THE UNIVERSITY OF MANITOBA

AN INVESTIGATION INTO THE PROBLEM OF SCIENCE INTEREST AMONGST JUNIOR AND SENIOR HIGH SCHOOL STUDENTS

BEING A THESIS SUBMITTED TO THE COMMITTEE
ON POST-GRADUATE STUDIES IN PARTIAL
FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF
EDUCATION

BY
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CHAPTER I

INTRODUCTION

Some Considerations of Interest

Many Pupils Enjoy School These Days

Education has come a long way since the days of the Dame School and the mass-packed classrooms of Bell and Lancaster. While some classrooms may occasionally show vestiges of both these humble beginnings, there is plenty of evidence of pupils learning their lessons because they like them rather than because their teachers say, "You'll learn this and like it!" This liking of a school subject is often based upon an interest in that subject.

The Child Chooses the Curriculum

Teachers of science, in common with other teachers, have long been aware that their educational task is easier when pupils are interested. A multitude of studies in the field of interest in science have been undertaken in the past. Many of these were based on the concept of discovering the pupils' interest in science - the science areas they were interested in at various age levels - and then attempting to build a curriculum around these science areas.

Once the curriculum has been decided upon, whether by the pupils or otherwise, the question, "To what extent are pupils interested in science?" is still with us. There have been several investigations made that attempted to answer this question. Frandsen's [1] investigation, for example, deals with interest in science and achievement in science. Studies reported in the Times Educational Supplement [2] deal with interest in school subjects and the effect of examinations upon interest. Both these investigations, as with other investigations in the field of interest, rely upon some type of questionnaire. In the opinion of the writer a questionnaire often has intrinsic weaknesses. A candidate, particularly a child, answering a questionnaire has a tendency to respond to it as he thinks he should. Thus, intentionally or unintentionally, he sometimes reveals the ideal self - what he would like to be rather than what he actually is. This paper attempts to obviate, at least partially, this weakness of questionnaires by using voluntary activities as a criterion of interest and then comparing this to a questionnaire score on a percentage basis.

Few people today would minimize the importance of science as a subject of study. The changes in human living in the last century have been influenced more by science than any other subject.

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[1] Frandsen, A.N. "Interest and General Educational Development", Journal of Applied Psychology 31:57-66, February, 1947.

[2] Times Educational Supplement, February 1945, "A Study in Interests", from a correspondent.

There is, at present, a great demand for the services of applied scientists - engineers, doctors, and technicians. The achievements of these men, ranging as they do from nuclear fission and radar to penicillin and a thirty percent increase in life expectancy in the first half of this century, are vital to our life. Yet these achievements are only possible as a result of an original interest in science. This original interest is often found in youth. The extent of this interest, the measurement of this interest, and, above all the fostering of this interest, are factors that demand our attention if progress is to be maintained in science.

An investigation in the field of pupil interest in science would be a step in the right direction and enable comparisons to be drawn with similar investigations made elsewhere.

CHAPTER II

DEFINITIONS OF INTEREST

Most of the investigations in the field of pupils' interest in science do not undertake to define interest. Several writers, however, have attempted to do so and the definitions of three authorities will be considered here.

Dewey states, "The genuine principle of interest is the principle of the recognized identity of the fact to be learned or the action proposed with the growing self; that it lies in the direction of the agent's growth, and is, therefore, imperiously demanded, if the agent is to be himself." [1] He later concludes, "Genuine interest is the accompaniment of the identification, through action, of the self with some object or idea, because of the necessity of that object or idea for the maintenance of a self-initiated activity." [2]

Dr. Wees states that interest is a quality of mind and then goes on to say, "Those who have spoken in favour of the doctrine of interest are of two sorts; the group who think of mind in terms of volume, and the group who think of mind in terms of power. The volume-minded folk are not actually concerned about the child's interests as such; they wish only to use interests as

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1. Dewey, John, Interest and Effort in Education, Houghton Mifflin Company, 1913 p. 7.

2. Ibid, p. 14.

a kind of lever by which to prise large masses of knowledge into the bin of the mind . . . . . The power-minded teachers think of interest in a different way. To them, interest is not a tool; it is an end in itself. In their philosophy of education to arouse and maintain children's interests is one of the two main reasons for teaching. They consider their work well done when they find their students reading history for its own sake, discussing the news of the day because they consider it significant, working mathematical problems because of the excitement of getting solutions. In the minds of these teachers, education has failed when it graduates students in June with minds 'crammed with knowledge' but no continuing interest in the 'subjects' at which they have spent too great a fraction of their lives." [3]

Writing for the National Society for the Study of Education, Harris states, "An interest is defined by preoccupation with an activity when the child is free to choose." [4] He concludes, "In summary, then, a child's interests tend to grow,to channelize along with his developing abilities and skills. He generally likes to do what he can do well. Conversely, he tends to be uninterested in activities in which his performance is particularly poor." [5]

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[3] Wees, W. The introduction to The Enterprise in Theory and Practice, W. J. Gage and Co. Ltd. 1940, p. 8.

[4] Harris, D.B. National Society for the Study of Education Forty-Ninth Yearbook Part I, p. 131, Public School Publishing Company, Bollmington, Illinois.

[5] Ibid, p. 140.

From the foregoing paragraphs we have the opinions of three authorities. Perhaps Dewey and Harris provide the more commonly accepted viewpoints, while Wees' concept of interest is broader than most people would allow. These definitions will be considered later in the light of this investigation.

Purpose of Paper

Bearing in mind these foregoing definitions, it is the purpose of this paper to investigate pupils' interest in science in some Junior and Senior High Schools in Winnipeg. This investigation includes six types of enquiry:

Enquiry One

A study to determine the percentage of pupils over a period of five years in a Winnipeg Junior High School who are sufficiently interested in science to undertake voluntary construction-type projects related to their curriculum;

Enquiry Two

A study using an original questionnaire (Science Interest Scale Form A Revised) of the Thurstone-Chave-Likert type to measure interest in science of Junior and Senior High School students and to note variations of science interest through the grades;

Enquiry Three

A comparison between science interest scores of Enquiry Two and the percentage found in Enquiry One;

Enquiry Four

A comparison between students' interest in science, as found in Enquiry Two, and students' achievement in science as determined by report marks;

Enquiry Five

A study using Monroe's Standardized Silent Reading Test Revised to determine the reading ability of pupils tested in Enquiry Two and to compare the reading ability thus found with interest scores using correlations;

Enquiry Six

A study using a second original questionnaire (Science Interest Scale Form B) of the Thurstone-Chave-Likert type to measure interest in science of Senior High School students and to compare the interest scores thus found with the interest scores determined earlier in the school year using Science Interest Scale Form A Revised; in this same study the questionnaire (Science Interest Scale Form A Revised) will be compared with the questionnaire (Science Interest Scale Form B).

CHAPTER III

Voluntary Science Projects As An Index of Science Interest

It would not be out of line with the foregoing definitions of interest and statements relating to interest to say that a pupil who voluntarily undertook a science construction-type project would be interested in science. Without considering whether this interest would be high or low, it would be possible to use this criterion of interest as a means of testing science interest in a large group of pupils. If, then, we simply count the number of pupils that voluntarily undertake science projects in their free time (out of school time) we would have a definite index - the percentage of pupils interested in science. This method of estimating pupils' science interest will have one important advantage over the questionnaire type of investigation - it will not depend on the individual's opinion of his science interest, or what he thinks his opinion should be.

Another advantage of this type of investigation is that the activity itself is considered by many authorities in the field of science to be very worth while. According to Yothers [1], "Secondary and junior high school students, who are enrolled in science courses are usually given an opportunity to plan and carry to a

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[1] Yothers, L. R., A Method of Directing and Utilizing Project Work, School Science and Mathematics, 450 Ahnaip St., Menasha, Wisconsin, U. S. A. p. 462, 1941.

conclusion, the construction of one or more projects during the school year. That this activity is a popular one, for both student and teacher, is indicated by the numerous magazine articles which are written on this subject; and of greater significance, the increasing occurrence and emphasis placed on student projects, exhibited at Science Fairs and various science educational conferences for young people. This attitude is justified. Probably, no other phase of a science course offers quite the opportunity and privilege to students for self-planning, participating and expressing practical applications of the scientific knowledge and procedures which they have acquired about or from their environment."
Some of Yothers objectives are:
"Students may be encouraged to construct projects for the purpose of developing laboratory equipment."
"One may present this work from the viewpoint of developing and fostering a definite and wholesome interest in an actual interpretation of scientific principles and processes."

Another recognized authority in the field of science is H. S. Zim.[2] He considered voluntary participation in science activities as a criteria of science interest and investigated students who submitted exhibits to the Science and Engineering Fairs by means of a questionnaire. His main purpose in his investigations was to develop a science curriculum. Zim states, "These voluntary

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[2] Zim, H. S. Student Interest in Science, School Science and Mathematics 1941, 450 Ahnaip St., Menasha, Wisconsin, p. 385.

activities lead the adolescent to use a wide range of sources of science information outside of the classroom." [3]

Further justification for the construction of scientific equipment in junior high school science instruction is found in the Thirty-First Yearbook - A Program for Teaching Science - National Society for the Study of Education. Here a list of the activities and types of exercises which in practice have proved to be valuable is located. Number 25 of the list is, "Constructing models, appliances, and so forth." [4]

The writings of Hoff, also justify this type of activity. "Models are very effective in teaching certain concepts and principles in science. A new development has been 'modelograms' . . . . Pupils often can build their own modelograms which frequently are excellent." The appendices of many science textbooks also encourage pupils to construct models and make homemade science apparatus.

As stated previously this voluntary project work would be undertaken in the pupils' own time. Couper [6] used after school time for science activities. In his article, "Keeping the Science

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3. Ibid, p. 388.

4. Thirty-First Yearbook - A Program for Teaching Science National Society for the Study of Education, Public School Publishing Company, Bloomington, Illinois, p. 215.

5. Hoff, A. G. Secondary-School Science Teaching, p. 233, The Blakiston Company, Toronto, 1947.

6. Couper, D. G. Keeping the Science Room Interesting, School Science and Mathematics, 1936, p. 43.

Room Interesting", he states, "Most of the work of caring for the room is done after school hours."

In order more fully to illustrate how the construction of science equipment and models may be considered as an index of scientific interest, let us turn from the writings of science teachers and consider for a moment three hypothetical science lessons. Let us assume that each of these three science lessons is taught to the same number of pupils - 60 in each case. Furthermore, let us assume that after the first lesson is taught not one of the sixty pupils comes forward on his own free time to consider and study the subject of the lesson further. In the case of the second hypothetical science lesson two of the sixty pupils are sufficiently interested to spend their own time learning more about the subject and one of these might write a thousand word essay while the other might construct a working model of fine quality. In the third hypothetical lesson ten pupils may come forward to learn more about the subject in their free time and perhaps six of these may complete some worthwhile project. Now, most observers would likely agree that there was definite evidence of scientific interest in the second lesson and that there was more evidence of interest in the third hypothetical lesson. This would be in agreement with Zim [7] who considers the voluntary participation of pupils in science activities as a criteria of science interest. In these hypothetical cases, with the number

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[7] Zim, H. S. Op. Cit.

of students being equal in each lesson, we could say that the greater the number of pupil activities or projects completed, the greater the scientific interest shown by the group. Leaving the realm of the hypothetical, no one would deny that the percentage of pupils completing scientific projects or activities in their own free time would be a definite index of scientific interest of that group of pupils.

From the foregoing paragraphs it can be seen that the construction of scientific equipment and models by pupils in their own free time has been undertaken in several schools. Several authorities consider this a worthwhile science activity. Furthermore, although the use of this activity as a criterion of scientific interest was adopted only by Zim[8] in his investigation, ~~but~~ even he did not apply this criterion to a school or area on a percentage basis. It is the opinion of the writer that the percentage of pupils in a junior high school that will respond to this type of activity over a period of years has not been previously determined. This is, therefore, an original procedure developed for the purpose of this thesis.

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8. Zim, H. S. Op. Cit.

CHAPTER IV

A Description of the Projects

The purpose of this chapter is to describe each project telling how it was made, its relation to the science course, and if pertinent, the circumstances which instigated the activity. The twenty-two projects can be divided into two groups: 1) those that can be worked and thus produce further activity after they are completed, and 2) those that can be merely handled and looked at. There are nine projects in the first group and thirteen in the second. Before these projects are described, however, the science interest that prompts their construction is defined.

As previously stated, the viewpoint of Zim[1] is that voluntary construction of scientific apparatus and equipment is a criteria of science interest. With this viewpoint in mind, a definition of science interest applicable to Enquiry One may be stated as follows: a pupil who voluntarily undertakes to construct and finally completes science apparatus, equipment, or appliances with or without the help of others may be said to possess science interest.

While voluntary construction of scientific apparatus may be a criteria of science interest, it is quite

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[1] Zim, H. S. Op. Cit.

possible that a student who is constructing such apparatus may be stimulated by other interests. He may be working as a result of aesthetic or creative interests, or because he wishes to ingratiate himself with the teacher. There may be several reasons why pupils make science apparatus but few would claim that science interest is entirely lacking in the case of any one of these reasons. Creative interests, for example, particularly those creative interests related to mechanical construction deal fundamentally with applied science.

Project 1. Aircraft Wing on Metre Stick

This project was the result of several attempts to construct a wind-tunnel for the purpose of illustrating lift in the science classroom. The suggestion of such an undertaking came from several boys over a period of years but each attempt resulted in an incomplete model One noon-hour this series of failures was discussed with several boys who were Air Cadets, and the question was raised, "Is a wind-tunnel necessary to illustrate flight?" One of the model airplane makers offered to bring in part of an aircraft wing on the following day. That noon-hour there was a large gathering of boys. The model aircraft wing was fastened to a metre stick with an elastic band. The metre stick was then suspended with a lever clamp from a laboratory stand in such a way that the end of the stick on which the aircraft wing was attached was slightly heavier. This is shown on page 15. A stream of air from an electric fan was then directed over the surface of the wing and the wing came up - it actually flew! It was necessary to prevent the meter stick from swinging around horizontally. The uprights of two stands (not shown in the diagram) were used for this purpose.

Project 2. Cartesian Diver

A Cartesian Diver which illustrates transmission of pressure by a liquid, the principle of Archimedes and the compressibility of gases could be purchased from the Central Scientific Company,[1A] but it could be set up even more effectively with standard science equipment - a small test tube and a tall glass cylinder or graduate. The small test tube - three and one half inches long and one half inch outside diameter - was partly filled with water, and inverted in the cylinder which was filled to within an inch or so of the top with water. See diagram on page 16. If the bubble of air inside the small test tube was just enough to float it and no more, the apparatus was ready for action. The part that took some adjusting was filling the small test tube with sufficient water and no more. This was tested first in a large beaker - large

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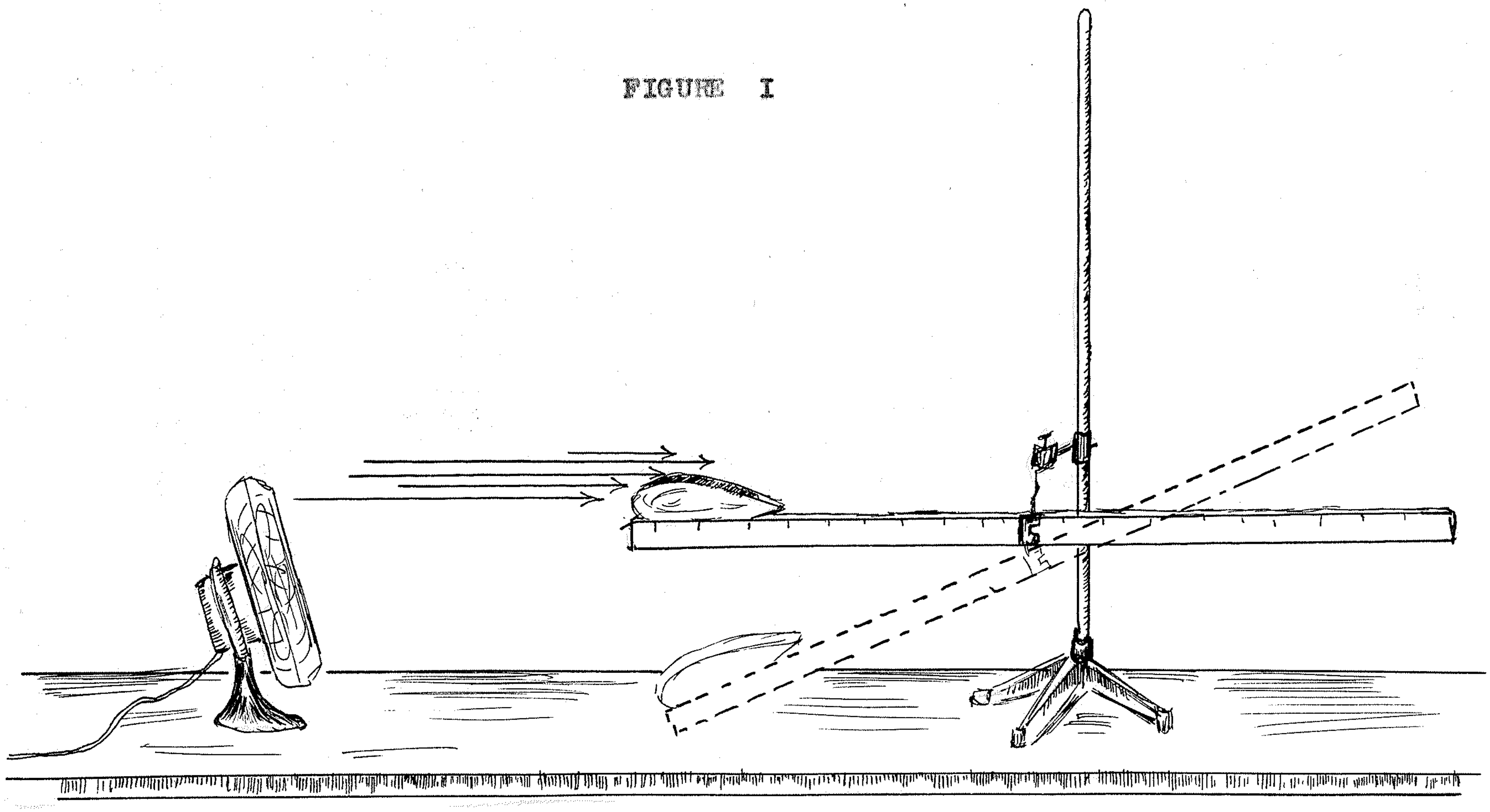
[1A] Central Scientific Company Catalogue, p. 822. Central Scientific Company, 1940.

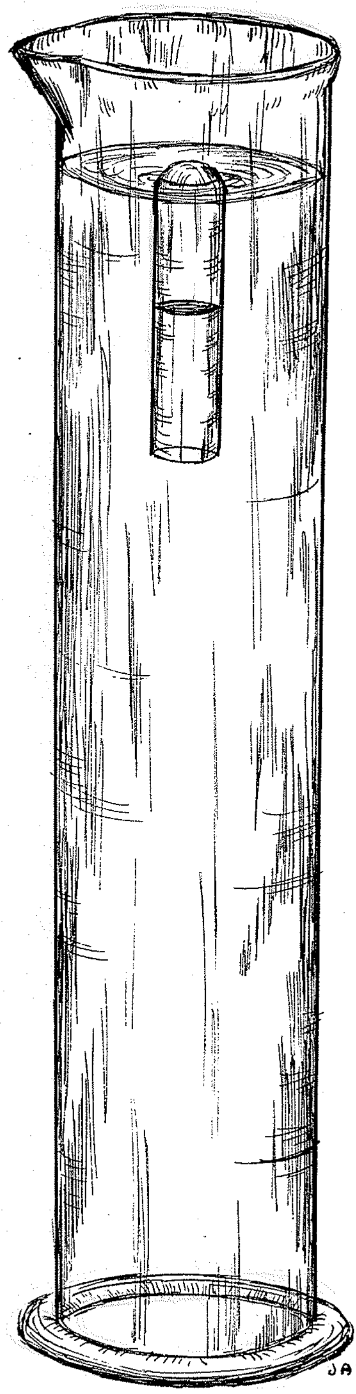
FIGURE I



Aircraft Wing on Metre Stick

FIGURE II

Cartesian Diver



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enough to get one's hand into if the test tube sank to the bottom. If it did sink then the test tube must be taken out and a drop or two of water allowed to escape. When the test tube floated with less than a sixteenth of an inch sticking out of the water, then it was possible, by simply placing the palm of the hand on the cylinder and pushing down, to cause the small test tube (diver) to descend to the bottom of the cylinder. By releasing the pressure of the hand the test tube obediently came to the surface.

Project 3. A Classroom Zoo

The classroom zoo was found to be an important item in the junior high science room. Pupils having more than usual interest in the zoo accepted the responsibility of giving the creatures the little attention they needed. It was observed that the following insects and animals could be kept throughout the winter months: a garter snake, a tiger salamander, garden worms, a giant water bug, and a water tiger. These creatures were chosen as members of the zoo due to the little attention they require.

The snake was found to be an excellent specimen because it adapted itself remarkably well to life in a classroom and was not offensive. Moreover, it requires very little food. It was observed that a garter snake - typical of those found in Manitoba - does not eat when first caught. The writer has never seen a snake caught in the fall or summer eat in captivity during the early fall. If, however, garden worms were placed in the cage during the month of November it would gobble them with gusto! Garden worms, however, must be kept in moist soil and the container they are in might become very offensive. A frog or a toad would make an excellent meal for a snake in late winter or early spring. The problem would be keeping the frog or toad over the winter months. Actually it was found to be unnecessary to feed a garter snake during the winter months. The writer has kept garter snakes alive in a class room over the winter months on four separate occasions and during that time they took nothing to eat. They were provided with shade, and, most important of all, a jar of water in which they would submerge themselves for days at a time.

A salamander is another native of Manitoba that gives very little trouble and takes very little time in a classroom zoo. The Tiger Salamander which is sometimes found around Ninette, Manitoba, is an interesting creature that plays a part similar to frogs and snakes in the animal world. It will live for weeks without feeding. It was found, however, that the salamander is more likely to eat meat after a period of fasting than the snake. The salamander requires four to ten inches of water in an aquarium and should be protected from the sun at all times.

Jars of earthworms were observed to have a double duty in the classroom zoo. First they were instructive as a means of showing the habits of the little "plowman" as Fox [2] calls the

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2. Fox, Florence C. Cycles of Garden Life and Plant Life, Bulletin, 1925, No. 15, Department of the Interior Bureau of Education, Government Printing Office, Washington. p. 44.

garden worm, and second the earthworms served as food for the snake and salamander. A suitable earthworm observatory could be made by placing a "tin can" inside a glass jar, and then filling the space between the glass and the "tin can" with earth. The earth must be kept moist. If no more than half a dozen worms were placed in each jar the tendency for the earth to sour was not so noticeable. If small leaves were placed on the soil the earthworm drew the leaves down into his burrow. The castings of the earthworm showed how the creature keeps the ground soft and moist.

The Giant Water Bug and the Water Tiger, or Predaceous Diving Beetle according to Hensley, Patterson and Armstrong, [3] were found to be easily kept in an aquarium. Since both insects breathe through a tail appendage, they should be placed in deep water on a window sill. Their swimming and diving ability may then be observed easily. These creatures can not climb on perpendicular glass nor can they fly off water. If they get the opportunity of climbing out of the water onto a rock or stone they then dry their wings and take off. It has been observed that a deep aquarium is an excellent place for keeping them where they should be.

Project 4. The Fuse Board

The Fuse Board made by the students was a piece of

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[3] Hensley, C. A. E. Paterson, D. A. Armstrong, O. A., Science Indoors and Out Book : 1, p. 270, W. J. Gage and Company, Limited, Toronto, 1949.

electrical equipment that enables a class to see a fuse actually burn out. It consisted of one porcelain split knob, one fuse socket with a five ampere fuse, one light socket with a sixty watt light bulb, one outlet socket, one male plug, two binding posts to take the two ampere fuse wire, and four or five feet of insulated electric double wire. This board shown on page 21 was first demonstrated to the writer by Allan Moore. A single strip of two ampere fuse wire was placed across the binding posts. The male plug was then connected with a one hundred and ten volt source of electricity. The electric bulb lighted since the circuit was completed. A toaster or a hot plate could now be placed in the circuit by plugging into the outlet socket on the board. The toaster and the light now drew ~~down~~ more current than the two ampere fuse wire could carry and the fuse wire across the binding posts melted. This broke the circuit and both the light and the toaster went out.

Project 5. Pneumatic Brake Model

The diagram of the pneumatic brake as shown on page 336 of "Science Indoors and Out" [4] was followed very closely when students tried to build a model of it. Naturally it was a simplified model though parts of it actually moved. It was not a working

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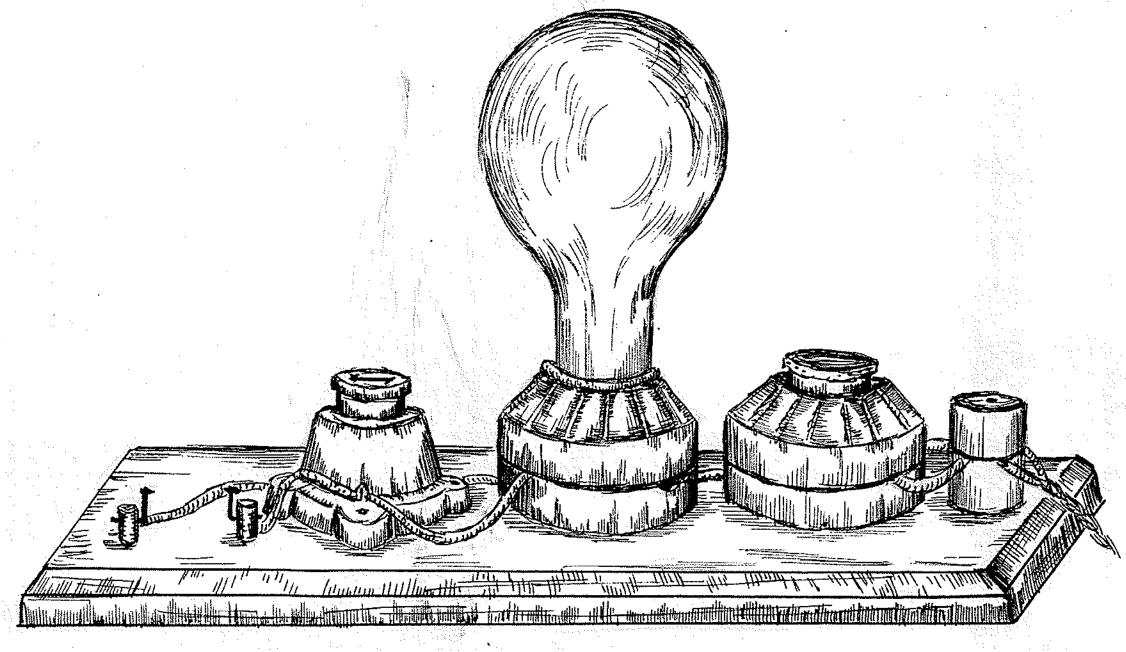
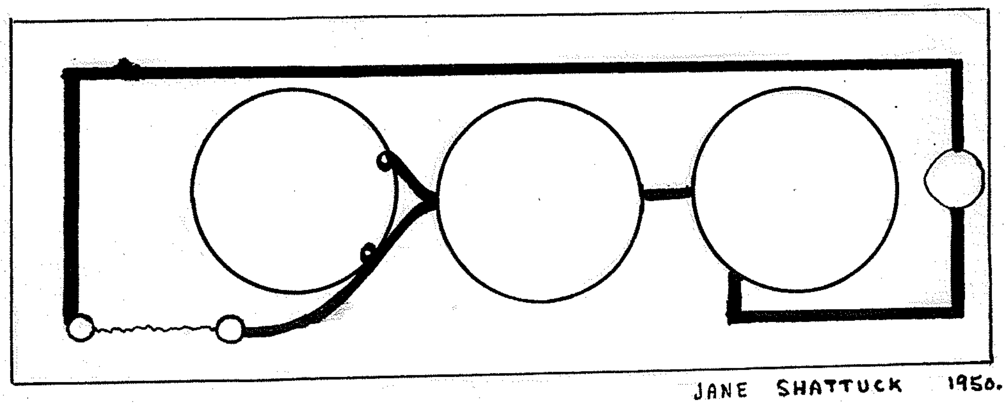
[4] Hensley, C. A. E. Patterson, D. A., Science Indoors and Out, Books I and II, The Educational Book Co., Limited, 1931.

