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A survey of weather information possessed by thirty-two pupils randomly selected from sixth and eleventh grades and from special classes

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Boston University
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Thesis

A SURVEY OF WEATHER INFORMATION POSSESSED BY
THIRTY-TWO PUPILS RANDOMLY SELECTED FROM
SIXTH AND ELEVENTH GRADES AND FROM SPECIAL CLASSES

Submitted by

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the Degree of Master of Education
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Boston University
School of Education
Library
This is one of a series of studies being done under the direction of Dr. John G. Read at Boston University.
The writers of this thesis are deeply grateful to Dr. Read and to Dr. Nelson of the Boston University School of Education, and to Janet Coombs for their able guidance and help in the completion of this thesis.
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CHAPTER I
INTRODUCTION AND JUSTIFICATION

1. Introduction

Information about the interests, needs, and achievements of young people in the science area has been sought by many studies. Most of these use a questionnaire, a test, or depend on the observation of activities. Few research studies have let children talk about what they believe, without directives. It seems logical that if children and young adults should be given time and freedom to talk in a relatively unrestricted situation, and with a sympathetic listener, there might emerge some statements largely uncolored by the classroom teaching about science. A pupil who can say, "I guess I don't know much about that" is likely telling also what he really does know about a topic, such as weather, in science.

This study reports the results when one pupil sits with an investigator (who establishes rapport through several devices) and talks for the taped record about "weather". The range of information sought is controlled by using only certain aspects of the topic, and the freedom of responses is enhanced by asking only, "What can you tell me about...?"
In order to extend the study into a comparative one, two levels of maturity were sampled. One was the sixth grade, the other the junior-senior level in the high school, grades 11 and 12. Further, it was possible to interview young people at each of these levels who had an opportunity to work intensively and for some time with the topic of weather. Each age-maturity level had a group which learned about weather to the extent that they operated an official United States Weather Bureau in their respective schools. It was presumed that the young people had had what amounted to "saturation" teaching and learning in the area of weather in these two criterion groups.

There were then, four groups. In the sixth grade, some twelve children randomly chosen from accessible schools were interviewed. In the criterion group at the same level, four children who had been conducting the weather bureau were interviewed. At the eleventh grade level, there were twelve young people, randomly chosen from accessible schools, who were compared with a group of four who had finished a course in meteorology and who had operated the station at their school.

2. Justification

The need for this study can be understood in this light. If a principle is not taught at the optimum age-maturity level, its meaning may be either distorted or
lost. The following excerpt from DeLano demonstrates the need of introducing a science principle at a definite grade level.

"The results of these tests show clearly that the different portions of a major concept can be most easily imparted on different grade levels. If this is generally true, it indicates that determination of the grade placement of all important concepts should be made before science teaching can become scientific.

This investigation seems to indicate that we are destroying interest in science at the very beginning of instruction whenever we do not start at the proper level. Because of lack of understanding, students often develop an aversion to a subject before they have a chance to learn its possibilities. This unnecessary antipathy is very difficult to overcome and may fundamentally change the life work of the student."

Work has carried on since the beginning of the twentieth century to introduce the teaching of science, and therefore the introduction of science principles, at the elementary level. Gilbert says that there is a definite need of evaluating the curriculum in the elementary school.

"As to grade placement of topics then and now, there has been a noticeable increase in frequency of topics occurring above the third grade, thus indicating again, more extensive study in the field.

This brief review of the content of the elementary science curricula shows that attention is being given


this phase of our elementary education. However, science in the elementary grades is still in a transitional stage. There is a great need for further research in determining the basis for the selection and placement of topics in the science program."

Leonelli refers to previous studies undertaken in the field of grade placement of science principles: "Gilbert, Pella and DeLano in their findings have one thing in common—that grade placement is necessary at the present time for science in the elementary school." Leonelli goes on to point out one of the purposes of his study: "This investigation is conducted to determine...the grade placement of the physical science principles which are included in the curriculum." Under Suggestions for Further Study, Leonelli recommends: "As a further study, the experimental method for grade placement could be conducted using the principles and grades already determined in this investigation."

Therefore it is obvious that there is a definite need for this type of study in all grades. The inconsistency between different science-series textbooks on the elementary level points out the necessity for a common basis of introducing a unified system of presentations of science principles.


5/Ibid., p. 200.
There exist lists of principles of science which have been thought to be exact and capable of understanding by elementary and secondary school pupils. Among such lists is one validated by Robertson for the elementary school. Among the principles are some concerned with Weather.

Each pupil was asked to respond to these by answering specific questions, which, it should be noted, were the only questions asked. Each question seeks to elicit the residual, unprompted, presumably learned information which the pupil has.

It is expected that there will be differences in the level of responses. Intelligence, past experiences, interest, and socio-economic background undoubtedly play a part. Nevertheless, maturity and the increased awareness that comes with the broader environment allowed to older pupils will affect responses, especially in an area which is so culture-fair as is Weather. Weather has been around and about the child since birth, and its impact is constant. School learnings can have immediate applications in day by day weather. The young person who wishes can learn more than he is taught about Weather. This study seeks to discover just what a small sample of the school population

does "know" (as represented by what he says) about Weather; and what a part of that school population at two maturity levels has learned with every opportunity so to do by being immersed in formal saturation studies of weather and the application of the principles to the running of a weather station.

That the fixing of ideas, facts, words, appreciations, attitudes, and skills about science is important needs no defense. The response to particular principles, however, by pupils of various maturities and sophistications is the subject of considerable research. At Boston University School of Education the age-maturity placement of certain science principles here has been a subject of research for many years. The hypothesis is being tested that there is an age-maturity level (or range of two or three years) where there is a reasonable assurance that, with good teaching and a class of median size and ability, a science principle can be taught-and-learned so that at least half the children will be able to use this principle as an envelope to include most if not all the common experiences which belong to the set of experiences described by that principle. The evidence to date (1960) is that such levels are possible of identification. The reader is
referred to the December, 1958 Journal of Education for a summary of the philosophy, and to Science Education, October, 1958 for a report on some specific research studies. At this date, only indications of the placement of some dozen principles are available. This study is part of the continuing research.

Need for more research.— A 1960 mimeographed publication of the National Association for Research in Science Teaching lists suggested problems for the consideration of the membership. On page III-12, ISSUES RELATED TO CURRICULUM, among Suggested Problems there is listed:

1. What concepts, principles, and generalizations are suited for each grade level K-12?

On page III-16, Suggested Problems, among those listed:

1. What are the criteria which can be used in selecting science content for different levels of instruction?

And on page III-17, Suggested Problems:

1. What science principles and concepts need to be taught at the secondary level to insure college level success in such areas as general education, engineering, pre-medical, etc.?


Also on page IV-21, Suggested Problems:

3. What is the basic psychological nature of concept formation and its antecedents at different maturity levels, and what implication does this have for curriculum organization, and instructional materials in science?

6. What are the precise methods and mental processes by means of which young people make ideas of their own?

Note that there is implied in all these studies the fact that any information as to the status of learning of science principles at various maturity levels is needed before any postulates as to how these principles are made the pupils' own can be written. On page IV-22 this is further explicated:

4. What are the psychological characteristics of the learning processes of generalizations and what are the implications for the inductive-deductive approach to developing an understanding of principles of science and their applications?

It seems self-evident that the use of the tape-recorder in a non-directed situation where children tell what they believe to be true can contribute to further knowledge of both levels of understanding of science principles and to the process by which these understandings are acquired.
CHAPTER II
SURVEY OF RELATED LITERATURE

1. The Need for the Survey

At the present time very little data are available pertaining to the grade placement of science principles. Educators are stressing the need for studies that will determine the age levels for effective introduction of science principles and concepts. The need for a change in curriculum development is brought on by the ever-mounting store of scientific knowledge and by the need for an understanding of the basic concepts which are necessary as background material for more advanced theories.

In 1948, Alfred D. Beck, stated that scientific knowledge is accumulating at such a rapid rate that there is not time to delay the teaching of elementary science concepts until the student reaches the secondary level of schooling. He further states that the beginning high-school student has an inadequate background of basic science principles necessary for the understanding of a specialized science course. The solution to the problem lies in research to determine, "what fundamentals of science can we expect

most children of similar ability and cultural background to master at each maturity level."

In a progress report of the committee on Research in Elementary Science for the National Association for Research in Science Teaching, Venill expresses the need for the introduction of certain science concepts at the junior-high level rather than, as has been done, waiting for their use in the more advanced courses of high school. In summary Venill states that, "studies should be made on pupil readiness for more advanced science concepts." The National Society for the Study of Education suggests that a twelve-year science program based on science principles and concepts be taught. Morrison says that there is much needed research in the field of science teaching, and arranges the grade placement of topics at the top of the list along with the selection and sequences of courses.

13/Ibid., p. 175.
15/Ibid., p. 354.
within the curriculum.

2. Teaching By the Use of Principles

The following section is an excerpt from an unpublished thesis on the place of projects and demonstrations in the learning of science principles by Chalmers Murray, et al. 16/

The Murray Thesis is here quoted: The teaching of science by principle rather than by extraneous collections of facts has been generally accepted by educators. The Thirty-first Yearbook of the National Society for the Study of Education says that life enrichment, one aim of education, can best be achieved if the schools' activities are "of the kind from which ideas may be developed and if the ideas may in turn be associated into principles and generalizations that are interwoven into human experience. Functional learning is conditioned upon attainment of some such integration." 17/

Hoban says: "Education is not simply the accretion of information. It involves a fundamental knowledge and the understanding of the basic principles of the universe, of which man is a part." 18/


The inductive method.-- Here the learner arrives at a general conclusion, e.g. certain laws of physical sciences, by examining a number of individual cases. The weakness in this method is that there is a possibility of too general a conclusion, as the enumeration of particulars can never be totaled. For example: after several enumerations of plants having flowers such as, the cactus has a flower; we might conclude all plants have a flower. This is too general a conclusion as there are active fungi which do not possess flowers. Induction is thus essentially imperfect as a mode of reasoning, though invaluable as a means of fixing general principles and laws amid the succession of particulars given in experience.

The deductive method.-- The learner reasons from a principle to a particular. It is in this method that we shall be mainly interested, for we are basing our whole experiment on the reasoning powers of the learners to go from the principle to a particular inference to the principles in their learning process. For example; if the learner understands the principle of friction he can deduce that heat is released and wear between the surfaces takes place when one body is rubbed over another.

A large amount of our teaching attempts to teach pupils to see the implications of the laws, principles, and rules that they might have learned. As contrasted with induction, deduction is a much simpler and shorter process. It is an unusual situation when a bit of deductive teaching lasts longer than a few minutes.

Advantages of deductive educative teaching:

1. Much more simple than the inductive method
2. Results in very desirable outcomes
3. Introduces factors of organization
4. Makes meaningful the principles that have been mastered already
5. Arouses puzzle or questioning instinct, a very valuable aid
6. Helps pupils to derive their principles from books or demonstrative techniques.

Jones, Leonelli, Martin, and others have emphasized the value of teaching science by principle, and have listed hundreds of principles.


However, there is some disagreement as to what constitutes a principle. Heinmann defines a principle as "a statement of relationship between two or more facts." Wilbur's definition as stated by Martin is much more precise and makes a principle a very specific kind of generalization. His criteria state that a principle:

"Is stated positively and definitively
Is true but with rare exceptions within the limitations set up by the statement
Clearly states or implies a dynamic process or interaction
Is demonstratable experimentally
Is clearly not a part of a larger principle which can be clearly stated
Is not merely a definition or description
Has wide application in the natural environment and is not ruled out by any of the preceding criteria."

Robertson's definition of a principle was the result of many weeks of consideration by a seminar in science teaching under F. D. Curtis at the University of Michigan:

"a. To be a principle a statement must be a comprehensive generalization
b. It must be true without exception within limitations specifically stated
c. It must be a clear statement of a process or an interaction
d. It must be capable of illustration so as to gain conviction


e. It must not be a part of a larger principle
f. It must not be a definition
g. It must not deal with a specific substance."

With this definition, Robertson sought to determine a comprehensive list of principles suitable as goals of instruction for elementary schools. He evaluated nine separate studies listing principles found in textbooks, arranged according to frequency and stress, by a jury of three science teachers and several subject-matter specialists. A list of the 243 principles found was sent to fifteen elementary-school science teachers and from their ratings 113 principles were chosen. These are the principles used in the present study.

Some results.-- There is considerable evidence that scientific principles can be taught effectively to students at the secondary level. Freud and Cheronis readministered a comprehensive test to students of a survey course in physical science one year after the course had been completed. They found that principles and the ability to apply such principles were retained much better than were unrelated facts.27/

Babitz and Keys paired eight classes in chemistry in two California high schools. Four of the classes, designated as the control groups, received standard instruction; the other four designated as the experimental groups, had direct

27/Henrietta Z. Freud, and N. D. Cheronis, "Retention in the Physical Science Study Course," Chemical Education, (June, 1940), 18:288-293.
and intensive training on the application of principles. The tests administered at the end of the experiment required the solution of problems in chemistry and the identification of scientific principles related these two. All the experimental groups showed superiority over the control groups in the same schools. The differences however were not statistically significant. Kilgore paired 120 students in high-school physics with respect to their previous experience in science courses studied and I.Q. He found at the end of his study that students of both high and low ability were significantly better in making applications of principles of physics when the instructor placed emphasis on such application.

The evidence from these studies seems to indicate that the learning of principles of science, and the ability to apply them, may be attainable objectives of the teaching of science at the secondary level provided such objectives are emphasized in instruction. (End of quotation from Murray Thesis)

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The following excerpts from a manuscript by Dr. Read describe and substantiate the reasons for this study. They point out the relationship between the teaching of principles and the learning process:

"Learning has taken place when a pupil is able to use a principle to classify correctly phenomena of his own environment. Having learned, he can recognize that the observed phenomena are members of the same class as those from which he derived the principle in the teaching-learning process. He does not necessarily state the principle in words. In general, except for sampling errors in a test, he will classify correctly every common situation of his own environment which exemplifies this principle. The correct response will be made in the face of strong distractors seeking to divert him from his decision.

