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Relative Effectiveness of Question Vs. Outline Technic in Teaching Physics

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RELATIVE EFFECTIVENESS OF QUESTION VS. OUTLINE TECHNIC
IN TEACHING PHYSICS

SISTER MARY SARIEL REDDING

A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ARTS
IN LOYOLA UNIVERSITY
1930
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The Assignment has been called, in recent educational literature, the "heart," the "hub," and the "key" of the Study Problem. In view of the demand for specific assignments and directed learning exercises, a number of work books have appeared. Certain of the history work books contain outlines and bibliographical references; others contain questions and a variety of learning exercises. Some include both outline and questions. The science work books in most cases are laboratory manuals with their name changed. One notable exception, however, is a work book in biology, which, though adapted to both the Unit Method of instruction, and the Contract Plan, and an ideal directed learning guide in biology, contains, with purpose perhaps, neither guidance nor summary outline.

The problem of this study is to secure data from observations, as rigidly controlled as classroom conditions would permit, to determine the relative value of questions and outline in directed learning exercises in physics, whether those exercises take the form of assignment sheets, contracts, or work books. An earnest effort has been made to be accurate and impartial, and though the study may not prove to be vitally significant, it is according to the suggestion of those who claim "that evidence gained from many small but carefully controlled experiments, under varying conditions and in different subjects, is valuable to corroborate and verify the conclusions drawn from more elaborate study."
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Introduction

Chapter I
THE STUDY PROBLEM

The purpose of this study is to make a contribution, insignificant though it may prove to be, to the scientific investigations which at present are being carried on, in the field of directed study. This contribution will take the form of experimental evidence bearing on the relative effectiveness of two important study procedures, namely the use of the question and of the outline in teaching physics. Though it is a minor problem of the large study problem, it nevertheless splits into several sub-problems, overlaps others, and suggests questions for further consideration.

If by study is meant the activity of the pupil in acquiring knowledge or solving problems, then the study problem is as old as man himself. But if by study is meant the process of extracting from the printed page the materials of thought and the data necessary for the solution of problems, then the study problem is of more recent origin. McMurry by the publication of his book, "How to Study and Teaching How to Study," gave impulse to a vast array of literature on "How to Study." It is to Hinsdale, however, that Butterweck gives credit for initiating all the activity that has been evoked by what has been called "Supervised Study". According to the latter author, McMurry was concerned with redefining study "in terms of what has become known as the Dewey philosophy of education, analyzed from the standpoint of a Herbartian." Hinsdale, in his book, "The Art of Study," published in 1900, having introduced the
terms "Study-Recitation," and "Study-Lesson" placed special emphasis on the importance of the assignment. It was supervision of the activity of the pupil in his attempt to carry out the assignment that became known as "Supervised Study" (9:2-5).

The supervised study problem, at first one of administration shifted gradually to focus its interest on the individual pupil. Brownell summarizes the literature on supervised study which appeared between 1910 and 1925. He clearly and concisely characterizes the fourteen distinct types of administrative procedure devised to provide for supervised study. He endeavors to distinguish between the essential element of pupil direction, and the accidental "technic" by which he designates the administrative plan. The controlled experimentation made by Breslich, Minnich, Breed, Heckert, Beauchamp, Brown and Worthington on supervised study, he critically evaluates. Beauchamp's study in particular is interesting in that it marks a transition between the studies of the various administrative plans, and the later work on "study habits". Brownell concludes by pointing out the way which future investigation may most profitably take. "Narrow problems, capable of adequate control in experimentation, with the emphasis upon the analysis of the results in terms of the type of learning called for and in terms of individual pupils, should receive the major share of experimental attention" (7:12-43).

Woodring and Flemming in a series of studies published in the Teachers' College Record have taken up the work where Brownell left off. A survey of investigations on study is given, in which is included the work done by Charters, Symonds, Johnson, Deich, Jones, Yoakum, and Sturtevant on methods and habits of study (70:527-49); and by Butterweck,
Johnson, Gilliland, Reeder, Cunningham, Book, and Crawford on determination and use of study technics (70:605-17). We shall have occasion to refer to the findings of certain of these studies later, but there are two points both which may be mentioned here. Jessie Allen Charters reports as a result of her interview study with college women that "the greatest difficulties which students find in study are caused by indefinite assignments (5:535). And Percival M. Symonds after a case study with ten high school boys concludes "that high school boys do exactly what is required of them. They go directly to these tasks and no others. Consequently, in the assignment is the key to study. The assignment should more and more take the form of practical exercises or the 'job'; it should not be a mere covering of material (58:713-24).

