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THE DEVELOPMENT AND APPLICATION OF A TEST TO DETECT CERTAIN HABITS OF THE SCIENTIFIC ATTITUDE AMONG HIGH SCHOOL SCIENCE STUDENTS

By
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Stockton
1946

A Thesis

Submitted to the School of Education

College of the Pacific

In partial fulfillment

of the

Requirements for the

Degree of Master of Arts

APPROVED J. William Harris
Chairman of the Thesis Committee

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PREFACE

Although the purpose of this paper is to present the results of a specific study, it goes further to set forth the author's teaching philosophy. That philosophy has its roots in several years of association with other teachers who have never failed to inspire this writer to develop the scientific habit of mind. To Dr. Vesta Holt of the Chico State College, and to Mr. C. Raymond Calkins of the Oakland Public Schools, the writer is deeply indebted.

Grateful acknowledgment is given Dr. J. William Harris, Dr. J. Marc Jantzen and Dr. Alden L. Noble of the College of Pacific for their direction in the research work and advice in improving the manuscript. To the librarians of the College of Pacific Library and the Lodi Public Library, thanks are due for their assistance in obtaining needed material. The writer is most appreciative of the helpful assistance of the numerous science teachers and administrators of the several California High Schools in which a portion of this work was accomplished.

June 1946. C.T.H.

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CHAPTER I

INTRODUCTION

Much has been written of the material benefits of science to society. Science is concerned with every branch of human activity. It is hailed as one of the major bases of our present culture and as the progenitor of an indescribably wonderful future. Industry, agriculture and other human ventures look to scientific research in those fields to create the wonders which we are apt to call progress and advancement. The men of science have become positive symbols in modern society. They are heroes. The common man, recognizing the need for these scientific researchers, thinks of science in terms of what it provides him to satisfy his needs of food, shelter, clothing, transport and recreation.

This recognition of the material benefits of science has had its effect on the curriculum of the school. Anything so worthwhile as scientific research and anything demanding so many able researchers cannot long occupy a negligible portion of the school's time. So a great deal of thought in educational research has been directed toward injecting pure and applied science into the curriculum. Reference to the several digests of investigations in the teaching of science prepared by Francis Day Curtis will be

convincing proof of the growth of research in this area of education.

Science instruction of a sort has been developed throughout the twelve-year public school. The senior high school has carefully divided the subject matter of science into appropriate courses and a few students have the opportunity of passing from course to course obtaining, to some degree, the usually well organized factual content of each. In the departmentalized junior high school there has developed a general science program which is assuming importance in the curriculum because of the fact that it is a terminal course in science for so many students. Hence, the school must endeavor to make its last contribution of scientific knowledge to most of these general science students. Finally, the elementary grades have wanted to contribute to a science education. Elementary school enthusiasts have surveyed the fields of science to obtain those areas and understandings that would be suitable. In recent years the tendency in the elementary field has been away from conventional nature study type of science instruction to a general infusion of science content into the social studies curriculum.

From the primary grades through high school, science is taught largely as a body of knowledge, laws, principles, theories and the various applications to man's uses. For

the most part this is the contribution of the educational system toward preparation for a life in an increasingly scientific age. Viewing the teaching of science in a superficial manner, this might seem sufficient.

There are several philosophers and educators, however, who believe that science instruction in the modern school has another and important purpose. Aside from teaching the organized truths of science there is the method or science to be considered. "Our first conclusion, then," wrote Karl Pearson at the beginning of this century, "as to the value of science for practical life turns upon the efficient training it provides in method."[1]

It is generally conceded by writers in this field that habits of scientific thinking should be the result of science teaching. Dewey, as early as 1910, in his book, How We Think, carefully analyzed the process of objective, scientific thought. He has consistently asserted that it should be taught:

> One of the only two articles that remain in my creed of life is that the future or our civilization depends on the widening spread and deepening hold of the scientific habit of mind; and that the problem of problems in our education is therefore to discover how to mature and make effective this scientific habit.[2]

[1] Karl Pearson, The Grammar of Science, 3rd ed., Pt. I, 9.

[2] John Dewey, "Science as Subject Matter and as Method", Science XXXI, 127, (Jan.28, 1910)

In an address to a lay group Robert Millikan presented the importance or science as a method when he maintained that:

> We need science in education, and much more of it than we now have, not primarily to train technicians for the industries which demand them, but much more, to give everybody a little glimpse or the scientific mode of approach to life's problems and to give everyone some familiarity with at least one field in which the distinction between correct and incorrect, or right and wrong, is not always blurred and uncertain and to let him see that it is not true that "one opinion is as good as another".[1]

Kilpatrick also upholds the essential concept of teaching scientific thinking and relates it to the education of the general citizen when he writes that:

> Science is a more vital matter of intelligent thinking than most who claim to represent science in education seem to wish or expect. These, in fact, often seem to uphold the idea that the rank and file can use the results without themselves thinking. This ... is a virtual denial of the essence of science.[2]

Kilpatrick's "essence of science" may be synonymous with the often used term "spirit of science". Writers take little or no space to explain their meaning of such terms. It seems reasonable to conclude, however, that they refer in these cases to the scientific attitude and method. Victor Noll is prominent among those in teacher

[1] Robert A. Millikan, "The Relation of Science to Industry", Science, LXIX, 30 (Jan. 11, 1929)

[2] William H. Kilpatrick et al., The Educational Frontier, 279.

education who most clearly advocate more attention to a science education to provide training in scientific thinking. Dr. Noll recently editorialized:

> .., It is only through the inculcation of the spirit of science that progress will come. It is to be hoped that the post war period may bring a greater sensitivity to it and a more universal acceptance of a responsibility to meet it through science education.[1]

It seems logical to expect that the science subject area of the curriculum should lead in developing the desirable habits of scientific thought. However, there is a dearth of evidence to support such a conclusion. Considering the importance of training in scientific method and attitude more studies in this field should be expected. Educational and psychological research needs direction toward this problem. To the teacher and then the student the so-called intangible scientific attitude and method need to become more tangible. They need definition and analysis; their teaching needs analysis and improvement; results need to be tested by some new type of evaluation instrument.

This development needs not only to take place in the science area of the curriculum but in each portion of the curriculum that lends itself to the problem approach.

[1] Victor Noll et al., "Symposium: How Can Science Education Make Its Greatest Contribution in the Post War Period?", Science Education, XXVIII, 287.

There will remain a curious inconsistency in our education for democracy as long as the curriculum is designed to teach an accumulation of facts rather than a method of thinking. To its educational system democracy, then, presents a problem. The problem is stated by Dewey in Freedom and Culture, when he writes:

> That the schools have mostly been given to imparting information ready-made, along with teaching the tools of literacy, cannot be denied. The methods used in acquiring such information are not those which develop skill in inquiry and in test of opinions. On the contrary, they are positively hostile to it. They tend to dull native curiosity, and to load powers of observation and experimentation with such a mass of unrelated material that they do not operate as effectively as they do in many an illiterate person. The problem of the common schools in a democracy has reached only its first state when they are provided for everybody. Until what shall be taught and how it is taught is settled upon the basis of formation of the scientific attitude, the so-called educational work of schools is a dangerously hit-or-miss affair as far as democracy is concerned.[1]

Karl Pearson recognized the need for solving this fundamental educational problem described by Dewey. Pearson referred to the close relationship between the scientific way of thought and citizenship when he wrote:

> ... such a man, [one trained in science] we may hope, will carry his scientific method into the field of social problems. He will scarcely be content with merely superficial statement, with vague appeal to the imagination, to the emotions, to individual prejudices. He will demand a high standard of reasoning, a clear insight into facts and their results,

[1] John Dewey, Freedom and Culture, 149-150.

> and his demand cannot fail to be beneficial to the community at large.[1]

It might be concluded, then, that within its method and the attendant habit of mind, science has a desirable moral value. It would be a progressive step to seek means by which those who teach could make more effective that moral value. And, as it could then be spread throughout the rank and file, perhaps some neglected problems of democratic society could be resolved.

[1] Karl Pearson, The Grammar of Science, 3rd ed., Pt. I, 9.

CHAPTER II

THE PROBLEM

Statement of the Problem.

This investigation is concerned with the development and application of a test to detect certain habits of the scientific attitude among high school science students.

Preliminary investigation relative to the problem centered around the two following procedures:

(1) An attempt to determine and define the scientific attitude and its relation to scientific method.

(2) A consideration of the results of previous studies related to the above problem.

An Analysis of the Problem.

With a general and possibly extensive study such as presented by this problem it would be possible to proceed in several directions. It was, therefore, essential that the problem be analyzed and limited. Then, on the basis of such an examination, the procedure of research could be developed.

Intelligent consideration of the problem first demanded that terms be defined. So it was decided that the term "scientific attitude" should be made clear. This in-

volved attention to the term "scientific method" with which the attitude is linked, and the more inclusive expression "scientific thinking".

Another preliminary task involved the discovery of previous attempts to study the teaching and testing of scientific thinking, scientific attitude and method.

Following a definition of terms and a review of the recorded research in the field of this problem it was decided that there was a possibility of inaugurating a testing procedure by which a partial study of the scientific attitude could be made. Ultimately it would seem desirable to attempt the construction of an evaluation instrument that could be called a test for the scientific attitude. In this study, however, it was thought best to limit the problem by testing for only certain aspects of the scientific attitude. The selection and delimiting of the problem is described in the introduction to Chapter V.

It was planned to construct the test, administer it to certain high school science students, assemble the data and extract whatever conclusions might become apparent. This was to be done knowing, of course, that validation of a test in this area is difficult. It was believed, however, that some significant information might be gained even though validation of the test proved to be a major uncertainty.

Summary of Problem Analysis.

(1) Analyze and define the scientific attitude, the scientific method, and scientific thinking.

(2) Review the research related to this problem.

(3) Attempt to construct a test to show evidence of the possession of certain aspects of the scientific attitude.

(4) Administer the test to check groups to determine value of items, arrangement of items, method of administration and time needed.

(5) Revise test into final form.

(6) Administer revised form to eleventh and twelfth year science students in a variety of high schools.

(7) Assemble data from tests and form any justifiable conclusions.

CHAPTER III

A CLARIFICATION OF TERMS

A Definition of Science.

For purposes of education science must be given a dynamic definition. Webster's dictionary has defined science as follows: "accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of great truths or the operation of general laws; knowledge classified and made available in work, life or the search for truth." The last phrase, "The search for truth" provides the idea of activity. It is of importance here that science be interpreted as an activity, as a method by which man seeks the truth. Call science, then, a search for the truth, a scientist the searcher.

"A mere collection of facts no more constitutes science than a collection of pigments constitutes painting," wrote Professor A.W. Meyer of Stanford.[1]

John Dewey distinguished between science as a collection of facts and science as a search for truth when he declared:

> Science has been taught too much as an accumulation of ready made material with which the students are to be

1 A.W. Meyer, "Science and Conduct", Scientific Monthly, XXVI, 222, (March, 1928)

> made familiar, not enough as a method of thinking, an attitude of mind after the pattern of which mental habits are to be transformed.[1]

Scientific Thinking - Attitude and Method.

It is difficult to separate science from its method of thought. "To me the basic thing about science," Eliot Blackwelder remarks, "is an attitude or habit of mind, a way of thinking which is characteristic of those entitled to be called scientists."[2] There is some confusion among modern writers regarding a proper distinction between the terms "scientific method" and "scientific attitude". Some authors use the two terms interchangeably. An understanding of both is necessary to apprehend the more inclusive term "scientific thinking".

Curtis, who has made a number of important contributions to the teaching of science, writes:

> Scientific methods and attitudes are of necessity closely related and inseparable but they are nevertheless distinctly different concepts.[3]

He expresses the relationship by adding:

1 John Dewey, "Science as Subject Matter and as Method", Science, XXXI, 122

2 Eliot Blackwelder, "Science and Human Prospects", Science, XCIII, 359-360 (April 18, 1941)

3 Francis D. Curtis, "Teaching Scientific Methods", School Science and Mathematics, XXXIV, 816-817 (Nov. 1934)

> Scientific attitudes are essential in the employment of scientific methods and employment of scientific method contributes training in the scientific attitudes.[1]

Continuing a discussion of the relationship of the scientific method and the scientific attitude, one of the most adequate comments is contributed by the late Elliot R. Downing. The following also most clearly defines the scientific attitude:

> Scientific attitude ... means that attitude which impels one to attempt the solution of problems which he faces by scientific thinking, or good reflective thinking rather than by trial and error method. The scientific attitude is more than an intellectual assent to the proposition that the scientific method of thought is a desirable method of procedure. It is an impelling attitude and is therefore at least partially saturated with emotional elements. The scientific attitude is a fervid conviction that problems within the range of science can only be successfully solved by the scientific method of thinking. The fervor is somewhat akin in its intensity to that of a religious belief.
>
> One judges, then, how completely the scientific attitude dominates a man by noting in how far he has recourse to the scientific method in solving his problems. And that is the sole criterion for judgment. If he tries to solve some specific problem by reflective thinking, he manifests in this instance the scientific attitude. If he habitually tries so to do when problems arise the scientific attitude is well established.
>
> But he may be quite unskilled in scientific thinking and so in nine cases out of ten reach wrong solutions. The success of his efforts depends on his skill in

[1] Ibid, 816-817

thinking not on his scientific attitude.[1]

With this careful separation of attitude and method an analysis of each may clarify further their meanings and relationship.

Analysis of Scientific Method.