There is a lowest grade level at which it is profitable, in terms of efficiency, to spend a reasonable amount of time in attempting to have pupils understand a physical science principle and learn to use it as a powerful tool for classifying phenomena of his current nearby environment. The level of efficiency was decided upon to be fifty per cent; that is, it is more profitable to teach a principle at that lowest grade level where one-half or more of the experimental group could learn or understand a principle as evidenced by their ability to use it effectively in a test situation. Note that there is no denial of the fact that many, but not all, principles can have been partially understood and partially used by pupils long before they reach the grade level suggested as a result of this research.

All of these occurrences are concerned with maturation. One aspect of maturation is the opportunity which it affords for pupils to adventure more widely in their environment. In two years, for instance, pupils may have just a few more noticed experiences; the membership of

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these experiences in a class of experiences is not recognized. They are latent. When formal teaching presents the demonstration-exposition, these experiences are seen to be part of a hitherto faint pattern. The latent experience is developed, as it were, by the strong, direct, and precise thought process as a single principle is taught.

Dr. Pearl Nelson, in her study, describes one method of evaluating the answers transcribed from tape-recorded interviews. The following section introduces her method of answer analysis.

"The numbers in parenthesis indicate the rating given the responses by the writer in collaboration with Dr. Rawson, after the tapes had been transcribed verbatim. The number two (2) represents a perfect score; one (1) indicates a correct pairing of models and some idea of the reason for so doing."

This method of giving full credit, partial credit, or no credit at all can be seen in the Item Count Tables included in Dr. Nelson's dissertation.

3. What Are Acceptable and Good Interviewing Techniques

The ideal interview is one which will be as non-directive as possible. For the purpose of this study, however, it was not possible for the writers to be non-directive per se, in their interviews. The non-directive approach precludes that the client, or for our purpose called the interviewee, comes


32/ Ibid., p. 115-132.
of his own free volition to the interviewer, with a problem. This was not the case in this study, since we went to him with a problem.

Erickson gives several suggestions that may be followed in conducting a successful and fruitful interview. The following is a summary of these suggestions:

1. Use a warming up period to get acquainted.
2. Study your client to determine your starting techniques.
3. Follow the interviewee's lead before moving from the general to the specific, from the obvious to the less apparent.
4. Accept his attitudes and statements as facts.
5. Don't try to persuade, argue or coerce.
6. Don't reveal your attitudes or you will condition the rest of your interview. Don't imply, suggest or indicate your reaction.

"The suggestions that follow are not to be considered a set of rules for interviewing; they merely attempt to summarize suggestions that interviewers may study in order to improve their own techniques."

Opening the interview.— If both parties in the interview are nervous, it is important that they both arrive quickly at a more relaxed state. A few of the ordinary rules of good manners, like greeting the client by name, and asking


him to sit down, come quickly to mind. Then a relatively neutral and causal statement may open up the interview for the client.

**Phrasing questions.**-- One of the best ways to cut off any conversational flow from the client is to ask a question that can be answered by yes or not, or some similar terminal statement. Such questions should be avoided wherever possible.

**Overtalking the client.**-- Many people in an interview may find it difficult to state what they mean concisely, and without some fumbling for words. Don't be in such a hurry that you override or overtalk the client.

**Cross-examining.**-- Do not fire questions at the client like a machine-gun. The interview is not a cross-examination. When questions are needed, space them out and phrase them in as neutral a manner as possible.

**Silences in the interview.**-- Silences do not represent necessarily a real absence of activity. The client may be groping for words or ideas. Do not fill up these silences with a lot of chattering that breaks the trend of thought. If it becomes necessary to break a silence, merely ask the client to tell you a bit more about the point he has just finished covering.

**Distribution of talking time.**-- Generally speaking, if the interviewer talks considerably more than one-half the time, that interview will be less productive than the one in
which the interviewee talks more than one-half the time.

The vocabulary of the interviewer.-- The interviewer must make some judgement of the level of verbal ability and understanding of the person to whom he is talking. He must then choose his words accordingly, striving to keep the words as simple as possible and to keep the ideas as clear as possible.

Control of the interview.-- If the interview is to have the continuity and the end results desired, the interviewer must keep control of the interview. He may have to pull the client back from conversational byways, from fruitless arguments or from temporary insoluble problems. This can be done by using such expressions as, "We were talking..." or, "What was it you said about?..." or, "How does this fit into what you said earlier?"

Avoid the personal pronoun.-- Generally speaking, the interview will be more effective and will result in a freer conversation if the interviewer will rephrase questions or remarks to eliminate the use of I or me or similar references to himself.

Setting limits on the interview.-- It is better if the interviewer and the client realize from the beginning that the interview will last for a fixed length of time.

35/Adapted from The Interview in Counseling, Retraining and Reemployment Administration, U. S. Department of Labor, Washington, D. C., pp. 17-25.
Davis and Norris suggest that the counselor should study his own voice through recordings in order that he may be sure of its pleasantness. He also will do well to study his diction and emphasis.

In a personal interview with Dr. Dugald Arbuckle of the Guidance Department, Boston University, one of the writers discussed the use of a non-directive approach to the problem involved in this study, and it was suggested by Dr. Arbuckle that pictures might be used. The pictures were to serve as a means of motivating the thoughts of the pupil. The textbook pictures were used for this purpose.

4. Rationale

The study being undertaken is only a small part of a large ongoing study. It must be realized that the conclusions, in themselves, will not be statistically significant. They will, when combined with all of the other studies in the series, take their place in determining the age-maturity level of placement of several of the major concepts in the field of elementary science. Only when the entire study is completed and the conclusions drawn can statistical inferences be made.

The reasons for using several small groups in the course of this study, in preference to using one large group, can

be pointed out. This study will, as it must, take place over a period of years. Walker states the following reasons in favor of small-sized samples:

"...the sample size has been kept small for several reasons. (1) As sample size increases, the distributions of many statistics become more like the normal curve. The difference in form of the various curves is more dramatically portrayed when $N$ is small. (2) Drawing a number of small samples and combining them into one larger sample will help to make vivid the change which takes place in the sampling distribution of a statistic as $N$ increases. (3) For a given expenditure of time the student will learn more by computing a variety of statistics for each of a few small samples than by computing fewer statistics for larger samples."

From results of this study, a description of two groups may be derived. The study is in a field of general interest, the age-maturity level of placement of a concept. This study, by itself, has not led to any striking statistical conclusions. The following statement by Walker is descriptive of the procedures of this study.

"A statistical question always relates to a group of individuals rather than to a single individual and asks what is true of the group. Statistical inquiries are of two types. One type of inquiry calls only for a description of the group of individuals actually observed. Summary measures, or statistics, such as percents, averages or measures of variability are computed from the observations made on members of the group. The statistics are then used for

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38/Ibid., p. 1.
description of this particular group, but they are not used as foundation for a general theory applicable to similar groups that have not been examined.

A second type of statistical inquiry is more characteristic of scientific investigation. It involves a search for principles which have some degree of generality. If an investigation deals with matters of any general interest, the findings are usually applied to a much larger domain than the cases actually observed."

The statements above hint at the possible far-reaching effects of the study being carried on by this group. In itself, this study can do little more than describe the small group which has been sampled, but, as part of a larger study, the information may be applied to this larger domain.

The design of the study.— Notwithstanding the limitations of the study, the following description of the comparative nature of the study is pertinent.

a. The criterion groups. The following articles, which have been contributed by the Principal of the Parmenter School in Arlington, describe the situation concerning the weather station set up at this school. The first section is the constitution of the club.

"Friends of Science

This club will be formed by pupils of the sixth grades of the Parmenter School who have an unusual interest in the field of science. To be eligible for membership the grade level may be waived in exceptional cases, if the pupil has demonstrated unusual interest in science. Meetings of this club will be held on Thursday afternoons. These meetings will be conducted by elected officers according to an agenda prepared in advance. At each meeting a member or members will present some experiment or project in science which
they have developed.

At each meeting it will be planned to have a speaker on some scientific field, with demonstrations.

A record of all meetings will be kept by a secretary.

Previous to the meeting a guest committee will contact the speaker for information and special help.

A bulletin board on science subjects will be kept in each sixth grade room.

This club will have charge of and the care and maintenance of the school weather station, the recording of the daily reading and the daily weather notice sent to each classroom.

Dues may be assessed on a club basis, said dues to be used for promotion and expenses of field trips and other club projects as voted by the members."

The following section is a description of the weather station and its use at the Parmenter School:

"Those new instruments that turn and twist so freely atop the roof of the Parmenter School? They are a part of the weather project recently installed to permit the school to become a Contributing United States Weather Station.

The instruments were erected, perilously, more than 65 feet above the ground, through the cooperation of Mr. Lester Cameron, head of the Police and Fire Telegraph of the Town of Arlington.

Initiated as a project of the sixth grade pupils taught by Mrs. Margherita Duffy and Miss Mary Shannon, the idea was welcomed by Clifford R. Hall, Superintendent of Schools, and Kenneth A. Cameron, Principal of the Parmenter, as a project which would reach beyond the scope of regular classroom work and into the field of science.

The instruments are a gift of the school's Parent-Teacher Association given after exhaustive study by a committee headed by Mr. Charles H. Pierce of the U.S. Weather Bureau, Logan International Airport, and including Mrs. J. A. Pierce, Miss Shannon, and Mrs. Duffy. In their investigations they visited the station at Malden High School, which is apparently the only contributing weather station in a secondary school in New England; as the Parmenter's will be the only one
in an elementary school.

The first reading was taken on Friday, and the first team of observers was installed that day. A series of weather classes will be given by Mr. Pierce so that students will be able to make the two daily readings and record them for government charts. During the year the entire science group will be taught the plan, and each team will train another group in turn. The daily observations will be recorded in the individual classrooms for their daily weather calendars.

The array of instruments is arranged in the office of Principal Cameron, which is made available to pupils.

In a shelter outside the window are the Hygrometer and a Minimum-Maximum Thermometer. The former, which registers humidity, involves the use of a blond hair from a woman's head, since this is less affected by heat and is more sensitive to changes in humidity than other materials available. The specialized thermometer is in the shape of a U. In the left arm an iron needle is pushed up by rising mercury until it comes to rest at the highest temperature of the day; in the right arm a similar iron needle is pushed up by mercury registering the lowest temperature of a 24-hour period.

An aneroid barometer is mounted on a panel, from which children are taught to read and interpret barometric pressure.

A rain gauge, specially designed for this school and not quite completed, will be installed on the roof in such a way that the rainfall readings can be made in the office.

The anemometer panel in the office permits reading of the direction of the wind by lights that blink or show at one of the eight points of the compass. In the center a green light registers the wind velocity by giving one green flash per mile per minute. The anemometer and weather vane, installed above the roof higher than any of the surrounding buildings, are the gauges which are registering on this panel.

Students, who are members of the Friends of Science Club, are taught to interpret their readings and may be ahead of the forecasts available to the public.

The weather group at Malden High School is made up of students interested in the study and forecasting of
weather, and who are also members of the class in Meterology. Active membership involves some twenty or thirty students, with others who participate now and then.

This group had its beginning with the gift to the school of a set of good weather-forecasting equipment by a private citizen. Under the guidance and leadership of the head of the Meterology class, this weather group provides both daily and long-range forecasts for the entire city of Malden, from its station on the roof of the school.

b. The regular groups. The students making up the regular groups used in this study were randomly selected. This involved choosing the seventh boy and seventh girl at the sixth and eleventh grade levels. It should also be noted that this random selection included the schools from which the pupils were picked, except in the case of the two criterion groups. Choice of the particular schools depended on the locality and convenience of the particular thesis member.
CHAPTER III
PROCEDURE

A review of the literature established that the teaching of principles is thought to be one effective method for teaching science. It was found that facts were retained better when pupils were taught by principles. Also, relationships in applied learning were perceived more easily.

1. Planning the Procedure

The first step involved the selection by the investigators of principles of science to be tested. The accepted list of Robertson was used.

Nine general topics were considered as being those areas of science with which students would most likely be concerned. The topics considered were as follows:

1. Atomic molecular theory
2. Burning
3. Color
4. Electricity
5. Gravity

\[39^{\text{op. cit.}}, \text{ pp. } 65-70.\]
It was decided that this study should be done in the field of Weather on the basis that this area of science is one with which the greatest number of students would be most familiar, regardless of the amount of formal instruction. Such an area is said to be "culture-fair".

The second step consisted of selecting those principles, as listed by Robertson, which applied to the selected area of science to be tested. The principles from this list, relating to Weather, are as follows:

1. The principle cause of wind and of weather change is the unequal heating of different portions of the earth's surface by the sun; thus all winds are convection currents caused by unequal heating of different portions of the earth's atmosphere, and they blow places of high atmospheric pressure to places of low atmospheric pressure.

2. The more nearly vertical the rays of radiant energy, the greater is the amount that will fall upon a given area, and the greater is the amount of energy

\footnote{Op. cit., p. 67.}
that will be received by that area.

3. The atmosphere of the earth prevents the heat of the earth's surface from escaping, and the earth begins to cool only when the amount of heat lost during the night exceeds that gained during the day.

4. The higher the temperature of the air, the greater is the amount of moisture required to saturate it.

5. The pressure of air decreases with an increase in water vapor content, other conditions remaining unchanged."

The third step was the compilation of a list of twenty-five questions to be used as a guide by the investigators in their taped interviews with students. Eighteen of the questions were deemed pertinent, by the group, to the principles selected for the study and were used in the study. Seven questions were considered merely warm-up questions used to set the tone of the interview. Each interviewer was to adhere rigidly to these questions in his recorded interviews to insure uniform procedure. A copy of this list of questions and a sample response is included here.

**List of interview questions.**

1. What can you tell me about wind?

2. What can you tell me about the different types of winds?
3. What can you tell me about the causes of winds?
4. What can you tell me about wind measurement?
5. What can you tell me about the seasons?
6. What can you tell me about the causes of seasons?
7. What can you tell me about shadows?
8. What can you tell me about the atmosphere?
9. What can you tell me about the way in which the earth is heated?
10. What can you tell me about the cooling of the earth?
11. Is the temperature of the earth the same everywhere?
12. What can you tell me about precipitation?
13. What can you tell me about the cause of precipitation?
14. What can you tell me about the water cycle?
15. Does temperature have anything to do with precipitation?
16. What can you tell me about air pressure?
17. Does air pressure have anything to do with the weather?
18. Can air pressure be measured? How?