FIGURE III



The Fuse Board



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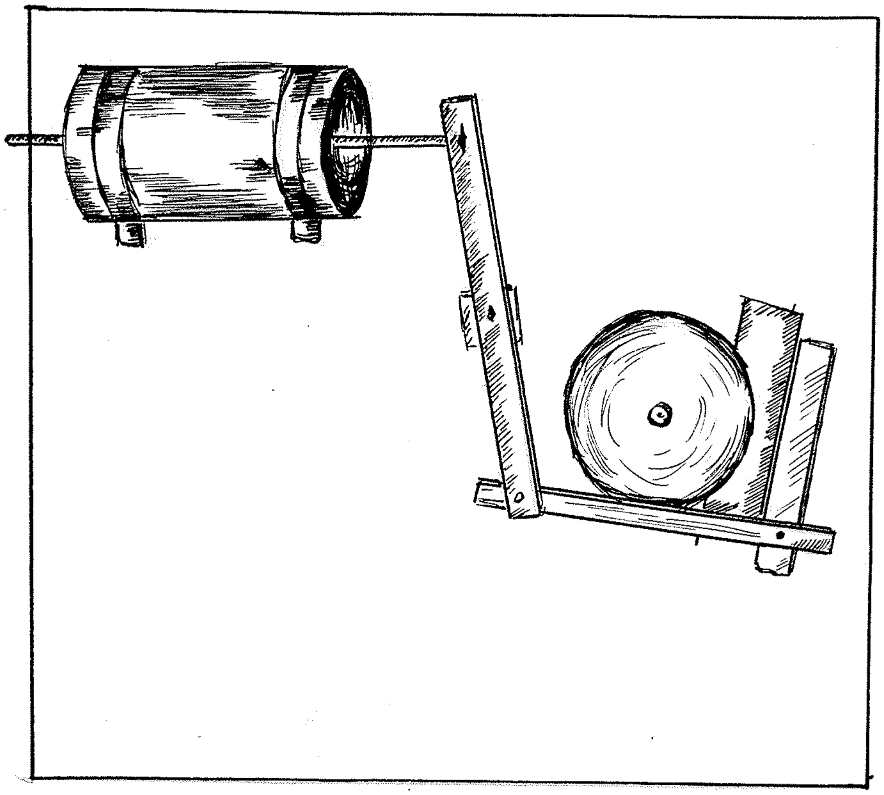
model in so far as it did not work by compressed air, but the brake shoe actually pressed against the wheel when the piston moved down the cylinder. A drawing of this model is shown on page 23. The model consisted of a three ply base, a cylinder, a piston, a piston rod, several wooden levers, a brake shoe, a wheel, two wooden bosses and an air lead into the cylinder. This air lead was a copper tube soldered to an oil can. The oil can represented the cylinder. This cylinder was held in place with strips of sheet metal. It may be worth noting that as simple and as interesting as this model may appear it was actually not completed within two years.

Project 6. A Six Inch Reflector Telescope

By far the most ambitious and spectacular activity undertaken by the writer, and perhaps the most useful from the standpoint of creating pupil interest, was the construction of a six inch reflector telescope. The optical parts of the instrument were a round mirror six inches in diamater, a small ($1\frac{1}{4}$" x $1\frac{3}{4}$") mirror or prism, and an eye piece. A diagram is shown on page 24. Besides the optical parts, some type of support and a wooden board or tube were required. This support and the tube were a minor construction problem. A parent donated the support and the manual training room provided the wood for the tube. The prism or small flat mirror and the eyepiece were purchased as is usual in making a first telescope. This brought us to the six inch slightly concave mirror -

FIGURE IV



Pneumatic Brake Model

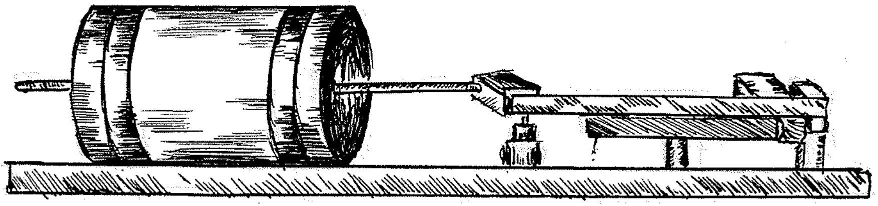
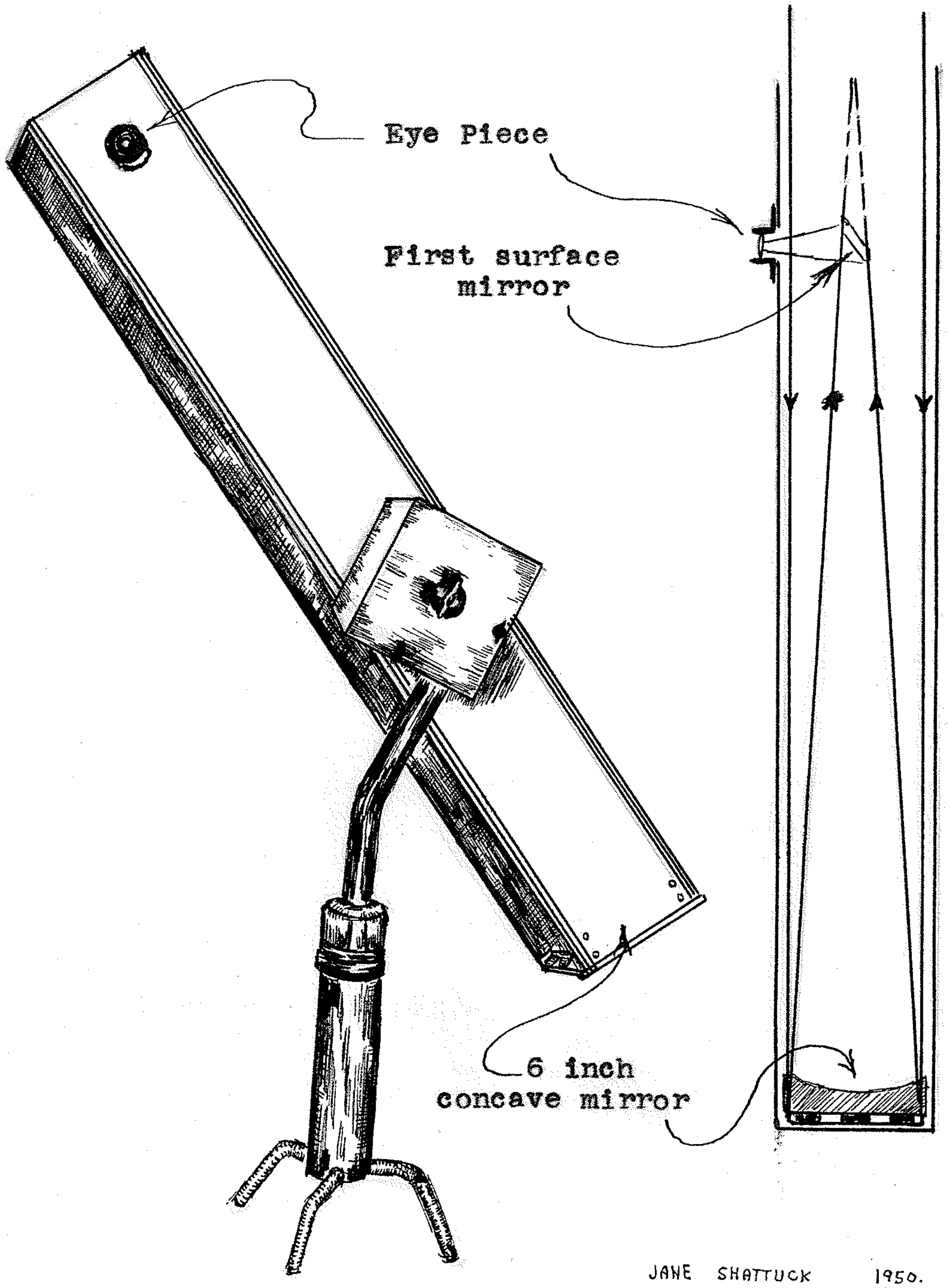


FIGURE V



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A Six Inch Reflector Telescope

the 'magnum opus' of the undertaking.

The making of the concave mirror or speculum involved the following stages: 1. grinding; 2. polishing; 3. figuring; 4. silvering. Each of these stages involved in turn several steps. It was these facts that caused the writer to decide to purchase a kit of equipment for making a six inch mirror and the book, "Amateur Telescope Making".[5] The Kit included the following materials:

One 6 inch diameter x 7/8 inch thick glass
disk for the speculum

One 6 inch diameter x 7/8 inch thick glass
disk for the tool

3/4 lb. No. 80 abrasive (No. 1 in Pierce kit)

2 oz. No. 120 " (No. 2 " " ")

2 oz. No. 220 " (No. 3 " " ")

2 oz. No. 400 " (No. 4 " " ")

2 oz. No. 500 " (No. 5 " " ")

2 oz. No. 600 " (No. 6 " " ")

2 oz. best grade optical rouge

½ lb. tempered optical pitch

1 Instruction Sheet

The book "Amateur Telescope Making" is actually a collection of articles from the Scientific American magazine dealing with telescope making. The volume is a veritable gold mine of information

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[5] Ingalls, A. G. (Editor) Amateur Telescope Making, Munn and Company, Incorporated, 1946.

concerning the subject but, unlike most books, it does not follow from one chapter to another nor does it treat a certain subject fully and then leave it alone. The information for any one operation must be culled in bits and pieces. This fact had some bearing on the difficulty encountered in having the pupils read the book and decide what they wanted to do as a contribution to the activity. The book arrived several days before the kit of materials and three or four of the more academically inclined students were invited to read. To the deep chagrin of the writer who considered himself used to such disappointments, each of these superior students handed back the book within a day or two with a little shake of the head and a tendency to run away. When the kit of materials arrived and a meeting of all interested pupils was called these superior students were absent. The instruction sheet provided with the kit, however, was comparatively brief, to the point, and very much easier to read. Working in relays four days a week between 12:45 and 1:30 noon the grinding was finished in about two weeks.

Grinding consisted of pushing one six inch diameter piece of glass back and forth over the other piece of glass with a little abrasive and water between them. There are six stages of grinding. Polishing consisted of pushing the concave piece of glass back and forth over a layer of pitch. This pitch has grooves cut into it and jewelers' rouge smeared over it. The activity was delayed here for several weeks. No matter how carefully the instruction sheet was followed, we did not seem to be able to make a pitch lap. The writer having recourse to the book "Amateur Telescope Making", found that it was worthwhile to ignoreone of the cautions given in the instruction sheet. By leaving the mirror on the lap, but with glycerine and water between, it was found that excellent contact was obtained. This was extremely important in polishing.

When the frosted glass effect left by the final stage of grinding had been eliminated by polishing, then the glass was ready for figuring or parabolizing. The grinding and polishing should leave the glass spherical or nearly spherical. How shall we find out if it is perfectly spherical? "Amateur Telescope Making" may be quoted here. "How shall we find out? The method I shall now describe is one of the most delicate and beautiful tests to be found in the realm of physics. By it, imperfections of a millionth of an inch on the glass can be detected, and all the tools required are a kerosene lamp and a safety razor blade! This method of testing mirrors, called the Foucault knife-edge test, was unknown until about 1850; before that time mirror makers were groping in the dark. Even the great Herschel - father of the reflecting telescope - did not know when his mirrors were right, except by taking them out and trying them on a star. If an artificial star made by a tiny pinhole (use a needle point) in a tin chimney on a kerosene lamp (an electric lamp will also be suitable) were placed at the center of the sphere of which the mirror's curve is a very small part, all of that portion of the light that emerges from the pinhole and strikes the mirror, is reflected back to the pinhole; for these light rays are all radii of the sphere, and by reflection they must return as radii back to their source, the pinhole.

"In practice, the pinhole is pushed over a little to the right of the center of curvature so that the cone of reflected light may clear the chimney and enter the eye, as shown in Figures 7, 8 and 9." (See page 29 of this paper.) "The mirror is placed on its edge on some suitable support, at table height, in a fairly darkened room. The lamp and the knife-edge (mounted on a block of wood) are placed on a table as shown, and about eight feet from the mirror, viz., at its center of curvature. The lamp remains stationary." [6]

More difficulty was encountered when we tried to interpret the shadows seen in the Foucault test. The services of a professional speculum maker were called upon in this problem. Mr. H. E. Rasmussen gave us generously of his time and sold us an excellent one inch effective focal length eye piece at a ridiculously low figure. As a result of Mr. Rasmussen's advice, a new pitch lap was made with a star cut in the middle and in time a spherical shape was obtained in the glass. Shortly after that the mirror was considered parabolized and the final step of silver-

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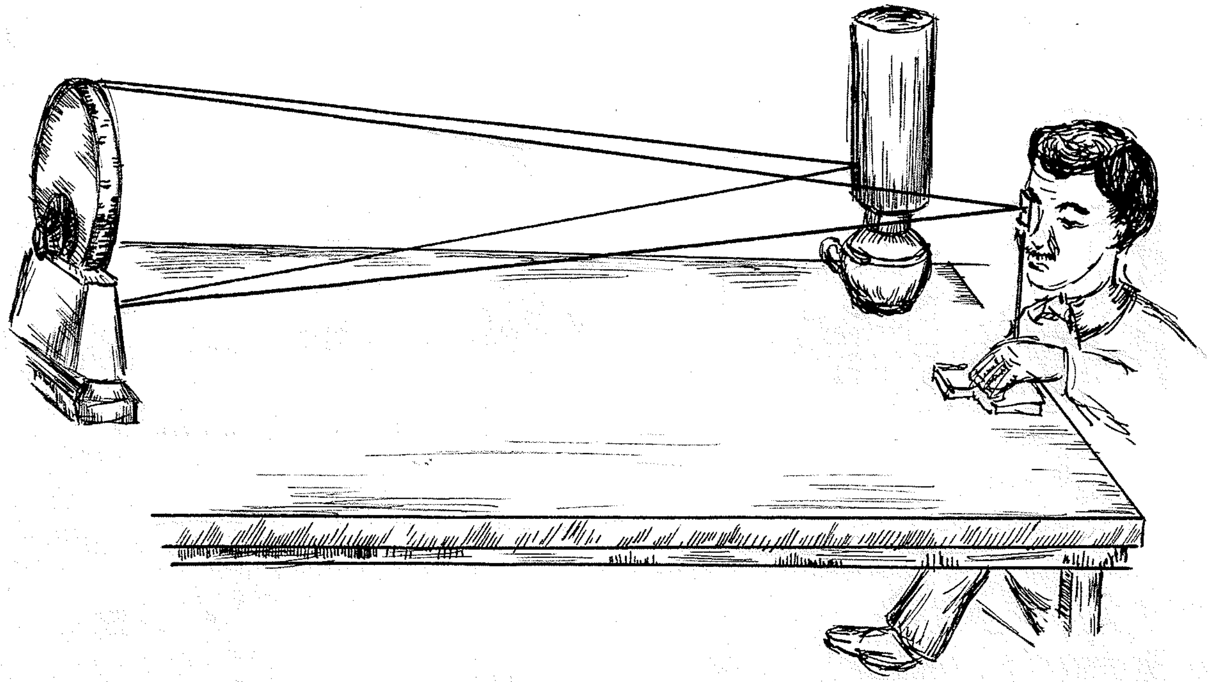
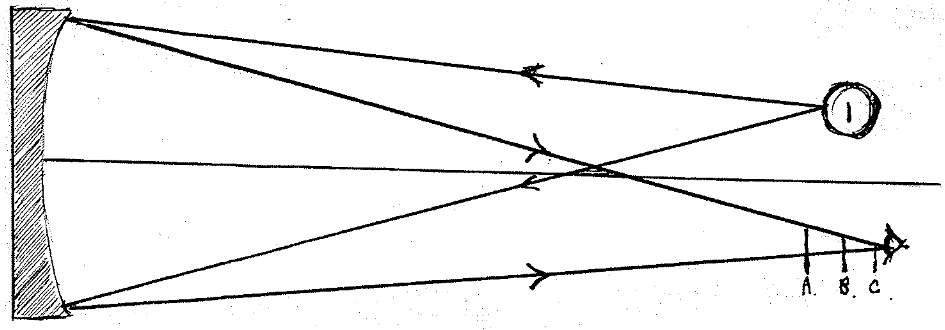
6. Porter, R. W. (Contributor) Amateur Telescope Making, Munn and Company, Incorporated, 1946, pp. 6-8.

FIGURE VI



The Foucault Knife-Edge Test



JANE SHATTUCK 1950.

ing had to be considered.

The problem of silvering was solved by taking the mirror to a professional looking-glass maker. "(Need it be said that it is the front of the disk - the concave side - which is to be silvered? However, if the disk is taken to a professional looking-glass mirror silverer he will probably silver the back, in spite of all orders, and give the silver a coat of nice green paint into the bargain. This has happened on numerous occasions. Stand over him with a club.)" [7] The looking-glass maker handed the writer the mirror with an I-told-you-so-nod. He had silvered the proper side but had forecast that the silvering would be a failure and was no little pleased with the poor results. Actually the results were a little disappointing to look at - the glass seemed to be covered with grey dust. When this top layer of grey dust was removed at home with a pad of absorbant cotton, the silvering job did not seem too bad and the words of the Reverend William F. A. Ellison [8] came to mind. "Even when appearing very badly tarnished a silvered mirror retains nearly all its original light-grasp. Silvered glass, even at its best, never looks as bright as speculum metal. But appearances are deceptive. Silvered glass looks dull

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[7] <u>Ibid</u>, page 406, Ingalls, A. G. (Contributor)

[8] <u>Ibid</u>, page 101, Ellison, W. F. A., M.A., B.D., F.R.A.S., F.R. Met. Soc., Director of Armagh Observatory, Member of the British Astronomical Association, and of the Societe Astronomique de France, and onetime Rector of Tintern Abbey, (Contributor).

and is bright; speculum metal looks bright and is dull ..... Even when very badly tarnished, the silver film is still vastly superior to the metal at its best. This is a fact not always realized even by professional astronomers."

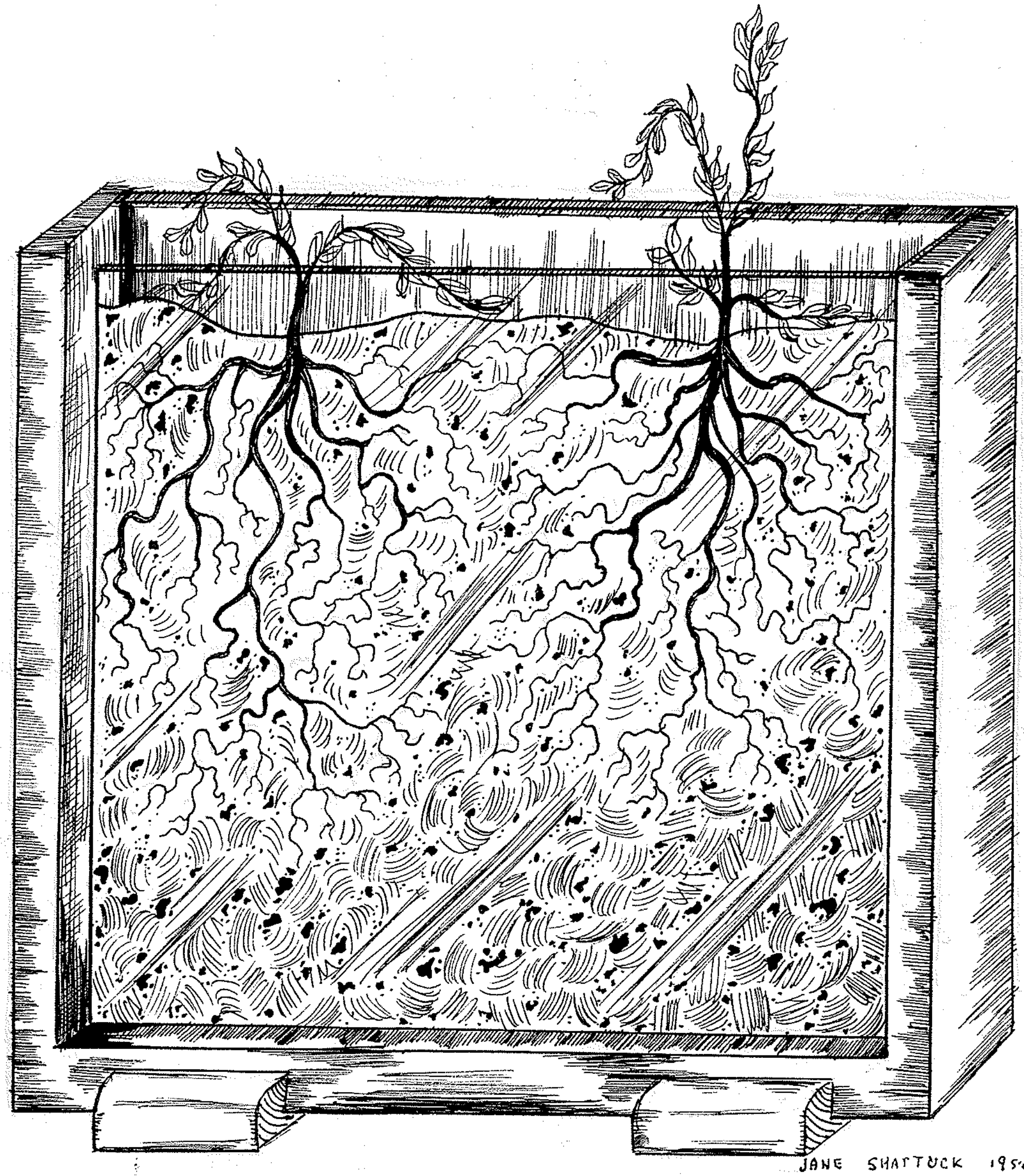
The silver surface was next lacquered with a mixture of amyl acetate and collodion and the mirror was stood on edge to dry. When dry the mirror was placed on three strips of sponge rubber in the cell of the telescope, see page 24. A first surface mirror was placed as shown, the eyepiece was inserted in the adapter tube and the telescope was completed!

Project 7. A Root Cage

While this article was comparatively difficult to make, it provided pupils with an opportunity of actually seeing a root system of a growing plant. As shown in the sketch on page 32 the root cage is a thin layer of earth covered by a piece of window glass in a wooden frame. The soil is kept dark by a sheet metal screen that can be withdrawn when required. The construction diagram on page 33 shows the positions of the glass and sheet metal screen and the dados necessary to hold these objects in place. Two pupils who attempted to make this root cage found it difficult and the teacher was required to do most of the work himself. The activity was mostly undertaken in the manual training room at noon hour. The manual training room supplied some of the wood and the writer supplied the rest. The glass was obtained

FIGURE VII

A Root Cage



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A Root Cage

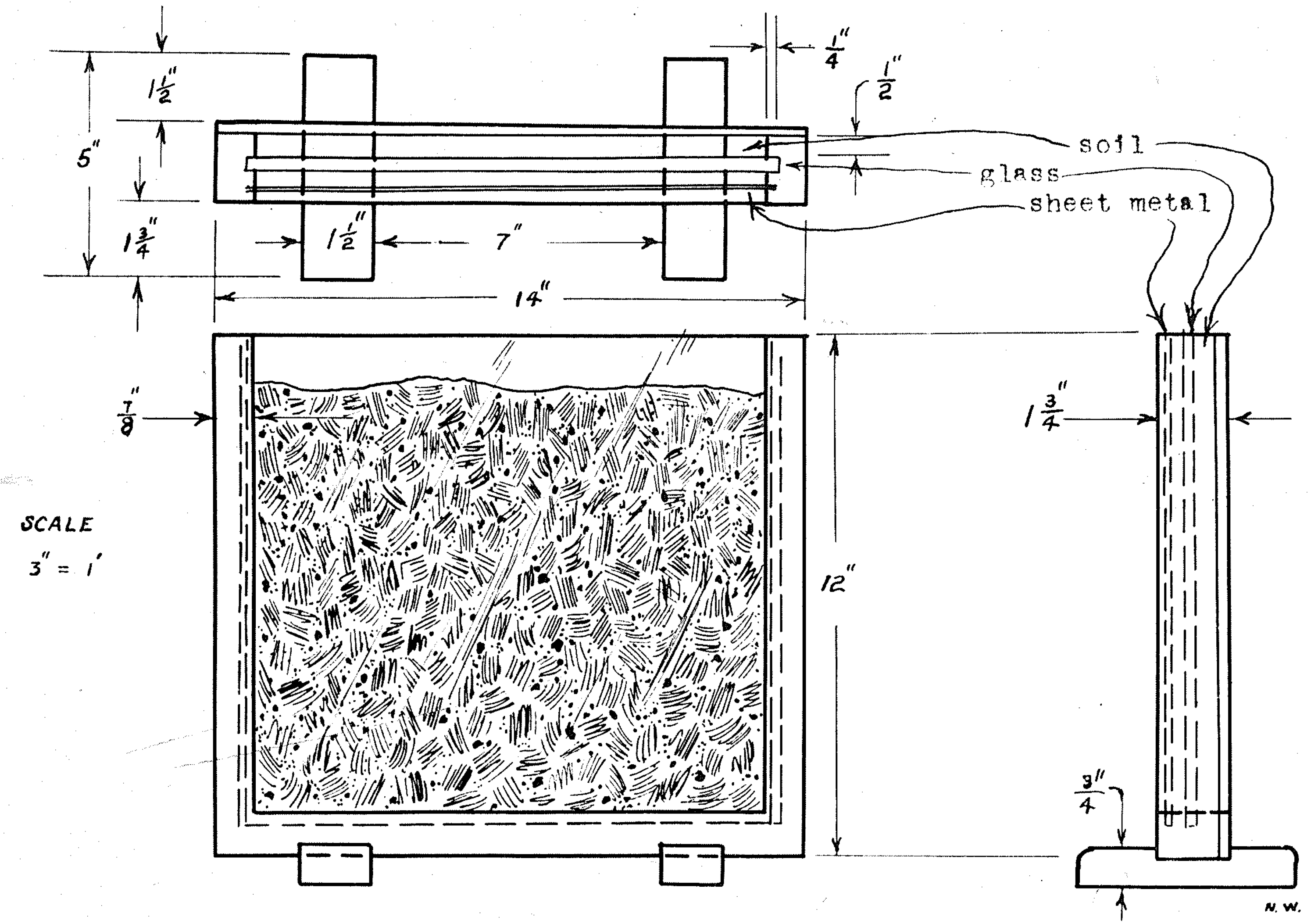


FIGURE VIII

through the school caretaker, and the sheet metal was obtained through school funds.

Project 8. A Large Star Chart

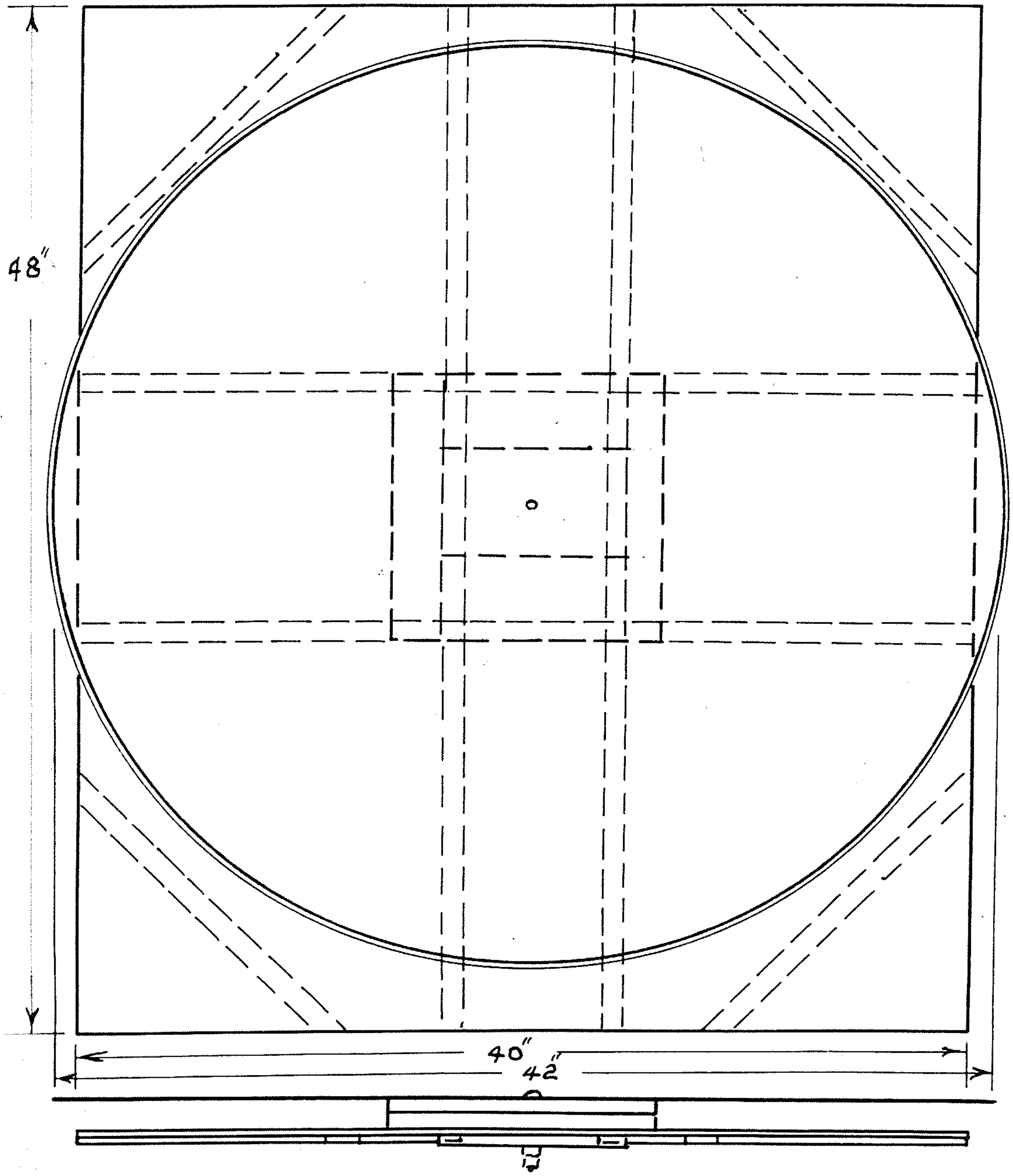
This chart consisted of a large sheet metal wheel 42 inches in diameter mounted on a frame. The wheel had a wire turned edge. As the wire was approximately one eighth of an inch in diameter, five sixteenths of an inch was added to the radius of the wheel to allow for turning the sheet metal around the wire. This is shown in the construction drawing on page 35. This wire edge was executed by hand - four boys took turns using two pair of pliers. Such an edge gives the wheel rigidity and eliminates the possibility of cutting or tearing flesh or clothing on the edge of the galvanized iron. This wheel is fastened to a large frame 40" x 48" by a 3/8" carriage bolt five inches long. The frame is built up of lath and corrugated cardboard as shown by the construction drawing on page 35. Two ends of an apple box act as a bearing surface between wheel and frame. One end of the apple box is fastened to the wheel and the other end is fastened to the frame.

The 24 gauge galvanized sheet iron was obtained through school funds. The wood lath and the corrugated cardboard were supplied by the pupils.