The following is a brief outline of the scientific method. This is the method which John Dewey calls the "Pattern of Inquiry".[2]

The scientific method requires at least these six steps:

(1) Recognition of a problem.

This involves an alertness, a curiosity which leads to location, isolation and acceptance of a problem.

(2) Analysis of the problem.

Attention must be given to carefully defining all aspects, and carefully observing all implications of the problem. Here too concern is given to the plan of attack on the problem.

(3) Provision for research.

[1] Elliot R. Downing, "The Scientific Attitude and Skill in Thinking", School Science and Mathematics, XXXIV, 302-303 (March 1934)

[2] John Dewey, Logic the Theory of Inquiry, Ch. VI.

Research procedures include the collection of related facts by:

-- observation

-- experimentation

-- reasoning

(4) Formation of hypothesis.

The hypothesis or hypotheses occur as a result of synthesis of factors resulting from the research activity. The hypothesis is tentative.

(5) Subjection of hypothesis to test.

Again exhaustive observation, experimentation, reasoning, reclassification of facts are used to justify the acceptance or rejection of the hypothesis.

(6) Establishing a conclusion.

The conclusion has a definite relation to the original problem and results from careful use of the previously stated steps in the scientific method.

Analysis of Scientific Attitude.

An attitude does not have such qualities that make it easy to define or establish. Downing has given a fairly clear distinction between the scientific attitude and its

accompanying method.[1] Some writers lack this clarity, however. There seems to be no decision among science educators whether there is one scientific attitude or many. In this investigation Victor Noll's analysis of the scientific attitude will be used. Noll has accepted the point of view that an attitude is established by the acquisition of a number of habits. In the scientific attitude there are probably many interrelated habits, the combination of which produces a whole single attitude which directs thought and behavior patterns of the individual. Noll lists the following habits as the constituents of the scientific attitude.

(1) The habit of accuracy.

(2) The habit of intellectual honesty.

(3) The habit of open mindedness.

(4) The habit of suspending judgment.

(5) The habit of looking for true cause and effect relationships.

(6) The habit of criticism including self criticism.[2]

Other studies present additional habits or subdivisions of those given above. For the most part, however, those given here will suffice for clarification of the

[1] Elliot R. Downing, loc. cit.

[2] Victor Noll, The Teaching of Science in Elementary and Secondary Schools, 24

term "scientific attitude."

Summary.

In this paper the term "scientific thinking" refers to that method of thought which is used when an individual possesses both the scientific method and the scientific attitude.

Scientific method is used in the singular and refers to that method which includes recognition and analysis of a problem, research activity for selection of facts by observation and experiment, hypotheses formation and testing, and finally the formation of a conclusion.

The scientific attitude is used in singular number. It is regarded as being the result of several interrelated habits such as habits of accuracy, intellectual honesty, suspending judgment and others.

CHAPTER IV

RESEARCH STUDIES RELATED TO THE PROBLEM

Listed in the bibliography are a number of studies related to this problem. Many such studies are reported in periodical literature while a smaller quantity is in book form. A few of the noteworthy pieces of research are summarized in this chapter.

Philosophers, educators and scientists have pointed out the importance of scientific thinking since the time when Francis Bacon wrote the Novum Organum - the new method. But even before Bacon's era a student of Vesalius was once supposed to have said that he was so taught that he could discover new truths for himself. Was he not referring to the method of science?

Careful attention to the teaching of scientific attitude and method, however, does not appear in educational literature until the beginning of the twentieth century. Dewey's presentation of scientific thinking in "How We Think" in 1910 as well as Armstrong's "The Teaching of the Scientific Method", published in the same year were probably both important actuators of later writing. John F. Woodhull spoke and wrote a great deal about the "true scientific spirit", which he thought was best taught through

what he called the "project method".[1] His work was very largely practical and of definite value, therefore, to the classroom teachers of the time.

It is interesting to note that a recognized textbook in the principles of science teaching published in 1917 spends little space (two pages) in discussing scientific thinking and makes no practical suggestion for its teaching other than reference to Woodhull's "science by projects".[2] It does contain, however, an enthusiasm for the "spirit of science". A chapter on testing makes no reference to the possibility of testing any aspect of the scientific attitude.

Although there may have been a few earlier studies, one of the significant contributions to a study of scientific thinking came from Curtis in 1924.[3] Among other procedures he devised a test for the scientific attitude and administered it to various groups. Some groups had received emphasis on development of the scientific attitude while the control groups had not. The test included thirty-four items in the nature of problems about which the

[1] John F. Woodhull, The Teaching of Science, Ch. XIII.

[2] George R. Twiss, A Textbook in the Principles of Science Teaching, 484.

[3] Francis Day Curtis, Some Values Derived from Extensive Reading of General Science.

student was to express an opinion or conclusion. Following are two sample items from the test:

> Item 15. I needed the lights yesterday morning, but when I pushed the wall button none of the electric lamps would light. I immediately concluded that the power must be off in the main line.[1]

(Here the student received credit if he indicated that the conclusion was unsound.)

> Item 32. Not long ago a miner returning from Alaska reported that on the frozen tundras, where he believed no other man, Indian or white, except himself had ever been, he actually saw a live mastodon or mammoth.
>
> a. It is undoubtedly true.
> b. His report is unlikely to be true.
> c. I wouldn't believe the report unless I saw the mammoth or mastodon myself.
> d. His report might be true but is very unlikely to be.[2]

(Here the student received most credit for answer (d), not quite as much for answer (b). He lost considerable credit for answer (c) and lost even more for answer (a).)

The items of the test covered the following points which Curtis called the scientific attitudes:

> I. Conviction to universal basic cause and effect relations, rendering untenable
>
> a. Superstitious beliefs in general, as "signs" of "good or bad luck," and charms;
> b. "Unexplainable mysteries,"
> c. "Beats all" attitude, commonly revealed by
>
> 1. Too ready credulity;
> 2. Tendency to magnify the importance of

[1] Ibid., 63.

[2] Ibid., 66.

coincidence.

II. Sensitive curiosity concerning reasons for happenings, coupled with ideals -
   a. Of careful and accurate observation, or of equally careful and accurate use of pertinent data previously collected by others;
   b. Of patient collecting of data;
   c. Of persistence in the search for adequate explanation.

III. Habit of delayed response, holding views tentatively for suitable reflection (varying with the matter in hand).
   a. To permit adequate consideration of possible options;
   b. To permit a conscious plan of attack, clearly looking forward to a prediction of the probable outcome, or solution.

IV. Habit of weighing evidence with respect to its
   a. Pertinence,
   b. Soundness,
   c. Adequacy.

V. Respect for another's point of view, an open-mindedness and willingness to be convinced by evidence.[1]

It will be readily noted that the sample item number 15 taken from the test of scientific attitude would relate itself to IIIb above. In sample item 32, answer (a) relates to Ic showing too ready credulity. Curtis assumes that all items and possible answers in his test are connected with his list of scientific attitudes. Some of Curtis' findings were as follows:

1. A little instruction in scientific attitudes pays large dividends.[2]

[1] Ibid., 48-49.

[2] Ibid., 78.

2. Scientific attitudes can be measured objectively.[1]
3. Scientific attitudes are not possessed to any great extent by pupils in general science. Extensive reading of scientific literature contributes to the scientific attitudes of the individual, but not to an extent secured by a small amount of class time devoted specifically to the teaching of scientific attitudes.[2]
4. There is some evidence of positive correlation between brightness quotients and scientific attitudes.[3]

In 1933 Sinclair and Tolman studies the effect of scientific training upon prejudice and illogicality of thought among high school students. As a result of their studies these researchers stated that they "have found no evidence for the 'transfer' of logicality of thought or reasonable habits of thought from fields of specific scientific training to fields involving questions of economic, ethical and social judgment."[4]

As far as the writer has been able to discover, the first published test showing an attempt to measure any of the habits producing the scientific attitude was Zyve's

[1] Ibid., 112.

[2] Ibid., 112.

[3] Ibid., 78.

[4] James H. Sinclair and Ruth S. Tolman, "An Attempt to Study the Effect of Scientific Training Upon Prejudice and Illogicality of Thought", Journal of Educational Psychology, XXIV, 370, (May 1933).

Stanford Test of Scientific Aptitude.[1] The aim of the test was primarily to detect and measure certain traits such as experimental bent, accuracy of observation, suspended judgment and others. The test consists of eleven such parts. Scores on the test seem to show a positive correlation with amount of training in science and amount of interest in science. Zyve's test is of interest here because of his attempt to measure some of those "intangibles" that constitute the scientific attitude. His provision of problems to measure such habits as "suspension of judgment", "detecting inconsistencies", "accuracy of interpretation" and others are noteworthy.

Another contribution to the testing of scientific attitude is offered by Victor Noll.[2] His test is probably the most widely known of the few that exist. It was published at Columbia University in 1934. Of his test Noll writes:

> This test was designed to measure the chief phases or aspects of what are called the scientific attitudes. These included open-mindedness, suspended judgment, accuracy, understanding of true cause-and-effect relationships, intellectual honesty, and criticalness. The test does not depend on instruction in, or knowledge of, science, but aims rather to measure these attitudes in everyday life situations, on the theory that unless science teaching produces these habits of

[1] D.L. Zyve, Stanford Test of Scientific Aptitude, Stanford University Press, 1929.

[2] Victor N. Noll, What Do You Think? (A Test of Scientific Attitudes), Bureau of Publications, Teachers College, Columbia University, 1934, 35.

> thought in non-laboratory and extra-classroom environments, they are of little general value. Each form of the test aims to measure each of the six components mentioned through the use of 112 items of either a three-response or a true-false type. [1]

Some sample items from the Noll test follow:

(1) There is no use working any harder than is necessary to "get by".
(2) A high forehead is a sign of intelligence.
(3) Our next president will be a Democrat.
(4) Any nation that persecutes the Jews, as Germany has recently done, must be totally uncivilized.
(5) If my teacher says a thing is so, it must be so.[2]

Item 1 above is supposed to measure intellectual honesty, item 2, the habit of looking for cause and effect relationships, item 3, the habit of suspended judgment, item 4, the habit of open mindedness, and item 5, the habit of criticism. In addition to these five types there are thirty-eight items which purport to measure accuracy of observation and calculation.

An important implication of the Noll test described above is that the habits of scientific thinking are equally valuable within and without the field of science. Glenn Blair, in a study of the Noll test, challenges its validity.[3] He gave the test to sixteen scientists, each holding

[1] Victor H. Noll, The Teaching of Science in Elementary and Secondary Schools, 231.

[2] Glenn M. Blair, "The Validity of the Noll Test of Scientific Thinking", The Journal of Educational Psychology, XXXI, 53, (Jan. 1940).

[3] Ibid., 59.

a Ph. D., and found that several items are debatable. Blair recommended changing the scoring key to conform with the answers of the scientists and the elimination of debatable items.

A.G. Hoff reports an unpublished test for scientific attitude in 1936.[1] Using the five points of the Curtis outline of the scientific attitude Hoff developed a 150 item test. The average time for high school seniors was 40 minutes. Students circled one of four symbols preceding each item. Some sample items follow:

(T - true, F - false, ID - insufficient data, DK - I do not know.)

Item 5. A president of the United States should not serve more than two terms only because it has been customary not to do so.

Item 22. My motor seems to lack power today; there must be some reason for it and the trouble should be corrected.

Hoff found no significant correlation with scientific aptitude, school grades nor with comprehension and speed of reading.

Kenneth Love presented a test for the scientific attitude in 1937. The test was called "Scientific Attitudes - Thinking Test". It was composed of twenty-four items to be completed in 40 minutes. One part involved testing the

[1] A.G. Hoff, "A Test for Scientific Attitude", School Science and Mathematics, XXXVI, 763-770, (Oct. 1936).

pupil's ability to develop an experiment in a scientific manner. The second and third parts contained items of increasing difficulty in which the student wrote out or chose statements showing his ability to recognize and weigh assumptions. This test, as well as the Noll test, attempted to establish tentative norms. Both tests seem to be unavailable at present.

Two interesting contributions toward evaluation of teaching scientific thinking have been made by work-shop groups in recent years. The value of the work lies mainly in its usefulness to the classroom teacher. Participants in the science group of the Progressive Education Association workshop in 1937 prepared test-like exercises in scientific method and attitude although they did not refer to them as such. In general the test items were extensive requiring more than ten minutes to complete each exercise.

One of the tests is shown in part in Appendix I. It will be note there that a paragraph of information is given followed by several interpretations of the data in the paragraph. The student is instructed to mark each interpretation as either true, probably true, probably false, or false. Where the student thinks the data given are insufficient to decide among these possibilities he is to classify the interpretation as such.

On the basis of an analysis of the students' responses

to tests of this type it is possible to detect the following significant tendencies of behavior:

1. Recognizes true statements as true, false as false, etc.
2. Tendency to be overcautious.
3. Tendency to be extremely overcautious.
4. Tendency to go somewhat beyond the facts.
5. Tendency to go rather far beyond the facts.
6. Tendency to confuse the probably true and the probably false.
7. Tendency to judge statements as being in the direction of 'true' or 'false' when the data support an opposite direction. Wide errors in judgment.
8. Tendency to judge statements as having a greater certainty of truth than the data justify.
9. Tendency to judge statements as having a greater certainty of being false than the data justify.
10. Tendency to be more certain than the data justify.[1]

In 1939, a workshop group at Stanford University developed evaluation instruments similar to the one just described. The following is an example of a test to discover the student's ability to draw a correct hypothesis:

> One evening a boy entered the bathroom of his home and turned on the cold water faucet of the lavatory. He found that the water merely trickled from the pipe. Usually when the faucet was turned on there was a copious flow of water.
>
> Instructions: Read the following four possible explanations for the lack of flow of water from the faucet and, before reading the statements of facts and observations listed below, place in the blank space just under the list of hypotheses the letter (either A, B, C, or D) of the hypothesis which you would check without further evidence.

