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# The significant differences found in certain areas of science learning between ninth grade, rural, and urban pupils

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SCHOOL OF EDUCATION

Thesis

THE SIGNIFICANT DIFFERENCES FOUND IN CERTAIN AREAS  
OF SCIENCE LEARNING BETWEEN NINTH GRADE,  
RURAL, AND URBAN PUPILS

Submitted by

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(B.S. in Education, Boston University, 1949)

In partial fulfillment of requirements for  
the degree of Master of Education

1950

Boston University  
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## CHAPTER I

### PURPOSE OF THE STUDY

#### INTRODUCTION

Step by step, in one field or another mankind has been increasing his knowledge of common things. He has come to see how science has given both understanding and control of the great forces of nature: how it has increased man's physical comfort and happiness and how, by giving man an understanding of his bodily machinery, science has lengthened life itself. Today, as never before, man is in real working accord with his environment.

The gradual betterment of living conditions and general welfare, the steady improvements in the methods of protecting and restoring health, the improvement in means of communications and transportation, and in preserving and making available to all the scientific knowledge already gained, illustrate what we mean by progress or advance in civilization. Many volumes have been already written on the contributions of science to world progress, with emphasis on its political, social, economic, and religious aspects. With due respect to the materials that could be included, of necessity, the scope of this chapter will be a brief and general consideration of the fact that the environmental requirements of the pupils should be considered in the selection of materials being used

in the General Science courses as they are being taught in the public schools of today.

Early man lived in uncertainty and fear. His world was mysterious; nature to him seemed undependable, full of whims, storms, famine, pain, and death. Being afraid of these disasters, he blamed the evil spirits and unfriendly gods. On the other hand, he was made happy when he found sunshine, plentiful food, and good health, and for these he thanked the good spirits and friendly gods.

The early Greeks were the first to break away from such superstitions, for they began to ask the "Why" and "How" of things. Aristotle (384 B.C.), one of their earlier philosophers who believed that nature was orderly, began in a systematic way to study nature, Hunter<sup>1</sup>, in his text on Science Teachings, quotes Aristotle as saying, "Trust more to observation than to speculation, and to the latter no further than it agrees with the phenomena." Glenn<sup>2</sup> in his History of Philosophy, has this to say about Aristotle;

"He was the first to employ the analytic-synthetic science of Logic. He was the first to give due recognition to the value of induction from facts of internal and external experience; and since induction is the all necessary instrument

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<sup>1</sup>George W. Hunter, Science Teaching, New York; American Book Co., 1934, pp 209.

<sup>2</sup>Paul J. Glenn, The History of Philosophy, St. Louis, Mo. Herder Book Co., 1930, pp 100.

of the natural sciences, Aristotle is justly called, "The Father of Natural Science."

As a result of his idea he insisted on observing and on drawing conclusions from facts. Thus he was convinced that errors arise not so much from faulty see as from faulty interpretations of data observed. Only by observation and experiment, he insisted, could true knowledge be gained; hence, he was convinced that evidence obtained in this way was more reliable than mere guesses, argument, or debate.

For more than fifteen centuries after the time of Aristotle very little progress was made in natural science. Then, according to Downing<sup>1</sup>, Galileo performed his famous experiment of letting two objects of unequal weight fall from the top of the Leaning Tower of Pisa. The two objects reached the ground at the same time. Before this experiment was performed it was generally believed that the heavier object would fall more rapidly than the lighter one. This seemed reasonable, yet, Galileo's simple experiment, however, disproved a belief which had been held for centuries.

From the time of Galileo (1564-1642), progress in dis-

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<sup>1</sup>Elliot R. Downing, Teaching Science in the Schools, Chicago; University of Chicago Press, 1929, pp 3-9.

covering truth by means of experiment has increased rapidly. The methods of experimenting were improved by Francis Bacon (1561-1626), and even today, the methods used by scientists are very similar to his. The rapid progress made in discoveries and inventions in the nineteenth and twentieth centuries would not have been possible if these early scientists had not prepared the way. To them we are indeed grateful for aiding our more modern students of research in their efforts to explain the many other phenomena of Nature that still challenge the understanding of human beings.

Some of us are inclined to accept the present methods of living without questioning the origin of many of our modern conveniences. Clement, Collister and Thurston<sup>1</sup>, in their text, our surrounding, present detailed information concerning the progress which has resulted from scientific discoveries. The invention of the lever, the pulley and other simple machines has helped to bring about our so-called "Machine Age". The wheel has made possible circular motion and most of our modern methods of transportation. The plow has given us a better type of agriculture and better methods for improving the fertility of the soil. The compass has enabled us to travel without landmarks or guides. The pendulum has given us clocks;

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<sup>1</sup>Clement, Collister, and Thurston, Our Surroundings, New York; The Iroquois Publishing Co., 1928, pp 549-555.

the telescope has made possible the study of the sun and other stars, the moon, the planets, and other heavenly bodies. The magnifying lens has helped us to understand better the nature of living and non-living things, and has brought to our knowledge the existence of a world of microscopic beings unseen by the naked eye.