Sample response.—Albert C., Grade 11, Age 17.

7. "I've seen them around. A shadow is caused by anything that has mass. I think even a window would make a shadow. In the summer you would have a shorter shadow, especially at noontime, because the sun would be directly overhead. In fact, you would hardly have any shadow at all. In the northern hemisphere in winter, the sun seems to be low on the horizon, and you would have a longer shadow."
In addition to the selected questions, each interviewer was to use two other aids in conducting his interviews. A radiometer was to be exhibited to each student at the beginning of the interview. This device was to be employed to interest the pupil and direct him towards the field of weather. After a short discussion of the operation of the device, the direct questioning was to begin. An elementary science text was to be employed at the end of each interview. Pictures from this text depicting some principle of weather were selected by the interviewer and shown to the subject in hope of obtaining additional information not offered under direct questioning.

The fourth step was to be the selection of persons to be interviewed. It was decided that the study be done at the sixth and eleventh grade levels. It was also decided that each investigator would interview four persons; a sixth grade boy, a sixth grade girl, an eleventh grade boy, and an eleventh grade girl. A random selection was decided upon; that the subjects be the seventh person in alphabetical order in their class. Criterion groups were selected because of their proximity to the Boston area in which the study was being conducted, and the groups are

unique in that they actually participate in the operation of U. S. weather stations as part of their school's curriculum. Schools selected were the Parmenter School (sixth grade) in Arlington and Malden High School (eleventh grade). Two investigators conducted the interviews of the criterion groups; the others made their recordings in their respective residence areas of Massachusetts and New Hampshire.

The fifth step was to be the actual process of conducting interviews, carried out by the investigators, after they had obtained parental and school permission to carry out this study.

After the interviews had been conducted, a sixth step was to be followed. The interviewers were to transcribe the material from the tapes and meet as a group, to adjudge the correctness of the answers given. Answers will be judged either "right" or "wrong".

The seventh step will involve the compilation of data gained from this study into comparative, graphic charts which will be contained in the conclusions of this study.

In the course of discussing the method of evaluation, it was decided that the method of evaluating the transcribed responses as either true or false would be used.

The answers in this study will be evaluated on the basis of understanding of the principle or insufficient understanding of the principle involved. It will be
therefore, on this basis, that the results of this study will be obtained and figures for the graphs compiled. The eight members of the thesis group will act as a jury in deciding what responses will be acceptable as indicating an understanding of the principle involved.

2. Directions Decided Upon by the Group for Carrying Out the Study

1. Contact the Superintendent.
2. Contact the Principal.
3. Contact the teacher or teachers involved.
4. Randomly select every seventh boy and every seventh girl from either the office list or the teacher's list. If more pupils are desired, go down the list, selecting every successive seventh name on the list; i.e. 7, 14, 21, 28, etc.
5. Contact the parents of the pupils involved and obtain their permission for the interview. At the same time, the permission of the pupil must be obtained, and this is usually the same as the parents.
6. In the event that one of the parents or pupils declines the interview, it is suggested that the

42/Note the importance of this random selection. It gives stability to the study and enables future investigators to combine their results if their subjects are chosen in the same random manner.
next name in order on the office or teacher's list be selected; i.e. 8, 15, 22, 29, etc.

7. After permission has been granted, obtain the parameters from the office or teacher's files.

8. Contact the pupil or parent and set up the time for the interview, either at the school or at the pupil's home; explain that the interview will take from 45 to 75 minutes from the time of entry into to the time of exit from the home.

9. Try your questions, your voice, and the voice of the pupil out on the tape recorder before you attempt the interview.

10. Obtain some sort of device, related to the topic, to use in the beginning of the interview to break the ice and establish better relations between you and the pupil.

11. Check your recorder, questions, device, and anything else that you may decide to use in the interview before going into each interview.

12. When entering the home of the pupil, or welcoming the pupil into the classroom, be warm and friendly and do not give the appearance that you have a job to do and you want to get it out of the way as fast as possible. Indulge in idle talk for a few minutes to permit the pupil to become used to you
and you to him.

13. Commence the interview with a few pertinent, but not significant, questions. Make use of the device in these introductory questions. Gradually ease into the main questions of the interview.

14. Do not rush the pupil into answering. Give him time to think and mull the answer over in his mind.

15. As the pupil answers the questions, encourage him with such statements as good, fine, ok, and yes. If you think the pupil knows more than he is telling you, ask him additional questions on the topic without leading him to any answers.

16. When all of the questions have been completed, give the pupil a chance to add anything else that he might think to add. It might be well to have something which might aid him in remembering; such as a book, pictures, or diagrams which pertain to some of the different questions in the interview.

17. If the pupil desires, let him listen to the tape that he has made.

18. When you leave, make sure that you leave the pupil and the parent with a good impression of you and what you are doing. Others will be following you to continue this study. It will help them and the study greatly to find receptive pupils and parents.
3. Selection of a Topic

The following topics and the principles, as set forth by Robertson, included under them were presented to the group for their consideration; to select one of these topics and its principles as the central theme of the study.

1. Atomic molecular theory: "All substances are made up of small particles called molecules. These are alike in all samples of the same substance, but are different in different substances."

2. Burning: No precise principle can be found.

3. Color: "The colors of objects depend on what light rays they transmit, absorb, or reflect."

4. Electricity: "An electric current may be produced in three ways; by rubbing or friction, by chemical actions, and by using magnets."

5. Gravity: "Movements of air, water, and solids on the earth are due to gravity plus rotation of the earth."

"The pull of gravity is proportional to the mass of the body and inversely proportional to the square of the distance between the center of the body and that of the earth. (Gravity may be a "push".)"

6. **Matter:** "Matter and energy may be transformed but they cannot be created or destroyed."

7. **Rock formation:** "Strata of rocks occur in the earth's surface in the order in which they were deposited, except in the case of overthrust faults."
   
   "The present is the key to the past."
   
   "The succession of fossils in the rocks show a progressive series from simple to complex."

8. **Water:** Water is the universal solvent. (A general principle)
   
   "Any substance that will dissolve in water will cause the resulting solution to boil at a higher temperature and to freeze at a lower temperature than that at which pure water boils or freezes."

9. **Weather:** "The principle cause of wind and of weather change is the unequal heating of different portions of the earth's surface by the sun; thus, all winds are convection currents caused by unequal heating of different portions of the earth's atmosphere, and they blow places of high atmospheric pressure to places of low atmospheric pressure."
   
   "The more nearly vertical the rays of radiant energy, the greater is the number that will fall upon a given area, and the greater is the amount of energy that will be received by that area."
"The atmosphere of the earth prevents the heat of the earth's surface from escaping, and the earth begins to cool only when the amount of heat lost during the night exceeds that gained during the day."

"The higher the temperature of the air, the greater is the amount of moisture required to saturate it."

"The pressure of air decreases with an increase in water vapor content, other conditions remaining unchanged."

Eight of these topics were discarded. The following is a list of those topics and the reasons for discarding them.

1. Atomic molecular theory: The subject is too deep for pupils below grade seven; below junior-high level.

2. Burning: There is no precise principle for our grade range, as set forth by Robertson.

3. Color: The subject is too limited.

4. Electricity: The subject is too deep for pupils in grades below grade seven; below junior-high level.

5. Gravity: The subject is too deep for pupils in grades below grade seven; below junior-high level.
6. Matter: The subject is too deep for pupils in grades below grade seven; below junior-high level.

7. Rock formation: The subject is too limited, and there are too many technical terms.

8. Water: The principles listed are too deep for pupils below grade seven; below junior-high level.

The topic Weather was selected because it was the most universal of these nine topics. It was expected that a wider range of understandings on this topic and its principles would be found, in the range of grades in which the study was to be undertaken.

The selection of Weather as the topic made it possible to include two criterion groups as a part of the study; the sixth-grade pupils of the Parmenter School in Arlington, Massachusetts, and the eleventh-grade pupils of Malden High School in Malden, Massachusetts. Both of these groups have established weather stations in their schools, as previously discussed.

4. Use of Tapes for Interviews

The reason for placing "The Uses of Tapes for Interviews" here is because it gives directions for carrying out the use of the tape recorder, since the whole technique depends upon the free response of the youngster. Therefore, the correct use of the tape recorder is necessary.
The recorder itself.-- Before using a tape recorder, one must first become familiar with the limitations particular to that machine; secondly, he must discover if it has a single or double-tracked tape; and thirdly, he must learn the location and kind of the controls.

De Kieffer discusses these points very well, as follows:

"1. Determine the limitations of your recorder. Set the recorder for the desired speed. Remember, the faster the speed of operation, the better the quality of sound.

2. Determine whether the recorder is single or double-track. Some recorders will record on one-half of the tape going in one direction and can be reversed to record on the other half of the tape going in the opposite direction. These characteristics must be determined before you start operating the recorder.

3. It is suggested that the instructions for your tape recorder be studied regarding the correct methods for putting the machine into operation."

Once these three points have been checked and are understood, then it is time to try out your recorder.

De Kieffer points out six steps to follow:

"Operation Progress Chart

1. Set up and connect the A C plug.
2. Connect the microphone.
3. Thread recording tape in recorder.
4. Test volume controls to find desired recording level.
5. Record several minutes of live sound, rewind and play back for quality. If not satisfactory, try again.


Ibid., p. 154.
6. Try several different microphone placements to see which is the best, and record the results."

Recording conditions—acoustics. First, the area in which the recording is to be made must be studied for its acoustical quality. As Herrick says in "Better Ways to High Quality Tape Recording":

"It is the acoustical characteristics of the room which determine the basic quality of a recording. These characteristics result from the amount of sound reflection (echo or reverberation) from smooth, hard surfaces within a room, and from the size and shape of the room. It is the sound-absorbing qualities of the materials within a room, which alter these characteristics. Using a blanket booth is the easiest way to solve this problem of reverberation and acoustical difficulties. The reason for this being that a blanket booth works in two ways:

1. It cuts down acoustical size of the recording area.
2. It provides sound-absorbing, rather than sound-reflecting walls.
3. Also when children...record in such an obviously professional booth, there is a feeling of closeness, concentration on the job, and an intimacy which tends to provide a good atmosphere for the project."

Blankets, rugs, quilts, and other such things can be used for the walls of the booth. It might be practical to build a portable support for the booth. If such an arrangement is not possible, then every attempt must be made to make a room less live, by drawing the shades, or if there are

draperies, by spreading them out over as large an area as possible. "Wall hangings, cloth-covered screens, and other surfaces which can be hung temporarily with sound-absorbing material, will also help." However, if the room you are using is so crowded with draperies, rugs, and overstuffed furniture that your recording sounds hollow or dead, then some of these things should be removed. But, as Fowlkes says, "A room which is on the dead side is much to be preferred to an excessively reverberant (live) one." There are also other things which should be taken into account in order for the acoustical situation to be as perfect as possible, before recording begins. Mellenbruch cites three rules:

"1. Close doors, turn off fans and other electric motors.  
2. Wait until any unusual or loud noise has ceased.  
3. Place a 'Please Do Not Disturb' sign on the door, to avoid interruptions."

Another point cited by Brower is that, "the sound of telephones, doorbells, clock chimes, and janitors should be controlled."


The microphone - its position and use in recording.

When using a microphone, it must be remembered that: "a microphone does not have the power to differentiate between sounds." Therefore, it is a good idea to divide up the area in which you will be recording, and put the microphone into each one of these imaginary sections, and test the results. Sometimes it might help to listen, using only one ear, from various places in the area. When you have determined the best place for its position, check to be certain that you are away from corners or any reverberating surfaces. When the microphone is not being used, it should be set on a soft cloth or sweater on the table with the recorder. Mellenbruch states that: "the best results are obtained if the microphone is not handled or moved. But if it is necessary to handle the microphone, static may be avoided, by pausing until the microphone is in place."

Finally, one of the most important things to be careful of, and try to achieve, is the quality of presence. As Mellenbruch states:

"The desirability of presence can not be attained unless the speaker is on mike. A distance of six to eighteen inches is usually desirable for recording speech. When speaking from a closer distance, directing the voice at an angle across the microphone, rather

than into it directly, will reduce breath noises."

And, as Herrick states: "this eliminates those hissing 's' sounds, as well as reducing the 'pop' of 'p,' 'b,' 'd,' and 't' sounds." Dale in his book, Audio-Visual Methods in Teaching, cites four points to follow in using a microphone:

1. Find the correct distance from the microphone, by actually speaking and recording (experimentally) from various spots around the microphone - this should be done for each voice recorded.
2. Speak in a clear, distinct conversational manner. Don't shout or strain your voice.
3. All microphones are non-selective, and most of them are extremely sensitive.
4. Such sounds as: whispers, chairs squeaking, paper rattling, feet shuffling around may be heard on the recording.

The element of fatigue. -- Whether the recording is done in a room, cellar, or blanket booth, the recording area must be kept as comfortable as possible. If the place is too hot, the person being interviewed will become drowsy, and if it is too cold, he will become more concerned with keeping warm, and less concerned with doing a good job in the interview. Thus, proper consideration should be made for heat as well as for ventilation and light. Also, the person making the interview must keep a sharp lookout for signs of fatigue, denoting that the one being interviewed


has reached a stopping point, for a while. Seham cites four symptoms of fatigue:

"1. The child begins to yawn and sigh.
2. The child becomes restless and squirms around in his seat, resting in his hand, first his chin and then his forehead. His restless hands keep his hair disheveled and unkempt.
3. Does not pay attention to what he is doing or saying.
4. He becomes restless and his eyelids begin to droop."

But the symptoms of fatigue differ, depending on that particular person being interviewed. As Seham says:

"The signs and symptoms of cumulative fatigue... vary in number and severity, depending on the type of child, the state of his general health and the underlying causes. They may be different in an older child and in a young child, different in a boy and in a girl. They are subject also, to racial influences. Even in one and the same child they will vary at different times of the day, since activity and the intake of food necessarily have an effect on fatigue."