Butterweck carried on a series of experimental studies to determine whether the more efficient method of teaching a study habit was to give a course in best methods of study, or to subject the group to a series of practice material in study situations in which it was engaged throughout the year. He chose as situations for this study, "the solutions of originals in geometry," "reviewing for an examination in geometry and in general science," and "reading for the purpose of study." The experimental data, Butterweck concludes, seem to indicate that "systematic practice in the use of the elements of a study situation is a great deal more effective for the high school pupils as a whole than is a knowledge of what these study elements are, and that the effectiveness of the practice method over the non-practice method increases with a decrease in the intelligence of the pupils and is, therefore, far superior for pupils in the lowest quarter or even the lower half in intelligence" (9:72).

That the study problem is closely related to the reading problem has been shown by Yoakam. After enumerating the definitions and analyses made by Gray, Thorndike, Horn, and Huey; and of study, by McMurry, Earhart, Strayer, and Norsworthy, Hallquest, and Stormzand; and of the relations
between study and reading, by Judd and Buswell, and by Lyman, Yoakam characterizes study as purposive mental work, reaching its highest point when it becomes reflective, analytical thinking. "Reading may or may not constitute the major activity of study. It may be a form of study, an act of study, a type of study, and a tool of study, but it is not a term interchangeable with study" (74:124).

Though it is an accepted fact, according to the same author, "that education can easily be too much reading, and that the highest form of study is done independent of reading, or with reading only an incidental factor in connection with the recording of thought," (74:121), it still nevertheless is likewise true that effective and economic methods of assimilative reading play an important part, not only in the assignment method, as the study of the text-book is sometimes called, but in the assimilative periods of the Problem-project, and the Unit technic, as well as in the Winnetka and similar plans which aim in particular to provide for individual differences.

Questionnaire studies, among which in particular is that of Charters (11:41-49), show that the common practice, not only among college students, but also among students in the elementary and high schools, is to prepare an assignment by reading it once. That this is a desirable skill, the attainment of which, training may secure, and one which many life situations demand, is evident, but that in general it is a very ineffective method for students, is the conclusion, at which Yoakam arrived after a series of experimental studies on the effects of a single reading (74:185-209). Germane conducted experiments with groups in the elementary grades and in college, in which he investigated the effect of reading an article through once and spending the rest of the time mentally answering questions, compared with rereading the same article the same length
of time. He concluded that the effect of the mental summary was much more efficient than rereading of an undirected character (74:218).

The findings of Alderman agree with those of Butterweck in that though the effect of the directed-learning questions, (in this case the word question is used in a broad sense to mean any one of three types of learning exercises), was that the pupils made an average gain of two semesters in comprehension in reading, the most intelligent pupils gained least and were in some cases the losers (1:11-21).

The fact that the superior pupil does not gain as much as the inferior pupil from the use of directed learning exercises, in no way invalidates the opinion of those who claim their value, but rather points to the necessity of providing for individual differences in this as in all class room procedure. In response to the demand for specific assignments and study helps, a number of "Work Books" have of late appeared. The greater number have included a variety of problems, projects, and suggestive activities. With the exception of a few laboratory manuals in science which have simply changed their name, all include if not both, at least one study help, the Question or the Outline.
THE QUESTION

When a "Study of Questioning" was made by Yamada in 1913, the literature on the subject in English was not very extensive (74:129-36). Many of the books mentioned in the bibliography of that study are still among the best known sources of information and include the references by Bagley, Colvin, Foster, DeGarmo, and in particular, the study made by Romiett Stevens. That the subject of "Questioning" has not been exhausted and is still of current interest is apparent from the fact that some of the latest educational publications, including those by Monroe, Palmer, Burton, and Waples, give if not a chapter, at least considerable space to the discussion of "Questioning".

Romiett Stevens in "The Question as a Measure of Efficiency in Instruction," maintains as the findings of her critical study of classroom procedure, that the question and answer type of recitation, when rightly used is more fruitful for the teaching process than the topical recitation, the written lesson, or the lecture. The comparison between the questioning of the true teacher and the mechanical teacher, which is found in the same study, is in all probability the occasion for much of the literature which followed shortly on the "technic" of the question.