In use the sheet metal wheel is painted black and the bright stars and the constellations are dotted on the wheel with

FIGURE IX

SCALE 1½" = 1'



N. W.

A Large Star Chart

white enamel as the class becomes familiar with them. A sketch of this is shown on page 37. The wheel turns about the carriage bolt and therefore this bolt represents the North Star or Polaris.

Project 9. Windlass Model

On page 92 of Science Indoors and Out Book III [9] there is a diagram of a windlass. Very few students have seen a windlass in use. While discussing this point with a grade nine class, the feasibility of constructing a model of a windlass was broached. As a result of this a superior pupil offered to make a working model of a windlass. That same week he brought the model into the classroom and many pupils enjoyed using it to raise a small weight from the floor. The superior pupil was careful enough to ~~to~~ arrange his dimensions so that the mechanical advantage of the model was an integer. Page 38 shows a sketch of this interesting piece of home-made science apparatus. The material for the model was provided by the pupil.

Project 10. Cage for Snake

While this was the tenth activity when the activities are arranged in two alphabetical groups as mentioned in the first paragraph of this chapter, it was, in point of time, the first

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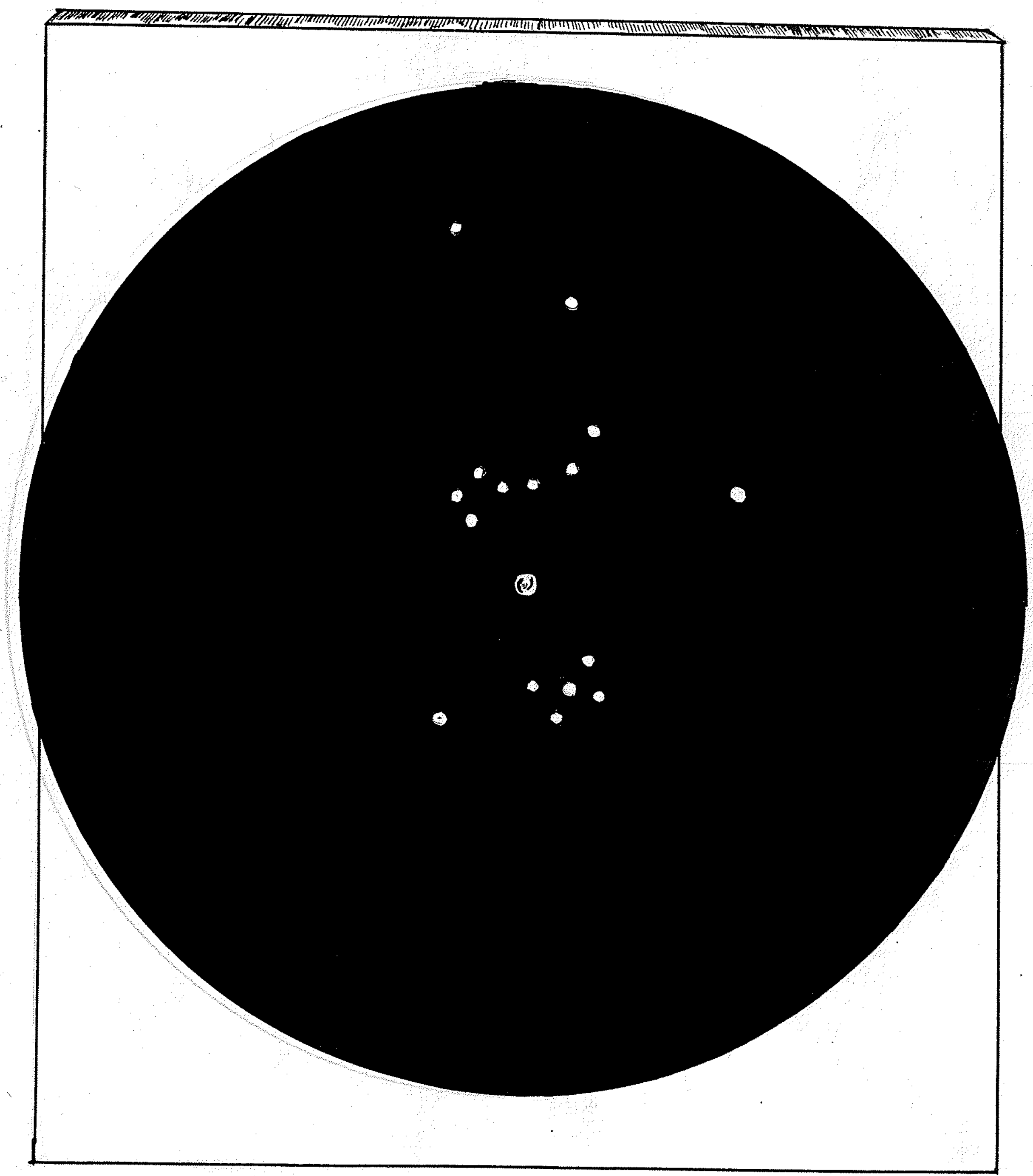
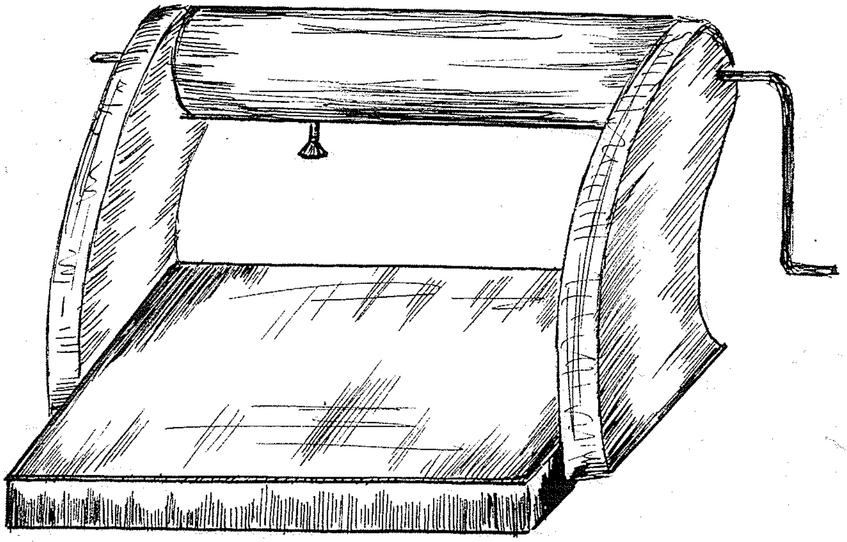
[9] Hensley, C. A. E., Patterson, D. A., Science Indoors and Out Book III The Educational Book Co., Limited, 1930.

FIGURE X

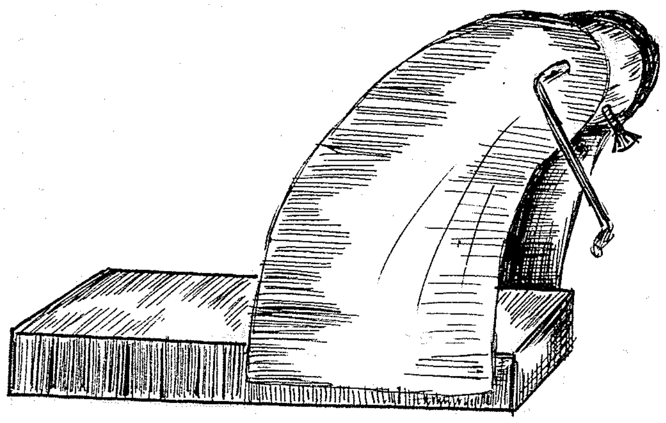


A Large Star Chart

FIGURE XI



Windlass Model



JANE SHATTUCK 1950.

activity undertaken by the writer in the Principal Sparling School. With a view to illustrating the method of instigating an activity program, this activity will be discussed in more detail than usual. The other activities do not require this detail since the methods of approach were similar.

The situation that was used in connection with the first activity came directly from the textbook. On page 449 of "Science Indoors and Out"[10] the subject of snakes is introduced. The writer had stated that he would like to have a live garter snake in the classroom and several pupils had offered to look for a snake when they visited their summer residences on the 24th of May. The day after this offer, the subject was again discussed in class and the problem of a cage for the animal was considered. Since a suitable home for the snake was not forth-coming, the writer suggested that perhaps one could be made with some $\frac{1}{4}$ inch mesh screen and some 24 gauge galvanized iron that had been obtained for the purpose. (This material was purchased through school funds.) Any student interested could drop into the science room at four o'clock and lend a hand - any student interested in soldering might learn something about soldering galvanized iron. Seven students turned up - all boys! Several sketches, as well as the following list of items, were on the blackboard:

Tray
Body
Top

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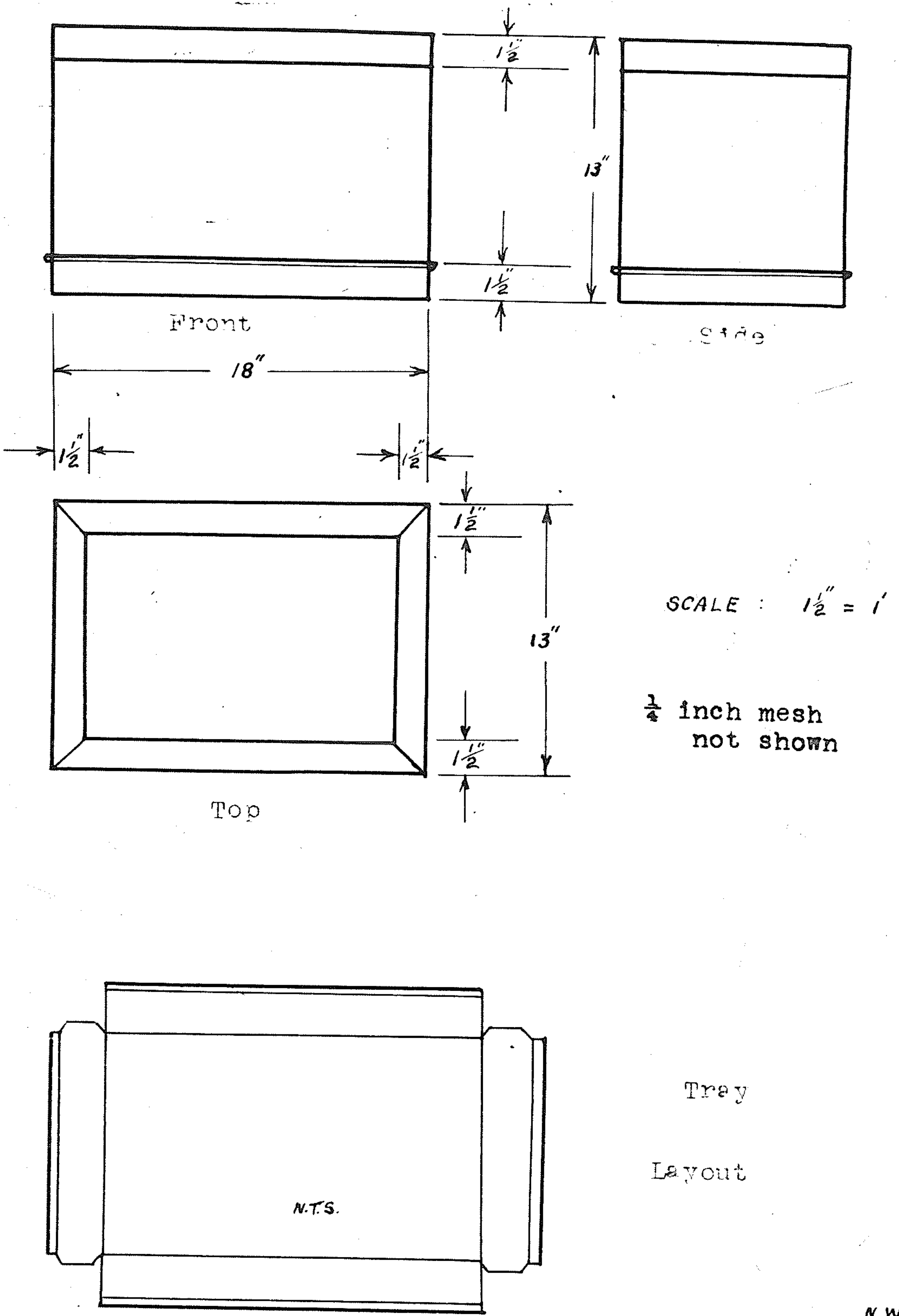
[10] Hensley, C. A. E., Patterson, D. A., Science Indoors and Out, Books I and II, The Educational Book Co., Limited, Toronto, 1931.

Group discussion and activity followed. What should be the size of our cage? Since it was to rest on the window ledge someone measured the ledge. With these dimensions in mind, suitable dimensions were added to the blackboard sketches. See page 41. The next step was to decide who was to make each item. Three boys chose the tray and the remaining four worked on the body and the top. Their first step was to copy the blackboard sketch which they needed. As it was now four-thirty, that was the end of the first day of hand work in the science room. The next day the boys worked at noon and four o'clock. The tray was soldered on the third day and the pupils who had not been working on these objects had many questions to ask, such as, "Who made that part?" and, "How did Ron Make that?" Ron, of course, only partially succeeded in feigning boredom as he related how he did it. Early the next week the cage was finished and fresh sod had been placed in the bottom of it. A live snake was not procured until a few days before the examinations started. The interest of city children in this oft maligned creature well repaid the extra effort that had been expended on the activity.

There were two very interesting sequels to this activity. One dealt with a boy who seemed to think that the tray was not necessary. When it was explained that the tray enabled the cage to be thoroughly cleaned, he stated that his cages were never cleaned. It seemed that he specialized in butterflies! He offered to make another cage - one suitable for live butterflies - with

FIGURE XII



Cage for Snake

the mesh that was left over. A sketch of his butterfly cage is shown on page 43 with a sketch of the snake cage.

The second sequel to the cage making activity was the suggestion of a pupil that a bee cage be used to house the garter snake. Since a bee cage has screen netting on two sides it allows ample light to enter so that the pet is easily seen. A door of some type must, however, be provided. This may be accomplished in a simple but effective manner by screwing a small square board ($\frac{1}{4}$"x5"x5") over the four inch diameter hole in the top of the bee cage. A snake must be kept all through the winter months in such a cage placed in the classroom window. In this respect, in the opinion of the writer, a simple bee cage is better than a terrarium which becomes foul due to its moisture, provides too many hiding places for the snake, and looks unsightly when it dries out.

Project 11. Geological Chart on Window Blind

A white window blind made an excellent base for a chart. A very enterprising and gifted student offered to combine the diagram on page 278 of Science Indoors and Out Book III[11] and the Geological ladder on page 333 of the same book. In this way the strata of rock beneath the surface of Manitoba and the divisions of geological time were placed on the same chart. The window blind which served as a base for this chart was purchased by the teacher.

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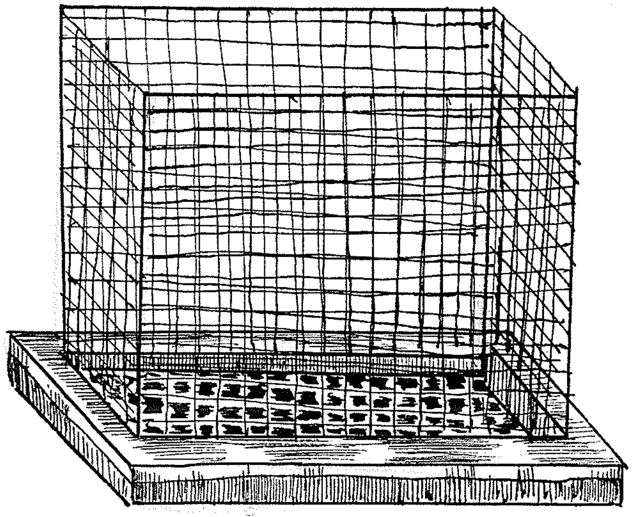
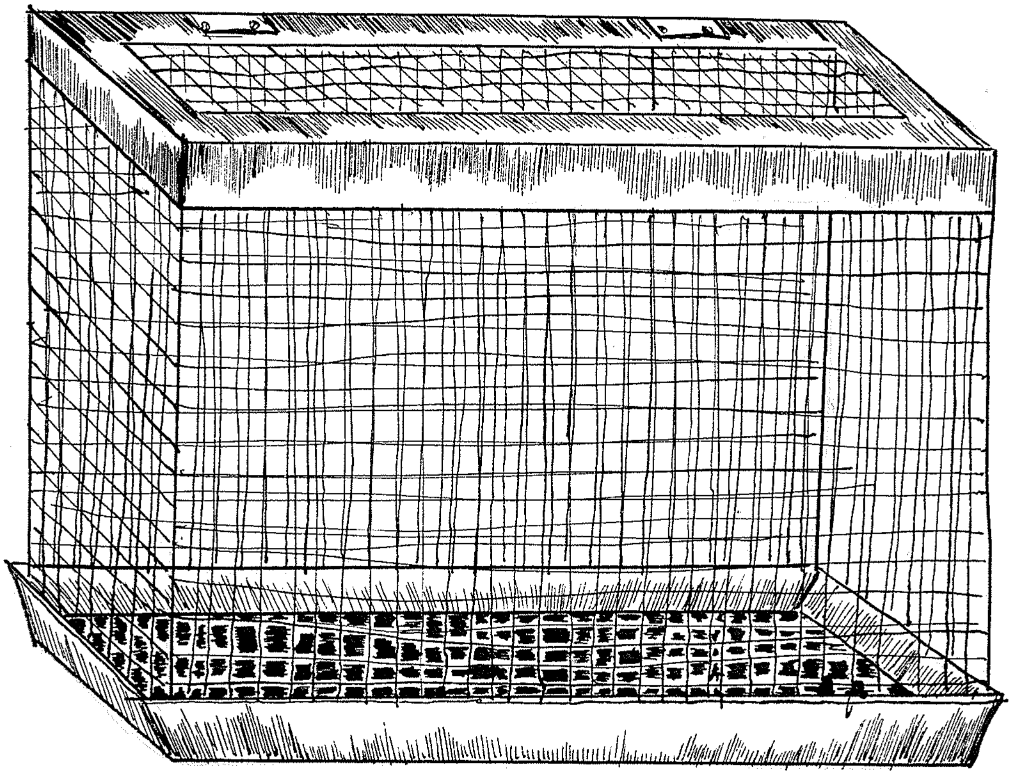
[11] Hensley, C. A. E., Patterson, D. A., Op. Cit.

FIGURE XIII



A Butterfly Cage



Snake Cage

A sketch of the chart is shown on page 45. It may be noted that typical fossils were added to each era by the student. Later - in High School - this student proved to be of scholarship caliber.

Project 12. Metal Pockets for Magazines

Since, like most science rooms, the science room at Principal Sparling School had several magazines, pamphlets, and government publications in the classroom library, it was decided to increase our scanty library space by having students make metal pockets to attach to the classroom cupboard. A metal pocket and the corresponding layout are shown on page 46. The pockets were of two designs. The longer pocket fits at the back of the cupboard while the shorter design fits on the side of the cupboard. All pockets have a wire edge at the top (See Project 8) and are held in place with small round head screws ½" #5 R.H.B.

Each pocket was first laid out on paper and a paper pocket was made as a mockup. After several corrections for size and shape, the design was then laid out on 24 gauge galvanized sheet iron. This material was supplied by school funds.

Project 13. Mounted Skeleton of Bird's Wing

In order to illustrate the similarity between a fowl's wing and the human arm bones, the bones of a domestic fowl's wing were attached to a small wooden board. This is similar to the

FIGURE XIV

Geological Chart on Window Blind

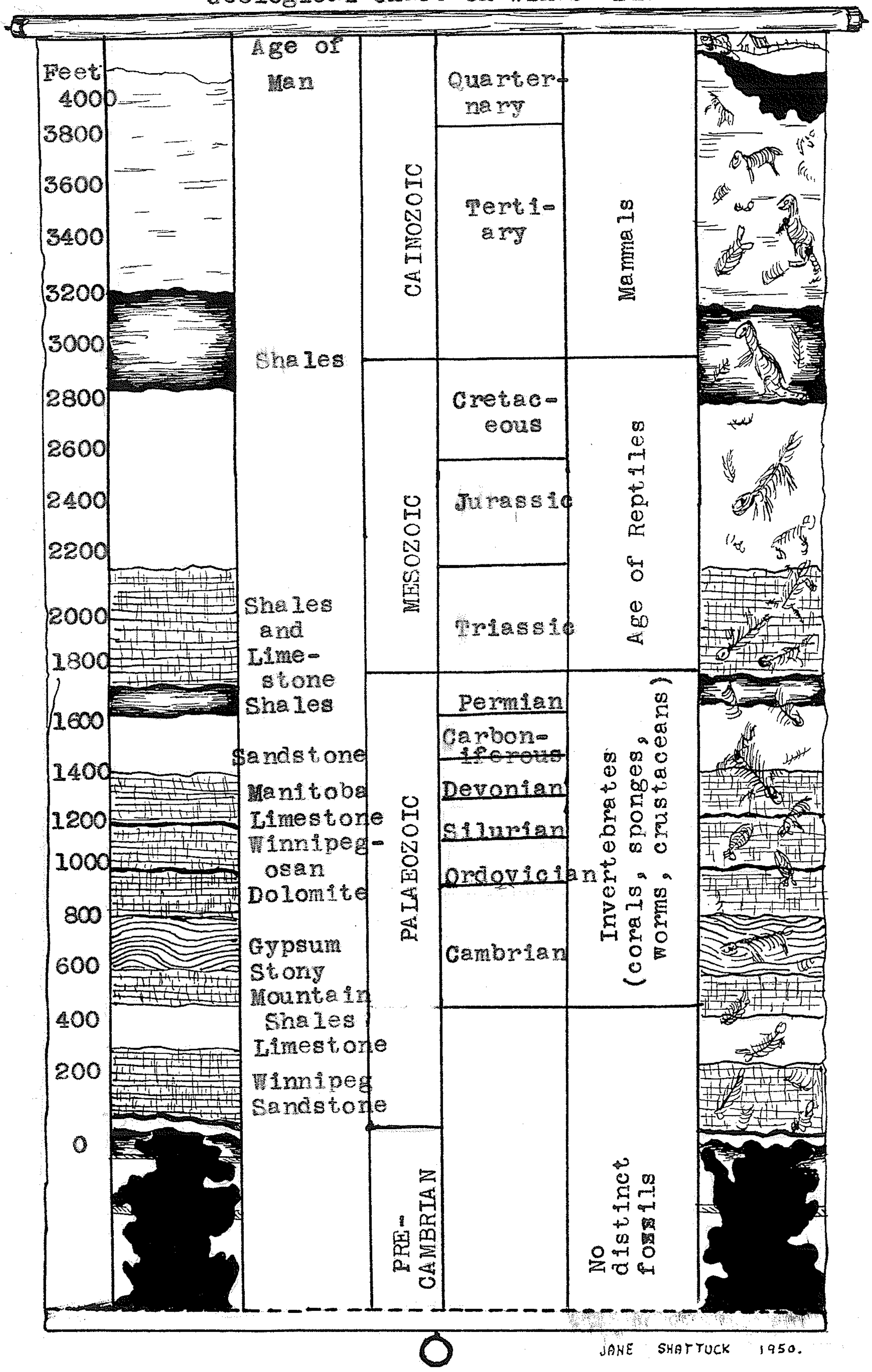


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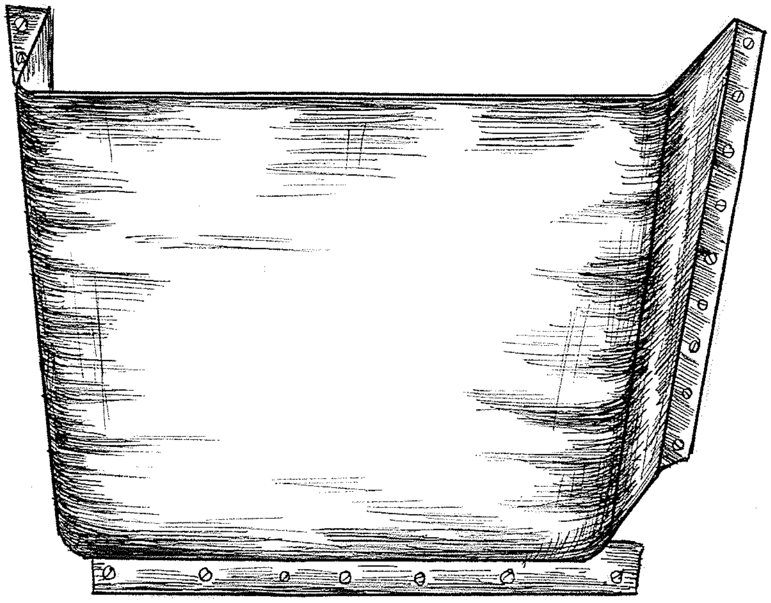
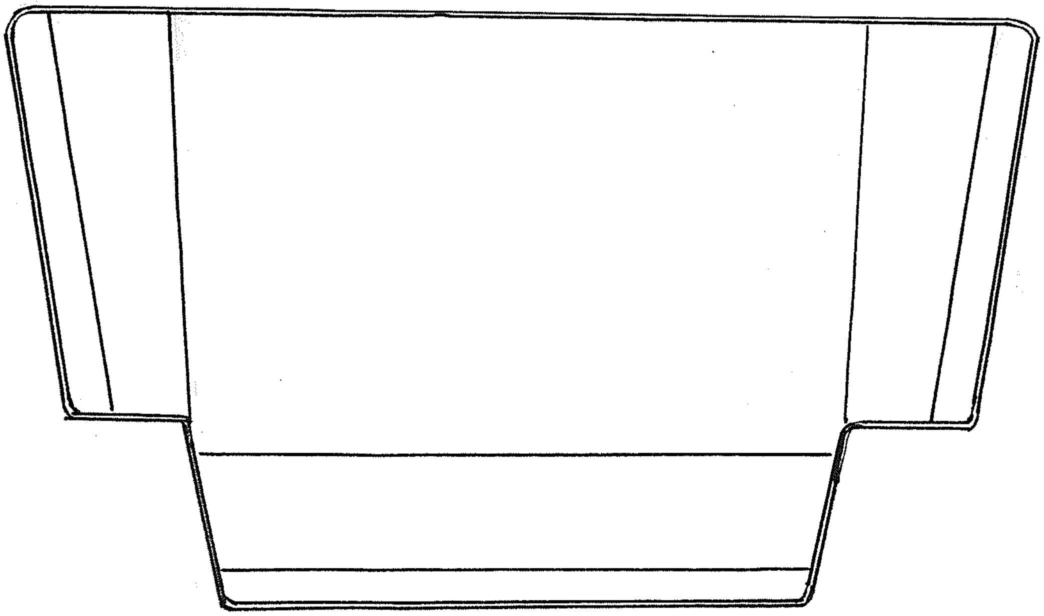
FIGURE XV

Metal Pocket for Magazines





JAN SHATTUCK 1950.

figure in the grade seven text page 94 "Science Indoors and Out Books I and II" [12] except that the bones are not hidden by feathers. The pupil first cut off the wing at the shoulder and then boiled it very slowly for several hours. The bones were cleaned and then wired into place on a $\frac{1}{4}$ inch board six inches by six inches. A sketch of the Mounted Skeleton of a Bird's Wing is shown on page 48 of this paper. All the material for this activity was supplied by the pupil.

Project 14. Mounted and Waxed Corn Plant

The mounted and waxed corn plant consisted of several parts of a corn plant that had been wired to poster board after being dipped in liquid wax. The parts of the corn plant were labeled, a title was added and a frame gave finish to the project. The pistilate flower or corn cob was cut lengthwise in half and then wired to the board after being dipped in wax. The stamenate flower or tassel was dipped in wax and then held in place with thread. A root and node as well as an internode were also included. These were held to the poster board by means of wire. Page 49 shows a sketch of this project. The wax for this undertaking was provided from the school science supplies, the rest of the material was provided by the student. The project is similar in appearance to the sketches on pages 22, 23, and 24 of Science Indoors and Out - Book Three [13].

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[12] Hensley, C. A. E., Patterson, D. A., Op. Cit.

[13] Hensley, C. A. E., Patterson, D. A., Armstrong, O. A. Science Indoors and Out Book : 3. W. J. Gage and Co.