Concluding comments.—Foster and Kidder cite three general points to remember when using a tape recorder:

"1. Always check to see that you record on the dull side of the tape.
2. Keep your connector cords under ten feet in length. See to it that you do not use microphone cords much over ten feet long. If for any reason you need a longer cord, it probably will be necessary to procure another microphone than the one furnished with your tape recorder. Consult a dealer about this.
3. Do not over-record, by setting your recording level


57/Ibid., p. 73.

volume too high. Experiment to determine optimum volume levels for your recorder."
CHAPTER IV
INTERPRETATIONS AND CONCLUSIONS

1. Interpretations

After all the tapes were made and the pupil contact part of the study was completed, the problem of interpretation of the results next was attacked.

It had been previously decided to use the group as a jury in deciding whether a respondent's answer to a question was acceptable or not acceptable. Some of the determiners of acceptability are listed below, but it must be remembered that these judgments were value judgments of a group.

1. A general recognition of the terminology of the question
2. Something more than the "is" of identity must be adduced.
3. There must be a relationship seen by the child between at least two of the basic facts of the principle. (This is usually evidenced by knowledge of more than one application.)
4. Something more than a definition must be evident.
5. The pupil's recognition of his own lack of knowledge was of great assistance in determining
whether a real understanding of the principle was present.

Method of scoring. With a total of eighteen questions, there was a possibility of a score of eighteen for each pupil. As each grade level had twelve respondents, there is a possibility of 216 correct answers for the regular groups. As each grade level had four respondents, there is a possibility of 72 correct answers for the criterion groups.

The tables and the figures which follow show the percentages of the several groups which successfully responded to the non-directive questions pertaining to that principle.

Numbers and percentages for graphs.

Table 1. Numbers and Percentages of Pupils Successfully Responding to Each of the Six Principles in the Regular Group

<table>
<thead>
<tr>
<th>Principle Number</th>
<th>6th Grade</th>
<th>Per Cent</th>
<th>6th Grade</th>
<th>Per Cent</th>
<th>11th Grade</th>
<th>Per Cent</th>
<th>11th Grade</th>
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<td>(7)</td>
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<td>(9)</td>
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<td>50.0</td>
</tr>
</tbody>
</table>

An examination of the typed transcriptions will reveal the presence of all these situations.

It is realized that small numbers introduce chance factors, although the total number of children examined in this prototype study is respectable.
Table 2. Numbers and Percentages of Pupils Successfully Responding to Each of the Six Principles in the Criterion Group

<table>
<thead>
<tr>
<th>Principle Number</th>
<th>6th Grade Boys</th>
<th>6th Grade Girls</th>
<th>11th Grade Boys</th>
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Translating percentages into graphs.— In examining the graphs, it is interesting to look for the 50 per cent level of achievement which is marked with a dotted line in each graph. Richardson says:

"It is pertinent to inquire into the method of selection of the sub-tests. In what respects does the method of selecting the sub-tests insure that the resulting scale will be valid? One of the devices is to plot the percentages of correct responses to any given sub-test against the chronological age, after the sub-test has been applied to 'unselected' children of various age groups. The age at which just half of the children pass the test is taken as the scale-position of the item."

The rationale back of this fifty per cent is that, to quote the introduction to this thesis:


62/Page 6.
The hypothesis is being tested that there is an age-maturity level (or range of two or three years) where there is a reasonable assurance that, with good teaching and a class of median size and ability, a science principle can be taught-and-learned so that at least half the children will be able to use this principle as an envelope to include most if not all the common experiences described by that principle.

2. Comparison Graphs on the Per Cent of Understanding of Five of Robertson's Principles on Weather

![Graph showing understanding of wind principles by grade and gender]

From the results, it might be concluded that this concept is more clearly understood on the eleventh-grade level than on the sixth-grade level.

Note that one purpose of the study is to compare the performance of pupils in the criterion groups with the pupils in the regular groups.
From the results, it might be concluded that this concept is fairly well understood at both the sixth and eleventh grade levels.
concept is quite well understood at both grade levels.

Figure 4. The Per Cent of Understanding of Robertson's Principle Concerning Precipitation

From the results, it might be concluded that this concept is generally not as well understood as the other four.

Figure 5. The Per Cent of Understanding of Robertson's Principle Concerning Air and Air Pressure
From the results, it might be concluded that this concept, although not too well understood in some cases, is fairly well understood in most cases.

![Bar chart showing percentage understanding by grade and gender.](image)

**Figure 6.** The Per Cent of Understanding of Robertson's Five Principles Concerning Weather

The fifty per cent or better understanding on the eleventh grade level, as compared with the less than fifty per cent understanding in all cases on the sixth grade level, is noteworthy. Oxendine refers to the fact that a fifty per cent mastery of a concept is considered to be adequate to term the teaching of that concept successful.

3. Conclusion

The conclusions of this study are, in themselves, not statistically significant as was pointed out in an earlier section of this study. This study is a prototype and a trial of a process.

The results of this study.--

1. The overall understanding of five principles concerning weather on the sixth grade level was below fifty per cent in all cases. That is to say that no one group, as a whole, achieved the fifty per cent level of understanding.

2. The overall understanding of these principles on the eleventh grade level was fifty per cent or better in all cases. That is to say that each group, as a whole, achieved a fifty per cent or better level of understanding.

3. The overall understanding of the criterion boys on the sixth grade level was appreciably lower than that of the boys in regular classes at the same level. This might indicate that the age-maturity level necessary for the understanding of these principles has not yet been reached.

"Understanding" means that the judges deemed 'acceptable' the responses of pupils.
4. There was no significant difference between the criterion girls and the girls in regular classes on the sixth grade level. The fact that both groups were below the fifty per cent level might indicate that the age-maturity level necessary for the understanding of these principles has not yet been reached.

5. Except for the eleventh grade criterion boys (who were superior), there is no appreciable difference between the groups on the eleventh grade level. This might indicate that the age-maturity level of understanding was attained below this grade level.

6. There was no significant difference between the boys and girls on either level except in the cases of the sixth (who were lower) and eleventh (who were higher) grade criterion boys. In view of the results obtained, it seems evident that the age-maturity level of understanding of these principles is somewhere between the sixth and eleventh grade levels.

**Success of type of interview.**-- It was found that the proper use of the tape-recorded interview is an effective method of obtaining information for this type of study. This is a relatively new method of interviewing, with very
few references in the research literature.

It has been concluded by the group that a period of from twenty to twenty-five minutes is the maximum ideal interviewing time at both grade levels. The tape was found to be the least fatiguing for both questionner and pupil.
CHAPTER V

SUGGESTIONS FOR FURTHER STUDY

The possibility of carrying out a study such as this one, though on a much larger scale, has many potentialities. The group was limited by time and funds, but a project under the auspices of a science foundation or publishing company might arrive at some statistical conclusions which could alter the present method of presentation both at the elementary and secondary levels.

Although the use of tape recorders is relatively new for this purpose, it is a method which provides a wealth of information, storing not only the fund of facts and principles, but also giving information about the process by which pupils learn.

There are many additional studies which could be made in connection with the age-maturity level of placement of various scientific principles. Other studies which might be made are:

1. A determination of the range of understanding of certain scientific principles which exists at a particular grade level.

2. The determination of which scientific principles are mastered after a prescribed course of study.
and which ones are difficult of mastery.

3. The determination of whether or not interests, and socio-economic background, have anything to do with the acquiring and retaining of scientific principles.

4. The determination of the method best suited to finding out the understandings possessed by students, whether it be through the use of selected questions and responses, picture tests, written questions, or other means.

5. The determination of the advisability of moving upward or downward the age-maturity levels at which certain scientific principles are presented.

This experiment should be duplicated until enough children have been interviewed, all over the country, to make this study of statistical significance. It is suggested that further sampling or interviewing may be carried out at levels between the sixth and eleventh grades.
1. Parameters

Name
Sex
Age
Grade
I.Q.
School
Location

2. Questions for Tape-recorded Interview

1. What can you tell me about wind?
2. What can you tell me about the different types of winds?
3. What can you tell me about the causes of winds?
4. What can you tell me about wind measurement?
5. What can you tell me about the seasons?
6. What can you tell me about the causes of seasons?
7. What can you tell me about shadows?
8. What can you tell me about the atmosphere?
9. What can you tell me about the way in which the earth is heated?
10. What can you tell me about the cooling of the earth?
11. Is the temperature of the earth the same everywhere?
12. What can you tell me about precipitation?
13. What can you tell me about the cause of precipitation?
14. What can you tell me about the water cycle?
15. Does temperature have anything to do with precipitation?
16. What can you tell me about air pressure?
17. Does air pressure have anything to do with the weather?
18. Can air pressure be measured? How?
The responses that follow are recorded in the same order as the questions, and the numbers of the questions correspond to the numbers of the answers. The responses are arranged in alphabetical order according to pupils' names, with the sixth grade responses first.

Note: The notation NPR throughout the transcriptions refers to the term "no pertinent response". The notation _c/ is used to point out members of the criterion groups.
3. Transcriptions

Peter B.
Male
Age - 12
Grade 6
I.Q. - 112
Grinnell Elementary School
Derry, New Hampshire

1. It blows. It starts hurricanes, does a lot of damage. There are tornadoes, hurricanes, breezes, and strong winds.

2. Not too much except that the big ones, like hurricanes, do a lot of damage and the little ones, like breezes, dry the women's wash good and can make you cool if you're hot.

3. I have no idea what causes them.

4. You can measure them and you can tell the direction they are going. I think maybe a thermometer has something to do with it.

5. There are four; Summer, Winter, Spring, and Fall. In the Winter it's cold; in the Summer it's warm; in the Spring the leaves come on and in the Fall they come off.

6. They're caused by the rotation of the sun, earth, and moon. The sun is in a different position in each different season. And that's how we have eclipses, too. Accurate description of eclipse, of sun, and of moon. In the Spring we plant and in the Fall, we pick and fertilize the ground again.

7. Well, when the sun is behind you your shadow is in front of you and when the sun is in front of you your shadow is behind you and it's like that on the sides. If the sun is on top of you you can only see the shadow between your feet. The size of the shadow depends on the size of the body blocking the sun.

8. Well, it's got something to do with gravity. Like if you throw a ball into the air it comes back on account of gravity. Gravity is around the earth. If something goes out into space and tries to come back it gets very hot on account of gravity. The stars and planets have atmospheres and there are gases in atmospheres.
9. It's heated by the sun and underneath it's very hot.

10. In the night when the sun is gone it gets cool. Underground springs cool it. The sun isn't the only cause of it being hot or cold, but it's mostly the reason.

11. No. It all depends where the sun is. When the sun is directly over a place it makes it hotter, the equator is the hottest place. That's a latitude running around the middle of the earth. It's coldest at the poles.

12. Right below the equator in Peru, the precipitation is the most. It rains up to 150 inches. The biggest rain in America is around the Gulf of Mexico. Where there isn't much it's all dry and dusty and nothing can grow. You can't farm there.

13. There's snow, sleet, hail. It snows in cold weather. The rain freezes and falls. I don't know what causes hail but I can tell you what it does. It destroys crops because it's so big and it beats the plants just like throwing rocks. Scientists are trying to design a rocket to destroy hail clouds.

14. The sun evaporates a puddle into the clouds; then the clouds get too full and heavy and the water falls back again and the sun evaporates it again.

15. I don't know. But I know that if it's real hot and moist and then it gets awfully cool and it usually rains.

16. You can measure it in a tank. They use it for cockpits. They measure air a certain pressure out of tanks and then they seal up the cockpit so no other air can get in.

17. I don't know.

18. You can measure it in a tank with a gauge.
1. I know the instrument that tells the wind direction. They have a circle of lights and one light in the middle. The outside light tells the wind direction. The light in the middle, how many times it flashes on and off, tells how many MPH the wind is blowing.

2. Slow winds, 0-5 MPH. Gale, about 60 MPH. Hurricane and typhoon.

3. I don't think I know.

4. Weather vane to tell the direction the wind goes in. More complicated instruments like the anemometer.

5. If we had no differences in the air pressure and differences in whether the air goes cold or hot, we wouldn't have any seasons. It would be all the same.

6. Winter, it gets very cold. The rain freezes and you get snow. Hail freezes in layers. Hail is much larger—frozen water vapor.

7. I don't think I know anything about shadows.

8. What do you mean? Made up of oxygen particles and carbon dioxide and other gases.

9. I don't think I know anything about it.

10. Same.

11. No, it isn't. Usually when we have night time, it is cooler. When one side of the earth has night, the other side has day. Different in North Pole and South Pole.

12. Hail freezes in layers, not like a single raindrop. Snow is water vapor; because the air is so cold, it freezes. Moisture in the air is humidity.

13. Clouds gather. If there are many clouds it is going to rain. This is water vapor in the air. When there is
too much, it has to let it out.

14. I don't know about this.

15. Yes, it does. When it is colder out the rain will freeze and become snow.

16. Warm air mass. Warm air down close to the earth, and the cool air above it. And the cool air is heavier than the warm air. And the warm air will try to push up through the cool air, and when it gets there it leaves a gap and air rushes in—maybe a big wind.

17. NPR

18. Yes, the barometer.
James C.
Male
Age - 12
Grade 6
I.Q. - Average
Swan School
Medford, Massachusetts

1. One day the wind could be strong and the next day it may not be so heavy and only blow a little.

2. Yes. There are winds that are nice and breezy and there are some that will try to knock you over, other times the wind is nice and mild.

3. The sun and the rain and the snow and things like that.

4. No we do not measure winds.

5. In Winter it is awful cold; in Summer it is warm. Yes we have four seasons, Winter, Summer, Fall, and Autumn.

6. The sun. One place it could be Summer and in Egypt it could be Winter.

7. One shadow could be in front of you, and another day in back of you. Sometimes you could be running and it is in front of you and then it is in back of you.

8. If the air is stopped everyone would be flying around in the air. We would not have any gravity.

9. From the sun. Sometimes the moon will give heat.

10. Wind and rain and snow.

11. No. Temperature changes everyplace.

12. Snow, rain, hail, and wind. Rain is just wet and water falling; hail is like rocks hard, hard rain coming down fast. I don't know about snowflakes.