The discovery of the nature of fire led to the invention of the stove and on to modern heating devices. The Bunsen burner led the way to the gas stove, the gas engine, the automobile, and the airplane. The steam engine has proved an invaluable tool in supplying power to run our machines. The electromagnet was the beginning of the telegraph, the telephone, the dynamo, and the electric motor. The phonograph has recorded sound in permanent form, and these records may be used for the benefit of people for generations to come. The camera has given us a method of preserving pictures for future generations; it is also the foundation of one of our largest industries, that of the motion picture. The electric light has made our day longer both as an aid to work and pleasure. The photo-electric cell enables light energy to control electrical energy, and has tremendous possibilities. It is already used for a great many purposes, one of which is television. Thus it is reason to suggest that in the not too distant future one may see and hear in their respective homes events and happenings that might occur in all parts of the world.

Without these inventions and discoveries we should still be living among the discomforts of the Dark Ages; with them we have our modern conveniences and methods of living. Progress has become rapid and widespread in its effects only as man learned the great laws of nature by careful experimenting and by making use of observed facts. Having classified into sciences his knowledge of the various fields of his surroundings, man finds it increasingly easy to apply his knowledge in endless ways; by so doing, he has come to control and use the forces of nature. With the help of Science, discoveries with their new applications of the powers of nature are being constantly made which will still further add to our comfort, welfare, and progress. Watson Davis<sup>1</sup>, past Director of Science Service, Washington, D.C., in a published article entitled, "Science in School and Human Life", has this to say:

"Whether we like it or not -- and we should like it -- science is recreating the world around us. It has been doing it since long before Aristotle and even before the first cave man. Often it seems to take an impossibility long time to accomplish what it should -- as our control over that insanity that is war. Sometimes it dumps into our lap a revolutionary luxury which becomes a necessity -- as in the case of the howling cajoling, or sweet singing, wisdom dispensing radio."

Thus, it is no wonder that we may measure the part that science has played in human progress which clearly justifies

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<sup>1</sup>Watson Davis, Science in School and Human Life, School Life, Oct. 1938, p. 19.

calling the present age, "The Age of Science."

Science courses in the modern high school curriculum need no apology. Like those of other subjects, they have been introduced, and subsequently modified again and again in response to needs which were real at the time of their introduction or change. Judged by the relative number of applications that their subject matter has to everyday life, there is probably no set of courses that exceeds them in importance with the possible exception of those in the social science field. According to Preston<sup>1</sup>, the informational side of education, speaking generally, centers around the answering of two great questions; namely, "How is man learning increasingly to utilize the forces and materials of nature for human benefit?" and, "How is man increasingly learning to live with his fellowman individually and collectively at work, and at play?" The former of these questions is answered by the natural, the latter primarily by the social sciences.

The most important element of transfer values commonly claimed for the study of general science comprises that methodology in intellectual enterprises which goes under the name of "scientific method". This according to Pearson<sup>2</sup> is

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<sup>1</sup>Carleton Preston, The High School Science Teacher and His Work, New York, McGraw-Hill Book Co., 1936, p. 19-25.

<sup>2</sup>Kenneth Pearson, The Grammar of Science, New York, American Book Co., 1934, p. 37.

marked by (1) careful and accurate classification of facts and observation of their correlation and sequence; (2) the discovery of scientific laws by aid of the creative imagination; (3) self-criticism and the final touchstone of equal validity for all normally constituted minds.

The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as to physical problems, and we must carefully guard ourselves against supposing that the scientific frame of mind is a peculiarity of the professional scientist. Now this frame of mind seems to me an essential of good citizenship, and of the several ways in which it can be acquired few surpass the careful study of some one branch of natural science. The insight into method and the habit of dispassionate investigation which follow from acquaintance with the scientific classification of even some small range of natural facts, give the mind an invaluable power of dealing with other facts as the occasion arises.<sup>1</sup>

Having seen the progress which has resulted due to the many scientific discoveries let us now turn to the real problem which confronts us. It is an evident fact that many texts have been written on the methods of teaching science, but not many have made a real effort to show any particular differences that are to be expected when these methods are applied to groups of pupils that differ with respect to geographic background.

This study has developed out of the consciousness that

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<sup>1</sup> Ibid, pp. 6-7.

many teachers of general science are today, as never before, in need of guidance and help. The educational currents, running strongly in the areas fed by the more active teachers' colleges, have caused great changes in the teaching of secondary school science during the past decade. It is true that none of us will question the importance of general science in our school curriculum, but, if we are to continue in our quest for a more uniformed science course of study, we should look into the future and see what is in store for our secondary school science students. By so doing we may be able to solve our teaching problems more intelligently and with a perspective including both present and future.

The investigator has always been interested in science instruction; in fact, during his period of teaching he has always been seeking aids which may better our science program, both with respect to the curriculum, and the teaching methods in science at the secondary school level.

The author wishes to acknowledge his indebtedness to the many books and articles on the subject which he has read from time to time. The most important of which will be found as references and abstraction in the body of this thesis. The investigator does not claim that he has solved the problem completely, but he has tried in a limited way to begin some of the work so necessary in helping the present science teacher and in preparing the future teacher for the important task of educating our new citizens that they will be better prepared

to cope with the complex problems that they will face in the years to come.