FIGURE XVI

Mounted Skeleton of Bird's Wing

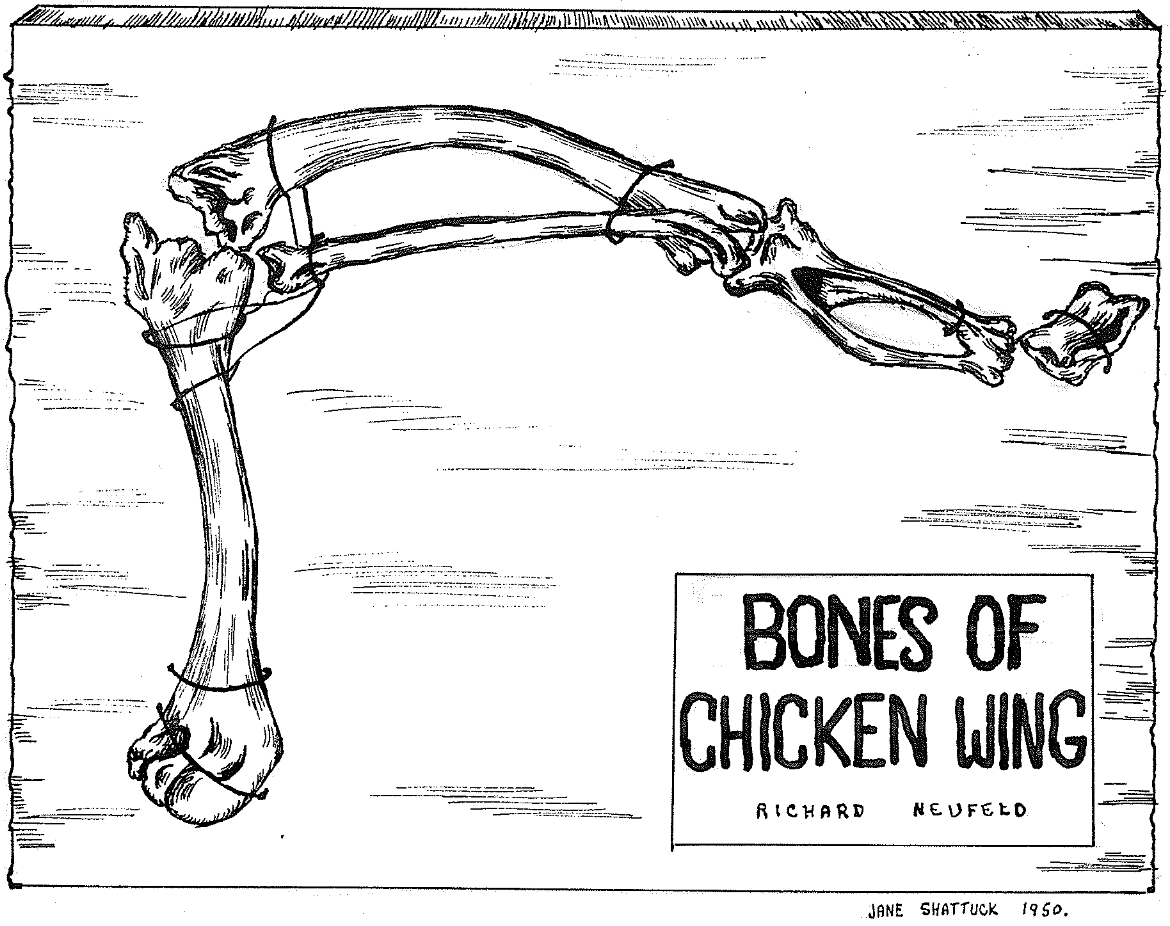
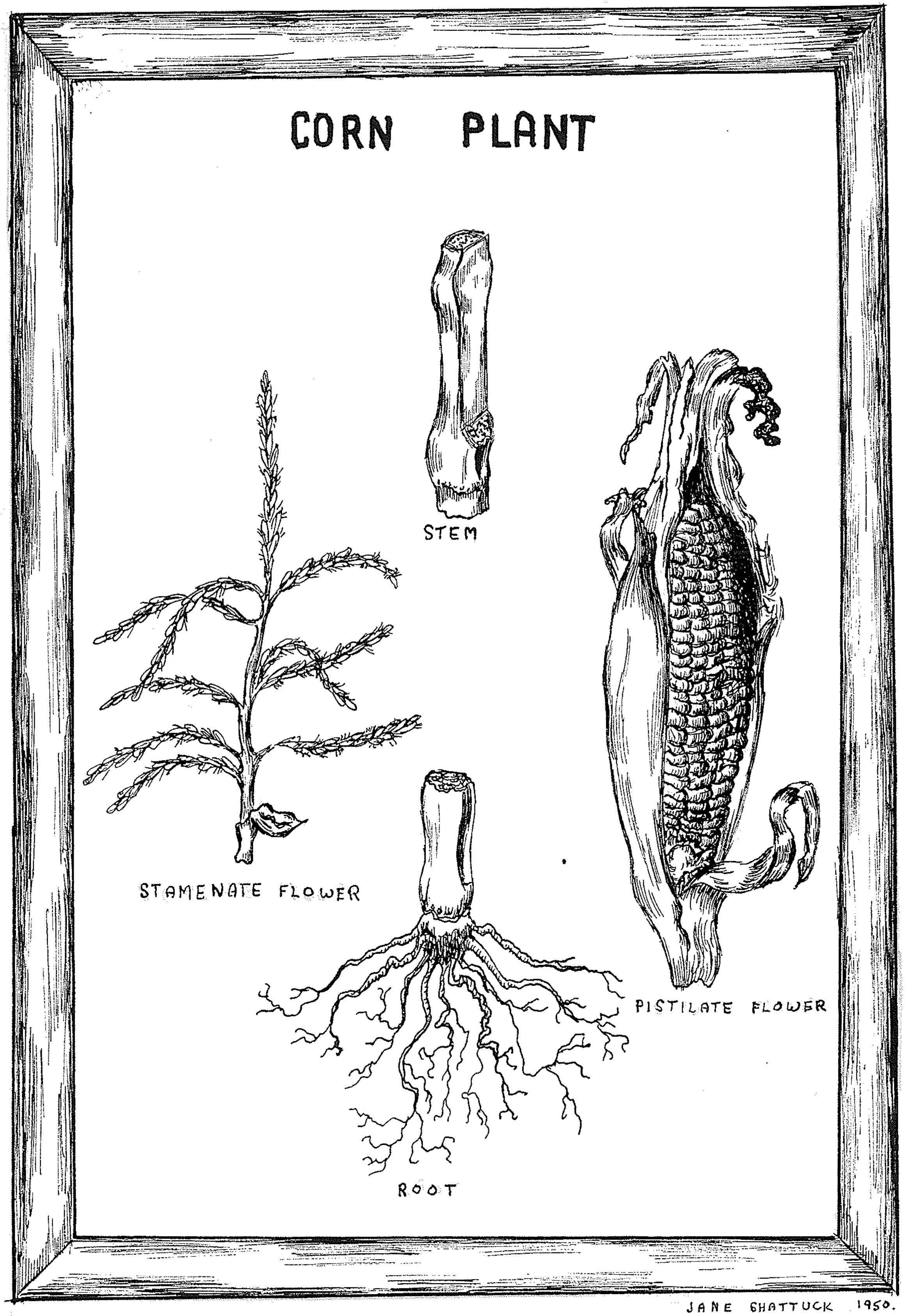


FIGURE XVII

Mounted and Waxed Corn Plant



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Project 15. Mounted Talon of Snowy Owl

The body of a Snowy Owl was found by several pupils in the West End of the city. As if to prove this find a pupil brought in one of the feet of the bird. In an effort to preserve the foot, the student wired it to a small block of wood to hold it in an open position and then submerged it in a fifty percent formalin solution for a week. When it was taken out of the solution and freed from the block of wood the talons (toes) remained in an outstretched position. A piece of stiff wire was then run up into the leg bone. The other end of this wire was then passed through a small block of wood and held in position by small nails. Page 51 shows a sketch of the project. The formalin solution was obtained from the school science supplies; the wire and the wood were supplied by the student.

Project 16. Pendulum (Foucault's)

Foucault's pendulum was mentioned on page 155 of Science Indoors and Out Book III [14] and a sketch of a pendulum was shown on page 454. The construction of such a pendulum was an interesting undertaking for a grade nine class and resolved into two problems - 1. fastening a substantial hook to the ceiling; and 2. casting a lead weight that would comprise the mass of the pendulum. Problem one was solved through the school principal. He contacted the school building department and a workman placed a hook in the ceiling.

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14. Hensley, C. A. E., Patterson, D. A., <u>Op. Cit.</u>, pp. 155, 454.

FIGURE XVIII

Mounted Talon of Snowy Owl

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Problem two was broken down into eight sub-activities as follows:

1. Collecting scrap lead,
2. Determining the amount of lead required,
3. Making the pattern,
4. Making the flask,
5. Making the sprue pin,
6. Making the mold,
7. Making the holder and scriber,
8. Pouring the lead.

The collection of lead was open to all grade nine pupils. The lead was placed on a pile on the demonstration desk. The pile slowly grew from day to day.

The determination of the amount of lead necessary for the ball was undertaken with three better than average mathematical students. Unfortunately the teacher was required to do most of the work in this sub-activity.

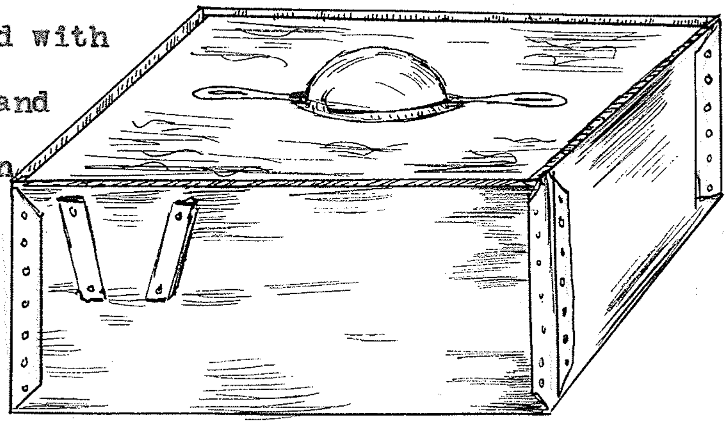
The pattern - a wooden ball - was turned at home by a grade nine boy who had a wood lathe.

The flask was made in the classroom at noon hour with lumber from the manual training room.

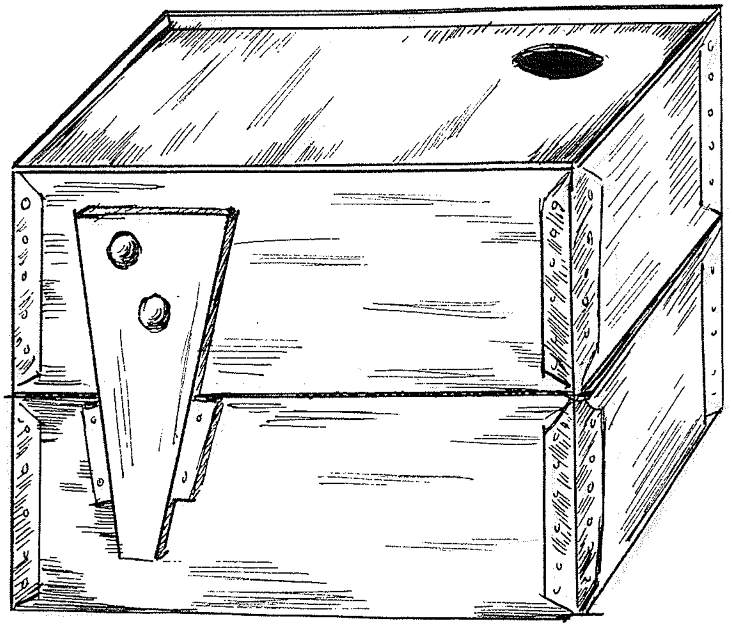
The sprue pin was made in the manual training room one noon hour. The mold was started in the classroom but the pattern was withdrawn from the sand in the boiler room. The flask with sand in it and the bottom part of the flask showing half the mold with the holder and scriber in position are sketched on page 53. A piece of

FIGURE XIX

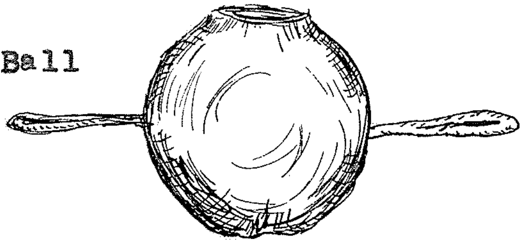
Half Mold with Scriber and Holder in Position



Flask Filled with Sand



Cast Lead Ball with Holder and Scriber



heavy wire was bent to act as a holder and scriber. This was laid across the mold in the drag or lower part of the flask. The writer undertook the pouring one morning before school. A sketch of the twenty-six pound weight with the holder and scriber running through it is shown on page 55. The lead ball is about five inches in diameter. It was fastened to the hook in the ceiling by a piece of heavy wire. This wire was supplied through school funds.

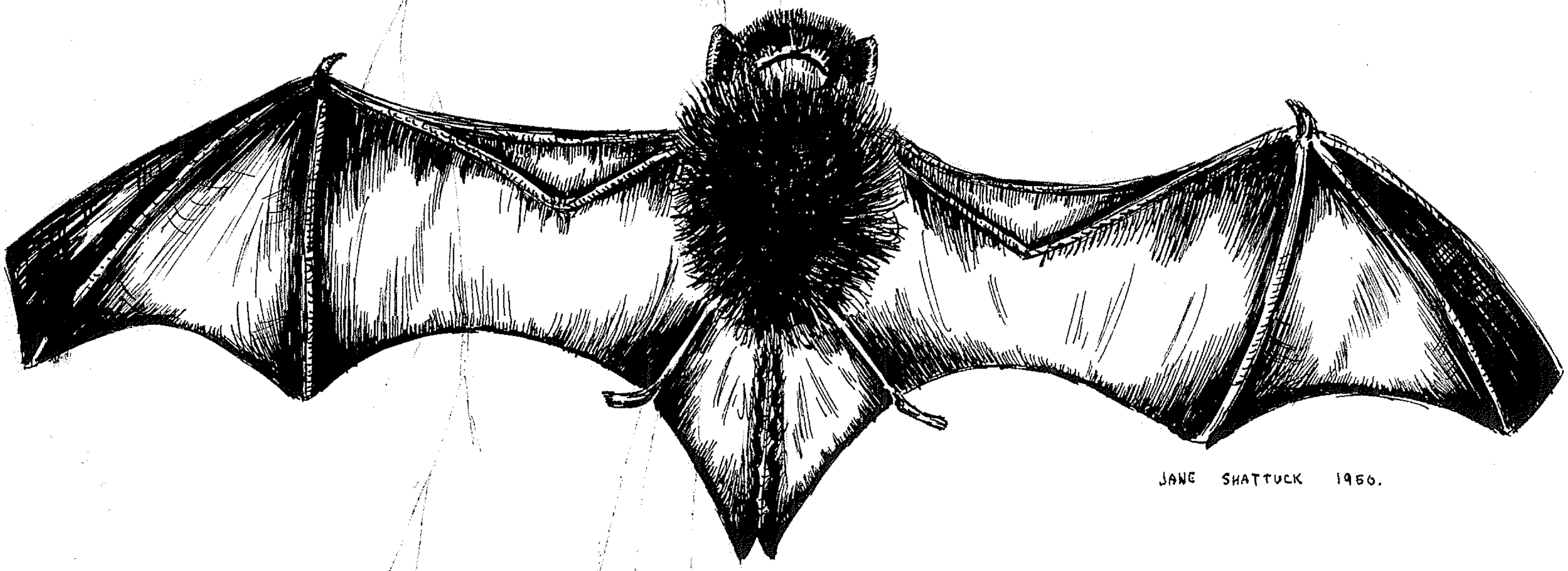
Project 17. Preserved Bat

Few city children have seen a bat at close range ~~so as~~ to see some of its interesting details. When a dead bat was brought into the classroom an interested pupil tacked it to a piece of wood with its wings outstretched. The piece of wood and bat were then placed in an empty aquarium and covered to a depth of one inch with a fifty percent solution of formalin. It was left in this solution for two weeks. During this time a little water was added to compensate for evaporation. At the end of two weeks the bat, still fastened to the wood, was washed thoroughly under running water. The nails that held the animal in place were then withdrawn and the bat was dried on several blotters. The formalin was obtained from the science room supplies. Page 56 shows a sketch of this bat.

Project 18. Preserved Wing of Goose

The wing of a Brantford Goose was brought into the classroom. This wing was first spread out and then nailed to a board

FIGURE XX



JANE SHATTUCK 1950.

Preserved Bat

by an interested pupil so that it remained in the spread out position. Then a fifty percent solution of formalin was injected into the muscle of the wing by means of a hypodermic needle (diabetic type). Cotton batting soaked in formalin solution was placed over the part of the wing that was attached to the body of the bird. This was repeated two or three times a week over a period of about two months. After this time the wing was taken off the board and it remained in the spread out position. Science supplies were used in this activity but a student donated the diabetic type hypodermic needle. Two sketches of this wing are shown on page 58.

Project 19. Preserved Deer's Hoofs

This activity was undertaken so as to illustrate facts presented by the textbook [15] on pages 279 and 280. Two deer hoofs were used. The student first made two small wooden wedges. These were wired to one hoof so that both the large toes and the two small back toes were in the open position. The other hoof was wired so that the toes remained together. The two hoofs were then preserved by placing the cut ends of the legs in a fifty percent solution of formalin for two weeks and then both legs (and hoofs) were completely submerged in the solution for three days. Both specimens were then washed in running water. The sketches on pages 59 and 60 illustrate the difference between the closed and opened toe specimens.

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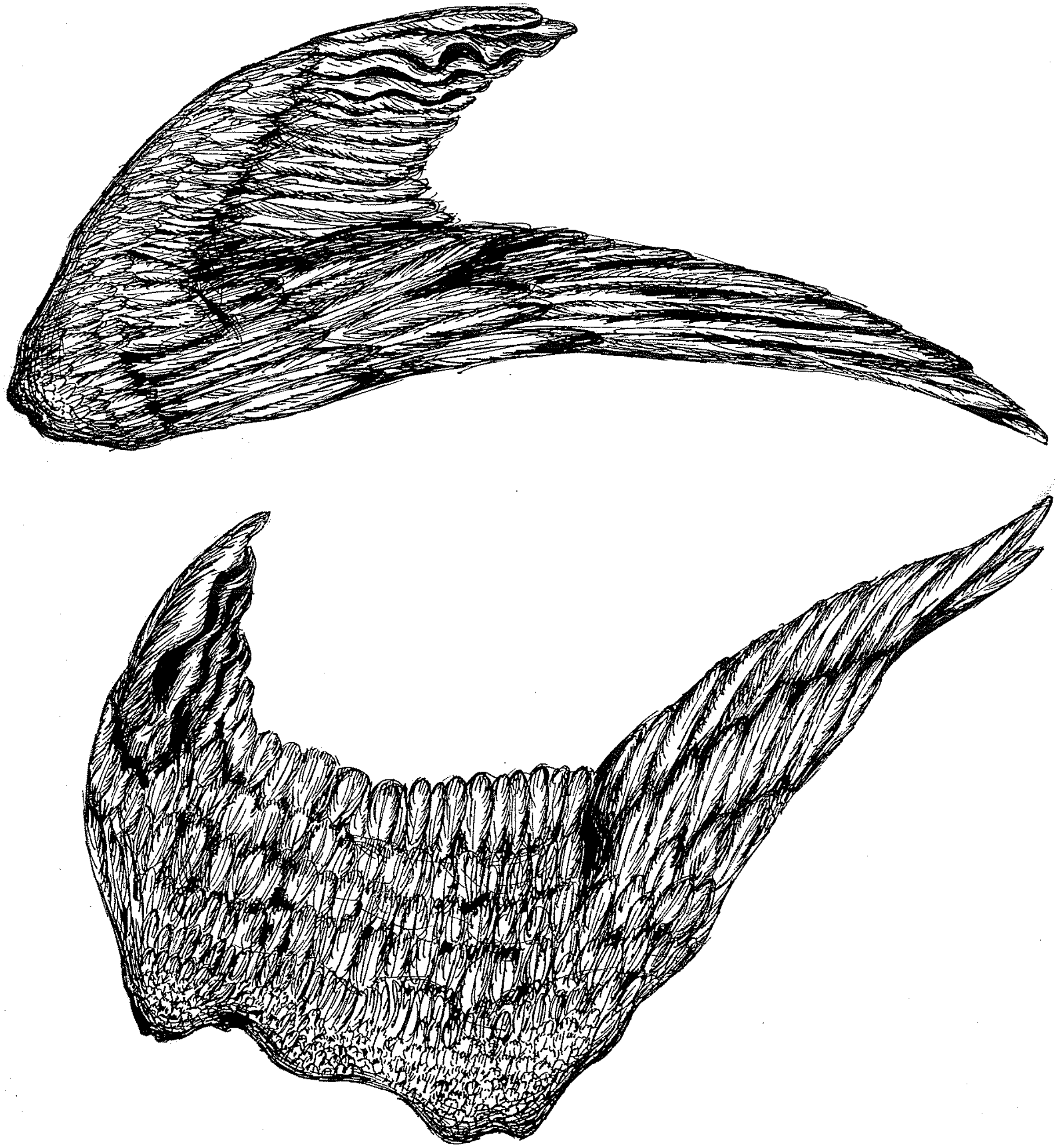
[15] Hensley, C. A. E., Patterson, D. A., Op. Cit.

FIGURE XXI



JANE SHATTUCK 1950.

Preserved Wing of Goose

FIGURE XXII

JANE SHATTUCK 1950.

Preserved Deer's Hoofs

FIGURE XXIII

JANE SHATTUCK 1950.

Preserved Deer's Hoofs

Project 20. Preserved Horse's Hoof and Bones

This activity was undertaken so as to illustrate facts presented by the textbook [16] on pages 278 and 279. The horse's hoof was a more complicated problem than the deer hoofs since the hide and meat had to be removed from the bones of the horse's leg. After the students obtained a horse's hoof - a total length of about twenty-four inches of leg was required - the hoof and leg were boiled for several hours. After this had been done all the bones and the hoof were placed in a loose wrapping of newspaper and left in an unused cupboard or hideaway for a year. At the end of this time moth larva etc. had stripped the remaining undesirable tissue from it and it was ready for preserving. The bones were simply placed in a fifty percent solution of formalin for two weeks. After washing the bones under running water the next problem was to mount them. This was done by drilling the larger bones longitudinally and threading them onto a piece of one-quarter inch shafting that had a machine thread on both ends. This shafting was then placed in a piece of hardwood (1" x 8" x 8") that acted as a base. A nut was then screwed onto the shafting under the base. A turned knob was next screwed onto the other end of the shafting and this pulled the bones together. A diagram of this activity is shown on page 62. Two small bones of the horse found on either side and towards the back of the second large bone

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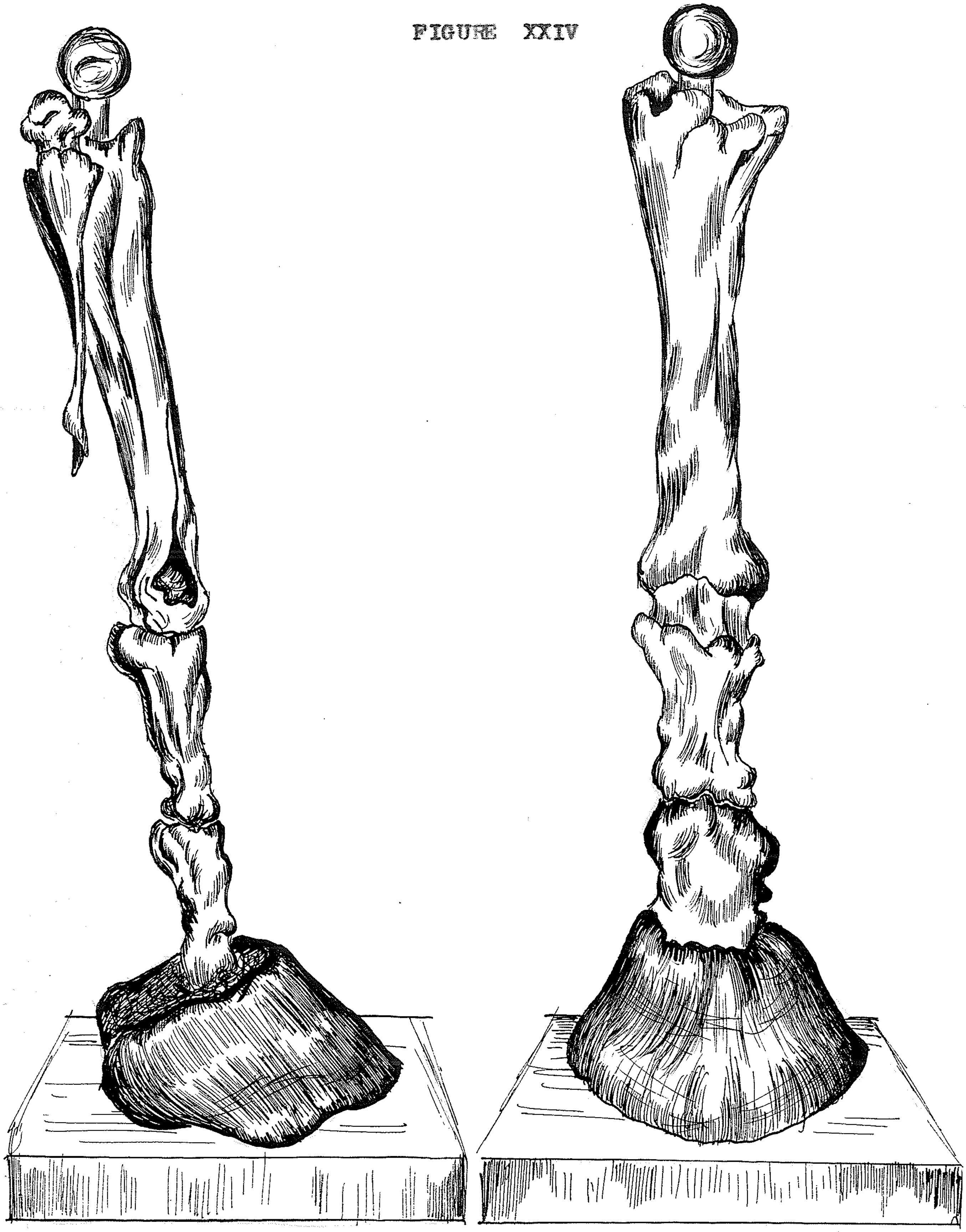
[16] <u>Ibid</u>, pp. 278, 279.

FIGURE XXIV



Preserved and Mounted
Horse's Hoof and Bones

from the hoof (counting upward) were fastened in place by wood screws. These small bones are the now unused toes. The hoof and bones were preserved since experience had shown that that was an effective method of preventing them from becoming odorus.

Project 21. Sectioned Dry Cell

On page 33 of Science Indoors and Out Book III [17] there is a picture of a dry cell cut longitudinally. During a science period in the fall of 1945 some of the girls of the class had difficulty understanding the picture. One of the boys of the class offered to cut a cell in half longitudinally with a hack-saw. Using the caretaker's vise he carried out this offer on the following day. A piece of window glass was taped over the cut surface. Page 64 shows two views of the sectioned dry cell.

Project 22. Shelves in Science Cupboard

Three boys agreed to fix small shelves between the large shelves in the science cupboard. These small shelves would provide storage space for small pieces of science equipment. Each shelf was ½" x 4" x 36" and held in place by two 4" brackets. The brackets were purchased from a hardware store with school funds. A sketch on page 65 shows how these small shelves were fastened between the large shelves in the science cupboard.

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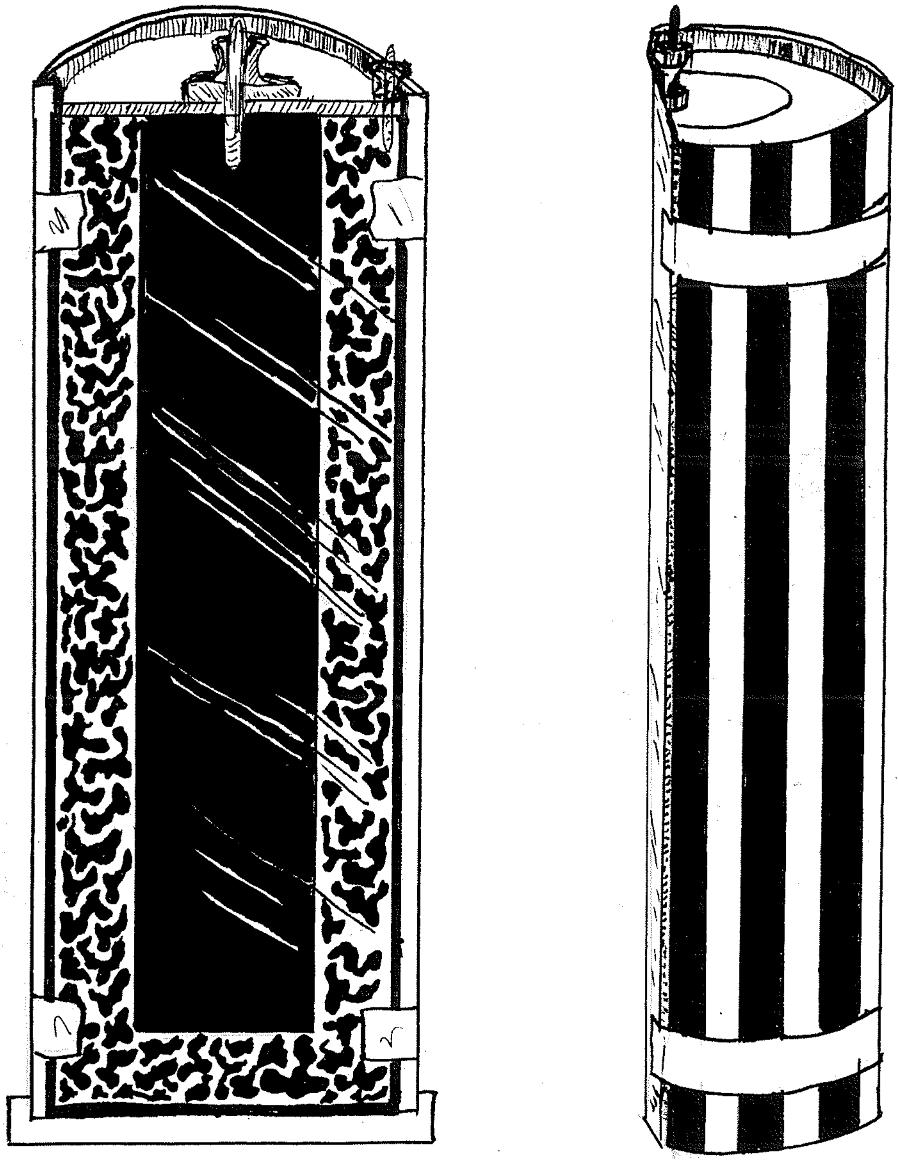
17. Hensley, C. A. E., Patterson, D. A., Op. Cit.

