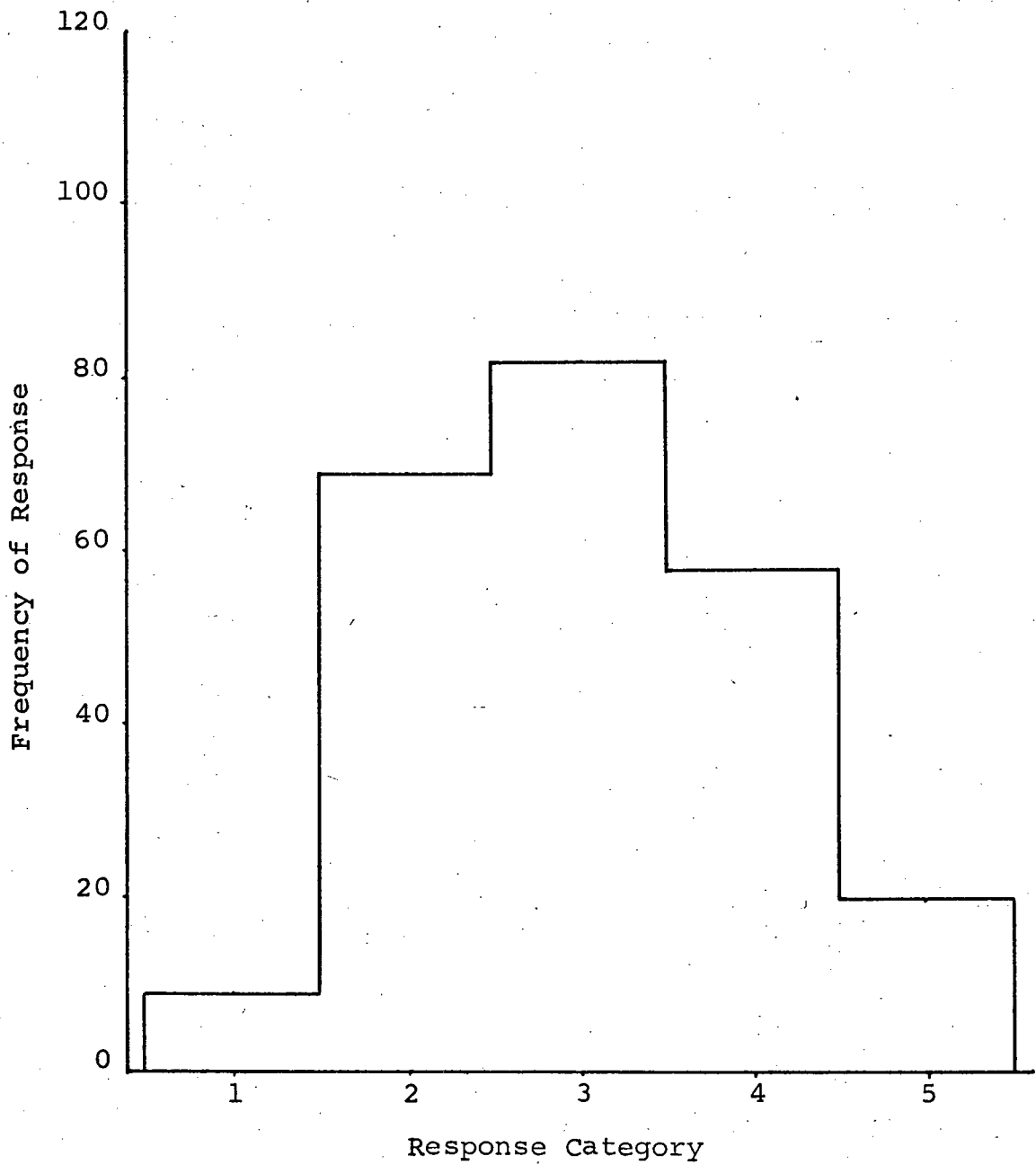




Fig. 11.--The Response Distribution to Statement 14 By the Control Group on the Initial Application of the Attitude Scale.