#### A STATEMENT OF THE PROBLEM

The problem of this study is to compare the results of a science test administered to students living in rural and urban areas. Through the analysis of the test items, this study hopes to discover whether the environmental conditions cause a significant difference in the number of right or wrong responses scored in four of the areas covered by the test; namely, factual, conceptual, charts, abstractual questions.

#### JUSTIFICATION OF PROBLEM

It is significant that practically every step in the upbuilding of courses in science was taken in response to a need keenly felt at that particular time. It is equally significant that once a certain bit of subject matter has been incorporated in a science course, or a certain process made a customary part of teaching routine, it tends to become fixed by tradition and to remain long after its appropriateness has become open to question. We must therefore keep constantly reevaluating our subject matter and our teaching method if we plan to keep abreast of progress. For times change; new and better methods supplant the old; new discoveries render earlier processes and devices obsolete; new ways of living bring new

points of view; ideas that are important today may become relatively unimportant tomorrow. Every science course of long standing is likely to contain, in addition to what is up-to-date, considerable material that although good in its time, should now be discarded in favor of that which is more forward-looking. We must examine the contributions made by each period, with a view to retaining all the advances then made which have present value, and eliminating all the material that has become obsolete. This demands most careful scrutiny of both subject matter and teaching practices.

Man is living in the most scientific age of his history. With the ending of World War II many new scientific problems and developments were introduced into the lives of American youth. The facts, principles and laws that have been discovered came about through science facing and solving these important problems. The demands of the day are not for a few memorized facts but are rather for the ability to face and solve everyday problems in a scientific way.

It has become now almost an universally accepted policy among beginning teachers to first teach in rural areas to acquire a certain amount of experience before they can hope to be appointed into a larger city system. Thus, it can be said that most rural schools are used as necessary stepping stones to teaching positions in urban schools. It is with this fact in mind that the following question is asked, "Are the materials presented in the rural schools just a preview of the materials

that the transient rural teacher plan to teach in the urban schools?" The environment within which any pupil associates is a constant teacher. This type of environmental learning may help to account for the wide span of individual differences that are found in the interests and abilities of our school children.

The geographic location of the pupil can be used as a device for achieving a difference in environment. If this is true and if General Science is the study of one's environment, which is what many authorities claim, then we begin to see the need for the geographic method of teaching. These facts should be recognized by all teachers of General Science.

To reinforce the claims of the exponents of the geographic method, some quotations will be used. Pringle<sup>1</sup>, in his text says:

"The pupil's environment is interesting to the degree that he understands it and can make it serve his purposes; that is, he is interested because he learns. But because of increasing needs and because of developing mental powers, he demands explanations; his curiosity is no longer superficial and he would like to know the cause of all things in his environment; he is no longer willing to take things for granted. This changed attitude is the science teacher's opportunity."

Downing<sup>2</sup>, expressing the same idea, has this to say:

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<sup>1</sup>Ralph W. Pringle, Junior High School, McGraw-Hill, 1937, p. 201.

<sup>2</sup>Elliot R. Downing, Teaching Science in the Schools, University of Chicago, 1929, p. 69.

"He who takes pains to study the commonplace things around him and learn something of their marvels, or who is taught to know the wonders of the commonplace by some wise teacher, has at hand a means of marvelous intellectual stimulus. He will see, in the plants and animals about him, the rocks and minerals, the commonplace hills and valleys, the stars that look down on him at night, great wonders. This is one function of science instruction."

From these quotations we see the prime importance of adapting pupils to their environment. Successful science teachers, for the most part, make the pupils' environment the guide post in organizing their science programs. An illustration of how this is done follows:

If the teaching is concerned with certain constellations, would it not be profitable for both teacher and pupil, if the discussion would be taken close to the time of year that such a constellation could be seen by the pupils? Will he not by so doing motivate their interest in the subject? If he is teaching in a rural district, would it not be more profitable for the group to devote more time on the section of general science that deals with plants, animals their diseases and cures? Desirable activities require genuine relationship to the present experience of the child of such variety and range as to provide for all desirable lines of development; to make full use of the resources of the environment; specifically utilize all potentialities of the environment for realistic social participation by the pupils; and assure in good time learnings essential to effective adult living.

<sup>1</sup>Rural teachers have had in mind two types of values:

(1) Agricultural and economic, the improvement of farm practices; and (2) esthetic and spiritual, the development of appreciation of the beauty and wonder of the rural environment, and consequently greater enjoyment and wiser use of leisure time.

Davis<sup>2</sup>, in his text on High School Courses of Study, has this to say in speaking of the sciences:

"Thus the leading value derivable from work in these fields is the practical value ... the knowledge which enables a person more fully to understand and appreciate his surroundings, and to control the forces of nature in the interest of human welfare and comfort."