13. Sun and clouds cause precipitation.

14. No.

15. Yes.

16. No.
17. Yes. Pressure pushes clouds, rain, and snow.

18. Yes--fly airplanes and tell by their thing that tells them how high they are.
Sandra E.
Female
Age - 12
Grade 6
I.Q. - 110
Oyster River Junior High School
Durham, New Hampshire

1. Can tell a little about how it's caused. When take a valley for instance, the sun shines in and the soil and everything in the valley gets warm, but when it shines on a forest it's not so warm and the cold air pushes up the warm air and it keeps moving around.

2. North winds and south winds. Don't think so.

3. Cold air pushes up warm air.

4. It's measured with a thing that turns around when the wind blows.

5. Well, there are four different kinds: Winter, when it snows; Summer, when it's hot; Spring is pretty cool; Fall is pretty cool also.

6. Not too sure, but it has something to do with earth turning and tilting when it turns.

7. When sun shines at a certain time of day it causes different kinds of shadows. The shadows move with the sun while the earth turns.

8. Well, weather is really what the air is around us.

9. Wind is moving air.

10. Well, the sun shines and it gets warm.

11. When sun goes down it gets cool.

12. No, farther north you go it is cooler, when you go south to the equator it gets warmer, the water and air currents warm it there.

13. Caused when clouds are made and they get heavy and cooled then can't hold it all, it condenses to rain. When it's freezing and the rain is coming down it sleets. Snow is when it's cold enough to make snow but not sleet.
15. Water comes off the ocean and turns to water vapor, then clouds are formed and then the water condenses and it rains.

16. Yes, because it can change the kind, such as rain or snow.

17. Air pressure changes from sea-level as you go up. And it changes when the storms come.

18. Yes, the high pressures and low pressures make the different kinds of weather conditions. It's measured with a barometer. When it's high pressure the air is usually dry and it's better weather. Low pressure is usually wet air and when it cools a little we get a storm.
Eric F.
Male
Age - 11
Grade 6
I.Q. - 117
Oyster River Junior High School
Durham, New Hampshire

1. Wind is caused by cold air, cold air is pulled down by gravity.

2. Cold winds, fast and slow. Cold winds come from the north, warm winds come from the south.

3. See number 1.

4. Measure wind with a wind gauge. Can tell direction of wind, a little thing on top of houses.

5. There are four seasons. Here they bring different kinds of weather like Winter brings snow, Summer brings warm weather, Spring and Fall are the turning of the seasons, like when Winter is turning to Summer it's Spring and when Summer is turning to Winter it's Fall.

6. The sun isn't shining on one place of the earth all the time and it's going around. The earth is tipping too, this makes the seasons.

7. Shadows are formed when the sun shines or any light.

8. I can't tell too much--clouds in atmosphere shade the earth, the warm air rising will become cold.

9. Earth is heated by sun shining down on flat level ground.

10. Cooled when sun is not shining, and cool winds.

11. No, because sun shines on different parts of earth at different times. It's in different places. Where it is, it will warm it up and where it has been will cool down.

12. When it's warm the water on the ground will change to water vapor and go up in the air. When it gets cooler it will condense and form a cloud.

13. Sleet is frozen rain, if it's colder it will form hail, if that melts it will cause snow.
15. Trees get water from the ground and it goes up to the leaves, then the leaves give it to the air.

16. Yes, when it's warm, water vapor will rise and collect in clouds. When it's cool it rains.

17. Not the same all over—usually 14.7, pressure helps the wind move and helps precipitation. Yes, it has to do with weather.

18. Take a ball and weigh it, then take the air out and weigh it again.
Anna H.
Female
Age - 11
Grade 6
I.Q. - 107
Merrimack Elementary Annex
Merrimack, New Hampshire

1. I can't think of anything. I think there are different kinds.

2. What I meant by different kinds of wind is that some are heavy and some are light, like a tornado is heavy wind and a breeze is a light wind.

3. I don't know.

4. I don't know.

5. There is Winter, Spring, Summer, and Fall. In different seasons, the weather changes.

6. I don't know.

7. When you are facing the sun in the path of the sun, that causes a shadow and light causes a shadow.

8. I don't know anything about it.

9. By the rays of the sun.

10. I don't know anything about the cooling.

11. No, different parts of the world are nearer the equator than other parts and the equator is the hot line.

12. There is hail, snow, rain, and sleet.

13. Hail is caused by rain and snow falling at the same time and it forms into little balls of ice. I don't know what snow, rain, and sleet are caused by.

14. The rain comes down and it seeps into the ground. When the water seeps into the ground, most of it goes into the roots of the trees and the rest keeps going down. I don't know where it goes.

15. Yes, when it is cold, it snows and it hails and sleet forms and when it is warmer, it rains.
16. I don't know.
17. I don't know.
18. I don't know.
Sherril H.
Female
Age - 11
Grade 6
I.Q. - 108
Grinnell Elementary School
Derry, New Hampshire

1. It has different directions. Sometimes it's warm; sometimes it's cold. Yes, there are.

2. Not very much. There are tornadoes, hurricanes, plain wind.

3. NPR

4. I think you use a weather vane.

5. There are four. Summer, Winter, Fall, and Spring. Yes, some are warm, some are cold, and Spring is rainy.

6. The sun's rays cause them. It depends on the inclination of the earth on its axis. When the sun is closer to the earth its rays are slanted and that's when we have Winter.

7. They're caused by the sun's position. When it is behind something the shadow is in front of the thing.

8. It's a layer of air around the earth. It goes out a certain distance.

9. It is heated by the sun's rays. The position of the sun has a lot to do with it. When your side of the earth is facing the sun it is hotter, then, when the sun goes around to the other side of the earth it is night on your side and it cools off.

10. Just like the heating...it depends on where the sun is.

11. The temperature is different in different places. Wherever the sun is the hottest. The equator is the hottest place of all. Breezes help to make the temperature different too.

12. Well, there's rain...fog, snow, hail.

13. Snow is cold. The clouds drop because they are heavy. Hail is rain at a cold temperature.
14. The water evaporates into the clouds, the clouds get heavy again and they drop it back.

15. Temperature controls whether it will rain or snow.

16. NPR

17. I don't know.

18. I have no idea, but I guess so.
Thomas H.
Male
Age - 11
Grade 6
I.Q. - 115
Merrimack Elementary Annex
Merrimack, New Hampshire

1. It has strong breezes, it occurs as tornadoes, it changes the cloud formation so that it will snow and rain and be warm outside.

2. I don't know.

3. I don't know.

4. No, I never even heard of that.

5. The sun goes around the earth and changes the seasons. When the sun is at the top of the earth, there is Winter at the bottom of the earth, and when the sun is at the bottom of the earth, it is Summer at the top of the earth.

6. I guess it would be the sun revolving around the earth that causes the seasons.

7. Shadows would be slipping something or walking in front of the sunlight would cast your shadow on the ground, or making images on the wall or putting your hand in front of light would be shadows.

8. I don't know.

9. The earth is heated by the sun and sunlight heating the water makes the water warm and it brings warm breezes to the land.

10. It is when the sun goes further away from the earth, it makes it cooler on the earth.

11. The temperatures are not the same everywhere because of the water temperatures and breezes going on to the land and the countries nearer the equator are warmer and get much rainfall. The countries near the equator are warmer because they are nearer the sun.

12. Precipitation is rain, snow, sleet, and hail that comes from the clouds.
13. Precipitation is caused by atmospheric pressure, wind, and the cloud formations.

14. After it rains, the sun rays evaporates the water and takes it up into the clouds and then it rains again and comes back on to the ground.

15. Yes; sleet, snow, and hail make the ground colder. There is cold rain and warm rain and there are cold breezes and warm breezes which make it warmer and colder.

16. Air pressure is the air pushing against something else.

17. Yes, air pressure would make it snow and rain and sleet and hail and make the wind blow.

18. I don't know.
Caroline L.
Female
Age - 12
Grade 6
I.Q. - Average
Swan School
Medford, Massachusetts

1. Wind is very strong.
2. Yes there are. Tornadoes; something that will blow dirt around.
3. From the ocean, when the ocean gets rough.
4. NPR
5. Summer is hot and dry; Winter is snowy; Fall the leaves fall off the trees and people gather their harvest. Yes we have four seasons.
6. Because the weather changes. Because the world keeps going around the sun.
7. Sometimes they are in front of you, and sometimes they are in the back or to the side of you.
8. If the world would ever stop, everything would go into the air, but I doubt if the world would stop. Sometimes the air around us is a dry air, a warm air, or a cold air.
9. By the sun or something under the ground to heat it.
10. By winds, rain, and snow.
11. No. Other places might be warm, but here it is mild.
12. I don't believe so. Hailstones, rain, and snow. Hailstones are made up of snow and water; rain is regular water from a faucet; snow is another mixture of water.
15. Sometimes... rain is when it is damp, snow when it is cold.
16. It mostly holds everything down on the ground.
17. Maybe with the wind a little.

18. Yes, I've heard it on television. I don't know how.
1. NPR

2. You can have a gentle breeze or a wind storm. A tornado can be a kind of wind; hurricane. Can have a fast weather change caused by the winds.

3. Can't think what makes them.

4. We have the instruments up on the roof, little black wind cups. In the office the instrument, when the wind hits the cups, the green dot in the center blinks on. The number of times per minute tells the wind speed. When the orange light blinks on, this tells what direction the wind is going in--anemometer.

5. I know what causes them. The earth is on a tilt. When the earth tips so the north pole goes slightly southward, we get Summer because we are closest to the sun. When it goes back again, we get our Winter. The earth has a cycle of doing that. That's where we get our seasons. Fall and Spring are sort of in between.

6. They are caused by the sun. It comes at you, and you are blocking it from the ground. That causes a shadow. At high noon there is no shadow because the sun is directly overhead. Gets shorter and longer. Shorter in Winter, longer in Summer.

7. Three layers; ionosphere, stratosphere, troposphere. It is made of oxygen and hydrogen mainly, and then there is little of the other gases. There are two poisonous gases in the air, but there isn't much of them; carbon dioxide is one.

8. From the sun.

9. The earth rotates and it goes around the sun. The earth turns every 24 hours. Half of the time our part of the earth is facing the sun and it is warm. Then this side of the earth goes away from the sun and it gets cooler. We are not the same distance from the sun all the time.
11. At the poles, it is coldest because they are farther away from the sun. At the equator it is hot because the equator is out. The sun will heat the equator harder than it will up on top. Tropic of Capricorn and Cancer are more or less hot. Cooler regions are north and south of these.

12. I don't even know what it is.

13. When you heat water in a teakettle, the steam comes out and goes up into the air. We have clouds in the air and a certain amount of moisture comes in to them. After they are filled to capacity and just a little bit more, they burst and it rains. Snow, sleet, hail. Snow; soft frozen rain. Sleet; sort of like frozen ice.

14. NPR

15. Cold; get snow. Hot; get rain.

16. It can do a lot of things. If you drink milk from a straw, the way you get it up is air pressure. There is a certain amount of air pressure on the liquid you are drinking and a certain amount of air pressure in the straw. Air pressure is there and we don't think much about it.

17. Yes, I think so. I don't know.

18. The barometer.
Ralph L.
Male
Age - 11
Grade 6
I.Q. - 105
Parmenter School
Arlington, Massachusetts

1. It moves, that's the only thing.

2. Winds that go in different directions.


4. We have a little gadget at school that blinks lights and tells which way and how fast it is going.

5. You mean Winter and Summer? In Summer--America, the Northern Hemisphere is pointed toward the sun. When it is in the other direction, it is Winter. When we get closer to it, it is Summer.

6. I don't think I know.

7. When the sun hits a certain object, behind it makes a shadow. In the Summer it is longer, in the Winter it is shorter.

8. There are different atmospheres. I don't know the order--Stratosphere. It is combined of different things like hydrogen and nitrogen.

9. By the sun; the rays hit the earth, I guess.

10. I don't think I know.

11. No, might be here, Southwest Asia might be warmer or colder. This is caused by the way it is pointed toward the sun maybe, the position it is in.

12. Precipitation is about storms, etc.. Precipitation zero would be everything is just right, no storms or anything; rain, snow, hail.

13. Something happens to the clouds; moisture. I don't know.

14. You mean the thing that measures the water? Water gauge.

15. I guess so, I'm not sure of that one.
16. The barometer takes the air pressure.

17. I guess so.

18. Yes, by the barometer.
1. Wind is made by the cold air coming in to take the place of the warm air that has gone up into the air. When the warm air contracts it will become lighter and rise into the air; while the cold air, which expands and becomes heavier, will come down and rush in to take the place of the warm air.

2. Yes. A small amount of hot air rising would cause a zephyr. A large amount of hot air rising would cause a much stronger wind, such as a hurricane.

3. Tropical winds which cause the warm weather, the high pressure, and then the Arctic winds that cause the cold weather. (See also Answer number 1)

4. A cup barometer measures the speed of the wind. An anemometer is something like the cup barometer; as a matter of fact, I think the cup barometer is the slang name for the anemometer. The wind sock at the airport tells the direction of the wind. Weather vane indicates the position of the wind and where it's travelling. The barometer measures air pressure.

5. There are four seasons: Fall, Winter, Summer and Spring.

6. The distance from the sun to the earth. The earth travels in an orbit, oval shaped, around the sun. In the Summer the earth is closest to the sun. During the Winter the earth is in its farthest path away from the sun. In the Fall it's just about in the middle and the same goes for the Spring, except maybe it's a little closer.

7. They're caused by the light rays hitting an object and the blackened area of the object, where no sun rays are hitting, is just a black area. They get shorter, I believe, during the Winter and longer in the Summer.

8. The atmosphere is the air region around us. It's composed of carbon dioxide, etc., etc. It helps us breathe. Up farther there's the ionosphere and stratosphere and so
on and so forth. We use the atmosphere for breathing, mainly.

9. The earth is heated by the sun that shines almost directly on the equator, enough to warm it, where there are daylight periods of twenty-four hours, etc.

10. That happens during night, usually when the sun is on the other side of the earth and this side is facing out toward space.