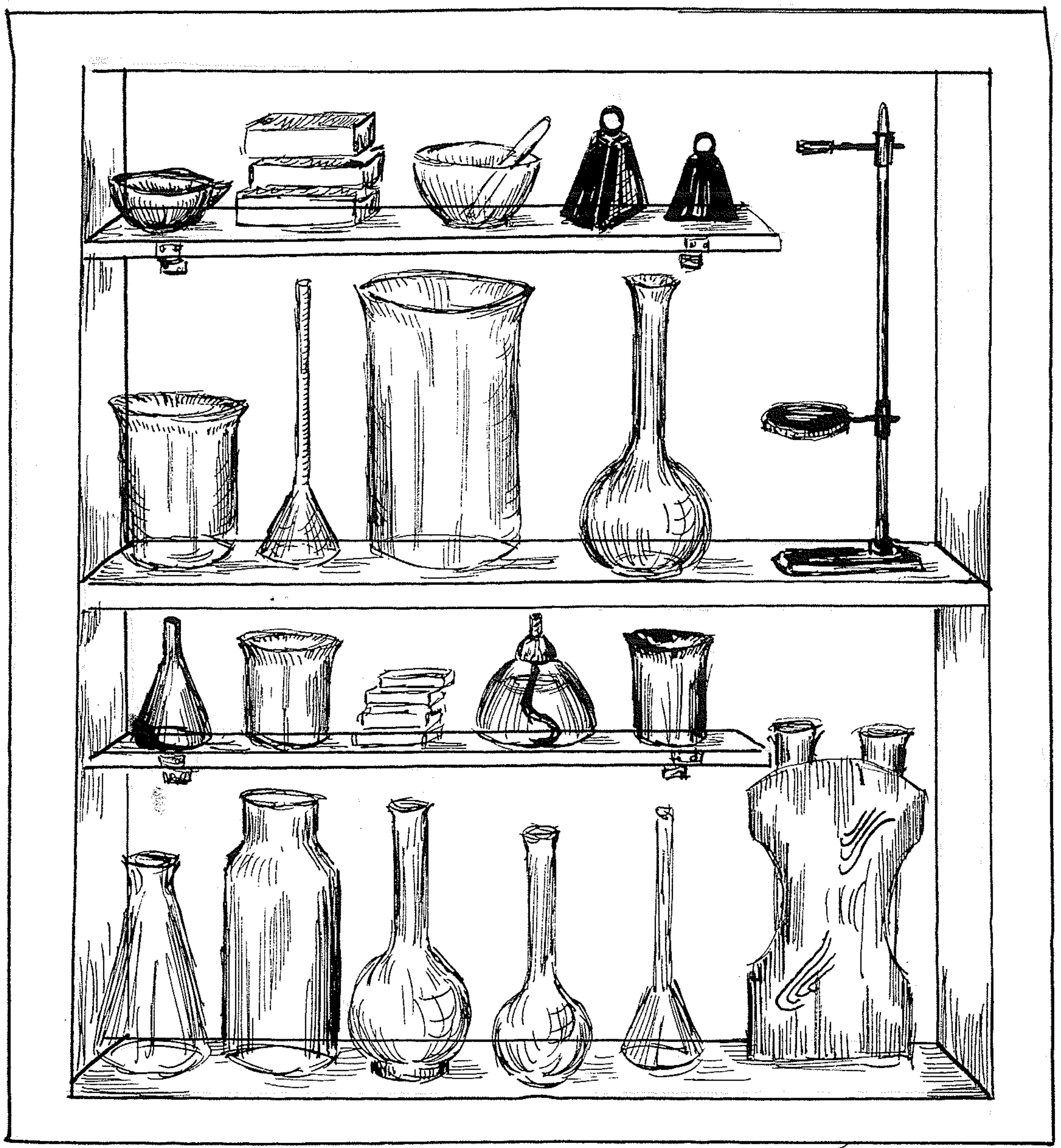
FIGURE XXV



JANE SHATTUCK 1950

Sectioned Dry Cell

FIGURE XXVI



Jane Shattuck 1950.

Shelves in Science Cupboard

Twenty-two projects and their methods of construction have been described in this chapter. Their relation to the science course and, when pertinent, the circumstances under which they were instigated were discussed.

67

CHAPTER V

Results of Enquiry One

The purpose of this chapter is to summarize the results of Enquiry One and present in tabular form the data concerning the number of pupils taking part in the 22 projects mentioned in the previous chapter.

The number of pupils making each project is shown in Table 1. The total for column two, 121, is actually not the number of pupils in the participating group since some pupils worked on more than one project. To obtain the number of different pupils who made projects in their own free time it is necessary to subtract the total for column three, 12 (the number of pupils employed in more than one project) from the total for column two. In other words, the total number of different pupils who made projects is 121 minus 12 or 109 pupils.

Having determined the exact number of pupils who undertook projects in their own free time - now referred to as the participating group - it was possible to determine the ratio of the participating group to the junior high school student body. According to Table I there were 109 pupils who voluntarily accepted science projects of a handwork nature. While this participation group consisted of 109 pupils, the total junior high school student body at the Principal Sparling School during the time these projects were being undertaken aggregated to 542 pupils. On a percentage basis we see that 20.2% of the student body at the Principal Sparling Junior High School between the years 1945 and 1950 were interested enough in science to undertake projects in their own free time.

Furthermore, as stated in previous chapters, the construction of scientific models and apparatus is a definite criterion of scientific interest, and therefore the figure 20.2% represents a definite index of scientific interest at the Principal Sparling Junior High School during the years 1945 to 1950. It is the opinion of the writer that this index has not been previously determined for any school area.

The reliability of this percentage may be shown by applying the formula $\sigma_p = \sqrt{\frac{pq}{N}}$[1]. Upon substitution this formula becomes $\sigma_p = \sqrt{\frac{.20 \text{ X } .80}{542}} = 2\%$ approximately.

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[1] Garrett, H.E., Statistics in Psychology and Education, Longmans, Green and Co. 1937. p. 227.

TABLE I

NUMBER OF PUPILS TAKING PART IN EACH PROJECT

Number of Project	Name of Project	Number of Pupils Making Project	Number of Pupils Employed in More Than One Project
1.	Aircraft Wing on Metre Stick	1	
2.	Cartesian Diver	3	
3.	Classroom Zoo	35	6
4.	The Fuse Board	1	
5.	Pneumatic Brake Model	3	
6.	Reflector Telescope	40	
7.	Root Cage	2	
8.	Large Star Chart	4	
9.	Windlass Model	1	
10.	A Cage for the Snake	7	
11.	Geological Chart on Blind	1	1
12.	Metal Pockets for Magazines	3	3
13.	Mounted Skeleton of Bird's Wing	1	
14.	Mounted and Waxed Corn Plant	1	
15.	Mounted Talon of Snowy Owl	1	
16.	Pendulum (Foucault's)	7	1
17.	Preserved Bat	1	
18.	Preserved Wing of Goose	1	
19.	Preserved Deer's Hoofs	1	
20.	Preserved and Mounted Horse's Hoof and Bones	3	1
21.	Sectioned Dry Cell	1	
22.	Shelves in Science Cupboard	3	
	Totals	121	12

Total number of different pupils that made projects 121 - 12 = 109

CHAPTER VI

ENQUIRY TWO

Other Investigations Using Questionnaires In the Field of Interest Measurement

Two investigations in the field of interest measurement and the relationship of interest to achievement are considered in this chapter. While these investigations are somewhat similar in purpose to that of this paper, they differ with respect to tests used and, in one case, to age groups considered.

An investigation by Frandsen [1] deals with scientific interest and educational achievement. By using Kuder Interests Tests and U.S.A.F.I. College Level Tests, Frandsen found a positive relationship between scientific interest and academic achievement in college students. Frandsen states, "The correlation of .50 between science interest and achievement in natural science is especially important." [2] also, " ....science and mathematical interests are definitely related to general achievement in parallel areas." [3]

A study that deals with students of the same age group as that undertaken in this paper is reported by the Times Educa-

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[1] Frandsen, A.N. "Interest and General Educational Development", _Journal of Applied Psychology_ 31:57-66, February 1947.

[2] _Ibid_, p. 61.

[3] _Ibid_, p. 63.

tional Supplement.[4] Here it states, "There is some evidence that pupils believe themselves to be influenced by a 'proficiency' motive in expressing their interests in school subjects, but the correlation obtained between interest and attainment, when these are measured objectively, has been found to be very low - of the order of .25 to .40 in most recent surveys." Under the heading of "Effect of Examinations" the Times article continues, "Very little research work has been done into the effect of examinations on the expression of interest, but a recent investigation has shown that approximately two-thirds of the pupils in a secondary school believe themselves to be uninfluenced by the effect of possible examination failure in considering their expressions of interest in school subjects. A comparison between expressions of interest in school subjects made over two equal periods, one of which included school examinations, gave a statistical difference which was barely significant. From both methods of investigation, therefore, the effect of school examinations would appear to be small."

It is seen that the results of Frandsen's investigation do not correspond with that reported in the Times Educational Supplement. This may be accounted for by the fact that Frandsen was dealing with an older group and older pupils usually select fields of study in which they have enjoyed some success.

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[4] Times Educational Supplement, February 1945, "A Study in Interests", from a correspondent.

An investigation in the field of science interest and its relationship to achievement in Winnipeg Junior and Senior High Schools may bring to light some very interesting considerations and afford some worthwhile comparisons with investigations made elsewhere.

CHAPTER VII

ENQUIRY TWO - CONTINUED

A SCALE FOR MEASURING INTEREST IN SCIENCE

Development of the Scale

For the purpose of this thesis, an original test or scale was developed to measure interest in science. This was constructed by selecting a number of statements that the author hoped might reflect the opinions of the pupils involved. These statements were of five types as follows:

A) Strong liking for science,
B) Moderate liking for science,
C) Neither like nor dislike for science,
D) Moderate dislike for science,
E) Strong dislike for science.

This collection of statements is similar to the Thurstone and Chave [1] technique of scale development but different in that it employs a five point system as used by Likert [2]. It is also similar to the technique used by Silance [3] in that it uses statements corresponding to, "I hate this subject." "I haven't any definite like or dislike for this subject", and "I like to study this subject."

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[1] Thurstone, L.L. and Chave, E.J. The Measurement of Attitudes, Chicago; University of Chicago Press, 1929.

[2] Likert, R.A. "A Technique for the Measurement of Attitudes." Archives of Psychology, XXII (1932), 1 - 55.

[3] Silance, E.B. and Remmers, H.H. "An Experimental Generalized Master Scale: A Scale to Measure Attitude Toward Any School Subject.", Purdue University Studies in Higher Education, XXXV (1934), 84-87.

Unlike the scales of Thurstone, Likert, and Silance, however, the pupils in this case were asked merely to check the items that coincided with their opinions.

The selection of the statements mentioned in the first paragraph of this chapter was undertaken in the following manner. Sixteen aspects of science were selected and the aforementioned five types of statements were written about each. These aspects of science are closely related to a child's experience such as - thinking about things dealing with science, reading science books and magazines, science pictures, biography, mechanical apparatus, etc. The five types of statements were labelled A, B, C, D, and E as previously mentioned.

An interest scale of this type must be submitted to an outside and competent authority. Dean N. V. Scarfe, a recognized expert in this field of measurement, very graciously checked not only the eighty statements (sixteen times five) referred to in the previous paragraph, but also, as will be mentioned later, the science interest scales developed from these eighty statements - Form A, Form A (Revised), and Form B. The eighty statements are shown in Appendix A.

The twenty-five statements in the Form A scale were chosen by selecting an A type statement from the first aspect group - thinking about things dealing with science, and a B type statement from the second aspect group, and a C type from the third group and so on. Five A type statements, five B type, five C type, five D type, and five E type statements make up the Form A scale.

The twenty-five statements in the Form B scale were chosen so that this scale would be correspondingly similar to but not identical with Form A. Here a B type statement was selected from the first aspect group, and a C type statement from the second group. This was continued up to the fourth group and then an A type statement was chosen from the fifth group. As is the case with the Form A scale, five statements of each type make up the Form B scale. A copy of the Form B scale is found in Appendix B.

With a view to refining the Form A scale, Dean N. V. Scarfe suggested that it be given a trial run with a typical class. A Grade Eight class at the Isaac Brock School, Winnipeg, was chosen for this refining technique. The method of presenting the Form A scale to this class was identical with the method that will be discussed later except for the fact that just before the pupils of the Isaac Brock School passed in their papers they were asked if they had experienced any difficulties with these statements. For several moments the class made no comment but later three queries were raised. After some consideration it was decided to change the wording of two statements - numbers 7 and 12. Number 7 now reads, "When I grow up I wouldn't mind work involving science," instead of, "When I grow up I wouldn't mind scientific work." Statement 12 now reads, "Often I like to spend my spare time making something mechanical or setting up science apparatus," instead of, "Often I like to spend my spare time making something mechanical or setting up some type of science apparatus."

Since there were no other individual comments other than those mentioned in the foregoing paragraph, the twenty-five statements were restencilled with the two changes. This scale is now referred to as the "Science Interest Scale Form A Revised" and a copy of this comprises Appendix C.

Administration of Science Interest Scales (Questionnaires)

A reading test was given to each class before they received the Science Interest Scale Form A Revised. After the reading test papers were collected the Science Interest Scale papers were handed to the class and the person giving the test spoke as follows:

"These twenty statements are part of an experiment to help teachers understand pupils' attitudes towards science. Your answers will have absolutely no influence on your standing so please answer as truthfully as possible. When you come to a statement which honestly states your attitude towards science, place a checkmark on the line to the right of that statement. Be certain about the statements you check. If in doubt about a statement don't check it. Some pupils may check only five statements while others may check fifteen. The number of statements you check does not matter as long as they are statements you could truthfully make. There is no time limit but do not spend too much time on any one question. First, however, turn over the sheet of paper so that you can fill in the blanks after the words "name", "grade", "school", and "teacher's name". You may write or print this information. (Pause) When you have finished this please turn over your sheets and begin completing the paper".

Scoring the Science Interest Scale

In scoring the scale papers marks were given as follows:

For each A type statement checked - plus two marks;
For each B type statement checked - plus one mark;
For each C type statement checked - zero marks;
For each D type statement checked - minus one mark;
For each E type statement checked - minus two marks.

Since there were five statements of each type it is seen that the possible scores ranged from plus 15 to minus 15.

The marking of these science interest papers proved a lengthy undertaking since accuracy was considered to be imperative. An original system was adopted that involved very simple operations yet provided means of checking each paper. This system made use of marking keys. A key was made for each of the five types (A,B,C,D, and E) of statements. The marking key for the A statements was first placed over each paper in turn. The number of A statements that had been checked could be counted at a glance. This was recorded at the top of each paper as will be explained later. The B marking key was then used for each paper, followed by the C. D. and E marking keys. On each paper the score for each letter was recorded. This original technique, developed solely for the purpose of this thesis, proved to be very lengthy but in the opinion of the writer was very worth while since it provided: 1) a means of checking each score - thus promoting accuracy; 2) a permanent record on each paper enabling each paper to be quickly rechecked - further promoting accuracy; 3) a series of simple operations in which errors were unlikely to occur. A set of marking keys is shown in Appendix D.

It will be observed that this set of marking keys is simply copies of the interest scale (Form A Revised or Form B) which have been clipped with scissors. The key used for marking the A type statements has spaces cut out of it exactly where check marks for the A type statements should appear. The key used for marking the B type statements has spaces cut out of it exactly where check marks for the B type statements should appear, and similarly for the keys used to mark C, D, and E type statements.

It will be further observed that each of these keys has a letter at the top of the sheet corresponding to the type of statement the key checks. Very close to this letter and to the right of it the sheet has been clipped with scissors. Where this clipped line intersects the double line under the words "Your Interest in Science", the top part of the sheet has been removed from each key. The lower line of the double line has been left on the key and this enables the individual marking the papers to line up the key from top to bottom with the paper being marked. To assist further in this matter one of the letters in the title "Your Interest in Science" has been split with the scissors. This enables the individual marking the papers to line up the key from left to right with the paper being marked. This original technique, developed solely for the purpose of this thesis, improves accuracy in marking and cuts down the time required to mark each paper.

As previously mentioned, a record was placed at the top of each paper showing the number of checks for each type of statement and the score for each type of statement. The following record is typical of many papers:

0 + 4 + 3 + 1 + 1 9✓
A B C D E
0 + 4 + 0 - 1 - 2 Score 1

The digits above the capital letters indicate the number of checks for each type of statement. The digits below the capital letters indicate the score for each type of statement. In this case there was no check against an A type statement, hence a zero score is shown under A. There were four checks against a

B type statement and therefore, since each B statement scores plus one, the digit four is placed under B. Each C type statement is scored zero, therefore the digit zero is written under C. Each D type statement is scored minus one and since there is one check against a D type statement minus one is placed under D. Finally, since each E type statement is scored minus two and one of these has been checked, a minus two is placed under E. This record shows that there were nine checks on the paper and the science interest score is plus one. A sample paper is shown in Appendix E.

The results obtained after giving this Science Interest Scale Form A Revised to 348 pupils are shown in the next chapter.

CHAPTER VIII

RESULTS OF ENQUIRY TWO

As previously stated, the investigation of pupils' interest in science using questionnaires has been undertaken elsewhere by other investigators. These investigations were undertaken in the United Kingdom and the United States and involved different age groups and, as mentioned in Chapter VI, obtained different results. Most likely they involved the use of entirely different questionnaires. Using an original questionnaire devised solely for the purpose of this thesis, the writer examined the science interest of 348 Winnipeg school children ranging in ages from twelve to eighteen. From these studies it is hoped to throw light on the problems of children's interests in science and the efficacy of new type interest tests.

The results of testing the 348 Winnipeg pupils with the Form A Revised science interest scale are shown in tabular form in Table II, page 82. In order to visualize these results from different viewpoints, graphs are shown in Figures XXVII, XXVIII, and XXIX.

From Table II we see that there are comparatively few very high scores and few very low scores. This is shown graphically in Figure XXVII and it would appear that the results of

TABLE II

FREQUENCY DISTRIBUTION OF 348 PUPILS UPON SCIENCE INTEREST SCALE FORM A REVISED

		BOYS AND GIRLS SHOWN SEPARATELY							
		BOYS				GIRLS			
Score Mid Points	f	f	d	fd	fd^2	f	d	fd	fd^2
15	2	1	4	4	16	1	5	5	25
12	14	11	3	33	99	3	4	12	48
9	22	13	2	26	52	9	3	27	81
6	54	33	1	33	33	21	2	42	84
3	74	45	0	0	0	29	1	29	29
0	96	44	-1	-44	44	52	0	0	0
-3	51	22	-2	-44	88	29	-1	-29	29
-6	15	1	-3	- 3	9	14	-2	-28	56
-9	12	3	-4	-12	48	9	-3	-27	81
-12	8	0				8	-4	-32	128
-15	0	0				0			
	N = 348	N = 173;	$\Sigma fd = -7; \Sigma fd^2 = 389;$			N = 175;	$\Sigma fd = -1; \Sigma fd^2 = 561$		

testing 348 Winnipeg pupils approximate a normal distribution.

The most outstanding feature that has come to light as a result of this investigation is the striking difference between boys' scores and girls' scores. As a result of this, boys' and girls' frequency distributions are shown separately in Table II. Once these scores are separated several interesting features come to light.

The first of these features is seen when the mean scores for boy and girl groups are considered separately for each grade. This is shown graphically in Figure XXVIII. Note how consistently the boys' mean score remains between 3 and 4 except for the grade nine group! The writer is at a loss to explain this consistency except for the comment that there may be a natural level of interest for these boys and, according to this interest scale, it lies somewhere between point 3 and point 4. On the other hand, if there is a natural science interest level for boys, what strange situation exists in Grade Nine according to the same standard of measurement? The boys in Grade Nine have certainly lost interest in science on the strength of the same interest scale!

With the girls the story is different. First of all, they are not consistent through the grades according to this science interest scale; secondly, they appear to have a definite antipathy to science in grades nine and ten on the strength of the

FIGURE XXVII

SCIENCE INTEREST SCALE

Histogram of the Scores of 348 Pupils

Form A Revised

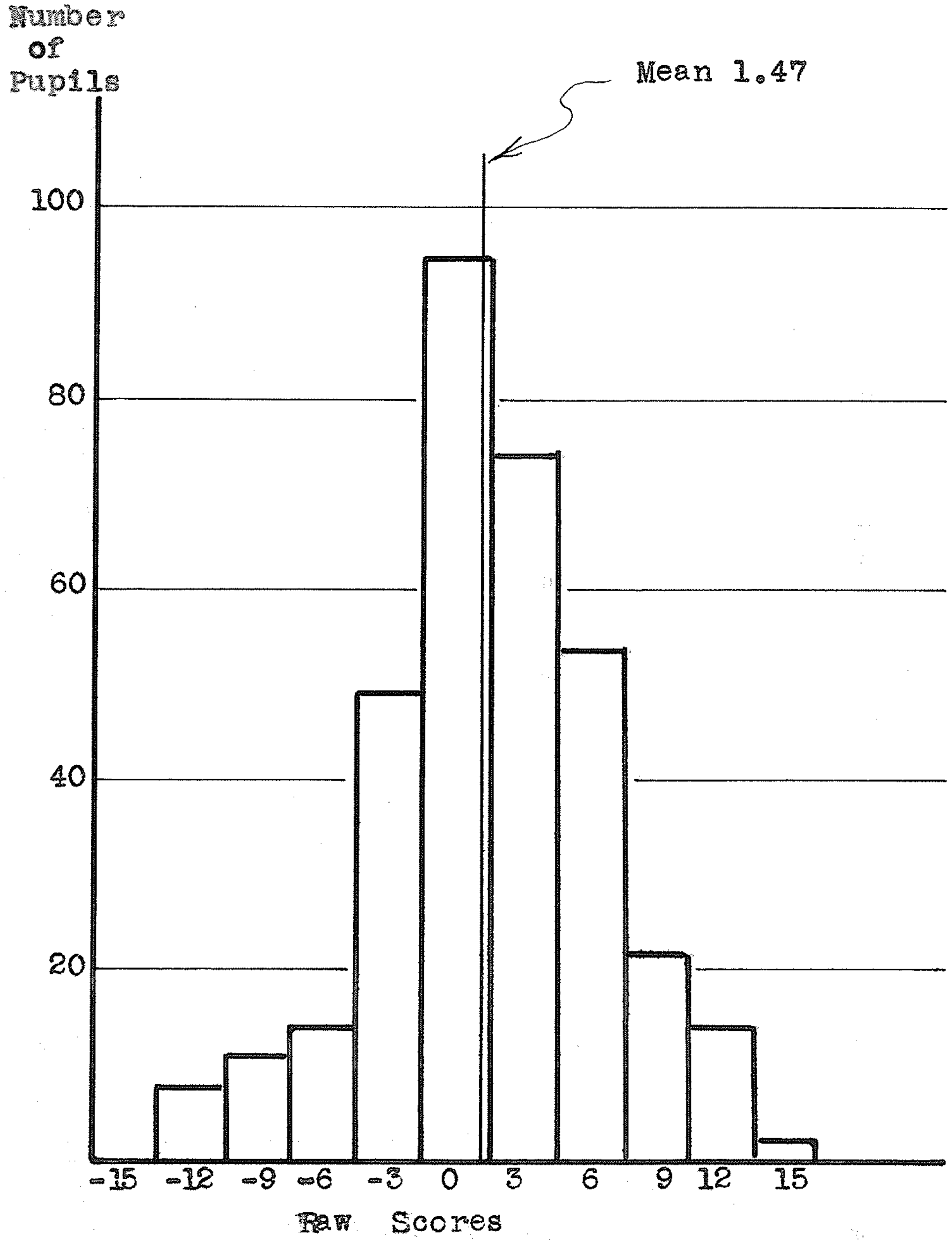
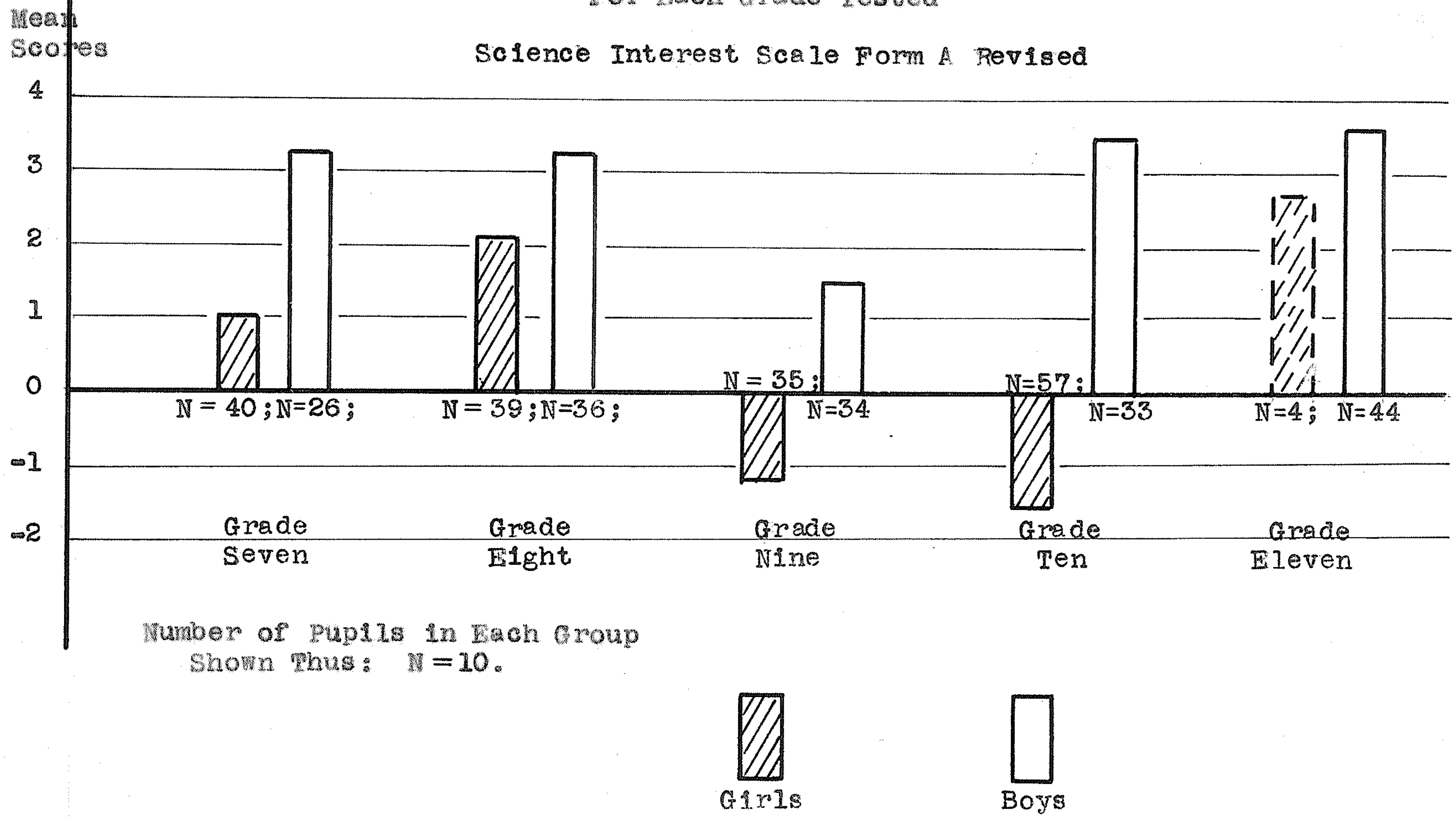


FIGURE XXVIII

Graphs Showing Mean Science Interest Scores for Boys and Girls

For Each Grade Tested

Science Interest Scale Form A Revised



Form A Revised science interest scale. The mean score of 2.7 for the Grade Eleven girls does not deserve much consideration since it is based on only four girls. Furthermore, these four girls were Physics students in Grade Eleven and may be considered a selected group since they would not likely have chosen the subject if they had not had previous success in science.

This sex difference in science interest, which the Form A Revised scale shows, supports a subjective view held by many educators in the past. Further to the point, girls are often more conscientious students than boys and this fact may have had the tendency to keep hidden the feminine lack of interest in science. It is more than likely that there is a sex difference in science interest as shown by this interest scale just as there is a sex difference in many other fields. Bingham [1] shows male and female norms for nine different tests. This implies that the sexes think and act differently as far as these nine tests are concerned and therefore norms for one group are not applicable to the other. Sex differences are pronounced in many tests. Horton [2] states, "Sex differentiation in test scores characterizes

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[1] Bingham, W.V.D., Aptitudes and Aptitude Testing, Harper and Brothers Publishers, 1937, pp. 280, 283, 286, 306, 311, 314, 325, 341, 353.

[2] Horton, S.P. A Research Program Applicable to Any Test, Human Engineering Laboratory Incorporated, Technical Report Number Seventy, November, 1940, Stevens Institute of Technology, 509 River Street, Hoboken, New Jersey, p. 34.