Another author<sup>3</sup> projects his thoughts thus:

"The nature study movement is the outgrowth of an effort to put the child into contact and sympathy with its own life. It is strange that such a movement is necessary. It would seem to be natural and almost inevitable that the education of the child should place it in an intimate relation with the objects and events with which it lives. It is a fact, however that our teaching has been largely exotic to the child; that it has begun by taking the child away from its natural environment; that it has concerned itself with subject-matter rather than with the child."

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<sup>1</sup>Fannie W. Dunn, New Types of Instruction in Small Rural Schools Yearbook 1938, Natural Science in the Modern Rural School (Washington, D.C. National Ed. Ass'n Office) U.S. Press 1938, p. 75.

<sup>2</sup>Calvin O. Davis, High School Courses of Study, New York World Book Co., 1929, p. 46.

<sup>3</sup>Liberty H. Bailey, Cornell Nature Study Leaflet, N.S.B. No. 1, 1904, (Albany Dept. of Agriculture) p. 21.

Thus we see the many different objectives to be attained by present day science teachers. Subject matter treated in a certain perspective for a particular group of people may not be effective for another group. Consequently, if education is to meet individual differences, and consensus of opinion among educators indicate it is, then our program of study in science should be so modified as to include the geographic needs of the pupil.

#### SCOPE AND LIMITATIONS

A science test is to be administered to a random sampling of 100 rural school children and 100 urban school children. These pupils will be chosen from the ninth grade level in schools located in ten scattered communities. This scatter technique will be explained fully in chapter II. It will suffice here to say that this technique will assure a representative sample of the available school children to be tested.

The Read Science Test was used in this investigation because the author of the test could be consulted in separating the items into the four areas; namely, factual, conceptual, charts and abstract questions. Each item in this test was based on information found in eleven best selling, recently published, science text books, and with a forward look into what year books are suggesting for scientific attitude.

### ASSUMPTIONS

One of the major assumptions is found in the classification of the rural and urban pupils. One general criteria used in the selection of the pupils assume that pupils who live on farms are exposed to a very different type of environmental learning than the pupils not living on farms. In this same respect some pupils living on farms may not have been exposed to the environmental situations usually found in a rural society but through a large sample this possibility should be normalized.

The widespread use of radio, television and printed materials are factors that will tend to level off some of the differences between the two groups. This means that any differences that are found can be attributed to the environment and not the availability of these mediums of propaganda to one group and not to the other group.

The intelligence factor must be taken into consideration whenever testing is carried on. This means that if you were comparing individual scores and found a difference this may be caused by one pupil having a relatively high "Intelligence Quotient" as compared to the other pupil. To equalize this situation the mental abilities of all the pupils should be known and then they could be compared with a greater degree of accuracy. In this study it will be assumed that the size of the sample will tend to level off any great differences in the mental abilities of any one group.

## CHAPTER II

### RESEARCH PROCEDURES

#### RANDOM SAMPLING

Nearly all experimental research in education involves the drawing of inferences about a population from what is known of a sample taken to represent that population. Thus, the fundamental problem to be faced is in choosing a representative sample, one that is truly representative. To begin analyzing this basic problem we must agree on certain definitions so as to assure a working vocabulary in this area. Lindquist<sup>1</sup>, explains:

"A random sampling technique assures that every member of the population has an equal chance to be selected. This means that each member must be selected independently of all others. It is sometimes said that a random sample is one so drawn that all possible combinations of an equal number of members from the population had an equal chance to constitute the sample drawn."

In any education research, the feasibility or accessibility of the population must be taken into consideration. This means the difficulty encountered in trying to reach the individual elements in the selected sample. In a practical situation, this means, how much of the entire population can be reached with the desired time and financial allotments that were

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<sup>1</sup>Lindquist, E. F., Statistical Analysis in Educational Reserach, Boston, Houghton Mifflin Co., 1940, p 3-4.

set-up as limits for the study. If the school is located in the furthest corner of the state, then this fact might make it inaccessible. If the superintendent of the system refuses to allow the investigator to enter the desired school then the school will be considered as inaccessible.

Some method of separating the communities into rural and urban areas must be agreed upon. Since it was impossible to conduct an ecological study in each and every place to be considered some other device must be used. The United States Office of Education in one of its studies<sup>1</sup>, uses the following:

.... compared the enrollment of High Schools in communities with a population of twenty-five thousand and more, known as urban, and communities with a population of fewer than twenty-five thousand, designated as rural.

With this as the criteria for separating the communities into rural and urban groups, the researcher began to group the cities and towns for this study. In this rather artificial method of limiting communities it was discovered that many areas classified as rural were in reality suburban sections of large industrial cities and the majority of the families in these towns had environmental conditions that were more urban than rural. To alleviate this situation some added techniques were used. It became necessary to arbitrarily leave out communities

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<sup>1</sup> Grayson N. Kefauver, Victor N. Noll & C. Elwood Drake, National Survey of Secondary Education Bulletin, 1932, No. 17, Monograph No. 4, (The Secondary School Population) U.S. Government Printing Office, Washington, D.C., 1933, pp. 5-6.

that appeared on the map as adjacent to a large city as they were in all probability used as "bedrooms" for the people employed in the larger city. So most of the rural communities chosen to be used in this study were located a considerable distance from industrial and commercial centers with the hope that the distance might be a factor in limiting the intermingling between the people of the defined areas.