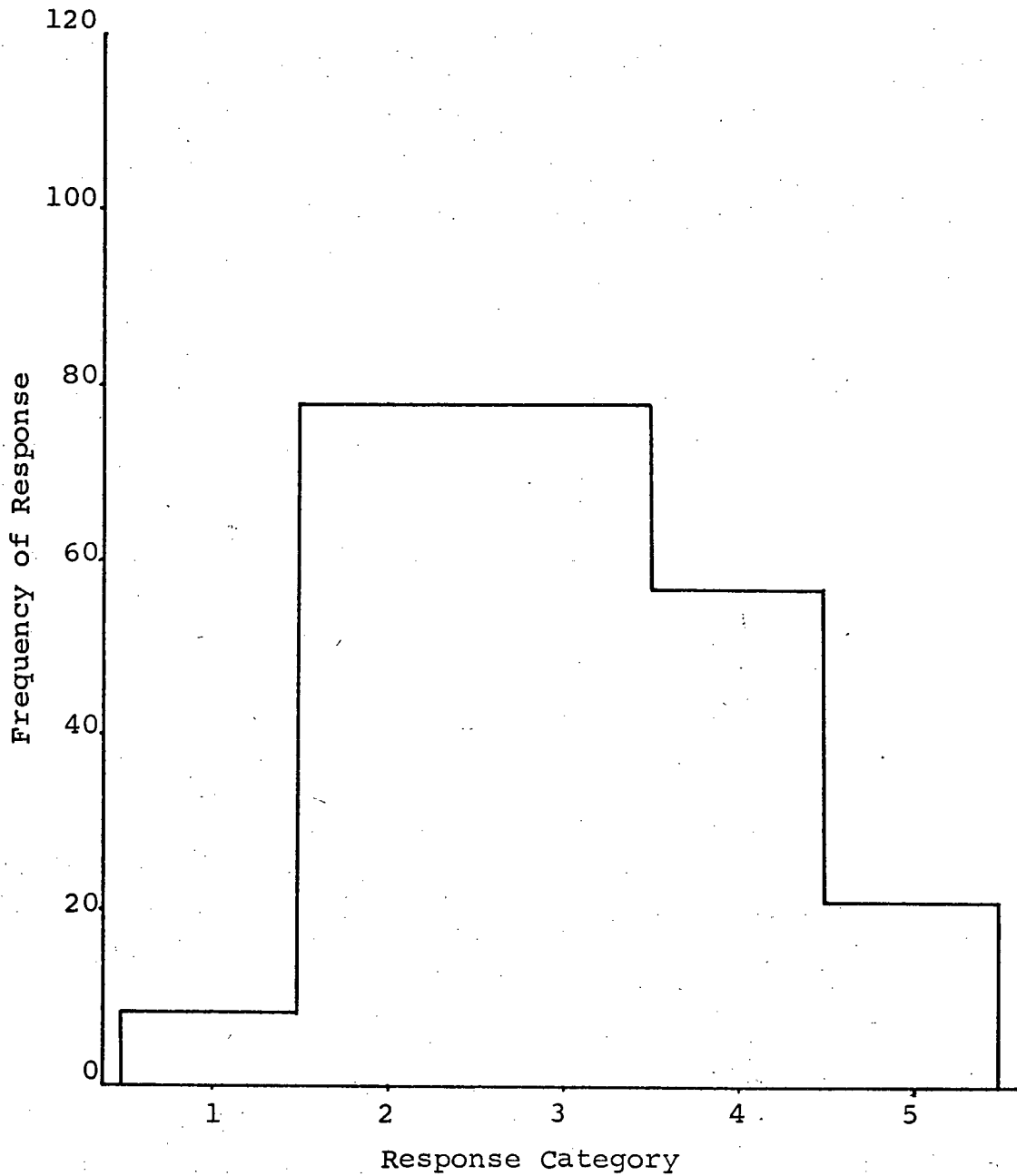


Fig. 12.--The Response Distribution to Statement 14 By the Experimental Group on the Final Application of the Attitude Scale.