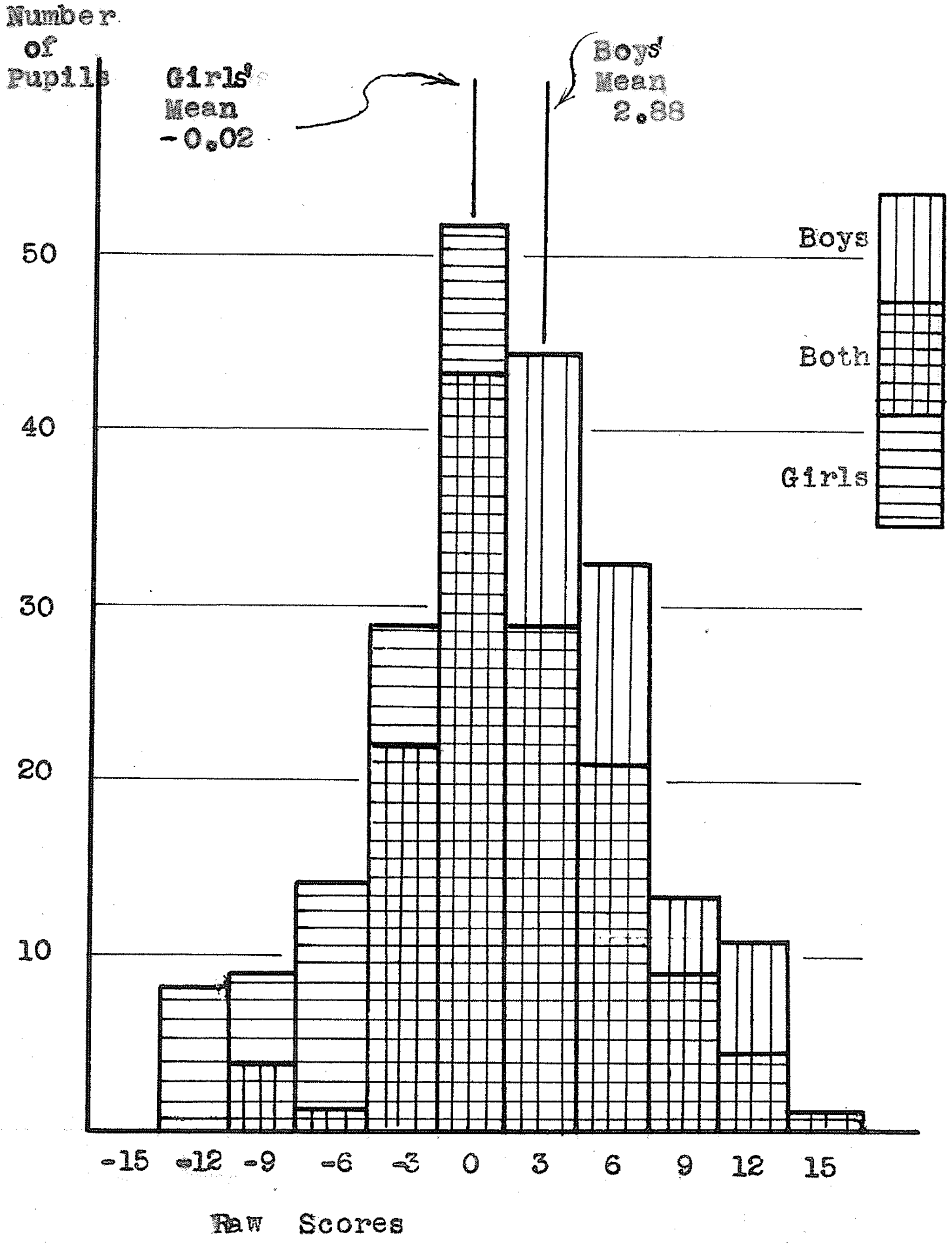
a number of Laboratory worksamples, and has been found by many other investigators with a wide variety of tests. A discovery that the score varies with sex of the examinee has a bearing on each of the concepts, reliability, uniqueness and validity. Pooling the scores of the two sexes for a reliability computation when one sex tends, as a group, to score appreciably higher than another will create a spuriously wide differentiation between individuals resulting in part from the sex difference, rather than from the accuracy of individual measurement only. The coefficient derived from such a pooling will therefore tend to be deceptively large. A knowledge of sex differentiation in score and the magnitude of the difference also provides clues as to the uniqueness of the test." On the basis of this information the writer has shown the frequency distribution for boys separately from that of girls in Table II. Histograms for boys and girls are shown differently in Figure XXIX.

Both the boys' distribution and the girls' distribution as seen in the histograms in Figure XXIX tend to approximate a normal distribution. The girls' mean score was found to be -0.02 while the boys' mean score came to be 2.88. This large difference between boys' scores and girls' scores implies that boys, according to the Form A Revised science interest scale, have a greater interest in science as taught than girls have. This difference, however, may be a characteristic of the scale used and another science interest scale might not show such a large sex difference.

FIGURE XXIX

SCIENCE INTEREST SCALE FORM A REVISED

Histograms of the Scores of 173
Boys and 175 Girls



The accompanying calculations show, as was stated previously, the boys' mean to be 2.88 and that for the girls to be -0.02. These figures are obtained from brief computations shown on page 89; and the data for these computations are in turn obtained from Table II. Standard deviation scores for both boys and girls are also computed on page 89. With the standard deviation for both boys and girls at hand, the standard error of the mean is found in each case. This is shown on page 90. With this information the standard error of a difference was found to be 0.53. The significance ratio, then, is $\frac{2.90}{0.53}$ or 5.4. A difference between two means is usually considered significant when the significance ratio is three or more. With a significance ratio of 5.4 we may say that the difference between the two means is too large to be due to chance.

In conclusion it may be said that, using an entirely new interest scale (Form A Revised) and original techniques, it has been found that:

1. science interest, according to the Form A Revised scale, follows a normal distribution for 348 Winnipeg pupils;
2. except at the grade nine level, boys' interest in science remains fairly constant from grade seven to grade eleven;
3. girls' interest in science is not constant through these same grades but seems negative at the grade nine and ten level;

	Boys	Girls	
Number	173	175	
Mean	2.88	-0.02	a difference of 2.90
σ	4.47	5.37	

Standard error of mean

$$\sigma_{M_{Boys}} = \frac{4.47}{\sqrt{173-1}} \qquad \sigma_{M_{Girls}} = \frac{5.37}{\sqrt{175-1}}$$

$$= \frac{4.47}{13.11} \qquad = \frac{5.37}{13.19}$$

$$= 0.340 \qquad = 0.407$$

Standard error of a difference

$$\sigma_{diff.} = \sqrt{\sigma_{M_B}^2 + \sigma_{M_G}^2} = \sqrt{.340^2 + .407^2}$$

$$= \sqrt{.1156 + .1656} = \sqrt{0.2812} = 0.53$$

$$\text{Significance Ratio} = \frac{M_G - M_B}{\sigma diff.}$$

$$= \frac{2.90}{0.53} = \underline{\underline{5.4}}$$

4. the level of girls' interest in science is definitely much lower than that of boys; the boys' mean score being 2.88, while that of the girls is -0.02, and this difference was found to be statistically significant with a significance ratio of 5.4. FOR THIS GROUP.

CHAPTER IX

ENQUIRY THREE

A COMPARISON BETWEEN INTEREST SCORES OF ENQUIRY TWO AND THE PERCENTAGE FOUND IN ENQUIRY ONE

In Enquiry One of this thesis the percentage of students who were interested in science to the extent that they constructed science apparatus and equipment in their own time was found to be 20.2. This group of pupils observed in Enquiry One were at the Junior High School level and there were two classes of grade seven, two classes of grade eight, and two classes of grade nine each school year. A total of 542 pupils were thus observed over a period of five years. In the opinion of the writer these six classes, year after year, could be considered typical of Junior High School classes in Winnipeg.

In Enquiry Two of this thesis six similar classes were investigated by means of an original science interest questionnaire. These children were of similar age levels, home background, and from the same school district, and should therefore, have corresponding attitudes and interests. Under these circumstances it is possible to compare the several Junior High School classes investigated in Enquiry One with the six Junior High School classes tested in Enquiry Two. In this way we have an opportunity to compare the science interest questionnaire technique with the voluntary project method of science interest investigation.

To begin with, a frequency distribution of science interest scores for the six Junior High classes was constructed. This is shown in Table III. Since there were 210 pupils in this Junior High School group it was a simple matter to determine the number of pupils who most likely would undertake voluntary project work if given an opportunity. This number was found to be 20.2% of 210 or 42.4 - actually 42 whole pupils for purposes of comparison.

The next step is to determine what score on the interest questionnaire a pupil must have to be in this 42 pupil or top 20% group. This is accomplished by turning to Table III and simply counting down 42 pupils from the top. We find that 41 pupils from the top of the group all have a score of 6 or more. This is not 42 but it is near enough for some interesting group comparisons. These same facts are compared graphically by means of a bar graph and a histogram in Figure XXX. Note how the line between the 20% and the 80% groups on the bar graph intersects the histogram at the interval having a midpoint of 6.

To compare the science interest questionnaire with the voluntary project method of science interest investigation we observe Figure XXX and Table III. Generally speaking we may say that a pupil should make a score of 6 or higher on the Form A Revised of the interest questionnaire to have a level of science interest comparable to that of pupils who will create science

TABLE III

FREQUENCY DISTRIBUTION OF SCIENCE INTEREST SCORES FOR SIX JUNIOR HIGH SCHOOL CLASSES

Score	Frequency		
15	0	41 pupils approx. 20%	122 pupils or 58%
14	2		
13	2		
12	2		
11	2		
10	4		
9	4		
8	10		
7	12		
6	3		
5	15	38%	
4	15		
3	15		
2	18		
1	18		
0	17		
-1	19		33%
-2	16		
-3	13		
-4	4		
-5	3		
-6	4		
-7	0		
-8	3		
-9	4		
-10	1		
-11	2		
-12	1		
-13	1		
-14	0		
-15	0		

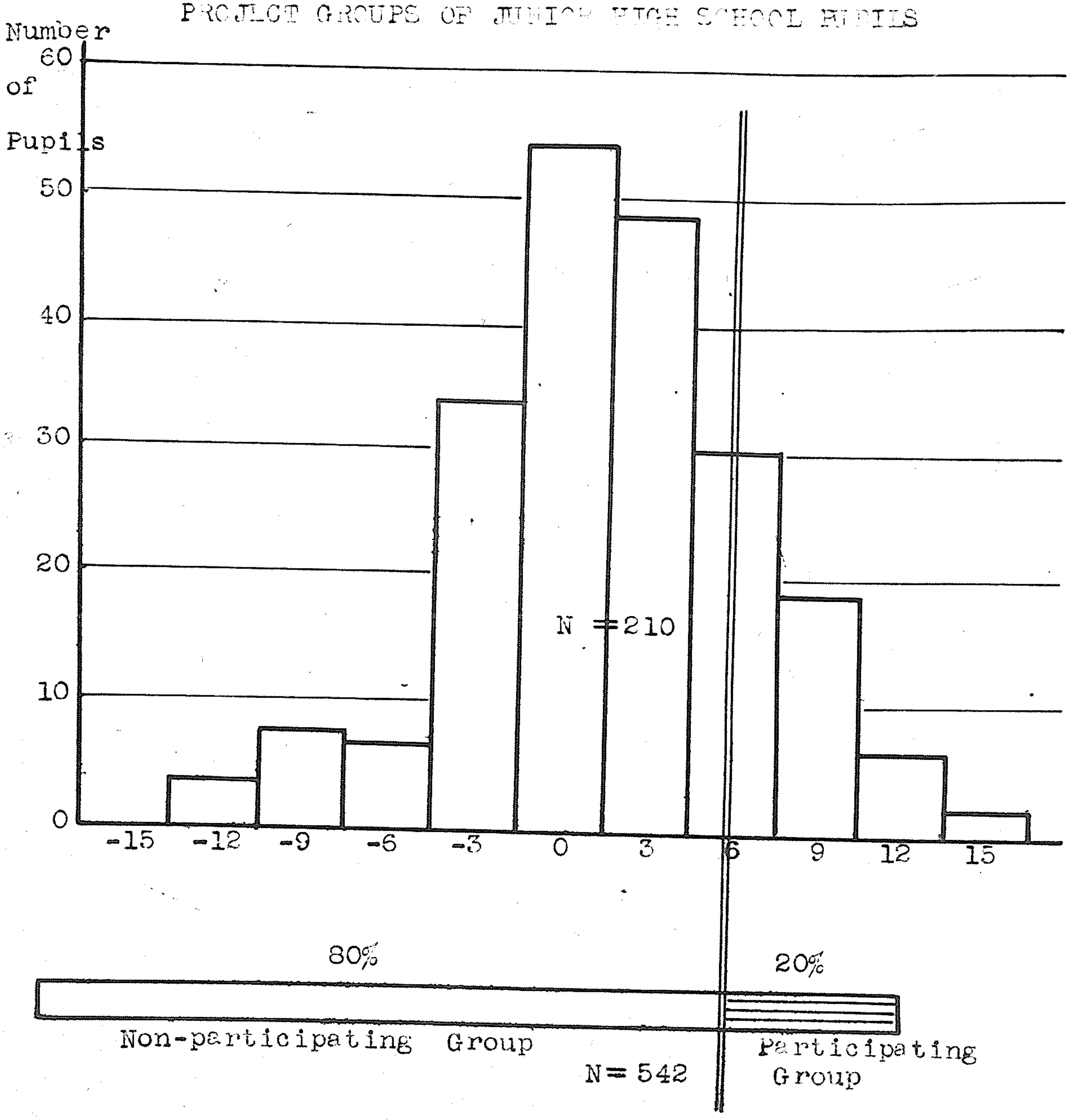
Science Interest Scale Form A Revised

FIGURE XXX

TWO JUNIOR HIGH SCHOOL GROUPS COMPARED

HISTOGRAM OF JUNIOR HIGH SCHOOL PUPILS SHOWING RESULTS OF SCIENCE INTEREST TEST

BAR GRAPH SHOWING NON-PARTICIPATING AND PARTICIPATING PROJECT GROUPS OF JUNIOR HIGH SCHOOL PUPILS



equipment and apparatus in their own time. To make such a score of six on this scale, however, a pupil must check at least one A type statement. A score of five or lower does not necessitate an A type statement. Furthermore, to make a score of six, a pupil must show no dislike of science by checking a D of E type statement unless of course he has checked several A type statements. This is unlikely since it can be seen from the scattering that very few very high scores are obtained. It is seen, therefore, that an active interest as exhibited by 20% of the pupils of Enquiry One corresponds to the superlative of A type interest statements as checked by pupils of Enquiry Two.

What does a science interest score signify? Besides being able to make comparisons of pupils' interest from the standpoint of their scores, as a result of this comparison between Enquiry One and Enquiry Two it is possible to say that a score of six or above on the Form A Revised scale means that the pupil might have that level of interest that prompts him to undertake simple scientific projects in his own time.

Again, all pupils at the Junior High School level who had a score above zero on the Science Interest Scale Form A Revised may be said to profess some interest in science. Actually 122 or 58% of the group tested, as shown in Table III are above the zero score. But while 58% say they are interested it is unlikely that any more than 20% will <u>do</u> anything about it. With these facts in mind it may be estimated that 58% - 20% or 38% of the pupils tested at the Junior High School level are passively interested in science.

From Table III we see that 71 pupils are below zero on the Science Interest Scale Form A Revised. It would appear that 71 out of 210 pupils or 33% claim to have no interest in science.

At this point it should be noted that Enquiry One enabled us to determine the percentage of pupils in the Principal Sparling Junior High School from 1945 to 1950 who were interested enough in science to construct scientific apparatus in their own free time. Furthermore, Enquiry Two enabled us to determine the number of pupils in six Junior High School classes in the Principal Sparling School in 1952 who said they were very interested, slightly interested, not interested etc. in science. The fact that Enquiry One revealed 20% of the Junior High School students at the Principal Sparling School made scientific apparatus in their own free time and that Enquiry Two determined that approximately 20% of another set of Junior High School students tested said they were very interested in science may be purely coincidental but may also suggest the possibility of a relationship between these two sets of statistics. It might possibly be that the 20% of Enquiry One would turn out to be the same 20% in Enquiry Two.

In this chapter two groups of pupils have been compared. In the first group it was observed, after five years of study, that approximately 20% would undertake scientific projects in their own time. The second group were given a science interest questionnaire - Science Interest Scale Form A Revised. It was estimated that:

1. a pupil answering this questionnaire would have to make a score of six to have a science interest level which might enable him to undertake science projects in his free time;
2. a pupil scoring six in this science interest scale must check at least one A type statement and show no or little antipathy towards science;
3. 58% of Junior High School pupils tested say they are interested in science;
4. 38% of Junior High School pupils tested are passively interested in science;
5. 33% of Junior High School pupils tested say they are not interested in science.

CHAPTER X

ENQUIRY FOUR

A COMPARISON BETWEEN STUDENTS' INTEREST IN SCIENCE AND STUDENTS' ACHIEVEMENT IN SCIENCE

The purpose of this chapter is to investigate the relationship between students' interest and students' achievement in the field of high school science. Students' interest in science will be that shown by the Science Interest Scale, Form A Revised; while students' achievement in science will be the students' report marks as determined by the December examinations, 1952. The interest scores and report marks of 112 pupils will be considered.

As previously mentioned in Chapter VIII, five classes were given the Science Interest Scale, Form A Revised, at the Technical Vocational High School between September 22 and October 3, 1952. Three of these classes were Grade Ten or Level One, while two of them were Grade Eleven or Level Two. Of the three Grade Ten or Level One classes, two were commercial and one was technical; of the two Grade Eleven classes one was a technical and the other was a matriculation class. These five classes were considered to be a typical cross section of the student body at the Technical Vocational High School. With a view to clarity, this arrangement of classes, the courses they are taking, the grades they are in, as well as the results obtained are shown in tabular form in Table IV. While these five classes are considered typical or regular classes of the Technical Vocational High School, they are actually taking four separate courses and therefore, at examination time, they will write four separate examinations. This is a very important point since the comparison of the science interest of each class with the examination results of that class must be undertaken for four separate examinations. The commercial classes at Level One can be combined but the other three classes must be considered separately since they write a science examination peculiar to their course and grade level.

Correlation coefficients were used to compare science interest with science achievement. Therefore:

r_{ia} - is the relationship between pupil interest in science and pupil achievement in science.

Calculation of the correlation coefficients

The coefficient as defined was determined for four different groups as shown in Table IV. Two way frequency tables were used in three cases and in the fourth case the correlation coefficient was determined by the rank difference method.

TABLE IV

A COMPARISON BETWEEN STUDENTS' INTEREST IN SCIENCE AND STUDENTS' ACHIEVEMENT IN SCIENCE AS DETERMINED BY COEFFICIENTS OF CORRELATION

Grade or Level	Class	Course	Pairs of Scores Available N		Coefficient of Correlation
Grade X or Level One	1 - 14	Commercial (all girls)	29	N = 52	$r_{ia} = -0.0391$
Grade X or Level One	1 - 39	Commercial (3 boys, 25 girls)	28		
Grade X or Level One	1 - 3	Technical (all boys)	23		$r_{ia} = 0.348$
Grade XI or Level Two	2 - 24	Technical (all boys)	15	(Pia)	$r_{ia} = 0.378$
Grade XI or Level Two	2 - 6	Matriculation (3 girls, 24 boys)	27		$r_{ia} = -0.123$
			112		

In the frequency tables, Figures XXXI, XXXII, and XXXIII, the vertical axis represents the pupils' interest in science as shown by the Science Interest Scale, Form A Revised. The horizontal axis represents the science achievement scores as determined by the December science examinations 1952.

In the case of the Level One Commercial Classes, 57 pairs of marks were available for comparison. Three boys and fifty-four girls were in these two classes. As determined in Figure XXXI, r_{ia} = −0.0391 ~~-0.0032.~~

The Level One Technical class is a boys' class and 23 pairs of marks were available for comparison. Figure XXXII shows $r_{ia} = 0.348$.

The Level Two Technical class is also a boys' class and 15 pairs of marks were available. By the rank difference method, shown in Table V, $r_{ia} = 0.3786$.

The Matriculation Class, class 2-6, produces a slightly different result. Here 27 pairs of marks were available, 24 boys and 3 girls, and according to Figure XXXIII $r_{ia} = -0.123$.

These four values for r_{ia} are shown in Table IV, and from this table we see that there appears to be little mathematical relationship between interest scores and achievement grades in science. In two groups the value of r_{ia} was found to be very small - actually negative in one case ! In the other

FIGURE XXXI

Two-way Frequency Table for r_{ia}

Classes
1–14
and
1–39

Science Achievement

Science Interest

	28	33	38	43	48	53	58	63	68	73	78	83	f_y	d_y	f_yd_y	$f_yd_y^2$	Σf_xd_x	$d_y\Sigma f_xd_x$
13									I $^{4}_{13}$				1	13	13	169	4	52
12													0	12	0	0	0	0
11													0	11	0	0	0	0
10								I $^{3}_{10}$					1	10	10	100	3	30
9													0	9	0	0	0	0
8													0	8	0	0	0	0
7					II $^{-2}_{14}$								2	7	14	98	-2	-14
6													0	6	0	0	0	0
5						I $^{0}_{5}$		I $^{2}_{5}$	I $^{3}_{5}$				3	5	15	75	5	25
4	I $^{-5}_{4}$			I $^{-2}_{4}$			I $^{1}_{4}$						3	4	12	48	-6	-24
3									I $^{3}_{3}$				1	3	3	9	3	9
2				I $^{-2}_{2}$									1	2	2	4	-2	-4
1						I $^{0}_{1}$	I $^{1}_{1}$			I $^{4}_{1}$			3	1	3	3	5	5
0					III $^{-3}_{0}$	II $^{0}_{0}$	I $^{1}_{0}$	I $^{2}_{0}$	II $^{6}_{0}$				9	0	0	0	6	0
-1					I $^{-1}_{-1}$	II $^{0}_{-2}$		II $^{4}_{-2}$		II $^{8}_{-2}$		I $^{6}_{-1}$	8	-1	-8	8	17	-17
-2				I $^{-2}_{-2}$		I $^{0}_{-2}$	I $^{1}_{-2}$	I $^{2}_{-2}$	I $^{3}_{-2}$				5	-2	-10	20	4	-8
-3				I $^{-2}_{-3}$		I $^{0}_{-3}$	I $^{1}_{-3}$	I $^{2}_{-3}$					4	-3	-12	36	1	-3
-4									I $^{3}_{-4}$			I $^{6}_{-4}$	2	-4	-8	32	9	-36
-5				I $^{-2}_{-5}$		I $^{0}_{-5}$	II $^{2}_{-10}$						4	-5	-20	100	0	0
-6					I $^{-1}_{-6}$								1	-6	-6	36	-1	6
-7									II $^{6}_{-14}$		I $^{5}_{-7}$		3	-7	-21	147	11	-77
-8					I $^{-1}_{-8}$								1	-8	-8	64	-1	8
-9												I $^{6}_{-9}$	1	-9	-9	81	6	-54
-10												I $^{6}_{-10}$	1	-10	-10	100	6	-60
-11				I $^{-2}_{-11}$									1	-11	-11	121	-2	22
-12													0	-12	0	0	0	0
-13				I $^{-2}_{-13}$		I $^{0}_{-13}$							2	-13	-26	338	-2	26
f_x	1	0	0	7	8	10	7	6	9	4	1	4	57		-77	1589	64	-114
d_x	-5	-4	-3	-2	-1	0	1	2	3	4	5	6						
f_xd_x	-5	0	0	-14	-8	0	7	12	27	16	5	24	64					
$f_xd_x^2$	25	0	0	28	8	0	7	24	81	64	25	144	406					
Σf_yd_y	4	0	0	-28	-1	-19	-10	-2	-2	12	-7	-24	-77					
$d_x\Sigma f_yd_y$	-20	0	0	56	1	0	-10	-4	-6	48	-35	-144	-114					

$\log a = 1{\cdot}44012$

$\log \frac{b+c}{2} = 2{\cdot}84780$

$\bar{2}{\cdot}59232$

$\log b = 2{\cdot}52388$

$\log c = 3{\cdot}17173$

$5{\cdot}69561$

$$r_{ia} = \frac{a}{\sqrt{bc}} = \frac{-114 - \frac{64 \times -77}{57}}{\sqrt{\left(406 - \frac{64^2}{57}\right)\left(1589 - \frac{-77^2}{57}\right)}} = \frac{-114 + 86{\cdot}45}{\sqrt{(406 - 71{\cdot}86)(1589 - 104{\cdot}0)}} = \underline{\underline{-0{\cdot}0391}}$$

two groups r_{ia} was found to be between 0.3 and 0.4; but in these cases, N - the number of pupils in each group - was small and therefore too much weight must not be attached to these coefficients. From these results, however, there appears to be a greater mathematical relationship between pupils' interest in science and pupils' achievement in science in the boys' technical classes than in the girls' commercial classes.

FIGURE XXXII

Pupils' Report Marks in Science

Science Interest

	23	28	33	38	43	48	53	58	63	68	73	78	83	88	fy	dy	fydy	fydy²	Σfx dx	
12								1^{2}_{10}							1	10	10	100	2	20
11				1^{-2}_{9}						1^{4}_{9}					2	9	18	162	2	18
10					1^{-1}_{8}								1^{7}_{8}		2	8	16	128	6	48
9															0	7	0	0	0	0
8															0	6	0	0	0	0
7															0	5	0	0	0	0
6			1^{-3}_{4}		1^{-1}_{4}										2	4	8	32	-4	-16
5					1^{-1}_{3}	1^{0}_{3}		1^{2}_{3}							3	3	9	27	1	3
4															0	2	0	0	0	0
3							1^{1}_{1}	1^{2}_{1}	1^{3}_{1}			1^{6}_{1}			4	1	4	4	12	12
2						1^{0}_{0}									1	0	0	0	0	0
1				1^{-2}_{-1}							1^{5}_{-1}				2	-1	-2	2	3	-3
0							1^{1}_{-2}								1	-2	-2	4	1	-2
-1	1^{-5}_{-3}						1^{1}_{-3}								2	-3	-6	18	-4	12
-2					1^{-1}_{-4}	1^{0}_{-4}									2	-4	-8	32	-1	4
-3															0	-5	0	0	0	0
-4															0	-6	0	0	0	0
-5															0	-7	0	0	0	0
-6															0	-8	0	0	0	0
-7															0	-9	0	0	0	0
-8	1^{-5}_{-10}														1	-10	-10	100	-5	50
-9																				
fx	2	0	1	2	4	3	3	3	1	1	1	1	1	0	23		37	609	13	146
dx	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7							
fxdx	-10	0	-3	-4	-4	0	3	6	3	4	5	6	7		13					
fxdx²	50	0	9	8	4	0	3	12	9	16	25	36	49	0	221					
Σfydy	-13	-	4	8	11	-1	-4	14	1	9	-1	1	8		37					
dxΣ(fydy)	65	0	-12	-16	-11	0	-4	28	3	36	-5	6	56		146					

$$r_{ia} = \frac{a}{\sqrt{bc}}$$

$$r_{ia} = \frac{125.09}{\sqrt{(213.67)(603.05)}}$$

$$r_{ia} = .3483$$

log a = 2.09699

log b = 2.32966

log c = 2.78035

b+c = 5.11001

$\frac{b+c}{2}$ = 2.55500

log a − ↗ = $\bar{1}.54199$

$$r_{ia} = \frac{146 - \frac{13 \times 37}{23}}{\sqrt{\left(221 - \frac{13^2}{23}\right)\left(609 - \frac{37^2}{23}\right)}}$$

$$r_{ia} = 0.348$$

Class 1-3

Two-way Frequency Table for r_{ia}

FIGURE XXXIII

Two-way Frequency Table for r_{ia}

Report Marks

Science Interest Scores	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	f_y	d_y	f_yd_y	$f_yd_y^2$	Σf_yd_x	$d_y\Sigma f_yd_x$
13																										
12						1^{-4}_{6}															1	6	6	36	-4	-24
11												1^{2}_{5}									1	5	5	25	2	10
10																					0	4	0	0	0	0
9																					0	3	0	0	0	0
8																					0	2	0	0	0	0
7	1^{-9}_{1}											1^{2}_{1}									2	1	2	2	-7	-7
6						1^{-4}_{0}				1^{0}_{0}											2	0	0	0	-4	0
5					1^{-5}_{-1}				1^{-1}_{-1}	1^{0}_{-1}		1^{2}_{1}				1^{6}_{-1}					5	-1	-5	5	2	-2
4						1^{-4}_{-2}	1^{-3}_{-2}	1^{-2}_{-2}	1^{-1}_{-2}	1^{0}_{-2}											5	-2	-10	20	-10	20
3						1^{-4}_{-3}									1^{5}_{-3}						2	-3	-6	18	1	-3
2						1^{-4}_{-4}					1^{1}_{-4}			1^{4}_{-4}	1^{5}_{-4}					1^{10}_{-4}	5	-4	-20	80	16	-64
1				1^{-6}_{-6}					1^{-1}_{-5}												2	-5	-10	50	-7	35
0						1^{-4}_{-6}				1^{0}_{-6}											2	-6	-12	72	-4	24
f_x	1	0	0	1	1	6	1	1	3	4	1	3	0	1	2	1	0	0	0	1	27		-50	308	-16	-11
d_x	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	.					
f_xd_x	-9	0	0	-6	-5	-24	-3	-2	-3	0	1	6	0	4	10	6	0	0	0	10	-15					
$f_xd_x^2$	81	0	0	36	25	96	9	4	3	0	1	12	0	16	50	36	0	0	0	100	469					
Σf_xd_y	1	0	0	-5	-1	-9	-2	-2	-8	-9	-4	5	0	-4	-7	-1	0	0	0	-4	-50					
$d_x\Sigma f_xd_y$	-9	0	0	30	5	36	6	4	8	0	-4	10	0	-16	-35	-6	0	0	0	-40	-11					

$$r_{ia} = \frac{-11 - \underline{\frac{-15 \times -50}{27}}}{\sqrt{\left(469-\frac{(-15)^2}{27}\right)\left(308-\frac{(-50)^2}{27}\right)}} = \frac{-11 \; -27.777}{\sqrt{(460.67)(215.41)}}$$

$$r_{ia} = \frac{a}{\sqrt{bc}} = \underline{\underline{-0.1230}}$$

$$\begin{aligned} \text{Log } a &= 1.58850 \\ \text{Log } \frac{b+c}{2} &= \underline{2.49833} \\ & \quad \bar{1}.09017 \end{aligned} \qquad \begin{aligned} \text{Log } b &= 2.66339 \\ \text{Log } c &= \underline{2.33327} \\ & \quad 4.99666 \end{aligned}$$

Class 2-6

TABLE V

CORRELATION COEFFICIENT FOR CLASS 2 - 24

Pupil	Marks		Rank		Difference	Difference Squared
	Science Interest	Science Examination	Science Interest	Science Examination		
M.H.	13	56	1	10	9	81
O.B.	7	80	2	4	2	4
F.Z.	5	85	3.5	1.5	2	4
G.M.	5	72	3.5	8	4.5	20.25
D.T.	4	85	5	1.5	3.5	12.25
B.T.	1	78	8.5	5	3.5	12.25
L.K.	1	83	8.5	3	5.5	30.25
B.S.	1	29	8.5	14	5.5	30.25
W.K.	1	39	8.5	12	3.5	12.25
E.K.	1	58	8.5	9	0.5	0.25
A.S.	1	50	8.5	11	2.5	6.25
M.B.	0	30	12	13	1	1
F.L.	-1	28	13	15	2	4
J.C.	-2	75	14	7	7	49
C.W.	-3	77	15	6	9	81
						348.00

$$\rho_{ia} = 1 - \frac{6 \Sigma D^2}{N(N^2 - 1)} = 1 - \frac{6 X 348}{15X 224} = 1 - 0.6214 = \underline{\underline{0.3786}}$$

CHAPTER XI

ENQUIRY FIVE

A COMPARISON BETWEEN SILENT READING ABILITY AND SCIENCE INTEREST

Since the science interest test developed for this thesis was a printed test and had to be read silently by the pupils, it was quite possible that a student severely handicapped in the field of silent reading might have difficulty reading the scale. Furthermore, it is quite possible that a student with little silent reading ability might have had less opportunity to develop an interest in science than a pupil with average silent reading ability. Such a student might not understand the statements on the scale and might quite conceivably check the statements at random. This would most likely produce nearly the same number of plus scores as minus scores resulting in a score near or at zero.