[1] From Materials Prepared by Participants in the Science Group of the P.E.A. Workshop, Sarah Lawrence College, Bronxville, N.Y., 1937.

Hypotheses

A. His father had failed to open fully the valve on the house main (water line) when he had used it earlier in the day.
B. The pressure on the street main was low.
C. There was gravel clogging the cold water faucet of the lavatory.
D. The main line to the house from the street was leaking.

Instructions: After having studied the following statements place a check mark in Col. I to the right of the hypothesis which you would then choose as most valid.

In Col. II place the numbers (eg. 1, 2, 3, etc.) of all statements which strengthen each hypothesis.

In Col. III mark similarly all hypotheses with the number of those statements which weaken each hypothesis.

In Col. IV mark similarly all hypotheses which are completely eliminated by certain statements.

Statement of Facts and Observations

1. His father had turned the house main off in order to put a new washer on the kitchen faucet.
2. There was a great amount of fine gravel in the ditch in which the service crew had repaired the broken main.
3. The flow from the hot water line in the kitchen also has been very small since early afternoon.
4. The service crew has repaired the broken line under water.
5. The water flowed freely and with usual pressure from the garden hose with which he had watered the roses later in the afternoon.
6. The sprinkler system in the lawn is working just as well as usual.[1]

Classroom use of such evaluation instruments as the two just described would add materially to the development of scientific thinking. Science and social studies classes

1 E.H. Hart, "Measuring Critical Thinking in a Science Course", California Journal of Secondary Education, XIV, 337, (Oct. 1939).

could use the exercises to advantage. The writer, however, has been unable to discover any study or report of the results of their usage.

A recent study on one aspect of the scientific attitude was made by Louis Teichman, Christopher Columbus High School in New York City. The general topic of his doctoral dissertation was "The Ability of Science Students to Make Conclusions".[1] His problem may be briefly stated by these three questions:

(1) What is the effect of instructional emphasis on ability to make conclusions?

(2) What is the relationship between mental age and ability to make conclusions?

(3) What is the relationship between reading ability and ability to make conclusions?

Teichman devised a battery of three tests and administered them to experimental and control groups in ninth grade general science classes. Approximately 550 students were involved. Following a period of training in the ability to develop sound conclusions, as a part of the semester's course, the experimental group was again given the test. The control group having had no instructional emphas-

[1] Louis Teichman, "The Ability of Science Students to Make Conclusions", Science Education, XXVIII, 268-79, (Dec. 1944).

is on the experimental factor was also given the test. The following conclusions were stated:

> (1) A teaching technique which emphasizes the ability to make conclusions, to judge conclusions, and to state reasons why some conclusions were faulty was found to produce significantly higher scores ... than did teaching techniques which did not emphasize these abilities.
> (2) Students with high mental ability are more likely to show initial skill in the ability to make conclusions than are those with poorer mental development.
> (3) Students with good reading ability are more likely to show initial skill in the ability to infer than are those not so well able to read.
> (4) Mental ability and reading ability are very poor indications of the ability to improve one's skill in making conclusions.
> (5) The ability to state a conclusion, the ability to select the best reason for a faulty conclusion, and the ability to select the best conclusion from among several presented, are not identical abilities.[1]

A particularly significant implication brought out by the Teichman study is that students in the lower percentile of mental and reading ability were able to improve their ability to make conclusions.

The few studies mentioned here would seem to indicate that the total amount of research on teaching the scientific attitude is inconsiderable. A hopeful sign is the large number of articles devoted to scientific method and attitude in educational periodical literature. Also the number of unpublished theses in this area is significant. The greatest amount of this material is found to have been written during the 1930's.

[1] Ibid., 272.

It has come under the writer's occasional observation that some science teachers are unaware of their responsibility for developing the scientific attitude. Some lack even a satisfactory understanding of the method of science and the habits of mind that should attend it. This condition is understandable when viewed in the light of teachers' education programs which contain few if any opportunities to develop scientific mindedness. To influence another to use the scientific attitude it would seem only logical to expect the teacher to possess the desired habit. Beauchamp, in 1932, completed a survey of twenty-six outstanding high schools in which he asked science teachers how they trained pupils to do scientific thinking. The following represents the general pattern into which all answers fell:

(1) The study of science results automatically in this ability because of the nature of the subject matter.

(2) It is not possible to train a pupil to think.

(3) We had a lesson in that "last week", or "next week".

(4) We take that up in the introduction to the course.

(5) The children learn the method by watching the procedure of the teacher.[1]

Fortunately this study was done in 1932 and since that

[1] Wilbur S. Beauchamp, Instruction in Science, National Survey of Secondary Education, Monograph No. 22, 57-58.

date some new science texts and increased general discussion of scientific thinking might have improved the type of answer for Beauchamp's question.

Summary:

A review of the research studies in the field of teaching scientific thinking leads to these conclusions:

(1) There is an increasing awareness of the need for recognizing, analyzing and doing further research on the problem of teaching scientific thinking.

(2) There are several researchers who maintain that various aspects of scientific attitude can be taught, can be developed in pupils.

(3) There is evidence that the results of teaching the scientific attitude are measurable.

(4) At present there are no adequately standardized tests for measuring the scientific attitude.

(5) There is need for continued clarification of terms and continued analysis of all aspects of teaching and measuring scientific attitude. The "intangibles" need to be treated by a vigorous research until they can no longer remain intangible.

CHAPTER V

PREPARATION OF A TEST FOR THE MEASUREMENT OF THE SCIENTIFIC ATTITUDE

The writer chose two habits of the scientific attitude on which to base a trial test. First, a test of intellectual honesty and second, a test for tendency to suspend judgment. This should be considered a preliminary attempt to discover whether or not such tests are significant, whether they really test what they are intended to test. If valid tests can be developed for these two parts of the scientific attitude then further work might produce tests for other aspects and finally a test by which the scientific attitude as a whole might be measured. This test of attitude combined with one to detect the ability to use the scientific method would ultimately give a valid measurement of the pupil's ability to think scientifically. This foregoing statement is based on Downing's analysis of the relationship of the scientific attitude and method given in Chapter III.

The Test for the Habit of Intellectual Honesty.

A test for intellectual honesty must attempt to discover whether or not the individual will, in all situations, respond to the truth. A student possessing a high degree

of "honest" thinking will be exceedingly careful of unfounded opinion, careful of prediction, and he will admit lack of knowledge. The student who tends to be intellectually honest will more often use the expression, "I don't know" rather than jump to unfounded conclusions.

Selecting the Type of Test.

It seemed evident from the outset that a camouflage type of test would be necessary. The student must be unaware of the intent of the test otherwise results would be affected by the student's desire to impress the teacher with his intellectual honesty. It was further decided that the test should not be restricted to items regarding science alone but rather touch upon a variety of high school experiences.

To allow as brief as possible response the true-false type exercise was used with the addition of a "don't know" alternative.

Selecting the Test Items.

Items were prepared to detect whether or not the student would admit lack of knowledge. This was done by the use of "fantastic" words developed by the writer. The student was asked to respond "true", "false" or "don't know" to statements containing the unknown and meaningless words.

The following will illustrate:

Item 28. Pyromorphidrine is medically useful.
Item 17. People who believe in aveltism are few in number when compared with the total number of true Christians.
Item 55. Prolingualism hinders some in learning a foreign language.

The terms pyromorphidrine, aveltism and prolingualism are the "fantastic" words to which the student should respond with the statement "I don't know". It seems logical to assume that a student who admits he knows nothing of "pyromorphidrine", "aveltism", and "prolingualism" is being intellectually more honest than one who states or guesses the statement to be true or false. From the standpoint of intellectual honesty to affirm or reject a statement implies that the statement is understood.

Another aspect of intellectual honesty is the tendency to refuse to make absolute predictions. Items which might test this aspect are illustrated by the following:

Item 3. Communism, as a form of government, will eventually disappear.
Item 7. The president we elect in 1948 will be a Republican.

Still another type item was used. Statements for which the student would lack sufficient factual background to say more than "I don't know". In these statements no "fantastic" words, nor any "prediction" situations were used. The two following items are examples of the third type:

Item 15. Communism is harmful to society.

Item 42. The Smith typewriter is superior to the Underwood.

Whether this last type of test item is usable may be debatable. The writer reasoned that such items should draw the "I don't know" response from the student who is more intellectually honest. The student who admits he doesn't know whether communism is harmful or valuable to society is thinking more honestly than one who responds with "true" or "false". The latter two answers would indicate less intellectual caution and more of a tendency to jump to a conclusion based on opinion. The test included only three items of this nature. The "fantastic" word type item was most numerous.

Judging the Test Items.

Trials of the test in high school classes showed that several refinements were needed. Comments of students and teachers and a study of trial results were used to make changes.

Among the "fantastic" word items it was discovered that some words were so closely related, either by similar spelling or pronunciation, to existing words that it was thought best to change them.

The term "altheism", too closely akin to "atheism" was changed to "aveltism" in the final wording of item # 17.

The term "isomerics" intended as a "fantastic" word for item #20 was discovered to have a chemical meaning influencing the response to the item. It was changed to the unknown word "cordition".

Item #13 originally read, "Democracy works" but was changed to "Democracy will work in any country".

Item #3 of the original test "Unions will keep workers' wages high" was discarded as an "I don't know" item.

Item #46 was originally stated as follows; "football is becoming less popular than baseball". Coaches and others vetoed the statement in favor of a "fantastic" word type of statement.

Item #49 was also invalidated by the athletes. It originally read, "Complete changes in next year's football rules will materially change the offensive tactics of the game". It was maintained that many boys taking the test would know that no football rules were to be changed and hence they would mark the item "false". It had been intended as an "I don't know" item.

Item #58 remains in the test but was not used as an "I don't know" item in scoring. The writer is still not convinced of the invalidity of item #58.

Final List of Items.

The following items are those finally used in the

test for intellectual honesty. These eighteen items were scattered among forty-two other non-essential items to make up the complete form given in the appendix.

3. Communism, as a form of government, will eventually disappear.
7. The president we elect in 1948 will be a Republican.
9. Heterocratic practices will hinder unions.
10. The Democrats will carry out a good program of internal reform.
13. Democracy will work in any country.
15. Communism is harmful to society.
17. People who believe in aveltism are few in number when compared with the total number of true Christians.
20. Future aviation will make use of cordition.
25. Laboratory work on rigomaniasis will aid mankind.
27. Einstein's work on fifth dimension will probably reveal a new mathematical theory.
28. Pyromorphidrine is medically useful.
36. The development of autovelite might increase our leisure time.
39. New saforized pigments render oil paints more durable.
42. The Smith typewriter is superior to the Underwood.
46. Rules in football tend to cathorize the offensive tactics of the game.
49. Dermenson's rules for basketball might change the usual defense plays in the game.
53. The books of Georji Spanzo are enjoyed by many Italians.
55. Prolingualism hinders some in learning a foreign language.

The Test for Suspended Judgment.

Section II of the test aims to discover to what degree a student will suspend judgment when confronted with erroneous or incomplete information. The acts of suspending or forming a conclusion should come after the student has carefully surveyed the facts or evidence presented in a

problem situation. No conclusion should be acceptable when the following conditions are apparent:

when evidence or facts are lacking
when evidence is doubtful, inaccurate or unsound
when evidence is contradictory
when evidence is based on insufficient number of cases or examples.

The alternative to the habit of delayed judgment would be that which is commonly termed "jumping to a conclusion".

It should not be too difficult to devise a test to measure the tendency to draw conclusions with care.

Selecting the Type of Test.

It was decided to build the test of a series of items each of which presented a problem for which a conclusion might be drawn. The majority of the problems, however, were to be so worded that conclusions were either not possible or difficult to uphold.

It was thought best to use some variety in this section. Some items call for a written answer. Other items are followed by several conclusions, one of which is to be checked. A third type has several conclusions but in addition a space for the student to write in his own answer or conclusion if he elects to do so. Of the twelve items finally selected five required conclusions written in by

the student. Four items required checking possible conclusions provided, and three items provided for either checking or writing a conclusion.

Selecting the Test Items.

Section II was originally composed of fifteen parts. Each part was an item of the test. Each part gave some information and requested the student to form a conclusion based on that information. As in Section I it was decided that the items need not necessarily be in the field of science. Items of the following types were developed:

1. Items for which a logical conclusion could be written or checked.
2. Items where evidence should be interpreted with great care.
3. Items where facts are presented in chart form and mathematical form.
4. Items for which no conclusion is possible because of insufficient information.
5. Items for which no conclusion is possible because of inaccurate information.
6. Items where there are insufficient cases or observations to justify a conclusion.