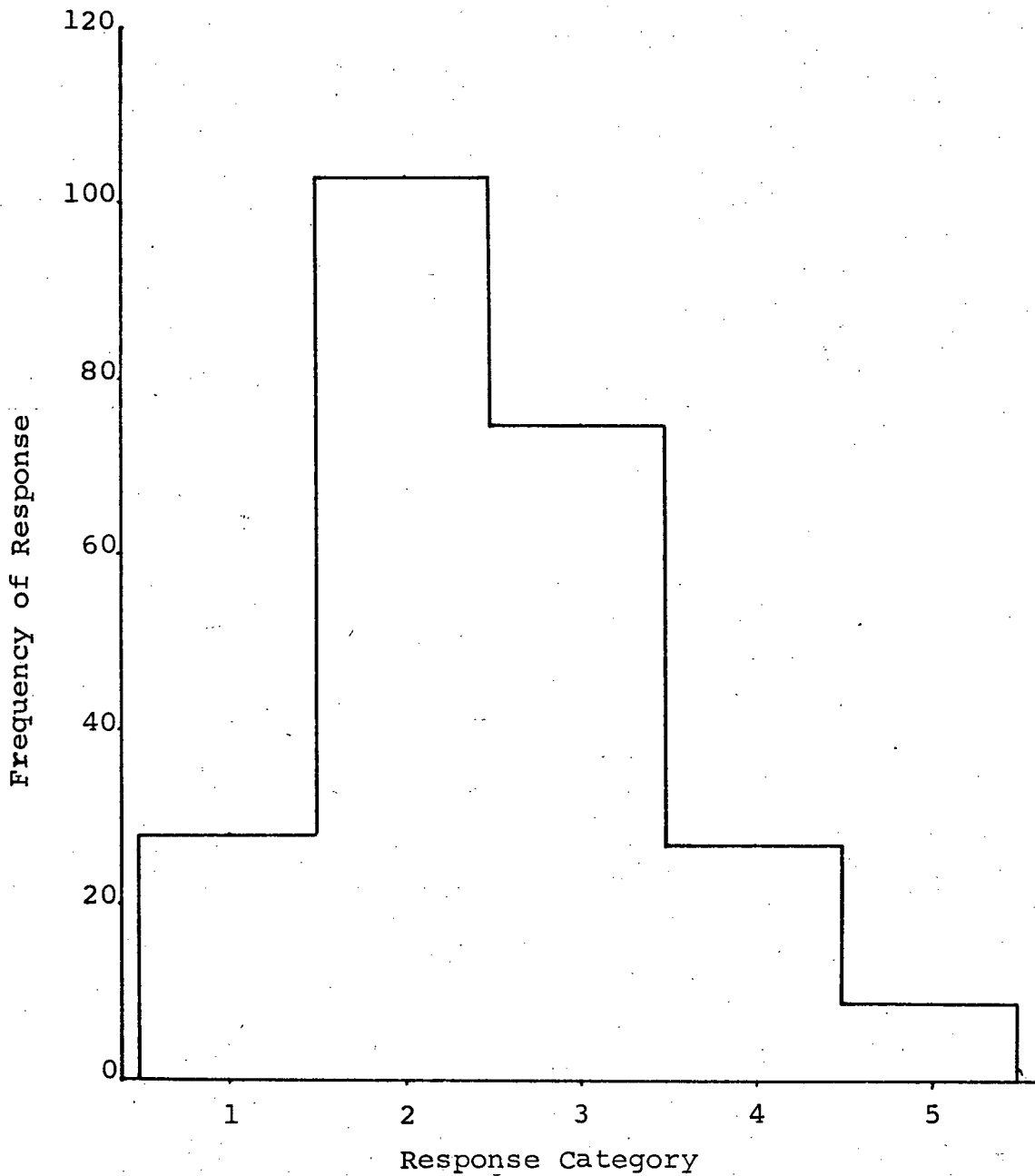


Fig. 13.--The Response Distribution to Statement 14 By the Control Group on the Final Application of the Attitude Scale.