11. No. Because sometimes the sun hits the earth from a different angle and for different periods of time.

12. I'm afraid I don't even know what precipitation is. Oh.

13. Well, rain is formed in the clouds and comes down in the form of droplets which are made in the clouds because clouds are made out of condensed water vapor. Well, the clouds come around until the water condenses even more and finally the little droplets become so heavily laden with water vapor that they just fall down to earth. Sleet is made just like rain, except on the way down it gets frozen. Snow is formed in the clouds by freezing. The water vapor, before it comes down, freezes and then it falls to earth. Hail is made by rain which tries to fall down but the wind will blow it back up again—the warm air will blow it back up, the cold air will freeze it, the warm air will blow it back up and so on and so forth for so many layers until finally it will fall down to earth because it will have become so heavy.

14. I know that water is water vapor condensed. It has most likely come down from rain and it's been formed for a long, long time...until finally it makes a source enough to go out from a little stream bed into a creek, into a river and finally into tributaries into other lakes until it finally empties into the ocean.

15. Some kinds, yes. A temperature change causes sleet, snow and hail. The air might get warm enough to condense the water vapor in the clouds and then it would fall to earth as soon as it got heavy enough.

16. Air pressure is mainly because of the atmospheric conditions. A high pressure point usually has warm air and fair or nice weather. A low air pressure circle would have very cold, rainy, miserable weather.

18. Yes. I think they use a barometer in measuring air pressure.
1. Wind is air moving.

2. Yes, there are mild breezes, gales, hurricanes and other storms.

3. The air starts moving faster, generally over bodies of water.

4. They use some instrument, but I don't know the name of it.

5. There are four seasons.

6. As the earth goes around it changes position from where the sun hits the earth and causes the seasons.

7. Shadows depend on where the sun is, when the sun is over you your shadow is beneath you.

8. The atmosphere is the air around you.

9. The earth is heated by the sun.

10. In different sections it's hot and in other sections it's cold. This depends on the earth being turned a certain direction towards the sun or away from it.

11. Answered in previous question.

12. It's rain, snow, dew, hail.

13. The sun pulls up dust and water and makes clouds. The clouds get bigger till they can't hold any more water and they break and it starts to rain. There are four kinds of clouds, Nimbus, Stratus, and I can't remember the names of the other two.

14. Answered in previous question.

15. Yes, because if it's hot it will rain, but if it's cold it will start to snow.

17. All I know is that it causes all weather.

18. Yes, but I can't remember how.
John M.  ___/
Male
Age - 11
Grade 6
I.Q. - 110 - 97
Farmenter School
Arlington, Massachusetts

1. I can tell you how the anemometer works. Up on the roof of the school are wind cups, and every time the wind makes contact it makes the cups spin and makes a contact on our anemometer and the green light flashes. We do this for a minutes' time and we have our wind velocity for the day. We have lights and we tell by the position of the lights which way the wind is blowing.

2. I haven't studied much about winds, but they generally have different speeds. You have high speeds in hurricanes and some days you get just low speeds.

3. That I'm not sure of.

4. Anemometer.

5. That's one thing about the weather I would like to understand a little better. I'd like to understand why in the Winter it is cold -- well -- I can tell you why it's cold. The sun is in a different position in the seasons. In the Summer, the sun is closer to us and in the Winter it's farther. It moves slowly and that is what causes the seasons. When it is about in the middle, it is Spring. When it is all the way up, it is Summer. And when it begins to go down, it is Fall. And then you get Winter, and it starts all over.

7. Nothing much. When the sun is farthest away from us it would give us a longer shadow, and when it is closer to us it would give us a shorter one.

8. Not too much. I think the air would be pure and there is more air here, closer to the earth, than there is away from it. In some areas of our earth the air isn't very pure because of all the big factories, etc.

9. I guess the sun. The sun is a glowing star; it is a glowing fire of gases. It causes intense heat when it comes down on us. But, in the Winter when the sun is farther away, we don't get the warmth from the sun, and the heat.
10. When the sun's rays hit the earth, like a meteor hits the earth, it melts fast. I don't know too much about it but I would think the farther away the sun is then it would be cooler and would get cold. The soil in the Summer when you get down deep is not hot, it is moist.

11. No, I don't think so. Because you take places like Japan where it is hot all year around. Down in Texas it goes up to extreme heats of 99 degrees—and very rarely in New England do we get such extreme heats.

12. The precipitation is what falls from the sky, like rain, sleet, hail, snow.

13. Rain—that's regular water coming from the cloud; but the snow is a crystal, and as it comes down the water particles catch on to it and then freeze and that forms the snow crystal. Sleet is a mixture of snow and rain. Hail is frozen rain.

14. That's what I don't know.

15. Yes, because when it gets colder you get snow. Before it snows it begins to get colder, I think.

16. That's a barometer. When the air pressure falls that means we are going to have a storm. A storm is a high pressure area. And when it rises, we'll have a high pressure area because the sky will be clear and we'll have clear weather.

17. Yes—low or high.

18. Barometer—barometric pressure.
Nancy M.
Female
Age - 11
Grade 6
I.Q. - 104
Rye Junior High School
Rye, New Hampshire

1. NPR

2. Yes. Winds come from the north and south and east and west. I don't think all winds blow at the same speed... I'm not sure.

3. Don't know.

4. Scientists have a barometer or something like that, that tells how fast the wind is going. A weather vane has an arrow that points in the direction the wind is going.

5. There are Summer, Fall, Winter, Spring. In the Winter it's cold and we have snow. In Fall, the leaves begin falling. In Summer it's pretty warm. In Spring, birds start coming back from the south and leaves start getting on the trees and it starts getting warmer.

6. We're in a region of changing temperatures.

7. Don't know.

8. Can't think of anything.

9. The earth is heated by the sun's rays. You can make fires and stuff.

10. The wind cools it down. At night, when the sun goes in, it gets cooler.

11. No. It's warmer near the equator. Near the north more, it's colder. If you live down in South America, down near the south is cooler.

12. Rain and fog.

13. If it didn't rain, everything would be dry.

14. Well, like put some water in a glass and you leave it on the window sill for a couple of days...the water gets
into the air and it's called "water vapor" and you can't see it any more. It goes up... and when it comes back down, sometimes it changes back into water. It could be dew.

15. Yes. Sometimes when it gets cloudy it will rain.

16. Air has pressure.

17. I don't know.

18. I'm not sure.
James R.
Male
Age - 11
Grade 6
I.Q. - 108
Weston School
Manchester, New Hampshire

1. Wind is air in action.
2. Yes, tornadoes, hurricanes, cyclones.
3. We haven't gotten that far yet.
4. NPR
5. There are four seasons.
6. The seasons are caused by, in the Summer the earth is closer to the sun, in the Winter, farther away, Spring pretty near, Fall moving away again. In general though it's the earth spinning around the sun that causes the seasons.
7. Shadows are caused by the sun shining on a person on one side. The sun can't get through so there is no light on the other side of the person.
8. The atmosphere is a thick band of air, oxygen and hydrogen, around the earth.
9. The sun is made up of gases and as the gases burn they give heat.
10. Cool winds and night because the sun isn't shining.
11. No, the farther north you go the colder it gets because the sun shines brightest and warmest where the equator is.
12. Snow is frozen rain. Snow freezes less than hail or sleet.
13. Precipitation is formed in the clouds.
14. NPR
15. NPR
16. I think it's air pressed together.
17. NPR

18. Yes, in the barometer.
Barbara A.
Female
Age - 16
Grade 11
I.Q. - Average
Medford High School
Medford, Massachusetts

1. NPR

2. I only know fronts and wind velocity.

3. A cold front meeting a warm front.

4. NPR

5. They go in a cycle; Winter, Fall, Spring, and Summer.

6. The weather and the sun.

7. The sun reflects on objects and you see a shadow.

8. Is made of carbon dioxide, gases, natural gases, and air.

9. Heated by the sun’s rays on the earth.

10. By the water when the wind comes in off the ocean.

11. No.

12. Different types—snow, rain, hail, and sleet.

13. Clouds cause rain, warm fronts and cold fronts meeting.
    Snow caused from rain up in the clouds. Hail is rain and
    snow mixed. Sleet is the same thing.


15. Yes.

16. High pressure and low pressure, but I don’t know what
    they mean.

17. Yes.

18. No.
Joseph A.
Male
Age - 16
Grade 11
I.Q. - Above average
Medford High School
Medford, Massachusetts

1. Winds come from different places and effect places on land, helps in pollination of flowers and other helpful aids, and at times it can be brutal.

2. There are definitely different kinds, but I can't remember the specific names.

3. It has a lot to do with temperature, and moisture, and the face of the earth, the natural terrain of the ground.

4. They tell velocity with a specific instrument, but I don't know the exact name.

5. Depends on where one lives; in some places we have different seasons, as Summer, Fall, Winter, Spring; but in some places they have one season all year round.

6. A change in temperature and there is something else, but I can't recollect it.

7. There is a law of reflection and if a solid is in front of a direct light it causes a shadow either smaller or larger.

8. Different layers of the atmosphere, the troposphere and the ionosphere. The higher you go the less oxygen there is.

9. Direct heat from the sunlight and heat from the center of the earth itself.

10. The earth has heat close to the ground, and the earth is cooled farther up from the direct surface of the earth. I am not sure exactly how they do it, but it is a change of temperature too. Water cools the earth.

11. No.

12. It is the amount of rain that has fallen on the earth's surface and is measured in a technical way. I can't think of any forms of precipitation.
13. The amount of rainfall. Moisture that has accumulated from masses of water and has evaporated to the sky to collect and condensed which formed drops of water and made it rain. Snow and humidity are precipitation. Snow is caused because of cold temperature in the air. Raindrops as they fall turn to snow flakes after 32 degrees.

14. Once rain falls, it is brought out to sea or lakes then it is partially absorbed, then it is brought to a cloud system and passes over land again, condenses it and releases it again.

15. No

16. Pressure is 14.7 pounds per square inch. It is an upward gravity holding things down.

17. Yes, high and low pressure areas.

18. Yes it must be measured 14.7. There is a device, but I don't know the name.
1. Winds are unpredictable. They come from every direction. They come up suddenly, and die down just as fast.

2. Yes, harsh winds, due to force, like the typhoon, tornado, and the hurricane.

3. Air comes together and pushes air and causes wind.

4. I think it's an anemometer, like a weather vane except it has cups on it to tell wind speed.

5. Weather changes in different seasons. There are four seasons.

6. The seasons are caused by the revolution of the earth. As the earth turns the seasons turn.

7. Shadows are caused by an object standing in the direct line of the rays of the sun.

8. There are four layers of atmosphere. The atmosphere is the air about us. As you go out into space the air gets thinner. Most of the storms start here.

9. The sun produces all the heat for the earth.

10. Clouds come between the earth and the sun.

11. I don't think so.

12. There are many kinds of precipitation, all formed in the clouds when the water on earth evaporates and goes into the air. When hot air and cold air come together, this causes the clouds to open.

13. Answered in the previous question.


15. There are many types of precipitation; snow, rain, hail and sleet, but I don't think temperature has anything to
do with it. In the Summer it could be hot and it could rain, but in the Winter it could be cold and it could still rain.

16. Air pressure is 15 pounds per square inch on earth.

17. Air pressure determines what kind of weather we are going to have.

18. It is measured by a barometer.
Philip B.
Male
Age - 16
Grade 11
I.Q. - 115
Winnacunnet High School
Hampton, New Hampshire

1. NPR
2. NPR

3. Air disturbances caused by hot air and cold air. Mountains, or some other obstruction of that sort, will cause either an updraft or a downdraft.

4. An anemometer measures the miles per hour of the wind. They measure speed in the air with the Pitot tube on an airplane which measures the miles per hour the plane is travelling, and it measures the wind speed too. Simple weather vane measures the direction of the wind.

5. There are four of them. In the Summer we have hot and mostly dry weather. Fall is cooler and moist. Then in the Winter we have cold weather with snow, sleet, ice and more freeze-up. In Spring it's thawing and there's a great deal of water and trees and plants and such begin to sprout.

6. Seasons are caused by the earth in its orbit coming closer and farther away from the sun; and the tilting, also, of the earth on its axis causes the seasons to change.

7. In Summer, the shadows are shorter because the sun is shining at a steeper angle -- more of an angle -- straight down. In the Winter, they are longer because the sun is lower on the horizon and away from the equator.

8. The atmosphere is made up of 79 per cent oxygen and the rest nitrogen and other gases. There are several layers. There's the stratosphere -- then you go up. There's the ionosphere. There are layers. As you come to each one, going up, the air gets thinner and there is less oxygen.

9. The earth is heated by the sun's rays hitting the earth, radiating out and bouncing back again, caused by the atmosphere.
10. The heat radiates off when the sun goes down and gets less and less as the earth cools.

11. No, it isn't. The heat from the sun is absorbed more by dark areas than by lighter areas. The sun shines directly overhead at the equator. As you get away from the equator it gets cooler; until you reach the poles, where it is coldest.

12. Precipitation is water -- moisture. Snow, rain, sleet -- which is frozen rain. Snow is frozen rain. Hail is droplets of rain that start to fall and are caught by an updraft and carried up to a colder part of the atmosphere, where they freeze, drop down again, and are carried up and down again until they come down about the size of a marble -- anywhere from a marble on up. Dew is moisture which has condensed from the atmosphere on a colder part of the earth at night.

13. Rain falls from clouds which are saturated with moisture, and hits the earth. Animals drink it -- or people or humans -- and they give off carbon dioxide and moisture which goes into the air and is drawn back into the clouds. Then it rains again and continues on.

14. If it's cold, chances are there would be snow or sleet. If it's hot, you won't get snow.

15. Air pressure at sea level would be 14 pounds per square inch -- that is, on the inside and outside of objects. As you go up, the pressure is less. As you go down, the pressure gets stronger on the outside.

16. Yes, it does -- barometer pressure. If barometer pressure is low, it means there will be a storm. When it's up -- 29 or up -- it will be a clear day -- won't rain anyway.
1. Wind is caused by the movement of the earth. Air is heated at the equator, and it rises and travels; as it goes higher, it gets colder, and it travels toward the North Pole. The wind actually slides down from the North Pole and gives us the prevailing westerlies and the trade winds.

2. Prevailing westerlies affect us most of the U. S., because they bring most of the weather down from southern Canada.

3. Winds are caused by the heating of the earth or of an air mass; can be caused by a front, or caused by the terrain of the land.

4. They have many instruments. They have an anemometer, it has more than three cups, that is exposed to the outside wind, and has a tubing that connects with a scale inside. They have weather balloons that tell the speed of the wind.