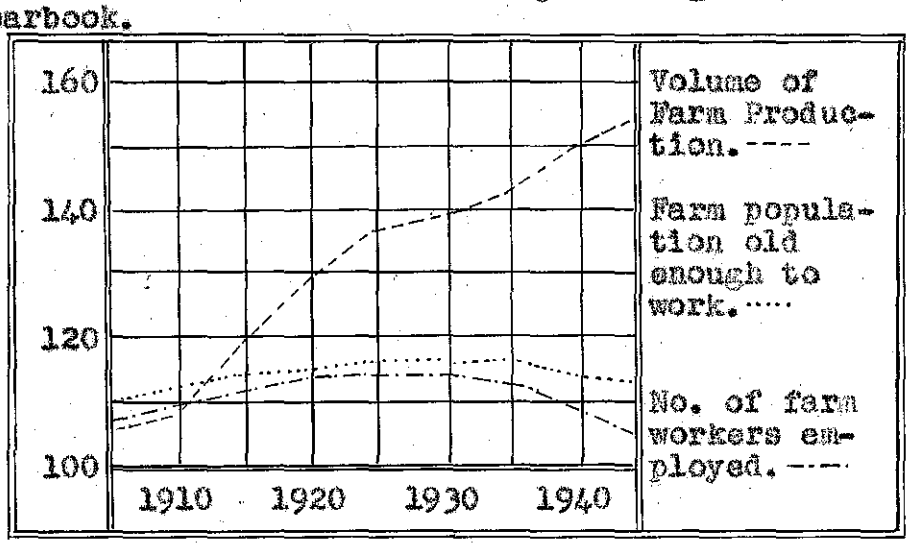
It was suspected that a student having the habit of suspending judgment would use care in preparing a written

conclusion or in checking one provided for him. A student who lacked this desirable habit would tend to form conclusions on inaccurate and insufficient evidence, might overlook data, might allow his own opinion to influence his conclusions.

The following samples serve to illustrate different types of items planned for the test.

Part 4

This chart is from the U.S. Dept. of Agriculture Yearbook.



Conclusion: _____

_____

This item represents the type of problem for which a conclusion is possible. Few of this type were used inasmuch as the primary aim of the test was to discover evidence of tendency to withhold judgment or a conclusion.

Part 11

In a nationwide survey of thirty representative high schools, research workers gathered the following information regarding the use of cigarettes among students between the ages 14 and 17.

Approximately 8% of the boys used cigarettes regularly. 5% of these used the word "habit" in describing their use of tobacco. 2% of the "smokers" positively stated that they enjoyed smoking.

78% said they had tried smoking a few times and stopped. 14% of those answering the questionaire stated they had never used tobacco in any form.

Conclusion: (Check one)

( ) Too many high school boys smoke cigarettes.

( ) Rural students smoke less than students in urban areas.

( ) Probably more than 50% of boys between 14 and 17 years try smoking and then stop.

( ) 18 year olds smoke more than 17 year olds.

( ) High school boys don't really enjoy smoking.

( ) Smoking is harmful until you reach 18 years of age.

( ) 5% of high school boys have the habit of smoking.

This item illustrates the type of problem for which the student may select a conclusion but care needs to be given to the numerous facts presented. Here it is possible to violate the habit of suspending judgment by allowing opinion to determine the conclusion.

Part 6

Mrs. Jones purchased a new guaranteed Sorex coffee maker. Several morning's use found it to be quite satisfactory in all respects. One afternoon Mrs. Jones used the Sorex to prepare tea for her guests. Results were not quite what she had expected.

Conclusion: (Check one)

( ) Mrs. Jones should have been more careful.

( ) Sorex coffee makers should never be used for tea making.

( ) This coffee maker was defective.

( ) Mrs. Jones needs to learn how to use a Sorex correctly.

( ) Mrs. Jones is stupid.

( ) Mrs. Jones did not have a tea pot.

( ) I can draw no conclusion from the facts given.

This item presents insufficient information, hence, the student with the habit of suspended judgment would most probably check the last sentence given above. Selection of any of the first six choices would indicate the tendency to "Jump to a conclusion".

Part 8

Information taken from a student's report in a social studies class.

Name of City	Area in sq. miles	Population	Population per sq. mile
X	200	6,000,000	30,000
Y	400	3,200,000	31,000

Conclusion:

( ) City X is growing rapidly.

( ) City Y is growing rapidly.

( ) City Y is slightly more crowded than City X.

( ) City X has approximately 1,000 more people than City Y.

( ) _____

( ) City X is more crowded than City Y.

( ) People in City X should gradually move to City Y.

For this item the student may either check or write in a conclusion. The student who forms a conclusion with due care for the given facts will soon discover an error in the numbers and will write in some statement indicating his discovery of the error.

Judging the Test Items.

In order to determine the usefulness of each test item a preliminary form of Section II, composed of fifteen items, was given to a number of high school students in a variety of classes. Students in chemistry, biology and social studies classes were used. Comments of teachers were noted. Interviews with individual students helped validate and invalidate various items.

No attempt is made here to list all the changes necessitated by several trials of the test. The following list indicates the types of changes that were made.

1. The number of items for which complete conclusions were possible were reduced to two. These two items were so placed that the student would not suspect that all items of the test were falacious. (See parts 1 and 10 of Section II of the final form of the test.)
2. Items requiring too much time because of the complexity of information were eliminated.
3. Some items were simplified. Item #9 was materially changed.
4. The directions for Section II were altered and emphasis was placed on forming a conclusion based only on information given.

There finally remained twelve parts or items in Section II. Ten of the twelve presented an opportunity for the student to show that he was careful in forming conclusions. The final list of items as used in Section II is found in Appendix II which contains the complete copy of the test.

Validation of Sections I and II.

It has not been this investigator's immediate intention to build a carefully validated test that might later be standardized. This does not minimize, however, the necessity of making some sort of evaluation of the validity of the instrument.

After careful analysis of the scientific attitude, it is believed that there is a possibility of developing a valid test for each of the several habits which make up the attitude. So little has been done in this field of attitude testing that any work of this kind is subject to the criticism that accompanies all first attempts in unknown fields. These first attempts may gradually provide enough experience and factual background that eventually the validation of a test for the scientific attitude will not be so difficult to secure.

It is believed that the two sections of this test do have a degree of validity which can be shown by logical

analysis of the attitude being tested. In referring to this type of validation, Greene, Jorgensen and Gerberich make the following statement:

> There are certain subjects in which it appears to be impossible to secure an objective or statistical basis of validation. In general, these subjects are in the complex fields made up of many interrelated abilities as, language and reading. The most effective approach to the validation of the content of tests in these fields appears to be through introspective analysis. That is, a sort of arm-chair psychological dissection of the total process is made, in which as many as possible of the basic abilities are identified. In the use of this method the analysis is the initial step. Statistical refinements later make possible the selection of the qualities which are best measured by objective methods.[1]

Summary.

This partial test for scientific attitude contains two sections:

Section I - A Test of Intellectual Honesty.

Section II - A Test of Suspended Judgment.

The items of the test were carefully examined by teachers of science and others for their usefulness. Preliminary trials of the tests were given to determine the value of the items. Individual students were interviewed regarding their responses to items in the test. Changes were made and the final form completed. It is believed

[1] Harry A. Greene, Albert N. Jorgensen and J. Raymond Gerberich, Measurement and Evaluation in the Elementary School, 60-61.

that the test has a certain logical validity.

It was discovered that most students completed the test in approximately 45 minutes. The usual 50 minute high school period was sufficient time for nearly all students.

CHAPTER VI

ADMINISTERING AND SCORING THE TEST

Both sections of the test were mimeographed and, together with a front page of directions and a final page for general information, were bound together in the form shown in Appendix II.

The following high schools cooperated in giving the tests:

George Washington High School, San Francisco, California

Tamalpais Union High School, Mill Valley, California

Stockton High School, Stockton, California

Lodi Union High School, Lodi, California

The writer gave the tests in Stockton and Lodi Schools. Tests were mailed to both San Francisco and Tamalpais, accompanied by the following:

Instructions for Administering the Test.

GENERAL INFORMATION: This two-part test is being developed in an effort to measure intellectual honesty and the extent to which students withhold conclusions when confronted with situations involving incomplete or erroneous information. The test is one of several contemplated to cover various aspects of the scientific attitude. It is desirable that the information in this paragraph be withheld from the student. The results are adversely affected when the student is acquainted with the purpose of the test.

SELECTION OF STUDENTS: The test is intended for 11th and 12th year students who are enrolled in science classes such as chemistry, physics or an advanced biological science class. It is preferred to give the test to a regular class group during their regular period in their usual room.

TIME REQUIRED: Approximately 50 minutes.

SPECIFIC INSTRUCTIONS:

(1) Pass tests to class; at the same time request students:
   a. not to open booklets.
   b. fill in name, etc. at top of front page (either pencil or ink may be used for the test.)
   c. read front page.

(2) After the students have read the front page read the following to them. (Or generally cover the same ideas verbally in any way you may see fit.)

"THE WORK YOU ARE GOING TO DO THIS PERIOD IS PART OF A RESEARCH PROJECT BEING CARRIED ON AMONG MANY 11th AND 12th YEAR STUDENTS IN HIGH SCHOOLS. THE AUTHOR OF THIS TEST WANTS TO OBTAIN ACCURATE INFORMATION AND HE WANTS YOUR BEST EFFORTS. THE TEST WILL SEEM DIFFERENT THAN THOSE WE USUALLY HAVE. IT WILL HAVE TWO PARTS. THE DIRECTIONS FOR THE FIRST PART WILL BE FOUND ON THE FIRST PAGE AND THEY WILL BE EASILY UNDERSTOOD. THE DIRECTIONS FOR PART II SHOULD BE READ CAREFULLY WHEN YOU COME TO THEM. THEN GO RIGHT ON AND COMPLETE THE TEST.

REMEMBER YOU MAY ASK NO QUESTIONS AFTER YOU HAVE STARTED. YOU MAY BEGIN NOW.

(3) Please discourage any questions concerning items in the test.

(4) As students complete the test, ask them to fill in the final information page as accurately as possible.

(5) Collect the tests, package them and express them collect to:

Charles E. Hamilton
Lodi Union High School
Lodi, California

I.Q.'s were obtained for students taking the test except Tamalpais' students, where no intelligence tests had been given.

Scoring Section I.

To facilitate the scoring of Section I keys were prepared. These consisted of cardboard strips which, when placed on the pages correctly, covered all answers except those "X's" which were to be circled by the student. By counting the number of circled X's showing through the key, the total score could be obtained. Appendix III contains sample pages showing the use of the scoring strips.

The total possible score for Section I is 15. The score was recorded on the information page at the end of the test and on large summary sheets.

Scoring Section II.

The scoring of Section II was not as simple as Section I, inasmuch as written answers had to be evaluated. It was possible for a student to have as many as eight written conclusions needing interpretation. On the following pages analyses of the conclusions for the twelve parts of Section II are given. Where the items require written conclusions, quotations of satisfactory and unsatisfactory responses are given with the comments under each part.

Part 1

The monthly averages given below have been taken from Police Records in City X.

Time of Day	No. of Auto Accidents	No. of Casualties
6:00 - 8:00 A.M.	4	0
8:00 -10:00	3	1
10:00 -12:00 P.M.	3	0
12:00 - 2:00	5	2
2:00 - 4:00	5	1
4:00 - 6:00	8	3
6:00 - 8:00	8	4

Conclusion: _____

Any simple statement in which the student concluded that accidents and casualties, or both, increased in the afternoon and evening was given credit. Only when there was excessive interpretation of why the accidents occurred was credit withheld. The student had been cautioned in the directions preceding Section II that conclusions were to be based on the information given.

Accepted conclusions:

"Auto accidents and casualties are higher in the afternoon and evening than in the morning."

"The highest rate seems to be from four to eight o'clock."

"It is not as safe to drive later in the day in City X. This may be because of more crowded conditions."

Unsatisfactory conclusions:

"The police in City X make extensive research in auto accidents in order to improve their traffic."

"There are more accidents between 6:00 and 8:00 P.M. because more people are traveling then and it is harder to see."

Part 2

A vicious bull on the Jackson Ranch has attacked three men on separate occasions. All three men are known to have been wearing brilliant clothing. One man wearing inconspicuous clothing was not harmed.

Conclusion: (Check one).

( ) Entering this bull's pasture is very dangerous.

( ) No one should ever enter a bull's pasture.

( ) People need to be careful around the bull on the Jackson Ranch.

( ) Brilliant clothes should never be worn near any bull.

( ) Inconspicuous clothing does not enrage the bull.

( ) I can draw no conclusion from these facts.

Credit was given for a check in either the third or sixth conclusion. All other statements seem to be conclusions which the few facts given will not justify.

Part 3

Make of Car	Color	Cost	No. of Sales
X	black	$ 760.00	2500
Y	blue	$ 800.00	2489
Z	brown	$ 775.00	2960

Conclusion: (Check one or write in a conclusion).

( ) Car Z is most popular because it is brown.

( ) The least expensive car sells more rapidly.

( ) Make X is the best car because it is the least expensive of the three.

( ) Blue cars cost more than black ones.

( ) _____

No credit was given for any of the prepared conclusions. Credit was given for written statements which found that the information given was inadequate.

Satisfactory conclusions:

"There can be no conclusion drawn from these facts; there are not enough facts given."

"You can't tell the best car from this."

Unsatisfactory conclusions:

"Car Z must be the most economical to run."

"More brown cars were sold because the price was neither too cheap nor too expensive."

Part 4

In a test made by the Tajal Soap Company 500 women were given six unmarked bars of soap. Each represented a leading brand. The ladies were asked to judge the best soap. Over 300 of the women chose Tajal soap.

Conclusion: (Check one.)

( ) Tajal soap is a superior soap.

( ) There is not enough information here to help me judge the value of Tajal soap.

( ) All soaps are about the same.

( ) Many people buy Tajal soap.

( ) The best soaps have the greatest sales.

( ) Tajal Soap Company probably increased their sales enormously.