With these considerations in mind, it was thought worthwhile to determine the silent reading ability of all pupils taking the science interest scale. The Monroe's Standardized Silent Reading Test Revised, Test 1, Form 1, and Test 2, Form 1 were used. These two tests are comparable according to a statement in the direction sheet shown in Appendix F. Test 1 was used with two grade seven classes, two grade eight classes, three grade ten classes and one grade eleven class while Test 2 was used with two grade nine classes and one grade eleven class. Test 2 was given to those classes which the writer considered to be better silent readers.

These Monroe tests were used because they required little time, they gave a silent reading score in terms of school grades, and they were reasonably valid for determining silent reading ability between the grade levels of three and eight.

The results of testing eleven classes are shown in Figure XXXIV. Here class mean scores are shown by bar graphs. As may be expected the two grade seven classes have the lowest mean scores.

Since we were primarily concerned with the factor of low reading ability affecting a pupil's science interest score, it was considered necessary to determine the relationship between reading ability and science interest in the case of three classes - two grade seven classes and one grade nine. The two grade seven classes were combined into one group for the purpose of computing one of the coefficients of correlation.

The two coefficients of correlation obtained in this enquiry were derived from the usual product - moment formula and may be defined as follows:

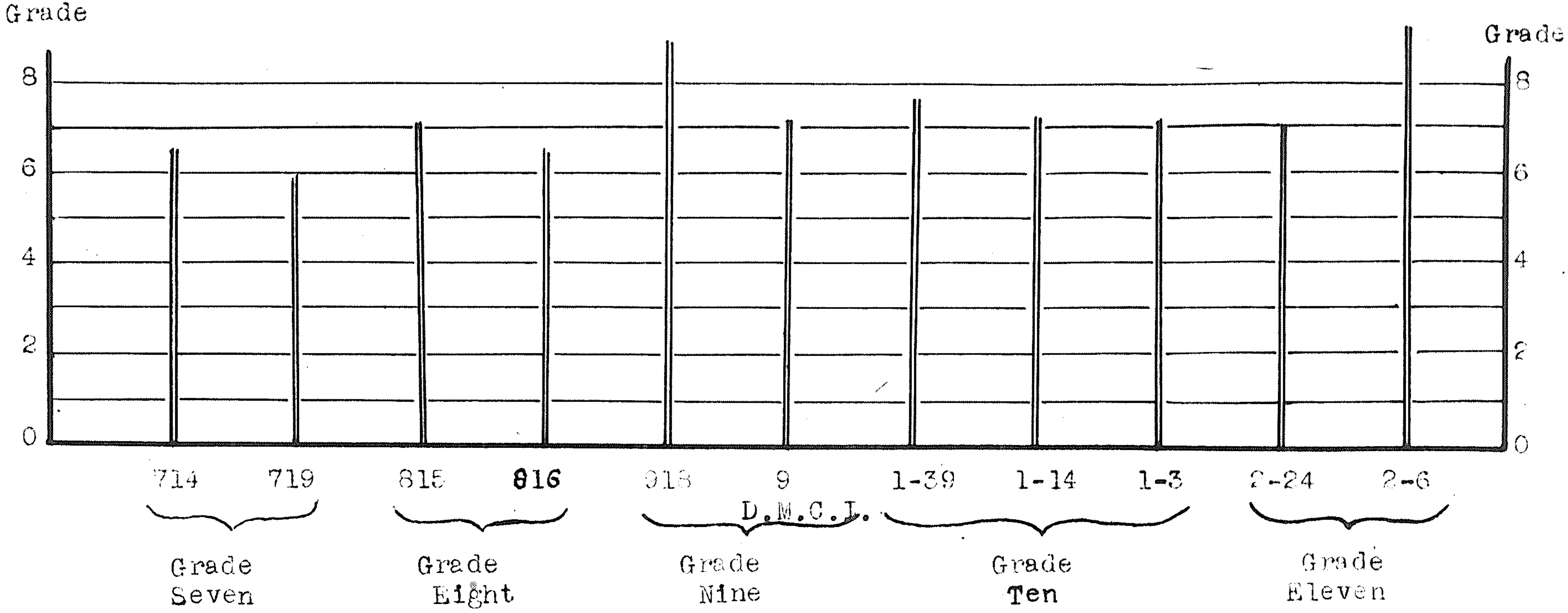
r_{ir} - the relationship between science interest and silent reading ability.

The calculations of the two correlation coefficients

FIGURE XXXIV

BAR GRAPHS SHOWING MEAN READING SCORES FOR EACH CLASS TESTED

MONROE'S STANDARDIZED SILENT READING TESTS REVISED - TEST 1 AND TEST 2



were undertaken using two way frequency charts. In both frequency charts (Figure XXXV and Figure XXXVI) the vertical axis represents the pupils' science interest scores, and the horizontal axis represents the pupils' reading scores in terms of Monroe raw scores. From Figure XXXV it is seen that the coefficient of correlation between science interest scores and silent reading scores for the Principal Sparling Grade Seven classes (714 and 719) is -0.072. From Figure XXXVI it is seen that $r_{ir} = 0.0957$ for one Daniel McIntyre Grade Nine class. It will be seen that these coefficients are very close to zero and therefore we can say that they indicate no consistent relationship between silent reading ability scores and science interest scores in the classes tested.

At this point the limitations of the two tests used should be considered. The validity of Monroe's Standardized Silent Reading Test may be questioned on the grounds that it is a short test. The writer's experience, however, has been that this reading test is very useful for determining the poor silent readers at the elementary and junior high school levels. The validity of the Science Interest Scale Form A Revised can also be questioned. With the limitations of both tests in mind it is possible to draw reasonable conclusions. The silent reading test may not be testing the kind of reading required in understanding the science questionnaire but every effort was made to avoid technically scientific language.

From this enquiry it appears that there is little if any mathematical relationship between silent reading scores and science interest scores of the classes tested. Science interest, therefore, does not appear to depend on silent reading ability. Also, it would seem that the mean silent reading scores of the classes tested range from grade six up to the limits of the test used (approximately grade nine or over).

FIGURE XXXV

Reading Scores

Science Interest Scores

	6	7	8	9	10	11	12	13	14	15	16	F_Y	D_Y	F_YD_Y	$F_YD_Y^2$	$F_{XY}D_X$	$D_YF_{XY}D_X$
15						1_{5}^{0}						1	5	5	25	0	0
12						1_{4}^{0}						1	4	4	16	0	0
9			1_{3}^{-3}			1_{3}^{0}	1_{3}^{1}		1_{3}^{3}			4	3	12	36	1	3
6				1_{2}^{-2}	11_{4}^{-2}	111_{6}^{0}	11_{4}^{2}	11_{4}^{4}	1_{2}^{3}			11	2	22	44	5	10
3	1_{1}^{-5}		111_{3}^{-3}	1111_{4}^{-8}	1_{1}^{-1}	11_{2}^{0}	1_{1}^{1}	111_{3}^{6}	11_{2}^{6}		1_{1}^{5}	18	1	18	18	-5	-6
0	1_{0}^{-5}	1_{0}^{-4}	1_{0}^{-3}	1_{0}	11_{0}^{-2}	11_{0}^{0}	11_{0}	11_{0}	$\cancel{1111}_{0}^{15}$	1_{0}^{4}		18	0	0	0	9	0
-3					1_{-1}^{-1}		$\cancel{1111}_{-5}^{5}$	11_{-2}^{4}	1_{-1}^{3}	1_{-1}^{4}		10	-1	-10	10	15	-15
-6				1_{-2}^{-2}			1_{-2}^{1}					2	-2	-4	8	-1	2
-9												0	-3	0	0		0
-12					1_{-4}^{-1}							1	-4	-4	16	-1	4
F_X	2	1	5	7	7	10	12	9	10	2	1	66		43	173	23	-1
D_X	-5	-4	-3	-2	-1	0	1	2	3	4	5						
F_XD_X	-10	-4	-15	-14	-7	0	12	18	30	8	5	23					
$F_XD_X^2$	50	16	45	28	7	0	12	36	90	32	25	341					
$F_{XY}D_Y$	1	0	6	4	0	20	1	5	6	-1	1	43					
$D_XF_{XY}D_Y$	-5	0	-18	-8	0	0	1	10	18	-4	5	-1					

$$r_{IR} = \frac{\sum D_X F_{XY} D_Y - \frac{(\sum F_X D_X)(\sum F_Y D_Y)}{N}}{\sqrt{\left(\sum F_X D_X^2 - \frac{(\sum F_X D_X)^2}{N}\right)\left(\sum F_Y D_Y^2 - \frac{(\sum F_Y D_Y)^2}{N}\right)}} = \frac{-1 - \frac{23 \times 43}{66}}{\sqrt{\left(341 - \frac{23^2}{66}\right)\left(173 - \frac{43^2}{66}\right)}}$$

$$r_{IR} = \frac{-15 \cdot 98}{\sqrt{(332 \cdot 98)(144 \cdot 99)}} = \frac{a}{\sqrt{bc}} = \underline{\underline{-0 \cdot 072}}$$

$\log a = 1 \cdot 20358$

$\frac{b+c}{2} = \underline{2 \cdot 34169}$

$\underline{\bar{2} \cdot 86189}$

$\log b = 2 \cdot 52231$

$\log c = \underline{2 \cdot 16107}$

$\underline{4 \cdot 68338}$

Classes 714 and 719

Two-way Frequency Table for r_{ir}

FIGURE XXXVI

Reading Scores

Science Interest	6	7	8	9	10	11	12	13	14	15	16	17	F_Y	D_Y	$F_Y D_Y$	$F_Y D_Y^2$	$\Sigma' F_{XY} d_X$	$d_Y \Sigma' f_{xy} d_x$
12					1^{-2}_{4}								1	4	4	16	-2	-8
9					1^{-2}_{3}		1^{0}_{3}						2	3	6	18	-2	-6
6				1^{-3}_{2}		1^{-1}_{2}		1^{1}_{2}		1^{3}_{2}			4	2	8	16	0	0
3						11^{-2}_{2}				1^{3}_{1}	1^{4}_{1}	1^{5}_{1}	5	1	5	5	10	10
0							1^{0}_{0}	1^{1}_{0}	11^{4}_{0}	11^{6}_{0}		1^{5}_{0}	7	0	0	0	16	0
-3				1^{-3}_{-1}				1^{1}_{-1}	1^{2}_{-2}	11^{6}_{-2}			5	-1	-5	5	6	-6
-6			1^{-4}_{-2}										1	-2	-2	4	-4	8
-9					11^{-4}_{-6}			11^{2}_{-6}	11^{4}				6	-3	-18	54	2	-6
-12		1^{-5}_{-4}											1	-4	-4	16	-5	20
F_X		1	1	2	4	3	2	5	5	6	1	2	32		-6	134	21	12
D_X		-5	-4	-3	-2	-1	0	1	2	3	4	5						
$F_X D_X$		-5	-4	-6	-8	-3	0	5	10	18	4	10	21					
$F_X D_X^2$		25	16	18	16	3	0	5	20	54	16	50	223					
$\Sigma' F_{xy} D_y$		-4	-2	1	1	4	3	-5	-7	1	1	1	-6					
$D_x(\Sigma' F_{xy} D_y)$		20	8	-3	-2	-4	0	-5	-14	3	4	5	12					

$$r_{ir} = \frac{D_y \sum F_{xy} \cancel{D_x} - \frac{(\sum F_X D_X)(\sum F_Y D_Y)}{N}}{\sqrt{\left(\sum F_X D_X^2 - \frac{(\sum F_X D_X)^2}{N}\right)\left(\sum F_Y D_Y^2 - \frac{(\sum F_Y D_Y)^2}{N}\right)}} = \frac{a}{\sqrt{bc}}$$

$$r_{ir} = \frac{12 - \frac{21 \times -6}{32}}{\sqrt{\left(223 - \frac{21^2}{32}\right)\left(134 - \frac{-6^2}{32}\right)}} = \frac{15.93}{\sqrt{(209.22)(132.88)}}$$

$\log b = 2.32056$
$\log c = 2.12336$
4.44392

$$r_{ir} = 0.0957$$

$\log a = 1.20303$
$\log \frac{b+c}{2} = 2.22196$
$\bar{2}.98107$

One Grade Nine Class

Two-way Frequency Table for r_{ir}

CHAPTER XII

ENQUIRY SIX

A Comparison between Mean Science Interest Scores as Found in January and Those Found in September; A Comparison between Science Interest Scale Form A Revised and Science Interest Scale Form B

The purpose of this chapter is to compare science interest scores of high school pupils found in September with those found in January; at the same time a comparison will be made of the two science interest scales - Science Interest Scale Form A Revised used in September and Science Interest Scale Form B used in January. These two comparisons are made simultaneously since the one is concomitant with the other.

As has been previously noted, a marked difference between the boys' mean score and the girls' mean score was found to exist. A mean score for a mixed group would, therefore, be meaningless since it would depend upon the percentage of boys or girls in the group rather than upon the science interest of the group. With this fact in mind it was decided to compare high school pupils' science interest scores as found in September with those found in January, and at the same time compare the Science Interest Scale Form A Revised with the Science Interest Scale Form B in the four following ways:

1. By determining the difference between the mean score for boys on the Form A

Revised and the mean score for boys on the Form B;

2. By determining the difference between the mean score for the girls on the Form A Revised and the mean score for girls on the Form B;
3. By constructing bar graphs for each grade and sex for both Form A Revised and Form B;
4. By determining the coefficient of correlation between Form A Revised and Form B for 103 pupils.

The results for 1. and 2. in the previous paragraph are shown in Tables VI and VII. The difference between the means of Form A Revised and Form B for boys is seen to be 0.12. This difference is almost negligible compared to the statistically significant difference found in Chapter VIII. As if to confirm this small difference, the difference in the means of Form A Revised and Form B for girls is found to be 0.039. From these two small differences it would appear that the Science Interest Scale Form A Revised is very similar to the Science Interest Scale Form B. It is also apparent that there is little change in interest in science on the part of the pupils from September to January.

The third method of comparison deals with the bar graphs shown in Figure XXXVII. From these bar graphs it is seen that the differences in mean scores of the A and B forms are definitely larger than when the grades are considered separately. At the grade ten level the mean score for boys and the

TABLE VI

A COMPARISON OF SCIENCE INTEREST SCALE FORM A REVISED WITH SCIENCE INTEREST SCALE FORM B USING THE SCORES OF HIGH SCHOOL BOYS

Score Mid Points	Form A			Form B		
	f	d	fd	f	d	fd
15	0	4	0	0	5	0
12	7	3	21	3	4	12
9	3	2	6	13	3	39
6	19	1	19	10	2	20
3	18	0	0	17	1	17
0	23	-1	-23	15	0	0
-3	6	-2	-12	6	-1	-6
-6	0	-3	0	1	-2	-2
-9	1	-4	-4	1	-3	-3
-12	0	-5	0	0	-4	0
-15	0	-6	0	0	-5	0

$N = 77;\ \Sigma fd = 7$

$$\frac{\Sigma fd}{N} = 0.0909$$

In score units
$0.0909 \times 3 = 0.273$

Mean = A.R. + correction

Mean = $3 + 0.273$

Mean = 3.273

$N = 65;\ \Sigma fd = 77$

$$\frac{\Sigma fd}{N} = 1.13$$

In score units
$1.13 \times 3 = 3.39$

Mean = A.R. + correction

Mean = $0 + 3.39$

Mean = 3.39

Difference between the means of Science Interest Scale Form A Revised and Form B
$3.39 - 3.27 = 0.12$

TABLE VII

A COMPARISON OF THE SCIENCE INTEREST SCALE FORM A REVISED WITH THE SCIENCE INTEREST SCALE FORM B USING THE SCORES OF HIGH SCHOOL GIRLS

Score Mid Points	Form A			Form B		
	f	d	fd	f	d	fd
15	0	5	0	0	6	0
12	1	4	4	0	5	0
9	1	3	3	3	4	12
6	5	2	10	4	3	12
3	8	1	8	10	2	20
0	19	0	0	9	1	9
-3	12	-1	-12	11	0	0
-6	8	-2	-16	4	-1	-4
-9	3	-3	-9	4	-2	-8
-12	4	-4	-16	6	-3	-18
-15	0	-5	0	1	-4	-4

$N=61; \Sigma fd= -38$

$\frac{\Sigma fd}{N} = -0.622$

In score units

$-0.622 \times 3 = -1.866$

Mean = A.R. + Correction

Mean = 0 -1.866

Mean = -1.866

$N=52; \Sigma fd=19$

$\frac{\Sigma fd}{N} = 0.365$

In score units

$0.365 \times 3 = 1.095$

Mean = A.R. + Correction

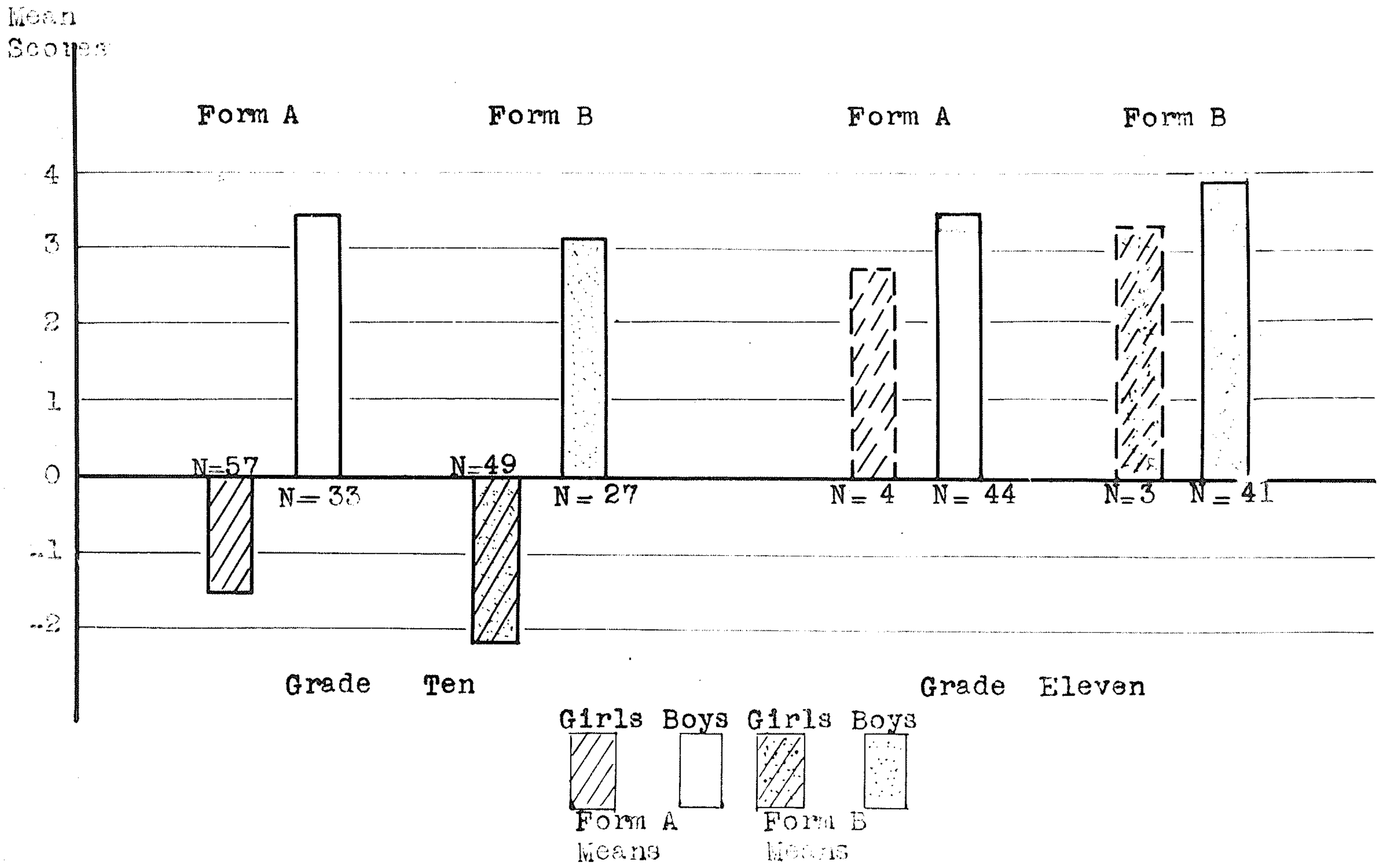
Mean = -3 + 1.095

Mean = -1.905

Difference between the means of the Science Interest Scale Form A Revised and the Science Interest Scale Form B $-1.866 + 1.905 = 0.039$

FIGURE XXXVII

Graphs Contrasting Form A Revised Science Interest Mean Scores for High School Boys and Girls with Those of Form B



mean score for girls on the Form B seem approximately 0.5 lower than the same groups on the Form A Revised. At the grade eleven level, however, the mean score for boys and the mean score for girls is approximately 0.5 higher. If we assume for purposes of argument that the two forms of the test are for all practical purposes identical, then it would appear that the grade ten group have lost interest in science while the grade eleven group appear to have gained interest. Furthermore, the group that had least interest lost the most interest while a group that had the most interest gained the most interest.

The fourth method of comparison employed with the Science Interest Scale Form A Revised and the Science Interest Scale Form B is the most accepted method of expressing the relationship between two sets of measures - the coefficient of correlation. The product moment coefficient of correlation was determined for Form A Revised and Form B.

r_{AB} - is the relationship between Science Interest Scale Form A Revised and Science Interest Scale Form B.

As shown in Figure XXXVIII the coefficient of correlation as defined was determined for 103 school pupils. In Figure XXXVIII the vertical axis represents the Science Interest Scale Form A Revised scores while the horizontal axis represents the Science Interest Scale Form B scores. $r_{AB} = 0.758$.

The value of $\frac{2.58}{\sqrt{N}}$ in this case is 0.254. Since the

FIGURE XXXVIII - TWO-WAY FREQUENCY TABLE FOR r_{AB}

Science Interest Scores – Form B

Science Interest Scores – Form A

	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	F_Y	D_Y	F_YD_Y	$F_YD_Y^2$	$\Sigma F_{XY}D_X$	$D_Y(\Sigma F_{XY}D_X)$
14																																		
13																								I^{9}_{13}					1	13	13	169	9	117
12																						I^{7}_{12}	I^{8}_{12}						2	12	24	288	15	180
11																						I^{7}_{11}			I^{10}_{11}		I^{12}_{11}		3	11	33	363	29	319
10																									I^{10}_{10}		I^{12}_{10}		2	10	20	200	22	220
9																													0	9	0	0	0	0
8																													0	8	0	0	0	0
7															I^{0}_{7}				I^{4}_{7}	I^{5}_{7}									3	7	21	147	9	63
6																	I^{2}_{6}	I^{3}_{6}											2	6	12	72	5	30
5															I^{0}_{5}	I^{1}_{5}		I^{3}_{5}	I^{4}_{5}	I^{5}_{5}	II^{12}_{10}	I^{7}_{5}	II^{16}_{10}	I^{9}_{5}	I^{10}_{5}				12	5	60	300	67	335
4									I^{-6}_{4}								I^{2}_{4}			I^{5}_{4}	II^{12}_{8}	I^{7}_{4}	I^{8}_{4}				I^{12}_{4}		8	4	32	128	40	160
3												I^{-3}_{3}	I^{-2}_{3}	I^{-1}_{3}		II^{2}_{6}		I^{3}_{3}		II^{10}_{6}			I^{8}_{3}	I^{9}_{3}					10	3	30	90	26	78
2												I^{-3}_{2}					II^{4}_{4}		II^{8}_{4}						I^{10}_{2}				6	2	12	24	19	38
1												I^{-3}_{1}		I^{-1}_{1}	I^{0}_{1}		II^{4}_{2}	I^{3}_{1}	III^{12}_{3}										9	1	9	9	15	15
0				I^{-11}_{0}					I^{-6}_{0}		I^{-4}_{0}		I^{-2}_{0}		II^{0}_{0}	III^{3}_{0}	I^{2}_{0}	II^{6}_{0}											12	0	0	0	-12	0
-1							I^{-8}_{-1}			I^{-5}_{-1}		I^{-3}_{-1}	II^{-4}_{-2}	I^{-1}_{-1}	I^{0}_{-1}	II^{2}_{-2}													9	-1	-9	9	-19	19
-2			I^{-12}_{-2}									II^{-6}_{-4}	I^{-2}_{-2}	II^{-2}_{-4}	I^{0}_{-2}														7	-2	-14	28	-22	44
-3															I^{0}_{-3}			I^{3}_{-3}											2	-3	-6	18	3	-9
-4							I^{-8}_{-4}								I^{0}_{-4}														2	-4	-8	32	-8	32
-5	I^{-14}_{-5}		I^{-12}_{-5}								I^{-4}_{-5}					I^{1}_{-5}													4	-5	-20	100	-29	145
-6																													0	-6	0	0	0	0
-7					I^{-10}_{-7}				I^{-6}_{-7}		I^{-4}_{-7}																		3	-7	-21	147	-20	140
-8																I^{1}_{-8}													1	-8	-8	64	1	-8
-9							I^{-8}_{-9}																						1	-9	-9	81	-8	72
-10											I^{-4}_{-10}																		1	-10	-10	100	-4	40
-11				I^{-11}_{-11}																									1	-11	-11	121	-11	121
-12																													0	-12	0	0	0	0
-13		I^{-13}_{-13}		I^{-11}_{-13}																									2	-13	-26	338	-24	312
-14																																		
F_X	1	1	2	3	1	0	3	0	3	1	4	6	5	5	9	10	7	7	7	5	4	4	5	3	4	0	3	0	103		124	2808	103	2463
D_X	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12							
F_XD_X	-14	-13	-24	-33	-10	0	-24	0	-18	-5	-16	-18	-10	-5	0	10	14	21	28	25	24	28	40	27	40	0	36		103					
$F_XD_X^2$	196	169	288	363	100	0	192	0	108	25	64	54	20	5	0	10	28	63	112	125	144	196	320	243	400	0	432		3659					
$\Sigma F_{XY}D_Y$	-5	-13	-7	-24	-7	0	-14	0	-3	-1	-22	1	-1	-1	3	-4	16	12	19	22	18	32	29	21	28		25		124					
$D_X\Sigma F_{XY}D_Y$	70	169	84	264	70	0	112	0	18	5	88	-3	2	1	0	-4	32	36	76	110	108	224	232	189	280	0	300		2463					

The calculation of r_{AB} :

$$r_{AB} = \frac{\Sigma F_{XY} D_X D_Y - \frac{(\Sigma F_X D_X)(\Sigma F_Y D_Y)}{N}}{\sqrt{\left(\Sigma F_X D_X^2 - \frac{(\Sigma F_X D_X)^2}{N}\right)\left(\Sigma F_Y D_Y^2 - \frac{(\Sigma F_Y D_Y)^2}{N}\right)}} = \frac{a}{\sqrt{bc}}$$

$$r_{AB} = \frac{2463 - \frac{103 \text{ X } 124}{103}}{\sqrt{\left(3657 - \frac{103^2}{103}\right)\left(2828 - \frac{124^2}{103}\right)}}$$

$$r_{AB} = \frac{2463 - 124}{\sqrt{(3657 - 103)(2828 - 149)}}$$

$$r_{AB} = \frac{2339}{\sqrt{(3554)(2679)}}$$

$$r_{AB} = \underline{\underline{0.7580}}$$

$$\begin{array}{rcl} \log a &=& 3.36903 \\ \frac{b+c}{2} &=& \underline{3.48934} \\ && 1.87969 \end{array} \qquad\qquad \begin{array}{rcl} \log b &=& 3.55072 \\ \log c &=& \underline{3.42797} \\ && 6.97869 \end{array}$$

value of r_{AB} obtained in the foregoing paragraph exceeds 0.254, we may say that $r_{AB} = 0.758$ is significant at the 1 per cent level.

According to Garrett [1] this value of r and N gives a probable error of 0.029. Therefore the chances are 99 in 100 that the "true" r_{AB} falls within the limits $0.758 \pm 4 \times 0.029$, or between 0.642 and 0.874.

From this chapter it would appear that the Science Interest Scale Form A Revised is very similar to the Science Interest Scale Form B. The difference between the means for high school boys on the Form A Revised and the same high school boys on the Form B is about one tenth of one point on the scale, while the difference between the means for high school girls on the Form A Revised and the same girls on the Form B is far less than a tenth of a point on the scale. See Tables VI and VII. It will be recalled that a difference in means of 2.90 on the Science Interest Scale Form A Revised was found to be significant in Chapter VIII.