5. There are four seasons of the year. Summer is caused when the earth is tipped on its axis, so that the land area north of the equator is faced more to the sun, and its rays are more direct, and the days are longer. Winter -- the earth tips on its axis so that it turns away from the sun, and we get indirect rays.

6. The cause of the seasons has a relation to the sun. I think it has some relation to the moon, but I can't remember.

7. I've seen them around. A shadow is caused by anything that has mass. I think even a window would make a shadow. In the summer you would have a shorter shadow, especially at noontime, because the sun would be directly overhead. In fact, you would hardly have any shadow at all. In the northern hemisphere in Winter, the sun seems to be low on the horizon, and you would have a longer shadow.

8. It has many layers. I probably can't name them in order.
Stratosphere -- is the first layer, where all the weather takes place. Then there's the troposphere, the ionosphere, and the tropopause -- a line between the troposphere and the stratosphere.

9. The earth is heated by the sun -- by the direct rays of the sun. Could be radiation, or convection. Radiation -- heat of the sun's rays, hitting the earth. Convection -- the sun heats up the land, the soil, and it gives off heat. Water warms up slower than land, but holds the heat longer.

10. When the sun goes down, the earth releases the heat that has been stored up in the earth, and it gives a cooling effect at night.

11. No. It depends on what latitude you are in. The sun follows the equator -- could be earth follows the sun. The sun actually seems to follow the equator around the earth, and stays in that line. And the farther away you get from the equator, the colder it gets. That's why, at the North Pole you have ice and snow all the time, and at the South Pole; you have ice and snow, and at the equator, it's hot.

12. Precipitation could be rain, snow, sleet, or hail.

13. Snow is caused by -- up in the clouds -- could be nimbostratus, stratus -- it is not below 30 degrees Fahrenheit, but someplace between that cloud and the earth, is a place where it is below 32 degrees Fahrenheit. It rains as water droplets -- comes down and hits this cold area, and it solidifies to snowflakes. Rain is caused by -- in the clouds, these minute water droplets keep on building up, and when they get heavy enough, they fall. Sleet -- rain that is fallen, and on the way down, has become partly frozen. Hail -- occurs mostly in thunderstorms. In these thunderstorms, they have terrific up-and-down currents in which the rain, in the warmer part of the thunderhead, is blown up to the top where it becomes colder and freezes, and is forced down again. This cycle keeps on going -- get layers like an onion -- they eventually fall, because they are too heavy.

14. It is when it has rained and the rain has fallen on the ground, and it has formed puddles, or the ground has soaked it up. When the sun comes out again, the water
evaporates, or it evaporates without the sun, and it goes up as just moisture, and it reaches a certain point where it is cold enough, and this moisture condenses and forms a cloud.

15. Yes, it does -- because it determines what type of precipitation.

16. It is the amount of pressure that a certain piece of air, or part of the atmosphere, would push down on a certain spot.

17. Yes, usually when the air pressure drops, as indicated on the barometer, it indicates low pressure, and bad weather is usually associated with that.

18. Air pressure is measured with a barometer. They have different types of barometers. The aneroid barometer -- which has a small cell inside it, which has almost completely been made a vacuum, which is connected to a needle, which indicates on a scale what the pressure is. When the pressure increases, it pushes together this cell, and forces the needle to indicate a higher pressure. Mercury barometer -- is read like a thermometer, and you have to have so many inches of mercury, before it can indicate.
Andrea C.
Female
Age - 16
Grade 11
I.Q. - 115
Winnacunnet High School
Hampton, New Hampshire

1. Winds are moving air masses.

2. Some winds are stronger...hurricane, tornado. Hurricanes usually on east coast of United States...strong winds, driving rains, calm eye at center. Tornado is circular windstorm that moves along the ground...very strong winds.

3. Don't know.


5. Spring, Summer, Fall, and Winter.

6. When the earth rotates, it causes the sun to be in a different position and either warms the earth up or cools it down.

7. Shadows are longer on a Winter day than on a Summer day because the sun is lower in the sky in the Winter, and higher in the Summer.

8. It keeps all the plants and animals alive on the earth. It only goes up so far.

9. It's warmed by the sun. It has some heat of its own. It hasn't cooled off completely from way back.

10. It cools at night when the sun is not striking the surface of the earth.

11. No. On the equator it's always warmer because the sun shines directly on the equator all year long. It's always warmer on the equator than north or south of the equator.

12. When two air masses meet—a warm and a cold air mass—it causes 'precipitation,' either rain or snow or something like that. Snow is frozen rain. Hail is when rain freezes into little balls and when it hits the earth, it's hail.
13. See answer number 12 above.

14. When it rains, water goes into the earth and is taken up by the roots of the trees and is given off as water vapor from the leaves and goes back up and comes down as rain again.

15. Yes. Warm and cold air masses meeting cause precipitation.

16. Air pressure is thinner in the mountains than in the valleys. It is measured by a barometer. When the air pressure falls, it means that a storm is coming. When it stays steady or rises, it means it will be fair.
1. We have the sources from the North Pole and the South Pole. And they cool and warm by—when they go down. They come from the North Pole, and they circle until they get to the equator. Then they get warm, and they rise, and they circle up, and go back to the North Pole again.

2. There's westerly winds; there's easterlies. The westerlies are from the equator to the North Pole; and the easterlies—the east winds, are from the equator down. And there's a dense center, which I think they call the Horse Latitude—no wind either way, and there's a North Pole wind—I forget the name of these winds—they circle around.

3. The cause of winds, are usually fronts. You get the wind from the North Pole, and it will not come to us, unless there is something behind it, to push it, like a cold front behind it. Then it breaks through, and it comes down to the South Pole, or to the equator. Then it will heat up and go back again. And if it happens to hit a front before it gets to the North Pole again, it will cool, say from Massachusetts down, and go back to the equator again.

4. You measure wind by the cups—are used by—if you are plotting, you use a line with feathers on it, as we call it. You can use feathers, or you can use the triangle, of which I think means 25 miles an hour, or 20, I'm not sure.

5. We have four seasons, which are determined by the closeness or the farness of the sun. Now the sun, when it's Winter, is—seems strange, but the sun is closer to us. And when it's Summer, the sun is farther to us. It takes eight seconds, or point something or other, for the sun's rays to reach the earth. We have four seasons—there's Fall, Spring, Summer, and Winter. In some places, they have just one season.

6. The sun—the axis of the earth, compared to the sun. At certain times of the year, the North Pole has no sun at
all--its dark up there--for 24 hours, all the time, for about forty days or so. In other times of the season, it's sun, all day--is caused by the sun--the axis of the sun--the sun goes farther to the equator, and farther away from the equator, from north to south, and causes the seasons.

7. A shadow is a reflection. We have a shadow when our sun hits the moon--we have a shadow from the moon. The sun hits an object, and bounces off, and it has a reflection, and it is usually not the same as the object. A person may be six feet, and show a shadow of 12 to 18 feet. The length of a shadow from an object depends on where the light hits you. May be the sun, or a flashlight, or a bulb. You do sometimes have a longer shadow than at other times. If the sun was behind you, I think you would have a long shadow; and if the sun were in front of you--facing you--you would have a short shadow.

8. I think we have four stages, but I don't know them off-hand. You have atmosphere; you have the place where the radio waves go through; and we have snow, rain--I mean snow in the atmosphere--when it rains, it's really snowing, but the heat just melts it down to rain all the time--course it's cold down here; then we have not atmosphere at all--which is dense--you go up there--it's just black.

9. The earth is heated by reflections, and by the sun--the way the sun hits it, which I think is strange--is that the sun, during the Winter--it's closer to us, and it's cold.

10. Probably a front, like--a sea breeze or a land breeze would make it cool. If it was daytime, you'd have the breeze coming off the land, and it would be cooled; and if it was night, you'd have the opposite--you'd have a sea breeze at night, that would cool off the land. The cooling of the earth is the same as the cooling of the sea--it just happens at different times--I think land cools faster.

11. No. We have different seasons and different--the way the axis of the earth is. The North Pole--it's cold, and if you go to the equator, it's hot. And if you have boots or anything, it forms fuzz on it; it's so hot. The pores of the boots, or of anything, close and all the liquid goes out.
12. Precipitation is the moisture—like today, it's about 96 precipitation, and if it goes to 100, the atmosphere can not hold the water as long, and it will start to rain, or snow, or whatever it is—depending on the temperature.

13. Rain—usually a front, or the temperature can not hold too much water—it's 100. Snow—even if it's raining, it's really snow, but the temperature down here is hot, and it makes it melt in the rain; but if the temperatures down here—say about 30 or so, like that, it will snow. It will snow so far, and it would not melt, it would just come down as snow, because the ground and everything is cold. Some places where it is snowing out—the ground—it melts on some parts of the ground—on grass or anything like that—it sticks fast cause it's cold. Sleet is a mixture—it's in between snow and rain—it's depends—you'll have different temperatures during—along the atmosphere. Hail—it comes down as rain and it freezes in solid blocks of ice—in Texas last year, they had pieces that weighed a pound apiece. It's just so cold, it doesn't have a chance to turn into snow—it just melts into rain and forms into big pieces of ice, and it falls to the earth—it freezes so fast.

14. When it rains, and when it stops, you have puddles, and from there it goes into the ground (remembered this from Intermediate Science)—you have an underground river, and below that, you'll have another river. If you have a drought, the water level will drop, and if it rains, the water level will rise. The sun picks up the water. If they say it has rained an inch—when the sun comes out, it will probably take half an inch of it up and forms clouds, and precipitation happens.

15. It has a lot to do with it. Right after a rain storm, the sun comes out and it becomes hot, and from the puddles, form heat rays, and they rise so high, and reach a certain temperature, and form clouds.

16. The higher you go, the less pressure there is. At a certain height, there is no pressure at all—the United States is most interested in that—and balloons—they're sending up now.

17. I suppose it has, but I don't know what it is.

18. Measure it by these balloons they send up. They have
these little boxes with a radio, with about four tubes in it. They usually send it up at the airport and it measures pressure, and it sends down radio waves.
Margaret C.
Female
Age - 15
Grade 11
I.Q. - 114
Oyster River Cooperative High School
Durham, New Hampshire

1. Wind varies from spring breeze to hurricane.
2. Yes, don't know.
3. Wind is caused by air currents.
4. Measured in so many miles per hour.
5. There are four in New England. Spring, rainy season; Summer, hot and arid; Fall, rainy and cool; Winter, freezing temperatures.
6. Caused by air currents.
7. Are produced by sun or light.
8. Made up of gases.
10. Heated by the sun and cosmic rays.
11. Cools as earth rotates away from sun, the nearer the sun the warmer it is.
12. No, it's colder the higher the altitude.
13. It rains when air is saturated with moisture. Rain occurs when air is warm enough, it freezes when temperature is cooler, hail is caused by large drops of rain at freezing temperatures.
14. When clouds have accumulated enough moisture to drop it.
15. Well, air is constantly taking moisture from the soil, then when it's saturated it gives it back.
16. Yes, has to do with types of precipitation.
17. Air pressure around us remains constant at 15 pounds per square inch.
18. Yes, it forms a wall confining weather conditions to certain areas, low pressures and high pressures. Yes, by a barometer.
Mike D.
Male
Age - 15
Grade 11
I.Q. - 104
Oyster River Cooperative High School
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1. Something you can't see, can see effects, but not wind itself.

2. Slow, hard winds, soft winds, easterlies, westerlies, I don't know if you call the jet stream a wind or not.

3. Don't know what causes them. West blows from west, east blows from east.

4. Use a cup, half a cup on a building. It measures velocity.

5. Four seasons, Fall, Winter, Spring, Summer.

6. The sun, I think. As earth rotates it gets in different positions with the sun and causes the seasons.

7. As earth rotates it moves from one direction to another direction, when something gets in front of sun it causes shadows. When sun is high there is not much shadow as when sun is low. When sun is low, shadow is longer.

8. Four atmospheres; ionosphere, stratosphere, can't remember others, go up as you get farther out.

9. As you go up is less air, more of a vacuum. At 3000 ft. not enough oxygen, pressure is more extensive, planes need pressurized cabins.

10. Sunlight.

11. No, sun just gets cool.

12. No, farthest points like North Pole and South Pole are coldest. Around equator, that is where the hottest places are.

13. Caused by low pressure and high pressure, and cold air and warm air.

14. Don't know, all I know it does.
15. Sun evaporates water from the oceans and condenses in sky and clouds, then rains and happens again.

16. Yes.

17. Air pressure.

18. Yes, I believe standard pressure is 14.7, can't remember how it is measured.
Winds are formed when the cold air on the upper regions of the lower part of the atmosphere sinks closer to the surface forcing the warm air up.

There are different wind patterns in different hemispheres. Also, they travel in different directions. Some are quite warm and some are quite cold. There are also layers where closer to the surface, they will be running in one direction and maybe warm while up above, there are other layers of air running in different directions.

The cause of wind is when the cold air that is sinking comes down to earth, it has to push the warm air out of the way and the warm air can't go right up. It has to be blown along the earth and find a place to rise and when it does, it goes up and while it is going along, it is wind. There are also currents of air which cause wind.

There are many instruments which measure the speed of wind. When they have storms, they can tell whether it will be a hurricane or something similar to that.

There are four seasons, Spring, Summer, Winter, and Fall.

The cause of the seasons is the way the earth is tipped on an axis. It goes around the sun in one year. As it is going around the sun, it will change its position towards the sun. It is Winter here because this part of the earth is tipped away from the sun and the sun is giving most of its light to the lower part of the earth. Then when it is Summer, the earth is tipped back so our part is closer facing the sun and the sun's rays will be more directly on our part of the earth. In the Fall and Spring, it is more on an even basis, sort of on its way down to the lower part in the Fall. It's sort of coming back up to our part when it is in the Spring.
7. Shadows are caused by an absence of light; when the sun's light rays come down to earth, they hit objects and if the object is standing erect, the light rays either sink into it or reflect off; the back of that object will not have any light on it and so it will cast a shadow.

8. There are three layers of atmosphere. The lower layer of atmosphere closest to ground is where all the weather is caused, it's the air we live in and breathe. The three layers make up the atmosphere which is like an ocean of air surrounding the earth.