The second prepared conclusion represents the most satisfactory response for the student who has a tendency to suspend judgment.

Part 5

Mr. Adams on returning to his home at 9:00 P.M. met George Peterson who had recently been paroled from jail after being convicted on a burglary charge. Mr. Adams was impressed by the young criminal's seeming astonishment at their sudden meeting. Both greeted each other and proceeded on their way. Later that evening Mr. Adams discovered that money left in a drawer in his home had been stolen. He phoned the police.

Conclusion: _____

_____

Here the student is given an opportunity to complete a story. It is believed that the student who tends to reserve judgment will be careful of establishing George Peterson's guilt and will write a conclusion accordingly.

Satisfactory conclusions:

"Was the money really stolen?"
"Peterson's being in the vicinity would throw suspicion on him but he did not necessarily commit the crime."
"There aren't enough facts to work from."
"Peterson might be a suspect."

Unsatisfactory conclusions:

"He blamed the theft on Peterson."
"George Peterson took the money and that was the reason for his being astonished at their meeting."
" ... very few criminals reform."

Part 6

Mrs. Jones purchased a new guaranteed Sorex coffee maker. Several morning's use found it to be quite satisfactory in all respects. One afternoon Mrs. Jones used the Sorex to prepare tea for her guests. Results were not quite what she had expected.

Conclusion: (Check one.)

( ) Mrs. Jones should have been more careful.

( ) Sorex coffee makers should never be used for tea making.

( ) This coffee maker was defective.

( ) Mrs. Jones needs to learn how to use a Sorex correctly.

( ) Mrs. Jones is stupid.

( ) Mrs. Jones did not have a teapot.

( ) I can draw no conclusion from the facts given.

Credit was given for checking the final prepared conclusion. The last sentence of the paragraph should have created a doubt in the mind of the student as to what the results really were. Not knowing the results of using the Sorex for tea preparation, a conclusion should have been delayed.

Part 7

> Twenty children kept in the same nursery school were divided into two groups of ten each. Both groups had the same area for play but separate rooms for sleeping. Group A had sleeping cots on the first floor and Group B had theirs on the second floor. A study of health records showed that children in Group B had fewer colds than children in Group A.
>
> Conclusion: _____

Satisfactory conclusions for this part indicated lack of information. Unsatisfactory conclusions tended to carelessly develop some single factor as a cause for colds in one group.

Satisfactory conclusions:

"This is vague. Their colds depend on other conditions - heat, ventilation, etc."
"One conclusion is that sleeping on the second floor increases health. According to this what is health like on the 6th and 12th floors?"
"There could be a number of reasons for their colds."
"No conclusion from these facts."

Unsatisfactory conclusions:

"The first floor was probably drafty and colder."
"The second floor was a healthier place."
"Children in Group B had purer air to breathe."

"Group A must have opened their windows wider when they went to sleep."

Part 8

Information taken from a student's report in a social studies class.

Name of City	Area in sq. miles	Population	Population per sq. mile
X	200	6,000,000	30,000
Y	400	3,200,000	31,000

Conclusion: (Check one or write one in.)

( ) City X is growing rapidly.

( ) City Y is growing rapidly.

( ) City Y is slightly more crowded than City X.

( ) City X has approximately 1,000 more people than City Y.

( ) _____

( ) City X is more crowded than City Y.

( ) People in City X should gradually move to City Y.

Credit was given only when the student indicated that the figures were erroneous. Any checked conclusions were unsatisfactory.

Satisfactory conclusions:

"Chart inaccurate."
"The student needs to check his numbers."
"Isn't the population per square mile 8000 for City Y?"

Part 9

Results of a laboratory experiment carried out by students in a botany class:

Plants		
12 tomato plants	.01 gram Vitelex per gal. of water	11 plants bear fruit in 90 days. 1 plant dies.
12 bean plants	.01 gram Vitelex per gal. of water	11 plants mature and bear flowers within 50 days. 1 plant flowers in 70 days.
12 tomato plants	water without Vitelex	12 plants bear fruit in 3 months.
12 bean plants	water without Vitelex	10 plants mature and bear flowers within 50 days. 1 plant flowers only slightly.

Conclusion: _____

In this part the student should note the fact that there is little difference in the results of the two treatments. Furthermore, the student should note that only a few plants have been used. The trade name, Vitelex, should not influence the conclusion.

Satisfactory conclusions:

"This doesn't show that Vitelex affects the growth of either beans or tomatoes."

"I don't know whether Vitelex has any bearing on the growth of plants or not."

"Vitelex seemingly doesn't add to the growth of plants."

Unsatisfactory Conclusions:

"It seems as though when the class used Vitelex, the plants were healthier and grew rapidly."

"The beans and tomatoes get along better when Vitelex is used."
"Vitelex was valuable for rapid fertilization and protection against diseases."

Part 10

Information from a survey in City X showed these facts:

	Areas of City	
	Family Income Low	Family Income High
1. Number of boy delinquents per 1000 population.	48.0	5.7
2. Number of girl delinquents per 1000 population.	11.8	1.2

Conclusion: _____

Part 10 allows a conclusion to be drawn from the facts presented. It was included in the test, as was Part 1, so that students would not think all the items were of the same nature. However, credit was given only when the conclusion was in agreement with the facts given. Any attempt to draw a conclusion based on opinion, or other facts not given here, was unsatisfactory.

Satisfactory conclusions:
"In City X there are more delinquents in the lower income bracket."
"Delinquency is more frequently found where there is a lower income."
"Most delinquents are found in areas of the city where there is a low income."

Unsatisfactory conclusions:

"Families with high incomes provide more opportunities for pleasure and the children don't have to find their own."

"People should live in a nice house."

"Families with good income seldom have delinquent children."

"Higher wages has increased the number of boy delinquents."

Part 11

In a nationwide survey of 30 representative high schools, research workers gathered the following information regarding the use of cigarettes among students between the ages 14 and 17.

Approximately 8% of the boys used cigarettes regularly, 5% of these used the word 'habit' in describing their use of tobacco. 2% of the "smokers" positively stated that they enjoyed smoking.

78% said they had tried smoking a few times and stopped. 14% of those answering the questionaire stated they had never used tobacco in any form.

Conclusion: (Check one.)

( ) Too many high school boys smoke cigarettes.

( ) Rural students smoke less than students in urban areas.

( ) Probably more than 50% of boys between 14 and 17 years try smoking and then stop.

( ) 18 year olds smoke more than 17 year olds.

( ) High school boys don't really enjoy smoking.

( ) Smoking is harmful until you reach 18 years of age.

( ) 5% of high school boys have the habit of smoking.

In this part the student is challenged by prepared conclusions which may coincide with his own opinion but

not with the facts presented. He also must take care in interpreting the percentages. The only conclusion that can be justified is the third.

Part 12

Gerald Lawton, son of wealthy parents, became a doctor at age 26 and started a successful medical practice.

Thomas Silva, also a son of a well-to-do family graduated from medical school at 27 and soon thereafter was appointed to an important state clinic.

John Wallis, had to leave medical school because of lack of funds.

Bob Spanton, heir to a small fortune finished his medical training at the early age of 24 and began his practice in a rural district.

Lawrence Renton, after working two years to earn his tuition, returned to medical school and received his M.D. when 28 years old.

Dick Wright, was able to complete medical school at 27. His uncle was of financial aid to him.

Conclusion:

( ) It's easy to be a doctor if you have money.

( ) Well-to-do families find it little trouble to send their sons to medical school.

( ) One cannot become a doctor before he is 26 years old.

( ) Boys from wealthy families probably do not make as good doctors as those who must work their way through college.

( ) Two out of every 6 boys who go through medical school have to earn their own money.

( ) _____

( ) As is true in many kinds of work, boys who have money can get better positions.

Part 12, probably the most difficult, was developed in an effort to find out whether a student would refuse to state a conclusion based on only six cases. None of the prepared conclusions should be used.

Satisfactory conclusions:

"I can't seem to draw an intelligent conclusion on this."
"There's not enough information."
"There doesn't seem to be anything to decide here."
"If a person really wants to be a doctor he can be."
(Statements like this one were taken as objections to formation of any conclusion that the six cases might imply.)

Unsatisfactory conclusions:

"Money has a great deal to do with the position we acquire."
"Boys from the poor families are probably better doctors."
"Boys who have money get out of medical school sooner."

Summary.

The final form of the test was administered to 324 science students in four California high schools. Scoring for Section I was accomplished rapidly by use of specially constructed keys. Section II, because of the many written conclusions, took a greater period of time for evaluation.

Following the scoring of all tests, the results were organized in such a manner as to facilitate their study. This was done by giving each test a case number and then listing on large sheets of coordinate paper an item by item account of the total response. Additional information

given by each student on the final page of the test was also recorded after each case number. With all information listed in this convenient form, it was now possible to make a study of the test results.

CHAPTER VII

TEST RESULTS

The study of the compiled results of the two sections of the test shows that certain information has been gathered concerning the scientific attitude among high school science students. The charts presented in this chapter are attempts to show the results of the test in such a way that some of the significant interpretations may be discussed. It has been thought best to analyze results in the following ways:

(1) A study of the percentage of correct responses for items in section I of the test.

(2) A study of the percentage of accepted responses for items in section II of the test.

(3) A study of mean score, and the standard deviation for each of the four groups tested.

(4) A study of scores of certain selected students.

(5) The relation of test scores to number of years of high school science.

PERCENTAGE OF CORRECT RESPONSES FOR ITEMS IN SECTION I.

Figure 1 which follows on the next three pages presents in simple bar chart form the percentage of correct responses for each item in the test for the habit of intellectual honesty. The items are arranged in the order of increasing errors of response.

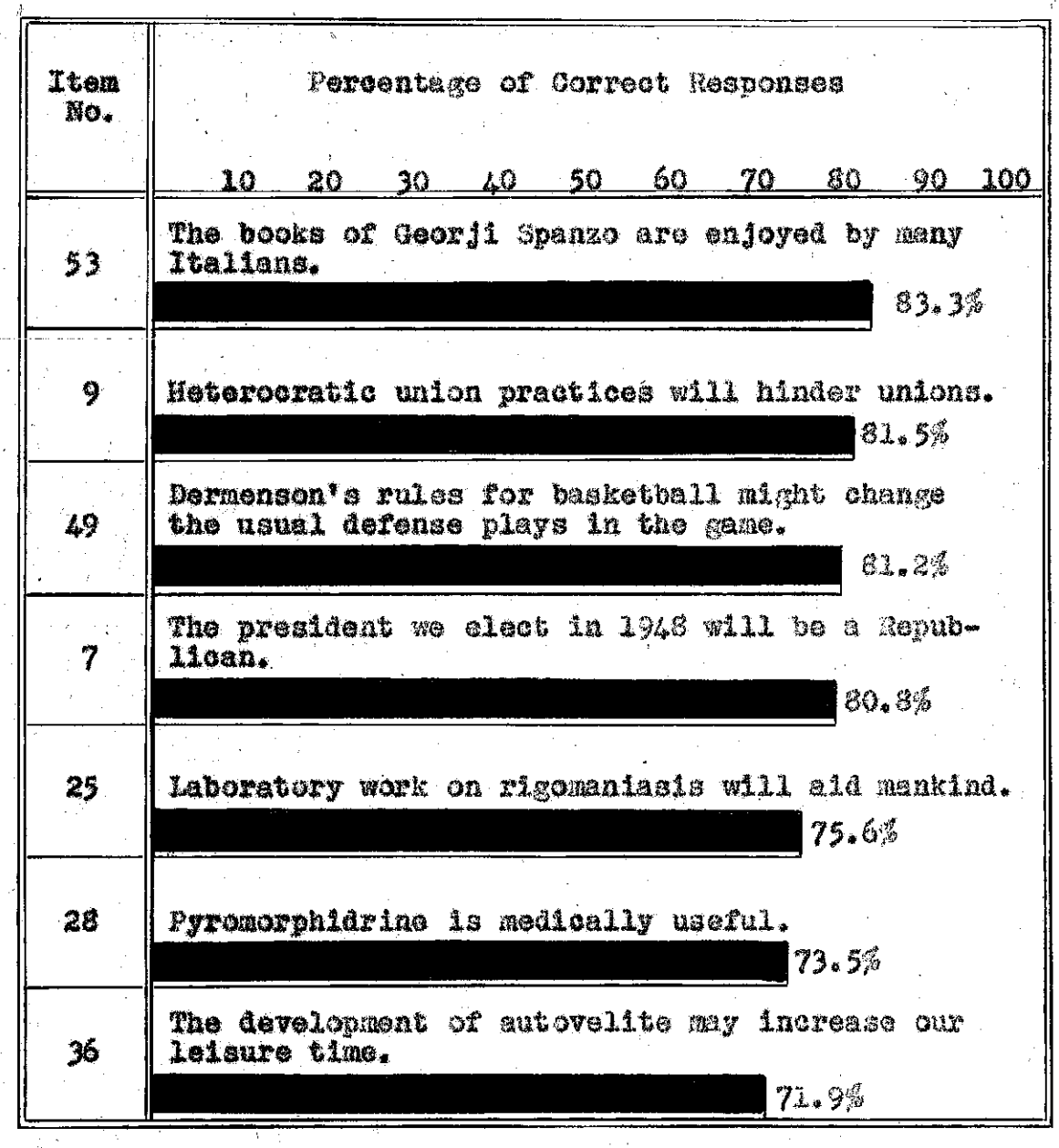


Figure 1.