Another factor that must be considered is the size of the schools to be used in this study. The schools must be limited in size so that the possible differences in learning due to extremes in school size would not be introduced. The Massachusetts State Department of Education in the Office of the Supervisor of Secondary Education has a complete survey file on all public schools in Massachusetts, and it was from this source that the size of the various school became known. From the group of school classified as having been two hundred and five hundred pupils were selected two groups of twenty rural and twenty urban schools that might be used in this study. From these two sets of twenty schools, two shorter sets of ten each were chosen by simply taking the odd numbered schools. This procedure gave two lists of ten schools each that had been randomly selected from the original group of eligible schools.

It was to this refined list of schools that a letter was sent (see appendix) requesting permission to administer the Read Science Test to groups of their ninth grade pupils. Inclosed

with the letter was a self-addressed postcard with a designated space for the superintendent to check either yes or no, with some space allowed for any remarks he might wish to write.

In the rural group all ten letters were answered with two negative replies. The urban group returned eight with one of these a negative reply. With this added information it now became possible to determine the final number of schools that would be included in this study. To facilitate this, the names of the eight rural schools were written on slips of paper and placed in a box from which five schools were drawn. This procedure was also followed in the urban group. Thus the five schools from each group were finally chosen.

There is no reason to suppose that the schools in our list differ significantly from the other schools in the state with reference to the scores their pupils might receive on any standardized test. If this is true then we are justified in considering our sample of ten schools as a random sample of all the schools in the state.

From each of these randomly selected schools a random group of twenty pupils is to be taken for this study. To do this the principal in each school was asked to submit to the investigator the entire ninth grade roster. The number of pupils in the grade was totaled and then divided by twenty, this would leave for the quotient a number that would be used in selecting the pupils. For example, if the total ninth grade enrollment was three hundred pupils, then this number would be

divided by twenty to get fifteen. Which would indicate that every fifteenth pupil should be included in the selection. The principal would then contact the pupil and arrange for the entire group to meet in one of the school rooms. These twenty pupils would be used as the representative sample from each school, which in turn was a part of the five schools in each large group.

It is assumed that the above procedure will produce a random sample of schools and pupils in both urban and rural areas. It is also assumed that random sampling used with the proper modification of formulas, will accurately predict the mean and standard deviation of the population from which the small sample was drawn. It is then possible to determine how often, out of each one hundred samples like the one we have drawn, the same statistical results could occur by chance alone or if there occurred a difference in results due to a significant difference in the abilities of the pupils.

#### TESTING METHODS

The administration of these tests was carried out by the investigator traveling to each of the selected schools and personally giving the tests. This method assured similarity in the approach discussion and in the actual giving of the tests. Thus the differences inherent in allowing the classroom teachers to administer the test to their own pupils was avoided.

The school officials appeared very cooperative when some of the advantages to the pupils were explained. It was mentioned that if the pupils have had very few standardized multiple choice type tests during the usual years work then this contact with a prepared test will be a new educational experience for them. Also, the classroom teacher may not have covered certain areas too thoroughly and some questions on the test, in those areas, may interest the pupil to the point of asking the teacher for added information.

To assure a similar orientation program for each new group to be tested, the investigator developed a standard approach discussion. It follows: "I want the whole group to relax for a few minutes while I tell you the story behind this test and how the results will be used. This test was made up by Dr. Read of Boston University for the average pupils in the ninth grade of school. Perhaps some questions will seem real hard to you but then again you will find many that you can answer easily. It all depends upon how average you are. (Laughs). Now to make certain that no one will ever know which paper belongs to which pupil, it will be necessary to only write the name of the town on the top of the answer sheet not your own name.

By now, I suppose, you're all wondering why in the world anyone would want to give a test and not know to whom the papers belong. Well to tell the truth I am interested in only the results as a group and not individually. This means that

the scores made in this test will be used only as a large group and from this total the average score of the group will be calculated. Now let's all look at the cover of the test and read the two sample questions. (pause) The correct answer for the first question is letter "d", this is the only answer you would write on the answer sheet. Please check the number of the problem against the number on the answer sheet and print clearly the letter you think represents the correct answer. Are there any questions? (pause) Then let's all begin on the real test now."

This explanatory period usually took five minutes and the test proper took forty minutes. Thus the entire procedure lasted for only one class period in most of the schools tested. This eliminated much of the confusion that would result from the pupils finishing in the middle of a period and then returned to their respective class rooms.

The school library was the most frequently offered free room for the administration of this test. In a few schools where they had no library facilities the science laboratory or biology room was offered. In all schools visited some suitable testing area was found without disturbing the regular classes.

The compiling of the test scores was done manually. This meant that the investigator had to correct all the tests taken and then the individual test items had to be tallied. These items were then grouped by Dr. Read and the investigator into the four areas; namely, factual, conceptual, charts, and

abstractual questions.

Some examples<sup>1</sup> of the type questions involved in the above grouping will be given with a brief discussion on each area. The factual questions are ones that involve only one thought which can be answered by an obvious fact. For example:

Pasteur is known for his work with ...