9. The sun is the source of heat and the sun heats the earth by radiation by rays of heat that come through space to earth and are absorbed by the earth.

10. At night when half the earth is swung around and not facing the sun, the sun's rays are not gotten on that side and the heat is used up.

11. No, because the sun shines more directly on some parts of the earth than it shines on others and wind cause different temperatures.

12. Precipitation is caused by the water coming from the clouds to earth. There are usually four kinds, rain, snow, sleet, and hail.

13. Causes of precipitation are the cooling of clouds. Clouds are in the air and cold air rushes in and this causes water vapor which makes up clouds to condense into little water droplets which form on particles of dust and group together until the drop is heavy enough to fall to earth and this is rain. In hail, the droplet of water is formed the same only while it's coming to earth, it's going through different layers of warm and cold air which causes it to freeze and melt until you have a ball of ice with different layers. Sleet is rain which falls and freezes as soon as it hits the earth. Snow is formed when water vapor in clouds is cooled to a degree that it changes instantly to ice and it falls as tiny flakes of ice.

14. The water in lakes evaporates and rises in air. When it gets to a certain point, it groups together and forms clouds. When the clouds cool, it will come down as rain. It will land on the ground and soak in and usually drop to a layer where there is a water table. It will go along the ground water until it gets to a spring and then back into a lake.
15. Yes, because of different temperatures, you have different forms of precipitation. The evaporation of water from earth is also affected by temperature.

16. Air pressure is pushing down of air on the earth's surface. Air pressure is 14.7 pounds per square inch.

17. When a storm is coming, air pressure will be lesser. When there's good weather, air pressure will be heavier.

18. Yes, air pressure is measured by a barometer. There are also metal instruments which are affected by air pressure.
1. It has a lot to do with weather. It can be a damage or a blessing. Yes. There are gale winds, a breeze, normal wind, calm.

2. Well, some are very strong and some are very mild.

3. Nothing. Well, the rotation of the earth has something to do with it, I think, and where you live.

4. I think they can measure it but I don't know how.

5. There are four... Fall, Spring, Summer, and Winter. It's windy in the Fall, it rains a lot in the Spring and Summer, and it's stormy in the Winter and there's not too much wind.

6. The position of the earth toward the sun causes it. The sun is nearer in the Winter but the tilt is greater and the rays aren't direct. The sun is farther away in Summer but the tilt of the earth on its axis is less and the rays of the sun are direct.

7. They are made by the sun's rays.

8. It's air. That's about all I know about it.

9. From the inside, I guess.

10. Breezes and night and the moon, I think, have something to do with it.

11. No, it's hotter around the equator and colder at the North Pole and the South Pole. No, I guess it's different everywhere.

12. It has something to do with clouds. Explained water cycle completely.

13. There's rain, snow, hail. The clouds are too full.

15. I don't know.
16. They measure it with a barometer.
17. Maybe it should have something to do with weather. They're always referring to it.
18. See number 16.
Wind is caused by convection currents.

I don't know.

Some of the air is heated. The warm air rises and pushes the other air down.

NPR

In the Winter, the sun is closer to the earth and in the Summer, it is further away.

I don't know what causes seasons.

Shadows are caused by the blocking out of the sun's rays.

The atmosphere is made up of one-fifth oxygen and there are eight different elements in the air.

The sun's rays bounce off the earth and heat the land around it.

Because the sun is not out.

No, because of the sun's position to the parts of the earth, the temperature is not the same everywhere.

There is moisture in the earth's atmosphere. It occurs as rain, sleet, and snow.

The freezing of the rain as it falls to earth is snow. Hail is caused by rain that falls. The wind blows it back up again and keeps it up in the air. It freezes many different times and then finally falls to earth. Electrical sparks jump between clouds and sometimes cause rain.

Water is given off into the air from lakes and other bodies of water and then it clings to dust particles and forms clouds and causes rain to fall.
15. Yes, it sometimes causes rain as it falls to change to other forms such as snow, hail, or sleet.

16. It's 14.7 pounds per square inch.

17. I don't know.

18. Yes, by a barometer.
Jean P.  
Female  
Age - 17  
Grade 11  
I.Q. - 104  
Malden High School  
Malden, Massachusetts  

1. It flows from the Arctic, down to the - it comes in a northeast direction and we get our wind from the Gulf of Mexico. There are also tropical winds.  

2. Coming from the Arctic, they're going to be cold, and warm if they're coming from the Tropics.  

3. I think they're caused by fronts.  

4. By isobars - they measure the front.  

5. We have four seasons: Winter, Fall, Summer, Spring.  

6. By the different rotation of the earth. In Winter, the earth is farther away from the sun, and in Summer, it's closer to the sun. When the sun is nearer to the earth, there is more heat. Spring - is when the sun is going away from the earth. Fall - the sun is farther away from the earth, and it's pretty close to Winter.  

7. A shadow is caused by the way the sun hits an object and the reflection on the ground. The size of a shadow depends on the angle of the sun.  

8. Composed of gases - 78% nitrogen, and 28% oxygen - 1% other gases. Troposphere - starts at the earth's surface and goes up. I think it's 2000 feet. Stratosphere - 2000 feet - I don't know to where. Ionosphere - 60,000 up.  

9. By the sun's radiation - the light is reflected off the dust particles, and then it reflects down to the earth.  

10. When the sun shines down on it, the heat is drawn into the earth, and the water and the earth will give off heat rapidly - (latter) more rapidly than the water - that cools the earth. The cooling of the earth is faster, and on the inland of the earth would be cooler weather; but if you got weather from the sea, it would be moderate.
11. No. Different places are farther away from the sun.

12. That's rain, snow, sleet, hail.

13. Rain - it comes because the air has reached its saturation point - Dew Point - is the point at which the water will come out of the - when it reaches a certain temperature, it will come out - the water will. Snow is colder - instead of rain, it will be cold enough up there, and it will turn to snow and fall. Sleet - don't know. Hail - ice crystals.

14. I know what the water cycle is. It rains, and the water goes into the streams, and the streams flow into the ocean, and the sun's rays evaporate the water, and it goes back up into the clouds, and then it rains again.

15. Yes. It depends on whether it rains, snows, or what.

16. Pressure decreases as you go higher. I think it's $5\frac{3}{4}$ degrees per ___.

17. I don't know.

18. Barometer. There is a mercury barometer and an aneroid barometer.
Jerry R.
Male
Age - 16
Grade 11
I.Q. - 113
Manchester Central High School
Manchester, New Hampshire

1. There are different currents of wind, they come down in different zones. There are cold currents and warm currents. When these meet they cause storms, such as cyclones, tornadoes, hurricanes and just plain old thunderstorms.

2. Answered in previous question.

3. Wind is air that is moving.

4. They use an anemometer and as the wind goes around it twirls the cups.

5. There are four.

6. They are caused as the earth goes around the sun. In the Summer the rays of the sun hit our part of the earth directly and in the Winter they curve and we don't get as much heat.

7. Shadows are cast when the sun hits an object and that blurs out the sun's rays and instead of light darkness appears on the other side of the object. The shadows go the opposite way the sun is shining.

8. The atmosphere is divided into many parts. Some parts are the troposphere and out in space is the ionosphere filled with electrical charges. This is where our electrical storms start.

9. Earth is heated by solar waves from the sun.

10. It is cooled by winds and darkness, when the earth makes a revolution it cools the earth from the sun's rays because they are not hitting it any more.

11. No, it is different in every latitude. The position of certain lands in relation to the sun cause this.

12. We know it as rain, snow, sleet, hail, etc. It depends
on temperature that is on whether it's cold or hot coming down. It may start out as snow and turn to rain as it nears the earth because it's warmer.

13. It is caused when water on earth is pulled up into cloud vapor and when the clouds get so full they burst. This is known as the water cycle. There are two steps to it, evaporation and condensation.

14. Answered in previous question.

15. Temperature can affect precipitation, like in hot climates it is very humid, there is a lot more moisture in the air so it is more likely to rain.

16. Air pressure causes storms and all weather. We have high and low pressures. It is actually a weight on the earth.

17. Answered in previous question.

18. Yes, with a barometer.
Corinne S.
Female
Age - 17
Grade 11
I.Q. - 105
Malden High School
Malden, Massachusetts

1. There's cold winds coming down from the north, called fronts. And there's warm fronts and cold fronts, and they combine. When two winds meet, sometimes it causes a big wind. Winds come from different places.

2. I don't know.

3. From the sky. From the clouds. Updrafts and downdrafts. When the updrafts and downdrafts meet, they cause a big wind. If there is a mountain, and there is an updraft and a downdraft, and you get in between, it can cause you to crash, because you can't control the plane.

4. I don't know.

5. Are four - Summer, Fall, Winter, and Spring. We have Indian Summer in the Fall. All places in the world do not have four seasons. Down south, it's usually warm all year round. And up in Montana, it's mostly cold all year, and they do get warmer. And in Alaska, it gets warm, but it doesn't get as warm as it does down here. And in the Winter, it's extremely cold.

6. The world is going around the sun, and we go far away from the sun, and every year we circle around, and we go away from the sun, and then we start coming closer. The farther away we get, the farther away from the sun we are. And it causes it to get colder, and coming back, it causes it to get warmer, and the sun melts the snow, if it's snowing. And it comes Spring, and then it comes Summer.

7. The sun causes shadows. If you are standing in a bright spot, and the sun is shining down on you, there's a shadow. You would not always have the same sized shadow. The way the sun is - if it is high up in the sky or lower down - would have a medium-sized shadow now. The shadow has a relationship to the season of the year.

8. Sometimes there's moisture in the air and sometimes it's
With a lot of moisture, it rains, sometimes, or it's sticky outside, muggy, like after it rains. It's muggy outside, because the air is damp after the rain comes down. On a warm day, there is a lot of moisture in the air because the heat from the ground and the heat from the sun mixes. When it is warm out, the heat from the ground and the heat from the sky, it makes it muggy out, and it isn't very dry. In the Winter when it's cold, it's not usually damp, unless it's a rainy day – it's just usually cold, and a dry day.

9. It's heated from the inside, and from the sun - the gases from inside the earth - they come up through the ocean and through the ground, and a lot of forms of different gases - like volcanos - they erupt, to let the hot gases or hot air out of the ground. The heat from the sun - in the warmer months - that heats the earth. If we didn't have the sun, there wouldn't be any light.

10. At night it's cooled when the sun goes down; and in the Winter, when we move away from the sun. There's a lot of water in the ocean, which has a lot to do with it. The seas and the land do not cool at the same rate. In the Summer - take Revere Beach, the water is usually cold, because it takes all Winter for the water to get cold, and by Summer, it's at it's coldest point, and then it takes all Winter again, for it to heat up from the Summer heat, and so, in the Winter, the water is warm, and in the Summer it's cold.

11. No. Wouldn't it be warmer down near the equator - there it is hot all year round. We are farther away from the equator.

12. There is rain, snow, sleet, and hail.

13. Rain - a warm cloud and a cold cloud meet and that causes a turbulence, and that causes it to rain. When they meet, they go in together, and then they get all mixed up inside, and then gradually they separate. Snow - clouds from - they're way up and then they come down. It's rain, but when the rain comes down, it's so cold, that it turns into flakes when it's coming down. Sleet - it's the same as rain - it's rain in ice form and sometimes, when it hits the ground, it softens - just like hail-stones. Sometimes, in different parts of the country, they are big - as a baseball. Hail - is caused - when all the rain - it gets - it mixes together, and causes - like a snowball - then it
comes down, and then it melts, and sometimes it can hurt a person. When a snow cloud mixes with a rain cloud, and it causes it to snow and the rain to mix, and it causes the hail.

14. The water - it rises - when it rains, it causes the water to get deeper. The moisture from the earth, it goes up and forms clouds, and then the cloud travels on its way; and then it meets up with a cold cloud, and they combine, and this causes rain.

15. Usually in the Winter, it doesn't rain as much as it does in the Summer, because it snows all the time - the majority of the time.

16. Updrafts and downdrafts. If you're in a plane, like going through the Grand Canyon in a plane, and there's a cold wind coming down and warm air going up. If you get caught in the middle, and that would cause you - your plane spins and you couldn't control it, and you would eventually crash, because the turbulence is too much. We could get a hurricane or a tornado - from the wind - like, it it's raining out and we have big winds - that's a hurricane. And a tornado - is wind - it's going around and around, and it picks up everything it goes near. A tornado is not very big, but it can do a lot of damage in a short amount of time.

17. I don't know.

18. Yes. If the wind's coming down and going up.
Wendell W.
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Grade 11
I.Q. - 115
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Derry, New Hampshire

1. It blows, comes from air, clouds help in it. Yes.

2. There are hurricanes, gales, gusts, breezes, gentle winds, cyclones, tornadoes.

3. NPR

4. I guess you could measure it with something like Don Kent has...that thing that goes around.

5. There are four: Winter, Spring, Summer, and Fall. Yes, Winter is cold, Spring is warm and rainy, Summer is hot, and Fall is cool and usually kind of dry.

6. In the Summer the direct rays of the sun focus all in one position and hit the earth all at once, close together. In the Winter the rays are indirect, they shoot out all over, scattered, and heat here and there.

7. They're caused by light focusing on you at a certain angle so you block out the rays.

8. It's air. There are different kinds, like ionosphere, stratosphere.

9. Not much. Sunlight, and they say there's some kind of volcanic matter in the center of the earth. Maybe that throws up some heat.

10. One way is the different seasons. Water helps, I guess.

11. No. At the South Pole near Antarctica it goes 'way below zero and at the Tropic of Capricorn and the Tropic of Cancer and different zones like that, the temperature is different. The equator is very hot and humid.

12. The amount of rain, or wetness, rain, snow, sleet, hail, ice.

13. The temperature causes the different kinds, I guess. It
has something to do with the kind of clouds.

14. It works like a cycle. The sun draws the water up into the sky. It makes clouds when it gets up high enough. Then the clouds release it and it falls back. Like a cycle.

15. Definitely. If it's cold it causes the precipitation to be snow or hail, and if it's warm it has to be rain.

16. NPR

17. I haven't any idea.

18. I think you use a barometer.
BIBLIOGRAPHY
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