Showing Percentage of Correct Responses for Items in Section I - The Test for the Habit of Intellectual Honesty

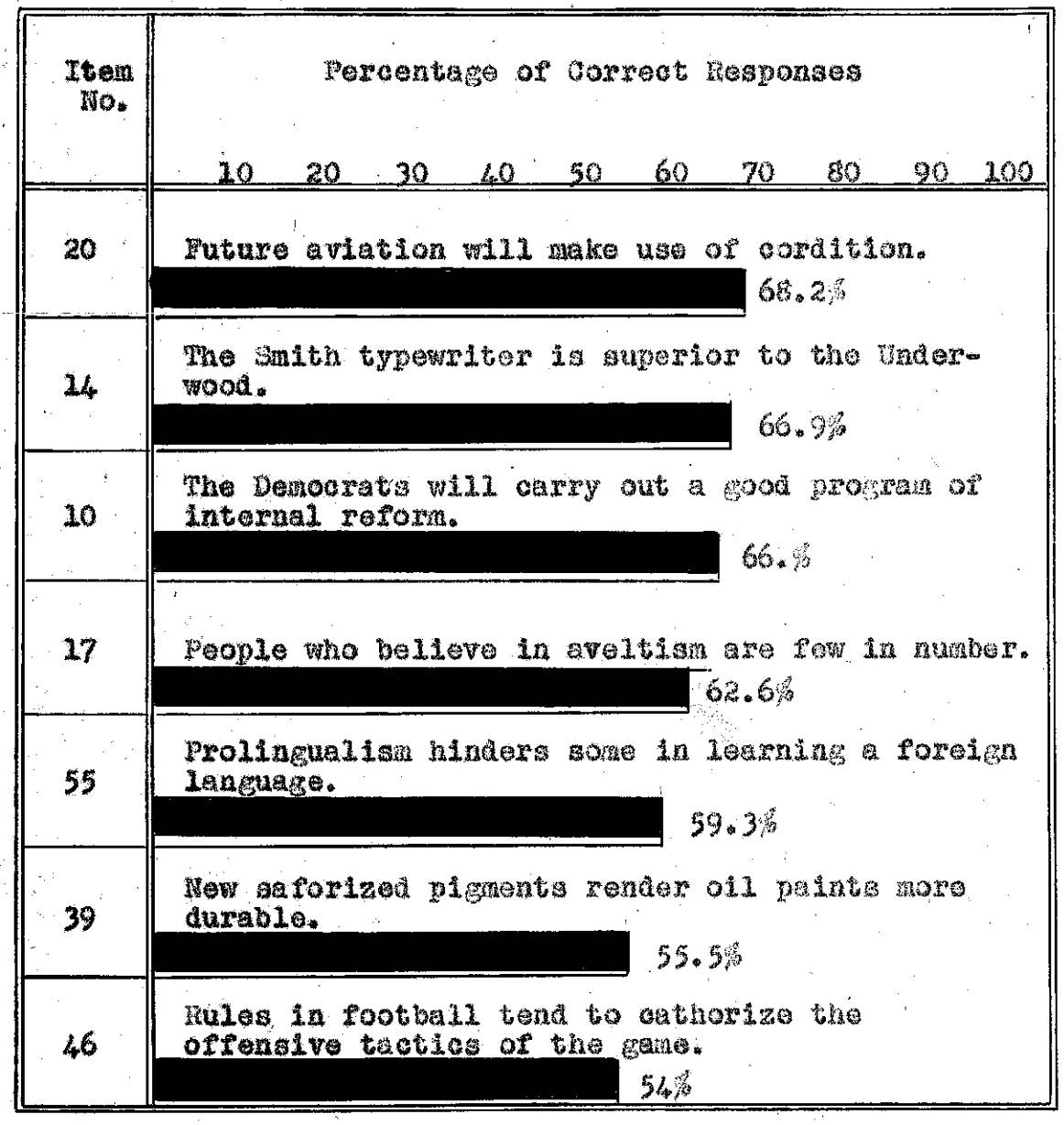


Figure 1 (Continued).

Showing Percentage of Correct Responses for Items in Section I - The Test for the Habit of Intellectual Honesty

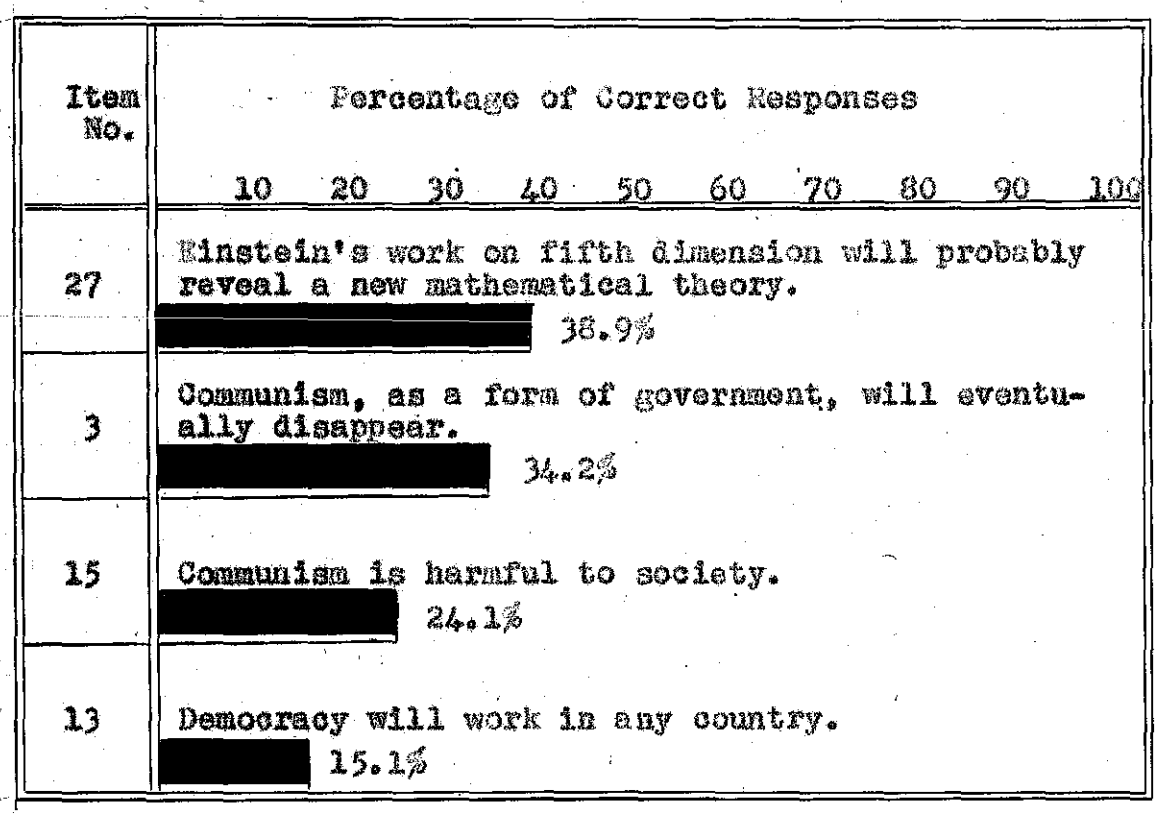


Figure 1 (Continued).

Showing Percentage of Correct Responses for Items in Section I - The Test for the Habit of Intellectual Honesty

It is a matter of interest to note the nature of the last three items charted in Figure 1 and their low percentage of correct responses. In a revision of this section of the test, it might be advisable to eliminate these items. Item #3, "Communism, as a form of government, will eventually disappear" has a particularly low percentage when it is considered that this item is a prediction type statement which should call for an "I don't know" response.

It is to be kept in mind that in the preparation of Section I, it was believed that an individual possessing the desired habit which is being called "intellectual honesty" should have given the correct responses for all eighteen items. This was true when the test was given to individuals who had special training or background in this scientific attitude. Of the 324 students tested, only three obtained the perfect score by having all eighteen items marked "I don't know." If this attitude is one to be desired and if this test detects its presence then, needless to say, the students scores are disappointing.

RESPONSES TO ITEMS IN SECTION II

Listed graphically in Figure 2 are the percentages of responses judged acceptable for each of the 12 items of Section II, the test for suspended judgment. The items

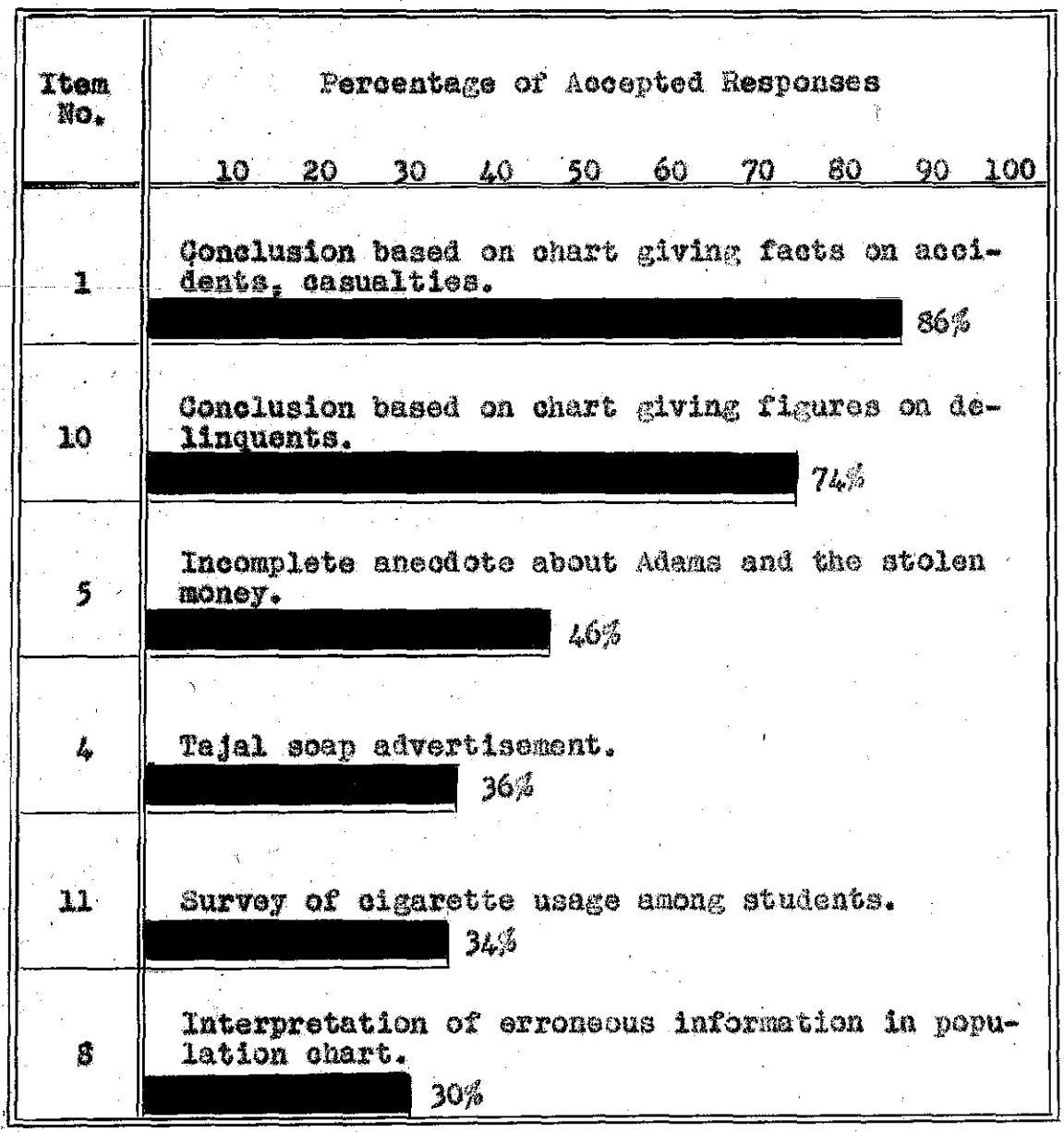


Figure 2.