- |                |             |
|----------------|-------------|
| a. electricity | d. X-rays   |
| b. molds       | e. bacteria |
| c. radium      |             |

What part of the blood is effective in destroying invading bacteria?

- |                   |                     |
|-------------------|---------------------|
| a. plasma         | d. white corpuscles |
| b. red corpuscles | e. lymph            |
| c. toxin          |                     |

The conceptual questions deal with problems that have greater implications and are more complex, than do the factual questions. The person must discriminate between the statement as given and the general situation that requires a definite rule or understanding. For example:

What tool is not a lever?

- |                |                     |
|----------------|---------------------|
| a. seesaw      | d. scissors         |
| b. derrick     | e. pencil sharpener |
| c. fishing rod |                     |

A pulley arrangement which gives no mechanical advantage is the ...

- |                   |                    |
|-------------------|--------------------|
| a. single fixed   | c. double movable, |
| b. single movable | single fixed       |

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<sup>1</sup>Read, John G., Read General Science Test, New York, World Book Co., 1950.

- d. double fixed,  
single movable
- e. double movable,  
double fixed.

The chart or graph problem needs little explaining. It will suffice to say that any question that had a chart or graph in either its question or answer fell into this category. The abstract problem solving type of question depended upon a question that was mythical in substance and presented a problem that involved projecting the conceptor principle into an artificial situation. Example:

A comic-book science story showed a man building a big balloon out of very thin sheets of aluminum cemented together so as to be airtight. He pumped the air out of the balloon, and the balloon then floated.

At present this would be impossible because ...

- a. Aluminum cannot be made airtight.
- b. It would take too much cement.
- c. The outside air pressure would crush the balloon.
- d. The balloon would not hold hydrogen.
- e. Aluminum is too heavy.

A sailboat going from the ocean without stopping, to a point 100 miles up the Mississippi River would ...

- a. Float higher in the river.
- b. Float lower in the river.
- c. Weigh less in the river.
- d. Weigh less in the ocean.
- e. Be buoyed up less by the ocean.

This test also had in it questions that have to do with scientific attitudes, but because they were limited in number they could not be statistically analyzed. The scores on these questions were compiled only because of the investigator's interest in this new type of question. An example of Dr. Read's scientific attitude question is as follows:

Which one of the statements is false?

- a. It is better never to drink when driving.
- b. It is practically certain that alcohol will slow down your reaction time.
- c. Alcohol is considered to be a poor food.
- d. Everyone can take one drink without having it affect him.
- e. Alcohol is often habit forming, and its users find it difficult to stop drinking.

When all the questions had been classified, the actual compiling of the scores began. This was accomplished by using tally marks for each correct response and the tallies totaled to give the number of correct responses for each question under each classification. It was thus possible to calculate the mean and standard deviation of each group of scores.

The null hypothesis will be assumed in this investigation. The level of significance will be needed to disprove this hypothesis set at the 5 per cent level. The actual statistical approach used will be explained and illustrated more adequately in the following chapter.

## CHAPTER III

### ANALYSIS OF DATA

#### STATISTICAL PROCEDURES

Any investigation or experiment is designed to answer some question or solve some problem which the investigator has in mind. The investigator's hypothesis may be in the nature of a general proposition or it may be a specific result. The specific type of hypothesis is, ordinarily, to be preferred to a general one, as the more definite and exact the thesis the greater the likelihood of a conclusive answer. In this investigation the specific hypothesis must be stated as follows: The urban pupils will not score any better than the rural pupils in the four areas to be tested in this investigation. This means that no true difference exists between our two groups; that, in fact, these samples were randomly drawn from the same population, and differ only by accidents of sampling. A null hypothesis constitutes a challenge; and the function of any investigation is to give the facts a chance to meet or fail to meet this challenge.

It is also very important to realize that the rejection or acceptance of the null hypothesis in itself does not force the acceptance of a particular view. If it were found that a significant difference exists between the rural and urban pupils in their achievements on the science test then it could be said

that the two groups do actually differ, but it does not prove that one group is better than the other. If, on the other hand, in subsequent comparisons of these groups, with all experimental variables likely to influence the scores under rigorous control, the difference still remains, then this difference in science learning can be accepted. This acceptance of the difference is usually the end result of a series of experiments and not the results of only one investigation. Thus, in the case of this investigation, any conclusions can be only tentative because this is the first investigation of a possible series of investigations that would be needed to conclusively solve the stated problem.

Some definite standard of significance must be decided upon as the basis for rejecting or accepting the null hypothesis. According to Lindquist<sup>1</sup>, in small samples, the use of the normal probability table, based on the areas out off under a normal probability (Gaussian) curve, is not proper, because small samples tend to be markedly peaked; therefore, another statistic, known as Student's  $t$ , is used to determine the level of confidence which we can have, that any particular result which we obtain arose only by chance.