To continue this summary, it was noticed that the differences in mean scores for Form A Revised and Form B are a little greater when the groups (boys' groups and girls' groups) are considered by grades. Here the differences are

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[1] Garrett, H. E. Statistics in Psychology and Education, Longmans, Green and Co. 1937, p. 281.

about half a scale point and the grade ten pupils show a slight loss of interest while the grade eleven pupils show a slight gain.

Finally, the relationship between the Science Interest Scale Form A Revised and the Science Interest Scale Form B is shown by the coefficient of correlation of $r_{AB} = 0.758$. Since this value of r_{AB} exceeds $\frac{2.58}{\sqrt{N}}$ it is significant at the 1 percent level. All in all, it would appear that, in the high school pupils tested, little change of science interest took place from September to January. Furthermore, the Science Interest Scale Form A Revised appears to be very similar to the Science Interest Scale Form B.

CHAPTER XIII

Comparisons, Applications, and Conclusions

The purpose of this paper, as stated in Chapter II, was to investigate pupils' interest in science in some Junior and Senior High Schools in Winnipeg. This investigation included six different enquiries which with their corresponding findings are briefly summarized below. The definitions of interest stated in Chapter II will also be considered in the light of this investigation.

Enquiry One

> A study to determine the percentage of pupils in a Winnipeg Junior High School who are sufficiently interested in science to undertake voluntary construction-type projects related to their curriculum.

This enquiry involved some 542 pupils during the years 1945 to 1950. A total of 109 different pupils completed science projects during this time. It may therefore be stated that, as far as these pupils are concerned, not less than 20% of them are sufficiently interested in science to undertake construction-type projects in their own time.

Enquiry Two

> A study using an original questionnaire (Science Interest Scale, Form A Revised) of the Thurstone-Chave-Likert type to measure interest in science

of Junior and Senior High School students and to note variations of science interest through the grades.

The Science Interest Scale Form A Revised revealed that for 348 Winnipeg pupils science interest appears to follow a normal distribution and that this interest is reasonably constant through the Junior and Senior High School grades except at the grade nine level for boys and the grade nine and ten levels for girls. At the grade nine and ten levels girls actually appear to have an antipathy towards science ! The difference between girls' interest in science and boys' interest in science was found to be statistically significant.

With these facts in mind it would appear that a worthwhile investigation could be undertaken to determine the cause of this feminine antipathy towards the science at the grade nine and ten levels.

Enquiry Three

A comparison between interest scores of Enquiry Two and the percentage found in Enquiry One.

If the Junior High School pupils who attended the Principal Sparling School during the years 1945 to 1950 are comparable to the pupils who were in attendance at the same Junior High School during September and October 1952, then it is possible to estimate that a pupil making a score of six or more on the Science Interest Scale Form A Revised would be likely to possess sufficient interest to undertake a construction-type project in his own time. This score of six or more indicates that a pupil has said he is highly interested in science. On the basis of this correspondence of the two 20% groups, it appears that the pupils have answered the questionnaire truthfully with regard to claiming a high interest in science.

It is also seen that 38% of Junior High School pupils are passively interested in science while 33% of Junior High School pupils say they are not interested in science.

Enquiry Four

A comparison between students' interest in science, as found in Enquiry Two, and students' achievement in science as determined by report marks.

The relationship between interest and achievement in science was found to vary. In one group it was found to be slightly negative according to the coefficient of correlation. In the largest group of pupils studied - mostly girls - it was very close to zero. In two groups of boys, however, the coefficient of correlation was found to be approximately $r_{ia} = 0.35$. This is in close agreement with a study dealing with students of the same age group reported by the Times Educational Supplement.[1] This article states, "There is some evidence that pupils believe themselves to be influenced by a 'proficiency' motive in expressing

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[1] Times Educational Supplement, February 1945, "A Study in Interests", from a correspondent.

their interests in school subjects, but the correlation obtained between interest and attainment, when these are measured objectively, has been found to be very low - of the order of .25 to .40 in most recent surveys."

Frandsen [2] found a positive relationship between scientific interest and academic achievement in college students. He states, "The correlation of .50 between science interest and achievement in natural science is especially important."

It would appear that the findings of this thesis agree with those reported by the Times Educational Supplement [3] with regard to the relationship of interest to achievement. Both these articles deal with pupils of the same age level. On the other hand Frandsen found a higher correlation between pupil interest and achievement than that found in this thesis. This may be accounted for by the fact that Frandsen was dealing with an older group andolder pupils usually select fields of study in which they have enjoyed some success.

On the basis of this report we may say that, generally speaking, the relationship between pupil interest and achievement in science is small and varies from group to group.

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2. Frandsen, A. N. "Interest and General Educational Development", Journal of Applied Psychology 31:57-66, February 1947, p. 61.

3. Times Educational Supplement, Op. cit.

Enquiry Five

A study using Monroe's Standardized Silent Reading Test Revised to determine the reading ability of pupils tested in Enquiry Two and to compare the reading ability thus found with interest scores using correlations.

The reading ability of the Junior High and Senior High School pupils tested might best be judged from the mean scores of each class tested. These mean scores range from grade six up to the limits of the test used (approximately grade nine or over). The relationship between reading ability and science interest appears to be negligible. The coefficient of correlation for two grade seven classes was found to be $r_{ir} = -0.072$, while that for one grade nine class was found to be $r_{ir} = 0.095$.

Enquiry Six

A study using an original questionnaire - Science Interest Scale Form B - of the Thurstone-Chave-Likert type to measure interest in science of Senior High School students and to compare the interest scores determined earlier in the school year using the Science Interest Scale Form A Revised. In this same study, Science Interest Scale Form A Revised will be compared with Science Interest Scale Form B.

From this enquiry it was found that in the group tested there was little overall change in science interest between the months of September and January. The grade ten pupils lost interest slightly while the grade eleven pupils gained in interest slightly. Since the coefficient of correlation between Form A Revised and Form B for 103 pupils was found to be $r_{AB} = 0.758$, we might say that there was a definite relationship between these two scales. This value of r_{AB} was found to be significant at the 1 per cent level.

As stated in the previous paragraph, the Science Interest Scale Form A Revised was given to the pupils in September while the Form B was given in the following January. During this time the pupils had written two sets of achievement tests. From this it would appear that school examinations have little effect upon science interest. This is in agreement with a study reported by the Times Educational Supplement [4] which states, "Very little research work has been done into the effect of examinations on the expression of interest, but a recent investigation has shown that approximately two-thirds of the pupils in a secondary school believe themselves to be uninfluenced by the effect of possible examination failure in considering their expressions of interest in school subjects. A comparison between expressions of interest in school subjects made over two equal periods, one of which included school examinations, gave a statistical difference which was barely significant. From both methods of investigation, therefore, the effect of school examinations would appear to be small." The agreement noted here between this thesis and the reports in the Times Educational Supplement not only strengthens the viewpoints of this thesis but points up the validity of the Science Interest Scales Form A Revised and Form B.

An application of these Science Interest Scales Form A

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4. Ibid.

Revised and Form B might well be considered in future investigations of science interest. Such investigations carried out in school areas other than that in which the present investigation was made could throw light on the change of science interest from grade seven to grade ten. Furthermore, since two forms of the Science Interest Scale are available, it would be possible to investigate changes in science interest in control and experimental groups that result from different methods of teaching.

To recapitulate - we may state that from these six enquiries concerning pupil interest in science:

1. Normally 20% of the pupils are actively interested in science at the Junior High School level;
2. Boys' interest in science remains reasonably constant through the grades except for the unexplained slump at the grade IX level; girls' interest does not remain constant through the grades but drops to the level of antipathy at grades IX and X; the difference between boys' and girls' interest in science is found to be statistically significant;
3. The percentage of pupils who are actively interested in science at the Junior High School level corresponds to the group who say they are highly interested in science;
4. The relationship between achievement and interest in science is small and varies with different groups; (this observation is supported by a report in the Times Educational Supplement)

5. The relationship between reading comprehension and science interest appears to be negligible, therefore reading ability is not a factor of science interest as this level;

6. The two forms of the Science Interest Scale developed for the purpose of this thesis appear to be very similar in their ability to measure scientific interest and we have reasons to believe they are valid tests of science interest; for the two forms the coefficient of correlation $r_{AB} = 0.758$ and this value of r_{AB} is significant at the 1 per cent level; in the groups tested those with most interest became more interested.

Returning for a moment to Chapter II, it will be recalled that the definitions of interest of three recognized authorities were there considered. It is now possible to reconsider parts of these definitions in the light of the foregoing recapitulation.

Dewey [5] states, "Genuine interest is the accompaniment of the identification, through action, of the self with some object or idea, because of the necessity of that object or idea for the maintenance of a self-initiated activity." This definition is in keeping with the philosophy underlying Enquiry One of this paper. The activity behind each of the twenty-two projects was self initiated since it was voluntary and undertaken in the pupils' free time.

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5. Dewey, John, Interest and Effort in Education, Houghton Mifflin Company, 1913, p. 14.

Wees'[6] contention that, "...to arouse and maintain children's interests is one of the two main reasons for teaching", may appear to be diffuse and ethereal. Yet when one considers that interest begets interest as stated in item six of the recapitulation, a new and richer meaning can be seen. Small interests in the minds of pupils might grow to become lasting interests in the minds of adults. Interest as an end in itself might be further justified if one considers that a science project undertaken and completed by a child actually modifies and enriches that child and in adult life any application of the scientific principles involved in that project is familiar territory in which he feels at home and confident. He is thus mentally alive with richer interest for the future. Interest begets interest.

Turning now to the quotation from Harris[7] statements are seen that are generally accepted yet are not validated by the findings of this paper. "In summary, then, a child's interests tend to grow and to channelize along with his developing abilities and skills. He generally likes to do what he can do well. Conversely, he tends to be uninterested in activities in which his performance is particularly poor." These are statements that are accepted by

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[6] Wees, W. The introduction to The Enterprise in Theory and Practice, W.J.Gage and Co. Ltd. 1940, p. 8.

[7] Harris, D.B., National Society for the Study of Education Forty-Ninth Yearbook Part 1, p. 131, Public School Publishing Company, Bloomington, Illinois.

many, possibly without justification, for they are rather sweeping statements. From observations made in this paper it would appear that, like many general statements, several important exceptions are to be found upon closer investigation. Contrary to the general statements of Harris, several grade ten girls with achievement marks in the eighties claim a distaste for science and an abhorrence of science examinations. Therefore factors other than science interest may produce their achievement. Another exception to the statements of Harris is the case of boys who, scoring in the twenty to forties on achievement examinations, will gladly turn up to set up science apparatus and make science equipment in their own time. Therefore factors other than attainment may stimulate their interest. In the opinion of the writer these two exceptions present fertile fields for further investigations.

On the other hand, if Harris [8] is in the main correct, then, in the light of this investigation, either the interest scales are not testing interest or the achievement tests are not testing science in the best sense. The interest scales, however, were validated in three different ways. First, the pupils expressing a great interest in science on the Science Interest Scale Form A Revised correspond on a percentage basis to a similar group of pupils who manifested their science interest by spending their free time making science apparatus. Second, mean scores on

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[8] Ibid.

the Science Interest Scale Form B were almost identical - within one tenth of a point - with mean scores on the Science Interest Scale Form A Revised for the groups of boys and the groups of girls tested. Third, the correlation coefficient for Form A and Form B was found to be 0.758 with a probable error of 0.029. Further support for the validity of these interest scales might be seen in the similarity of results obtained in this paper with those reported in the Times Educational Supplement.[9]

No such validation can be claimed for the achievement tests taken by these pupils in science and if we consider Harris' statements for the purposes of argument to be correct, then the achievement tests might not be testing the pupils' knowledge and understanding of science. We are therefore emboldened to say, since the Interest Scale has been validated and reading ability has been eliminated as a controlling factor, that achievement examinations very likely do not adequately test a pupil's potentialities in or understanding of science and its methods. Probably the practical projects of Enquiry One provide a better measure of judging whether children have acquired a scientific attitude and an understanding of science. These projects implied that the students had caught the true spirit and

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[9] Times Educational Supplement, Op. cit.

interest of the scientist. In the light of these statements it is suggested that other investigations might seek to improve achievement testing in science.

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APPENDIX A.

EIGHTY STATEMENT LIST

TYPE	Number	Statement
A	1.	I think of things that have to do with science most of the time I am away from school.
B	2.	I often think of things that have to do with science when I am away from school.
C	3.	I sometimes think of things that have to do with science when I am away from school.
D	4.	I seldom think of things that have to do with science when I am away from school.
E	5.	I never think of things that have to do with science when I am away from school.
A	6.	Science is the subject I enjoy most in school.
B	7.	I enjoy science more than most other school subjects.
C	8.	Science is just another school subject to me, sometimes I enjoy it, sometimes I don't.
D	9.	I seldom enjoy science as a school subject.
E	10.	I never enjoy science as a school subject.
A	11.	I like to read science books and magazines more than any other kind of book or magazine.
B	12.	I read science books and magazines quite frequently.
C	13.	I sometimes read science books and magazines but not more than I read other books and magazines.
D	14.	I seldom read science books and magazines.
E	15.	I never read science books and magazines.
A	16.	I like to do science experiments more than any other kind of school work.
B	17.	I like to perform science esperiments.
C.	18.	I neither like nor dislike science experiments.
D	19.	I don't like to perform science experiments.
E	20.	I hate science experiments.
A	21.	I like science more than any other school subject.
B	22.	I like science more than most school subjects.
C	23.	I neither like nor dislike science.
D	24.	I seldom like science as a school sujbect.
E	25.	I hate science.

APPENDIX A

EIGHTY STATEMENT LIST (Continued)

Type	Number	Statement
A	26.	Science interests me very much when I read it for an examination.
B	27.	Science interests me most of the time I am reading it for an examination.
C	28.	Science interests me about half the time I am reading it for an examination.
D	29.	Science interests me only part of the time I am reading it for an examination.
E	30.	Science never interests me while I am reading it for an examination.
A	31.	I am determined to take up scientific work when I grow up.
B	32.	When I grow up I wouldn't mind scientific work.
C	33.	When I grow up I don't think I should want a job that deals with science.
D	34.	When I grow up I don't want work that is partly scientific.
E	35.	When I grow up I shall avoid scientific work at all costs.
A	36.	I would rather do science homework than any other type of homework.
B	37.	I like science homework more than most of the homework I have to do.
C	38.	Science homework is no more pleasant than any other type of homework.
D	39.	I dislike science homework more than most other types of homework.
E	40.	I dislike science homework more than any other type of homework.
A	41.	I find I look at science pictures whenever I get a chance.
B	42.	I find science pictures interest me most of the time.
C	43.	I don't find scientific pictures more interesting than other pictures.
D	44.	I don't find most scientific pictures interesting.
E	45.	I don't find any scientific pictures interesting.

APPENDIX A

EIGHTY STATEMENT LIST (Continued)

Type	Number	Statement
A	46.	Science stories are the most attractive stories to me.
B	47.	I find magy science stories interesting.
C	48.	Science stories don't interest me more than other stories.
D	49.	Most science stories don't interest me.
E	50.	I find all science stories dull.
A	51.	I enjoy more than anything else hearing about the work of famous scientists.
B	52.	I generally like to hear about the work of famous scientists.
C	53.	The work of famous scientists doesn't interest me very much.
D.	54.	I dislike hearing about the work of famous scientists.
E	55.	I hate hearing about the work of famous scientists.
A	56.	There is nothing I enjoy more as a spare time activity than making something mechanical or setting up some type of science apparatus.
B	57.	Often I like to spend my spare time making something mechanical or setting up some type of science apparatus.
C	58.	I sometimes spend my spare time making something mechanical or setting up some type of science apparatus.
D	59.	I very seldom spend my spare time making something mechanical or setting up some type of science apparatus.
E	60.	I would certainly hate to spend any of my spare time making something mechanical or setting up some type of science apparatus.
A	61.	There is nothing I like better in school than listening to the science teacher.
B	62.	I enjoy listening to the science teacher.
C	63.	I neigher like nor dislike listening to the science teacher.
D	64.	I don't like to listen to a science teacher.
E	65.	If there is anything I hate it is listening to a science teacher.
A	66.	There are few things I like better than telling my friends in the lower grades about the science lessons we have.
B	67.	I often enjoy telling my friends in the lower grades about the science lessons we have.

APPENDIX A

EIGHTY STATEMENT LIST (Continued)

Type	Number	Statement
C	68.	I somtimes tell by friends in the lower grade about the science lessons we have.
D	69.	I rarely tell my friends in the lower grades about the science lessons we have.
E	70.	I never tell my friends in the lower grades about the science lessons we have.
A	71.	I very much enjoy hearing my friends in the upper grades tell me about their science lessons.
B	72.	I like to hear my friends in the upper grades tell me about their science lessons.
C	73.	I neither like nor dislike hearing my friends in the upper grades tell about their science lessons.
D	74.	I rarely like my friends in the upper grades to tell me about their science lessons.
E	75.	I very much dislike hearing my friends in the upper grades tell me about their science lessons.
A	76.	Science field trips would be more enjoyable to me than any other type of school activity.
B	77.	I should like to go on science field trips.
C	78.	I would neither like nor dislike science field trips.
D	79.	Science field trips would not interest me very much.
E	80.	I should hate to go on science field trips.

APPENDIX B

SCIENCE INTEREST SCALE FORM B

A QUESTIONNAIRE

Pupil's Name ______________________ Room Number ________

YOUR INTEREST IN SCIENCE

Make a check ✓ mark on the line to the right of any statement with which you honestly agree.

1. I often think of things to do with science when I am away from school. ____
2. Science is just another school subject to me, sometimes I enjoy it, sometimes I don't. . . . . ____
3. I seldom like to read science books and magazines. . . . . ____
4. I hate science experiments. . . . . ____
5. I like science more than any other school subject. . . . . ____
6. Science interests me most of the time I am reading it for an examination. . . . . ____
7. When I grow up I don't think I should want a job that deals with science. . . . . ____
8. I dislike science homework more than most other types of homework. . . ____
9. I don't find any scientific pictures interesting. . . . . ____
10. Science stories are the most attractive stories to me. . . . . ____
11. I generally like to hear about the work of famous scientists. . . . . ____
12. I don't find science pictures more interesting than other pictures. . ____
13. I don't like to listen to a science teacher. . . . . ____
14. I never tell my friends in the lower grades about the science lessons we have. . . . . ____
15. I very much enjoy hearing my friends in the upper grades tell me about their science lessons. . . . . . ____
16. I should like to go on science field trips. . . . . ____
17. I sometimes listen to science stories on the radio but I listen to other types of stories if I can. . . . . ____
18. I seldom enjoy science as a school subject. . . . . ____
19. I never think of things having to do with science when I am away from school . . . . ____
20. There are few things I like better than telling my friends in the lower grades about the science lessons we have. . . . . ____
21. I like science more than most school subjects. . . . . ____
22. The work of famous scientists doesn't interest me very much. . . . . . ____
23. I very seldom like my friends in the upper grades to tell me about their science lessons. . . ____
24. Science never interests me while I am reading it for an examination. . ____
25. I like to read science books and magazines more than any other kind of book or magazine. . . . . . . ____

(Form B - 1952)

APPENDIX C

SCIENCE INTEREST SCALE FORM A REVISED

A QUESTIONNAIRE

NAME ____________ GRADE 8

SCHOOL Spalding TEACHER'S NAME Mr. Holt

2+1+0+0+0 3✓

A B C D E

4+1+0-0-0 Score 5

YOUR INTEREST IN SCIENCE

Make a check ✓ mark on the line to the right of any statement with which you honestly agree.

1. Most of the time I am away from school I think of things that have to do with science. ____
2. I enjoy science more than most school subjects. ____
3. I sometimes read science books and magazines but not more than I read other books and magazines. ____
4. I don't like to perform science experiments. ____
5. I hate science. ____
6. Science interests me very much when I read it for an examination. ____
7. When I grow up I wouldn't mind work involving science. ____
8. Science homework is no more pleasant than any other type of homework. ____
9. I don't find most scientific pictures interesting. ____
10. I find all scientific stories dull. ____
11. I enjoy more than anything else hearing about the work of famous scientists. ____
12. Often I like to spend my spare time making something mechanical or setting up science apparatus. ✓
13. I neither like nor dislike listening to the science teacher. ____
14. Science field trips would not interest me very much. ____
15. I very much dislike hearing my friends in the upper grades tell me about their science lessons. ____
16. There is nothing I enjoy more as a spare time activity than making something mechanical or setting up science apparatus. ✓
17. I like to hear my friends in the upper grades tell me about their science lessons. ____
18. I neither like nor dislike hearing my friends in the upper grades tell about their science lessons. ____
19. I dislike hearing about the work of famous scientists. ____
20. When I grow up I shall avoid scientific work at all costs. ____
21. I like to do science experiments more than any other kind of school work. ✓
22. I read science books and magazines quite frequently. ____
23. Science stories don't interest me more than other stories. ____
24. I very seldom spend my spare time making something mechanical or setting up science apparatus. ____
25. I should hate to go on science field trips. ____

Form A (Revised) - 1952

Pupil's Name ____

ABCDE

YOUR INTEREST

Make a check / mark on the line to the right of any statement with which you honestly agree.

1. I often think of things to do with science when I am away from school. ____

2. Science is just another school subject to me, sometimes I enjoy it, sometimes I don't. . . . . ____

3. I seldom like to read science books and magazines. . . . . ____

4. I hate science experiments. . . . . ____

5. I like science more than any other school subject. . . . .

6. Science interests me most of the time I am reading it for an examination. . . . . ____

7. When I grow up I don't think I should want a job that deals with science. . . . . ____

8. I dislike science homework more than most other types of homework. . . ____

9. I don't find any scientific pictures interesting. . . . . ____

10. Science stories are the most attractive stories to me. . . . .

11. I generally like to hear about the work of famous scientists. . . . . ____

12. I don't find science pictures more interesting than other pictures. . ____

13. I don't like to listen to a science teacher. . . . . ____

14. I never tell my friends in the lower grades about the science lessons we have. . . . . ____

15. I very much enjoy hearing my friends in the upper grades tell me about their science lessons. . . . . .

16. I should like to go on science field trips. . . . . ____

17. I sometimes listen to science stories on the radio but I listen to other types of stories if I can. . . . . ____

18. I seldom enjoy science as a school subject. . . . . ____

19. I never think of things having to do with science when I am away from school . . . . . . ____

20. There are few things I like better than telling my friends in the lower grades about the science lessons we have. . . . .

21. I like science more than most school subjects. . . . . ____

22. The work of famous scientists doesn't interest me very much. . . . . . ____

23. I very seldom like my friends in the upper grades to tell me about their science lessons. . . ____

24. Science never interests me while I am reading it for an examination. . ____

25. I like to read science books and magazines more than any other kind of book or magazine. . . . . . .

(Form B - 1952)

APPENDIX E

SAMPLE OF PUPIL'S PAPER

NAME ____________________ GRADE VIII

SCHOOL Principal Sparling TEACHER'S NAME Mr. Kolt

1+0+5+1+0 7✓
A B C D E
2+0+0-1-0 Score 1

YOUR INTEREST IN SCIENCE

Make a check ✓ mark on the line to the right of any statement with which you honestly agree.

1. Most of the time I am away from school I think of things that have to do with science. . . . . ____
2. I enjoy science more than most school subjects. . . . . ____
3. I sometimes read science books and magazines but not more than I read other books and magazines. . . . . ✓
4. I don't like to perform science experiments. . . . . ____
5. I hate science. . . . . ____
6. Science interests me very much when I read it for an examination. . ____
7. When I grow up I wouldn't mind work involving science. . . . . ____
8. Science homework is no more pleasant than any other type of homework. . . . . ✓
9. I don't find most scientific pictures interesting. . . . . ____
10. I find all scientific stories dull. . . . . ____
11. I enjoy more than anything else hearing about the work of famous scientists. . . . . ____
12. Often I like to spend my spare time making something mechanical or setting up science apparatus. . . . . ____
13. I neither like nor dislike listening to the science teacher. . . . ✓
14. Science field trips would not interest me very much. . . . . ____
15. I very much dislike hearing my friends in the upper grades tell me about their science lessons. . . . . ____
16. There is nothing I enjoy more as a spare time activity than making something mechanical or setting up science apparatus. . ✓
17. I like to hear my friends in the upper grades tell me about their science lessons. . . . . ____
18. I neither like nor dislike hearing my friends in the upper grades tell about their science lessons. . . . . ✓
19. I dislike hearing about the work of famous scientists. . . . . ____
20. When I grow up I shall avoid scientific work at all costs. . . . . . ____
21. I like to do science experiments more than any other kind of school work. . . . . ____
22. I read science books and magazines quite frequently. . . . . ____
23. Science stories don't interest me more than other stories. . . . . . ✓
24. I very seldom spend my spare time making something mechanical or setting up science apparatus. . . . . ✓
25. I should hate to go on science field trips. . . . . ____

Form A (Revised) - 1952

APPENDIX F

DIRECTION SHEET FOR MONROE'S STANDARDIZED SILENT READING TESTS, REVISED

DIRECTIONS FOR GIVING MONROE'S STANDARDIZED SILENT READING TESTS, REVISED

Ask the pupils to clear off their desks and see that each one is provided with a well sharpened pencil. It is advisable for each pupil to have an extra pencil if this is convenient. Pen and ink should not be used.

The examiner should ask two or three pupils to distribute the test papers, placing a copy of the test folder on the desk of each pupil. This distribution will be facilitated if the examiner will place in separate piles the exact number of papers for the several rows. The examiner should not distribute the papers himself.

Have the pupils fill in the blanks at the top of the page which call for the pupil's name, age, grade, and so on. When all have completed this, ask them to look at the directions on the first page of the test folder while you read the directions aloud. See that the pupils draw a line under the correct word in each of the exercises in the direction. Do not tell the pupils what the answers are until they have had an opportunity to study the exercises. Before going on, ask the pupils if they understand what they are to do. If some do not understand, the examiner should go over these three exercises a second time. After the last paragraph of directions has been read, the examiner should say to the pupils: Turn to the next page but do not begin work. Attention. Pencils up! (Look at your watch and note the position of the second hand.) Ready Go! (Write down the position of the second hand. Allow exactly four minutes.) Stop! Attention! Draw a line through the number at the left of the line which you were reading when the signal to stop was given.

DIRECTIONS FOR SCORING

On this test the pupil is to be given two scores, one for rate and one for comprehension. The rate score is the average number of words read per minute. The words of the exercises have been counted and the accumulative totals printed in the left-hand margin. Take the number which the pupil has marked as indicating the line he was reading when time was called, and divide it by 4, since 4 minutes were allowed for the reading. The quotient is the number of words he has read per minute and becomes his rate score. The pupil's comprehension score is the number of exercises which he has done correctly. Each exercise answered correctly counts one point. Therefore, if eight exercises are correctly answered, the pupil's comprehension score would be 8. The pupil is expected to underline the correct word. However, accept any indication of the right word as correct. Write both the rate and comprehension scores in the upper right hand corner of the first page of the test folder. Note that in the case of Test II, 5 is to be added to the comprehension score and 29 to the rate score to make them comparable with the scores on Test I, and with the grade medians given below.

CORRECT ANSWERS

Test I, Form 1

1. swan
2. grandmother
3. happy
4. roof

5. hay
6. dog
7. mother
8. butterfly

9. cross
10. earth
11. unhappy
12. autumn

13. wet
14. insects
15. foolish
16. spring
17. severe

Test II, Form 1

1. productive
2. cheerless
3. rain
4. forest

5. contented
6. October
7. nature
8. brave

9. autumn
10. lazy
11. motion
12. sleep

13. sad
14. desert
15. drouth
16. downhearted

GRADE MEDIANS FOR MONROE SILENT READING REVISED

	Comprehension			Rate		
Grade	Form 1	Form 2	Form 3	Form 1	Form 2	Form 3
III	3.8	3.8	3.8	82	78	81
IV	7.7	7.7	7.7	122	116	121
V	9.8	9.8	9.8	142	135	141
VI	11.0	11.1	11.7	159	164	179
VII	12.5	12.6	13.3	171	176	193
VIII	13.7	13.8	14.6	185	191	208

These standards are derived from scores which for the most part represent the achievements of pupils early in the school year. The returns are about equally distributed between rural schools and city schools.

School .... Teacher .... Grade ....

Comprehension		Rate	
Number of pupils making each score		Number of pupils making scores between	
25		250–259	
24		240–249	
23		230–239	
22		220–229	
21		210–219	
20		200–209	
19		190–199	
18		180–189	
17		170–179	
16		160–169	
15		150–159	
14		140–149	
13		130–139	
12		120–129	
11		110–119	
10		100–109	
9		90– 99	
8		80– 89	
7		70– 79	
6		60– 69	
5		50– 59	
4		40– 49	
3		30– 39	
2		20– 29	
1		10– 19	
0		0– 9	
Total		Total	
Median		Median	

Instructions for Making the Distribution of Pupils' Scores, and for Finding the Median Score.

1. The teacher must be careful that her papers are grouped correctly by classes. If she has but one grade of pupils, say 5th grade, or but two divisions of one grade, say 5th A and 5th B, then her papers are all grouped together and but one "distribution" made. If, however, she has parts of two or more grades, say part 5th and part 6th, she must make two or more piles of papers, one for each grade.
2. Arrange the children's papers for any class group in order of the comprehension scores, the lowest score on top.
3. Record the number of pupils making each score in the column marked "Number of pupils" under comprehension. The sum of these numbers must equal the number of children taking the test.
4. The median score is the score on the middle paper in the pile of papers arranged according to size of scores. If there are 35 papers, the median score is the score on the 18th paper. If there are 36 papers, the median score is half way between the score on the 18th paper and the score on the 19th paper.
5. Repeat 2, 3, and 4, for the rate scores.

103-2p