Showing Percentage of Accepted Responses for Items in Section II - The Test for the Habit of Suspending Judgment

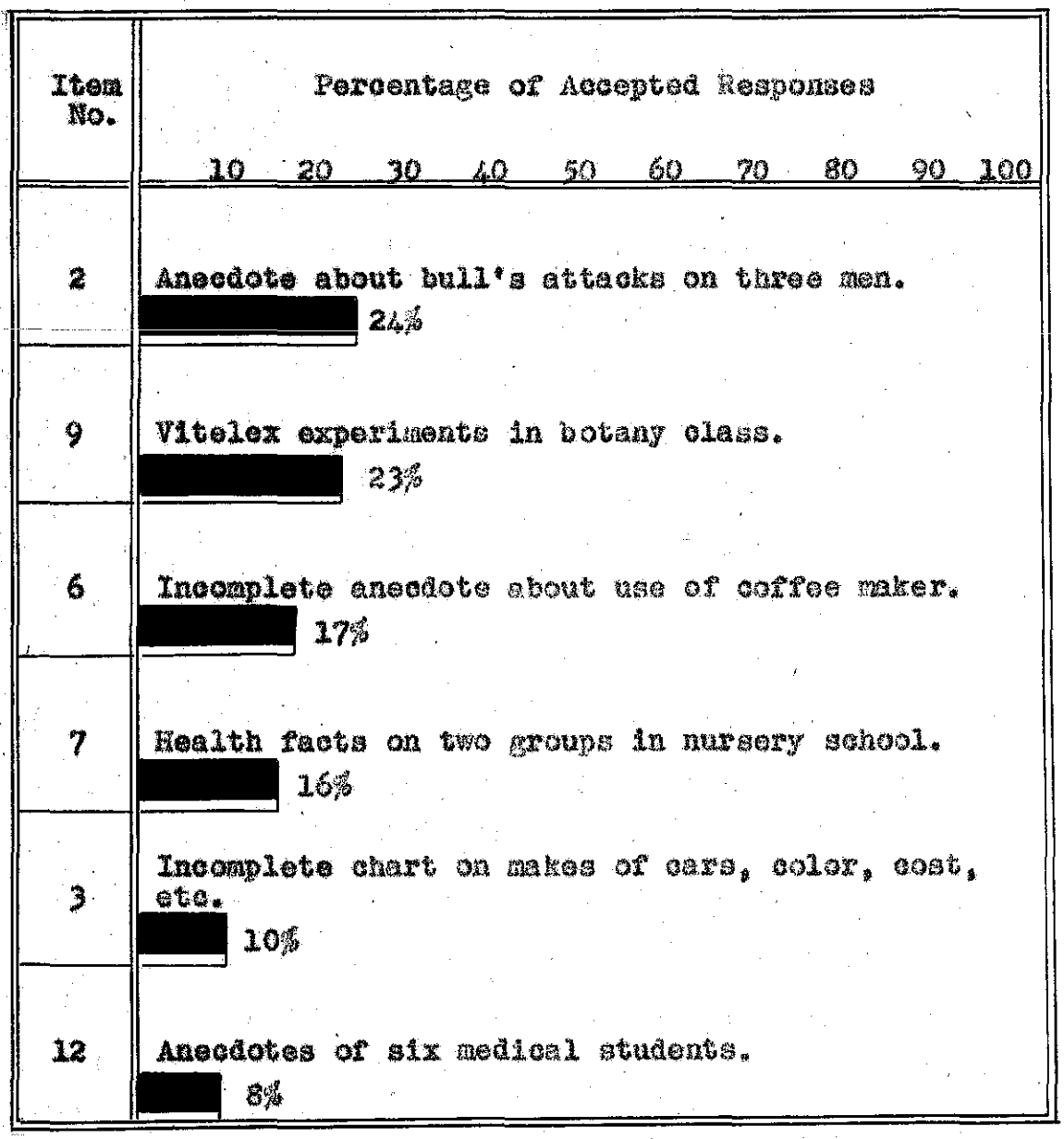


Figure 2 (Continued).

Showing Percentage of Accepted Responses for Items in Section II - The Test for the Habit of Suspending Judgment

are listed in order of increasing errors of response. To facilitate recall of the nature of each item, its number is followed by a descriptive note.

Items #1 and #10 for which the percentages of correct responses are shown at the top of Figure 2 are the only two parts for which any reasonable conclusions were possible. These two items were intentionally placed among the others and it was found that a certain percentage of students still drew erroneous conclusions. However, there is a noticeably lower percentage among the remaining ten items where conclusions should not have been drawn or extreme care should have been used in their formulation.

Observation of the number of correct responses for items in Section II leads to a general conclusion that a large percentage of the high school science students tested were likely to draw conclusions irregardless of the information presented. Many jumped to conclusions on little evidence, in spite of the fact that their science training should teach the opposite procedure. Items chosen for this test were to discover whether or not the student would avoid conclusion when given too little or erroneous information. In the last ten items listed in Figure 2 far less than 50% of the responses indicated that the students in these science classes were developing the habit of delaying conclusions until sufficient information is

obtained. Here again, as in Section I, the pupils' scores are disappointing. If the habit of suspending judgment is desirable and if this test indicates its presence or absence then the habit needs serious attention in teaching methods.

MEAN SCORES AND DEVIATIONS FOR THE GROUPS TESTED.

Study of Tables 1 and 2 will reveal some variety in mean scores and standard deviations for the four groups tested. It is to be noted that in both sections of the test the four groups rank in the same order in regard to their mean scores. The standard deviations do not appear to be particularly significant except in one instance in Table 1. The George Washington High School Group not only has a lower mean score but a greater dispersal of scores in Section I of the test.

SCORES OF SELECTED STUDENTS.

Tables 1 and 2 show the number of students tested in the Lodi High School group as sixty. Of that sixty, eighteen are selected students known to have had more than the usual amount of training in the scientific attitude and method. These eighteen cases probably account for the higher mean scores for the Lodi group as a whole.

Tables 3 and 4 on page 76 show the differences in mean

SCHOOL	NUMBER OF STUDENTS	MEAN SCORE	STANDARD DEVIATION
Lodi Union	60	12.34	3.22
Tamalpais	79	11.64	3.15
Stockton	102	10.22	3.75
Geo. Washington	83	10.09	4.63

Table 1.

The Mean Scores and Standard Deviations for the Four Groups Given Section I - The Test for the Habit of Intellectual Honesty

SCHOOL	NUMBER OF STUDENTS	MEAN SCORE	STANDARD DEVIATION
Lodi Union	60	4.56	2.06
Tamalpais	79	4.22	1.86
Stockton	102	4.00	1.97
Geo. Washington	83	3.44	1.70

Table 2.

The Means and Standard Deviation for the Four Groups Given Section II - The Test for the Habit of Suspending Judgment

	NUMBER	SCORE RANGE	MEAN SCORE
General Group	42	4 - 17	11.79
Selected Group	18	7 - 18	13.61

Table 3.

Range and Mean Scores for the General and Selected Groups in Section I - The Test for the Habit of Intellectual Honesty

	NUMBER	SCORE RANGE	MEAN SCORE
General Group	42	0 - 8	3.72
Selected Group	18	4 - 11	6.55

Table 4.

Range and Mean Scores for the General and Selected Groups in Section II - The Test for the Habit of Suspending Judgment

scores for the selected group and the remainder of the group in that school. This selected group was composed of students known to the writer. Each member of the group had at least a one year course in which the scientific attitude and method were stressed. It was expected that the scores of these students would be higher than those of students not having had similar direct training. A compilation of the scores shows this to be the case and adds more evidence to bear out the contention that direct teaching of scientific attitude pays dividends.

It is to be conceded that the selected group described above is far too small to provide useful data. Furthermore, the meager information given could not justify any general conclusion regarding the test's ability to detect the student trained in scientific attitude. This is true particularly in view of the fact that other students in each of the four schools tested had scores as high as many of those in the selected group.

Tables 3 and 4 are significant in that they point towards a means of validating a test for the scientific attitude. Further research should follow a procedure of comparing scores of the two groups, those trained and those untrained in scientific attitude.

SCHOOL	MEAN SCORES FOR STUDENTS HAVING			
	1 year science	2 years science	3 years science	4 years science
Lodi	12.00	12.15	12.62	12.75
Tamalpais	10.32	12.96	11.68	9.50
Stockton	8.70	11.35	9.65	9.85
Geo. Washington	10.60	9.58	9.84	12.67
Total	10.40	11.51	10.95	11.19

Table 5.

The Mean Scores of Students Having Various Years of High School Science in Section I - The Test for the Habit of Intellectual Honesty

SCHOOL	MEAN SCORES FOR STUDENTS HAVING			
	1 year science	2 years science	3 years science	4 years science
Lodi	5.12	3.96	5.33	3.50
Tamalpais	4.20	3.92	4.42	6.00
Stockton	4.16	3.89	3.69	4.57
Geo. Washington	3.15	3.17	3.65	5.17
Total	4.16	3.74	4.27	4.81

Table 6.

The Mean Scores of Students Having Various Years of High School Science in Section II - The Test for the Habit of Suspending Judgment

RELATION OF SCORES TO YEARS OF SCIENCE TRAINING.

It would be extremely significant if it could be shown that the scientific attitude grows with the number of years of science training. Students in their fourth year of high school science should, if the attitude is being developed here, possess the desired habits to a greater degree than those in their first year of science instruction. Tables 5 and 6 have been developed to present some data on the responses made by students having had from one to four years of high school science.

Table 5 presents, for Section I of the test, the mean scores for students who had one, two, three or four years of science. A study of the scores shows little change between the first and fourth year science students. The .79 gain between the two extremes is not indicative of growth in whatever this section of the test may measure.

Scores for Section II of the test are analyzed in Table 6 in the same manner as Section I in Table 5. A study of the mean scores shows only the slight gain of .65 between the scores for first year and fourth year science students. It will be noted that the Lodi group actually has a lower average score for its fourth year students than for the one, two or three year students in that same group.

A review of Tables 5 and 6 fails to show that there is any evidence of correlation between the number of years of science training and the habits measured by this test. If the sections of the test possess a degree of validity then some important conclusions may be based upon the facts shown in these last two tables.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

In the foregoing chapters there has been described the procedures used in developing a test for certain aspects of the scientific attitude. Careful attention has been given to an analysis of the scientific attitude and its relation to the method of science. The scientific attitude has been used throughout this paper in its singular form with the thought in mind that it is one attitude composed, probably, of many interrelated habits. It was reasoned that to test for the presence of this attitude it would be necessary to test individually the habits of which the attitude is presumably composed. In an effort to limit the scope of the work undertaken, only two of the numerous component habits were selected. Each of these two is the basis of one section of the test.

Section I A Test for the Habit of Intellectual Honesty

Section II A Test for the Habit of Suspending Judgment

The test was given to science students in four California high schools and a study has been made of the results. Information was gained not only about the students participating but also about the test itself.

Conclusions Regarding the Test Itself.

(1) The test was of interest to students. Curiosity was expressed regarding its intent and use. In testing situations where the teacher was able to discuss the purpose of the test with the students, there was a genuine interest in scores and their meaning.

(2) The test was easy to administer and not unnecessarily time consuming.

(3) The test allowed for wide differences in the pupils' abilities to respond correctly. In Section I scores ranged to the extremes of 0 to 18. In Section II scores ranged from 0 to 11.

(4) The scoring of Section I was accomplished with ease and within a minimum of time. The scoring of Section II, however, was time consuming, difficult and subject to error of interpretation.

(5) While there may be some reason for doubting the validity of both sections of the test, it can be stated that such an instrument may serve as a valuable teaching device. Individual conferences with students who took the test showed that test results could be used in student-counselling situations.

(6) The validity of the two sections of this test is not established. It is believed, however, that each sec-

tion does have a certain "logical" validity.

Conclusions Regarding the Students Tested.

(1) The students tested showed wide differences in ability to respond correctly to both sections of the test.

(2) The percentages of correct responses to the test for the habit of intellectual honesty are significantly low. If this instrument tests that which it means to test then it may be concluded that the habit of intellectual honesty was not a prevalent habit among the students tested.

(3) Likewise the percentages of acceptable responses to the test for the habit of suspending judgment are generally low. If this section of the test does reveal this desirable habit, then it may be concluded that very few of the students tested have been developing the habit of suspending judgment.

(4) Test results of carefully selected students who have had specific instruction leading towards development of the habits tested, show significantly higher scores than the average. This lends some weight to the validity of the test. It may be further concluded that specific training in the habits of intellectual honesty and suspending judgment is worthwhile.

(5) The test results seem to show that additional years of science in high school have no apparent effect

upon pupils' scores. Students completing their first year of science scored as well as those completing a four-year course. (If the two sections of the test do reveal the habit of intellectual honesty and suspending judgment, then it might be concluded that the additional training in their high school science courses failed to contribute a desired growth in these two habits.)

General Recommendations and Educational Implications.

At the outset it is recommended that the testing devices used in this investigation be further refined and additional efforts made to determine their validity. The logical validity of both sections of the instrument needs further support. Necessary additional data should be secured by a more complete testing program involving a greater variety of high school science classes and a larger number of cases. Given a test, the validity of which is more adequately established, there is reason to believe that significant information could be gained. A comparison of scores of science students with students majoring in other fields such as the social sciences or mathematics would be useful. Using a more highly refined test for the scientific attitude it would be of value to compare pupils' scores with the differing techniques of science teaching.

It should be noted here that further helpful study

needs to be carried out in regard to the analysis of the scientific attitude. As the definition becomes clearer the building of tests to detect its presence will become more satisfactory. There are several additional habits which go to make up the scientific attitude. In this study only two have been touched upon. Such habits as accuracy, open-mindedness, recognition of basic cause and effect relationships, curiosity, and the habit of weighing evidence should be analyzed and evaluated. These aspects of the scientific attitude, when made more readily measurable, might then have a more evident position in science instruction.

The success which this investigator has met in the use of the test described in this research suggests that further use of such testing procedures is recommended as a teaching technique. Though the test, because of its validity, cannot yet be used for comparative studies, it does have a noteworthy value as a teaching device not only in science classes but in social sciences as well. It is suggested that teachers give thought to developing tests of this nature and thus augment their courses of instruction.

Regarding the teaching of the scientific attitude there remains one further recommendation. It should be taught directly. Reliance upon incidental teaching of the

scientific attitude is unsatisfactory. There is little evidence either in this investigation or other investigations, that the acquisition of the scientific attitude automatically results from a study of science. Effective teaching of this attitude implies that instructors not only comprehend an analysis of the attitude but provide a time and a method for its teaching.

Research studies in the teaching of science are pointing emphatically toward an important direction in education. In an effort to contribute to effective citizenship science offers a way of thought to be accompanied by the scientific attitude. Once considered vague and intangible, this attitude now approaches mensurability. These techniques of measurement as they become more reliable will stimulate the teaching of scientific method and attitude.