The sampling distribution of  $t$  is known to be independent of all except one factor, the number of cases and of statistics concerned with the number of cases. The  $t$ -ratio is used

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<sup>1</sup>E. F. Lindquist, Statistical Analysis in Educational Research, Houghton Mifflin Co., Boston, 1940, p. 51.

frequently to determine the probability that a difference between means was a chance result alone. Tables give the level of confidence associated with a particular value of  $t$  for some degree of freedom. The two levels most used are the 0.05 and the 0.01 levels of confidence.

In interpreting the data derived from the investigation, it was necessary to determine the level at which a difference could be considered significant. For this purpose, the 0.05 level of significance was established.

To arrive at the critical ratio needed to determine the level of significance certain statistical procedures must be followed. To facilitate this analysis of the data from the raw scores the following steps were taken:

1. The mean of the grouped scores must be calculated.<sup>1</sup>

$$M = \frac{\sum X}{N}$$

2. The formula for the standard deviation from a mean:<sup>2</sup>

$$\sigma = SD = \sqrt{\frac{\sum X^2}{N} - M^2}$$

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<sup>1</sup> Broom, M.E., Educational Statistics For Beginning Students, New York, American Book Co., 1926, p. 29.

<sup>2</sup> Henry E. Garrett, Statistics in Psychology and Education, New York, Longmans, Green and Co., 1949, page 62.

3. The formula for the standard error of the mean:<sup>1</sup>

$$SE_M = \frac{\sigma}{\sqrt{N - 1}}$$

In all the statistical calculation of the standard error of the mean the above formula used rather than  $SE_M$ , because Garrett<sup>2</sup> in his book on educational statistics claims:

"No matter what the size of N, the formula using N-1 gives the best estimate of the standard error of the mean, i.e., of the SD of the sampling distribution of means. In very large samples the correction effected by using N or N-1 is so small that N can be safely employed. But when N is less than fifty it is advisable to use the more exact formulas, and imperative when N is quite small --- less than ten, say."

4. The simple subtraction of the mean with the lower value from the mean with the higher value.<sup>3</sup>

$$\text{Diff} \\ M_1 - M_2$$

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<sup>1</sup>Garrett, op. cit., p. 189.

<sup>2</sup>Ibid.

<sup>3</sup>Kvaraceus, W.C., Methods In Educational Research, (Course Outline and Study Guide), Boston University, 1949, p. 79.

5. The formula for the standard deviation (error) of the difference of two means:<sup>1</sup>

$$SE_{DIFF} M_1 - M_2 = \sqrt{SE_{M_1}^2 + SE_{M_2}^2}$$

6. The formula for the critical ratio:

$$CR = \frac{Diff_{M_1 - M_2}}{SE_{Diff_{M_1 - M_2}}}$$

This critical ratio formula will be used to determine the level of significance that any observed differences may reach. In Garrett<sup>2</sup>, table 29 can be used to determine the reliability of statistics. In other words, this table will give the number of times out of one hundred trials that a divergence as large as that observed may be expected in the positive and negative directions.

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<sup>1</sup>Kvaraceus, op. cit., p. 78.

<sup>2</sup>Garrett, op. cit., p. 190.

## RESULTS

The results have been reproduced in table form in the interest of convenience and clarity. The raw scores have been treated statistically and these are the derived results.

TABLE ONE

A COMPARISON OF THE STATISTICAL DATA DERIVED FROM THE SCORES OF 200 RURAL AND URBAN PUPILS IN THE FACTUAL AREA

| Statistic      | Urban | Rural |
|----------------|-------|-------|
| N of items     | 25    | 24    |
| Mean           | 61.88 | 56.71 |
| S. D.          | 20.27 | 23.45 |
| S.E.<br>M      | 4.36  | 5.00  |
| Diff.<br>M - M |       | 5.17  |
| S.E.<br>Diff   |       | 6.63  |
| C.R.           |       | 0.78  |

The one hundred test scores for the rural group range from 7 to 87. The one hundred test scores for the urban group range from 13 to 93. The above table shows that the difference between the mean scores, in the above area, is 5.17 in favor of the urban group. The critical ratio shows a value of 0.78, which is not statistically significant. Therefore, the groups can be considered equated in the area of factual questions.

TABLE TWO

A COMPARISON OF THE STATISTICAL DATA DERIVED FROM THE SCORES OF 200 RURAL AND URBAN PUPILS IN THE CONCEPTUAL AREA

| Statistic                   | Urban | Rural |
|-----------------------------|-------|-------|
| N of items                  | 15    | 15    |
| Mean                        | 48.12 | 51.69 |
| S.D.                        | 12.41 | 16.61 |
| S.E. <sub>M</sub>           | 3.27  | 4.29  |
| Diff <sub>M</sub> - M       | 3.57  |       |
| S.E.<br>Diff <sub>M-M</sub> | 5.39  |       |
| C. R.                       | 0.66  |       |

The one hundred test scores for the rural group range from 73 to 20. The one hundred test scores for the urban group range from 73 to 23. The above table shows that the difference between the mean scores, in the area covered by conceptual questions, is 3.27 in favor of the rural group. The critical ratio shows a value of 0.61, which is not statistically significant. Therefore, the groups can be considered equated in the area of conceptual questions.