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APPENDIX I

Tests made in Italy of 4000 school children showing effects of drinking wine on mental work in school:

	462 Abstainers %	1616 Drink wine occasionally %	2021 Drink wine daily %
Good marks	42.56	30.5	29.8
Fair	53.49	41.6	39.7
Poor	3.85	27	30.3

Directions: Consider carefully each of the following statements and indicate by a check mark ( ) in the columns to the right whether you believe:

(1) the evidence itself is sufficient to make the statement true.
(2) the evidence suggests that the statement is probably true.
(3) the evidence is insufficient to make a decision concerning the statement (uncertain).
(4) the evidence suggests that the statement is probably false.
(5) the evidence is sufficient by itself to make the statement false.

Statements:

a. Of the 4000 school children tested 1616 drank wine occasionally.
b. 50% of the Abstainers did poor work.
c. Of those school children who drank wine occasionally 30% were successful in life.
h. If school children drink wine they stand less chance of achieving good marks in school than they do if they do not drink wine.
o. From this chart we know that school children in Rome in the time of Julius Caesar who did not drink wine were the only superior scholars.

	1	2	3	4	5
a.					
b.					
c.					
h.					
o.					

Partial Sample Exercise From Material Prepared by Participants in the Science Group of P.E.A. Workshop, Sarah Lawrence College, 1937.

APPENDIX II

Name _____ 9 10 11 12 Gr.

School _____ Date _____

S P E C I A L R E S E A R C H T E S T

To the Student:

1. This is a special test which may seem different than those to which you are accustomed. It is important that you put forth your best efforts.

2. Although you are asked to do your best, this test will have no effect on your grades in any subject.

3. Listen to directions carefully as you will not be able to talk or ask any questions after you have started.

PLEASE WAIT FOR FURTHER DIRECTIONS
BEFORE OPENING THIS BOOKLET

SPECIAL RESEARCH TEST Section I Page 1

Explanation:

The following is a test on general information. Do the best you can in the time you are given. Draw a circle around the letter indicating your answer.

T - true F - false X - don't know

T F X 1. An isolationist wants to have our country avoid foreign entanglements.

T F X 2. P.A.C. refers to the Political Action Committee of the C.I.O.

T F X 3. Communism, as a form of government, will eventually disappear.

T F X 4. Majorities are right.

T F X 5. The majority represents the will of all the people.

T F X 6. The minority is occasionally in the right.

T F X 7. The president we elect in 1948 will be a Republican.

T F X 8. Roosevelt obtained more electoral votes than Dewey.

T F X 9. Heterocratic practices will hinder unions.

T F X 10. The Democrats will carry out a good program of internal reform.

T F X 11. Boys in a shop course have more chances for success than those in college preparatory courses.

T F X 12. Ability to read is necessary for success in school.

T F X 13. Democracy will work in any country.

T F X 14. Ellis received F's in all his subjects. This shows he has learned nothing in school.

T F X 15. Communism is harmful to society.

T F X 16. Religion aids civilization.

T F X 17. People who believe in aveltism are few in number when compared with the total number of true Christians.

T F X 18. Perfection is impossible.

T F X 19. Man is an animal species.

T F X 20. Future aviation will make use of cordition.

T F X 21. Mathematics is a science.

T F X 22. Aeronautics refers to the study of weather.

T F X 23. Chemistry is a science.

T F X 24. Quinine comes from trees.

T F X 25. Laboratory work on rigomaniasis will aid mankind.

T F X 26. Quinine has been produced chemically.

T F X 27. Einstein's work on fifth dimension will probably reveal a new mathematical theory.

T F X 28. Pyromorphidrine is medically useful.

T F X 29. Ornithologists are concerned with the study of birds.

T F X 30. Camouflage is an animal device for protection.

T F X 31. Sulfa drugs have aided the fight against disease.

T F X 32. All bacteria cause diseases in humans.

T F X 33. An engineer needs training in mathematics.

T F X 34. Plastics are mined in several mountain regions of the U.S.

T F X 35. Plastics are used in parts of automobiles and radios.

T F X 36. The development of autovelite might increase our leisure time.

T F X 37. Glass cloth is an impossibility.

T F X 38. One-way glass is practical.

T F X 39. New saforized pigments render oil paints more durable.

T F X 40. Television in color sounds impossible.

T F X 41. Electric clocks are reasonably accurate.

T F X 42. The Smith typewriter is superior to the Underwood.

T F X 43. Insurance has been shown to be financially impracticable.

T F X 44. A stenographer can write shorthand.

T F X 45. The war has made baseball more popular.

T F X 46. Rules in football tend to cathorize the offensive tactics of the game.

T F X 47. September always has just 30 days.

T F X 48. April has 31 days.

T F X 49. Dermenson's rules for basketball might change the usual defense plays in the game.

T F X 50. Baseball is a popular sport among Americans.

T F X 51. A student can learn to speak a language without being able to read it.

T F X 52. Every Californian should know Spanish.

T F X 53. The books of Georji Spanzo are enjoyed by many Italians.

T F X 54. Latin is essential for the speaking of good English.

T F X 55. Prolingualism hinders some in learning a foreign language.

T F X 56. Verbs are modified by adjectives.

T F X 57. A simple sentence has a subject and predicate.

T F X 58. In order to make the following sentence sound right you must emphasize the word "John".

John stole the purse.

T F X 59. Modern music uses an eight note scale.

T F X 60. An a capella choir sings without accompaniment.

GO ON TO THE NEXT PAGE

SPECIAL RESEARCH TEST Section II Page 5

Explanation:

This section of the test has fourteen parts. Each part gives you some information and you are asked to form a conclusion based on the information given. In some parts you will have to write the conclusion in your own words. In other parts you will notice that several possible conclusions are supplied and you will check one of them.

You will have all the time you need to complete this section. Be sure you either check or write a statement for every part. Each part is separate and has no relation to the other parts.

CONTINUE WORKING UNTIL YOU HAVE FINISHED.

Part 1

The monthly averages given below have been taken from Police Records in City X.

Time of Day	No. of Auto Accidents	No. of Casualties
6:00 - 8:00 A.M.	4	0
8:00 -10:00	3	1
10:00 -12:00	3	0
12:00 - 2:00 P.M.	5	2
2:00 - 4:00	5	1
4:00 - 6:00	8	3
6:00 - 8:00	8	4

Conclusion: _____

_____

_____

Part 2.

A Vicious bull on the Jackson Ranch has attacked three men on separate occasions. All three men are known to have been wearing brilliant clothing. One man wearing inconspicuous clothing was not harmed.

Conclusion: (Check one).

( ) Entering this bull's pasture is very dangerous.

( ) No one should ever enter a bull's pasture.

( ) People need to be careful around the bull on the Jackson Ranch.

( ) Brilliant clothes should never be worn near any bull.

( ) Inconspicuous clothing does not enrage the bull

( ) I can draw no conclusion from these facts.

Part 3.

Make of Car	Color	Cost	No. of Sales
X	black	$ 760.00	2500
Y	blue	$ 800.00	2489
Z	brown	$ 775.00	2960

Conclusion: (Check one or write in a conclusion).

( ) Car Z is most popular because it is brown.

( ) The least expensive car sells more rapidly.

( ) Make X is the best car because it is the least expensive of the three.

( ) Blue cars cost more than black ones.

( ) _____

Part 4

In a test made by the Tajal Soap Company 500 women were given six unmarked bars of soap. Each represented a leading brand. The ladies were asked to judge the best soap. Over 300 of the women chose Tajal soap.

Conclusion: (Check one.)

( ) Tajal soap is a superior soap.

( ) There is not enough information here to help me judge the value of Tajal soap.

( ) All soaps are about the same.

( ) Many people buy Tajal soap.

( ) The best soaps have the greatest sales.

( ) Tajal Soap Company probably increased their sales enormously.

Part 5

Mr. Adams on returning to his home at 9:00 P.M. met George Peterson who had recently been paroled from jail after being convicted on a burglary charge. Mr. Adams was impressed by the young criminal's seeming astonishment at their sudden meeting. Both greeted each other and proceeded on their way. Later that evening Mr. Adams discovered that money left in a drawer in his home had been stolen. He phoned the police.

Conclusion: _____

_____

_____

Part 6

Mrs. Jones purchased a new guaranteed Sorex coffee maker. Several morning's use found it to be quite satisfactory in all respects. One afternoon Mrs. Jones used the Sorex to prepare tea for her guests. Results were not quite what she had expected.

Conclusion: (Check one)

( ) Mrs. Jones should have been more careful.

( ) Sorex coffee makers should never be used for tea making.

( ) This coffee maker was defective.

( ) Mrs. Jones needs to learn how to use a Sorex correctly.

( ) Mrs. Jones is stupid.

( ) Mrs. Jones did not have a teapot.

( ) I can draw no conclusion from the facts given.

Part 7

Twenty children kept in the same nursery school were divided into two groups of ten each. Both groups had the same area for play but separate rooms for sleeping. Group A had sleeping cots on the first floor and Group B had theirs on the second floor. A study of health records showed that children in Group B had fewer colds than children in Group A.

Conclusion: _____

_____

_____

Part 8

Information taken from a student's report in a social studies class.

Name of City	Area in Sq. miles	Population	Population per sq. mile
X	200	6,000,000	30,000
Y	400	3,200,000	31,000

Conclusion: (Check one or write one in.)

( ) City X is growing rapidly.

( ) City Y is growing rapidly.

( ) City Y is slightly more crowded than City X.

( ) City X has approximately 1,000 more people than City Y.

( ) _____

( ) City X is more crowded than City Y.

( ) People in City X should gradually move to City Y.

Part 9

Results of a laboratory experiment carried out by students in a botany class:

Plants	Treatment	Observation
12 tomato plants	.01 gram Vitelex per gal. of water	11 plants bear fruit in 90 days. 1 plant dies.
12 bean plants	.01 gram Vitelex per gal. of water	11 plants mature and bear flowers within 50 days. 1 plant flowers in 70 days.
12 tomato plants	water without Vitelex	12 plants bear fruit in 3 months.
12 bean plants	water without Vitelex	10 plants mature and bear flowers within 50 days. 1 plant flowers only slightly.

Conclusion: _____

Part 10

Information from a survey in City X showed these facts:

	Areas of City	
	Family Income Low	Family Income High
1. Number of boy delinquents per 1000 population.	48.0	5.7
2. Number of girl delinquents per 1000 population.	11.8	1.2

Conclusion: _____

Part 11

In a nationwide survey of 30 representative high schools, research workers gathered the following information regarding the use of cigarettes among students between the ages of 14 and 17.

Approximately 8% of the boys used cigarettes regularly. 5% of these used the word 'habit' in describing their use of tobacco. 2% of the "smokers" positively stated that they enjoyed smoking.

78% said they had tried smoking a few times and stopped. 14% of those answering the questionnire stated they had never used tobacco in any form.

Conclusion: (Check one)

( ) Too many high school boys smoke cigarettes.

( ) Rural students smoke less than students in urban areas.

( ) Probably more than 50% of boys between 14 and 17 years try smoking and then stop.

( ) 18 year olds smoke more than 17 year olds.

( ) High school boys don't really enjoy smoking.

( ) Smoking is harmful until you reach 18 years of age.

( ) 5% of high school boys have the habit of smoking.

Part 12

Gerald Lawton, son of wealthy parents, became a doctor at age 26 and started a successful medical practice.

Thomas Silva, also a son of a well-to-do family graduated from medical school at 27 and soon thereafter was appointed to an important state clinic.

John Wallis, had to leave medical school because of lack of funds.

Bob Spanton, heir to a small fortune finished his medical training at the early age of 24 and began his practice in a rural district.

Lawrence Renton, after working two years to earn his tuition, returned to medical school and received his M.D. when 28 years old.

Dick Wright, was able to complete medical school at 27. His uncle was of financial aid to him.

Conclusion:

( ) It's easy to be a doctor if you have money.

( ) Well-to-do families find it little trouble to send their sons to medical school.

( ) One cannot become a doctor before he is 26 years old.

( ) Boys from wealthy families probably do not make as good doctors as those who must work their way through college.

( ) Two out of every 6 boys who go through medical school have to earn their own money.

( ) _____

( ) As is true in many kinds of work, boys who have money can get better positions.

SPECIAL RESEARCH TEST

Information

Name _____

Score

Fr. Soph. Jr. Sr. Gr.

Section I ____

School _____

Section II ____

Age _____ Birthday _____

Parent

Race _____ Occupation _____

High School Major(s) _____

_____

Field of interest: _____

_____

Probable Vocation _____

_____

Check the courses you have taken. If you have taken other science, social studies or mathematics courses, list them below.

Sciences	Social Studies	Mathematics
____ General Sci.	____ Orientation	____ Algebra
____ Biology	____ Soc. St. I	____ Geom., plane
____ Physiology	____ Soc. St. II	____ Algebra, Adv.
____ Botany	____ World Hist.	____ Trigonometry
____ Zoology	____ Ancient Hist.	____ Geom., solid
____ Chemistry	____ U.S. History	____ Shop Math.
____ Physics	____ Modern Prob.	
____ Applied Sci.		
____ Consumer Sci.	_____	_____
____ Voc. Chem.	_____	_____
____ 7th year Sci.	_____	_____
____ 8th year Sci.	_____	_____
____ 9th year Sci.	_____	_____
_____	_____	_____
_____	_____	_____

APPENDIX III

SPECIAL RESEARCH TEST Section I Page 1

lowing is a test on general information. you can in the time you are given. Draw nd the letter indicating your answer.

rue F - false X - don't know

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