TABLE THREE

A COMPARISON OF THE STATISTICAL DATA DERIVED FROM THE SCORES OF 200 RURAL AND URBAN PUPILS IN THE AREA OF CHARTS

| Statistic             | Urban | Rural |
|-----------------------|-------|-------|
| N of items            | 10    | 10    |
| Mean                  | 53.40 | 51.80 |
| S.D.                  | 13.19 | 18.70 |
| S.E. <sub>M</sub>     | 4.39  | 6.23  |
| Diff <sub>M - M</sub> |       | 1.60  |
| S.E.<br>Diff<br>M - M |       | 7.62  |
| C. R.                 |       | 0.21  |

The one hundred test scores for the rural group range from 70 to 30. The one hundred test scores for the urban group range from 80 to 43. The above table shows that the difference between the mean scores, in the area covered by charts, is 1.60 in favor of the urban group. The critical ratio shows a value of 0.21, which is not statistically significant. Therefore, the groups can be considered equated in the area of chart reading.

TABLE FOUR

A COMPARISON OF THE STATISTICAL DATA DERIVED FROM THE SCORES OF 200 RURAL AND URBAN PUPILS IN THE ABSTRACTUAL AREA

| Statistic                            | Urban | Rural |
|--------------------------------------|-------|-------|
| N of items                           | 12    | 12    |
| Mean                                 | 49.08 | 44.90 |
| S.D.                                 | 12.29 | 14.83 |
| S.E. <sub>M</sub>                    | 1.11  | 1.35  |
| Diff <sub>M - M</sub>                | 4.17  |       |
| S.E. <sub>Diff<sub>M - M</sub></sub> | 1.74  |       |
| C.R.                                 | 2.39  |       |

The one hundred test scores for the rural group range from 23 to 70. The one hundred test scores for the urban group range from 20 to 67. The above table shows that the difference in mean scores, in the area covered by abstractual questions, is 4.17 in favor of the urban group. The critical ratio shows a value of 2.39, which is significant at the 5 per cent level. Therefore, the groups can be considered as actually having a difference between them in this particular area.

## CHAPTER IV

## SUMMARY AND CONCLUSIONS

The purpose of this study was to determine if there was a significant difference between the rural and urban groups of pupils in the four areas tested.

The Read Science Test was administered to a random sample of the ninth grade pupils. This sample included one hundred ninth grade pupils from rural areas and one hundred ninth grade pupils from urban areas. These pupils were randomly selected from ten schools in ten scattered communities.

It was assumed that all pupils were using the standard text books and had nearly the same type of equipment available because the size of the schools was limited. It was also assumed that no significant difference in the means nor in the standard deviation of the pupils' I.Q.'s prevailed. Thus, any significant difference found in the results of these test scores can be attributed to the environmental surroundings of the pupils.

To determine whether the null hypothesis will be accepted or rejected, we find by the following results:

1. There are no significant differences found, at the 5 per cent level, between the rural and urban pupils in the factual area.
2. There are no significant differences found, at the 5 per cent level, between the rural and urban pupils in the conceptual area.

3. There are no significant differences found, at the 5 per cent level, between the rural and urban pupils in the area of chart reading.
4. There was a significant difference found, at the 5 per cent level, between the rural and urban pupils in the abstractual area.

Suggestions for the modification of classroom organization, teaching procedures, curriculum planning, and textbook revision are some of the educational implications which may be indicated by the results of this and other investigations in the area of science learning.

#### SUGGESTIONS FOR FURTHER RESEARCH

As a result of this investigation, the following problem for further study might be considered:

1. Investigate the results of a similar type of investigation, but instead of having the four areas used in this study substitute the general areas of science, i.e., mechanics, electricity, sound, motion, heat, light, geology, astrology, chemistry, medicine, botany, anatomy. With these results definite subject matter areas could be adjusted to eliminate any observed weakness.
2. Make a study analogous to the study by Durwald Eastman, 1948 Master's Thesis, Boston University,

in which he investigated the out-of-school application of scientific principles in the industrial concerns of a certain community, but in further research substitute for the industrial application some rural applications of the scientific principles that are now being taught in the high schools.

3. Initiate a questionnaire type follow-up survey of recent high school graduates to determine which general areas of science learning are the most useful to the high school graduate in vocational as well as educational endeavors.

A P P E N D I X    A

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A P P E N D I X    B

THE FIRST LETTER OF INQUIRY  
TO SCHOOL SUPERINTENDENT

November 10, 1949

Mr. R. Rogers  
Superintendent of Schools  
School Department  
Warren, Massachusetts

Dear Sir:

Your school system has been invited as one of several, to participate in an educational study conducted by one of the graduate students of Boston University.

This study will consist of administering a prepared science test to some of your ninth grade pupils, and evaluating the results as a total group, not as any one school system against some other school system.

The name of neither the school or the pupil will be recorded, and the data will not be made available to other persons.

If you are willing to allow this survey to be conducted in your school, please return the enclosed postcard as soon as possible.

Thank you for your cooperation and effort in answering this letter.

Respectfully yours,

Eugene E. Hellman