Stevens tells us that "when we find a true teacher at work in a classroom we generally find that he is using the question and answer recitation for a distinct educational purpose; he seeks through a series of skillful questions to draw forth from his pupils certain groups of facts related or unrelated; he then gives the pupils the incentives to assort his facts and put them together in new relations converting them into potential factors in his experience; he helps him to make over a mass of dry facts into living knowledge. The mechanical teacher seeks in his questioning merely to drive home a certain daily assortment of facts gleaned from the perusal of a text book lesson. The teacher who is a master of the
art of questioning knows how by the use of the right question in the right place, to teach his pupils to acquire and classify knowledge. If he is not a master of the art, if he cannot himself be clear and logical in his questioning, he fosters in his pupils negative habits of work, poor association and careless impressions. Young teachers should not be left to do haphazard work in questioning, but they should be made familiar with the functioning power of different types of questions, and shown how to incorporate in the plan of a lesson a framework of questions, possibly not more than eight or ten in number, that will indicate clearly the intended values of the lesson" (54:3).

Though the questioning technic which Stevens expects of teachers is just as important today as it was then, in the presentation and testing phases of instruction, it is not the accepted technic in the assimilation periods of the project-problem, the unit, or the individual methods. In these methods, however, the question does play a vital part in the assignment, which is to direct the intensive reading that forms, if not the exclusive, at least a major activity during those periods. Morrison, in speaking of the period of assimilation states that "one of the first things to do will be to select . . . . a passage from the basal text . . . and focus upon it a series of written questions touching the content and requiring intensive reading" (42:272). The same holds true of the importance and value of the question in the "goal book" of the Winnetka and similar plans, as well as in the "assignment sheets" of the supervised and directed study plans.

The word "question" is used in a broad sense by certain authors to include many different learning exercises. Branom states that a problem is a question demanding the organization of knowledge and the exercise of judgment before an answer is given. This definition would apply to what are called thought questions by Monroe (39:6-8), and by Moore (41:194-208). According to Monroe (39:6-8), even the requirement to summarize, to make an outline, or to formulate new questions is listed as a type of thought
question. Moore likewise includes the making of an outline as a thought question (41:1940208). Factual questions are of value where certain facts must be clearly comprehended, and memorized as a basis for the solution of further problems. Burton states that "such exercises contribute in some way to the reflective thought process" (8:375). A thought question may cease to be a thought question for an individual, even though it may call for relational thinking, because it can be answered by an exercise of memory on the part of that individual, rather than by a process of reflective thinking. However, according to Thorndike, even the reading of a simple paragraph of prose and answering questions about it is really an act involving "all the features characteristic of typical reasoning" (59:323-32). A question need not be in the interrogative form, though that form is considered more desirable and more incisive. Foster suggests that one way of securing the interrogative form and brevity as well, is to state the situation fully and clearly and then to isolate the problematic element in a concise question (22:56-59).

The experimental work on questioning involves a discussion not only of the thought type and the factual type question, but also of the problems involved in the relative difficulty and effectiveness of asking and answering questions. Carter suggests that one of the study habits which should be systematically developed is "that raising questions will become the regular practice of the pupil" (10:695-706). The question was raised at Batavia, "Who asks the better questions, teacher or pupil?" The superintendent, H. C. Storm decided to put the matter to a test. Questions were collected from pupils and from teachers. The teachers were asked to
vote on the best questions. The median number of fourth grade children's questions which were checked was twenty-seven as against seventeen of the senior high school teachers'. The number of questions was very small, only one hundred in all, and a great deal can be attributed to point of view. A question which might be of value in the high school might seem to rank very low to those who are teaching fourth grade pupils. However, the conclusion arrived at by those who carried on this experiment was "that pupils can ask questions that are equally thought provoking and equally as sensible as those asked by teachers." If the pupils ask as good questions as the teacher, the author adds, the pupils ought certainly to be the ones to ask the questions, because almost all will agree that the person who is doing the real thinking is the one who is asking himself or someone else questions. (57:610–15).

Helseth carried on a controlled investigation with sixteen pupils from September to May to determine "what improvement in thinking about questions from United States history will be made by a class of seventh and eighth grade pupils encouraged to ask questions with regard to United States history and to answer these questions according to their own plans."

While this study involves to a great extent the element of the socialized recitation, the conclusion at which the author arrives is that "children are capable of asking and answering for themselves good questions about history, and improvement in the children's skill in thinking about questions from history is possible" (31:76).

Beauchamp was one of the first, according to Brownell, to make a carefully controlled observation on the effect of instruction and practice in certain study habits. Beauchamp himself taught the control and the experimental group in elementary physical science. He was following the "mastery technic" of H. C. Morrison with both groups. To the experimental
in developing the habit of finding and answering questions in the material assigned; the value of direct coaching on the method of solving thought questions, together with practice in such solution. The data indicated a gain on the part of the supervised group, though not always by as large a margin as might have been expected (7:36-38). In an article in the "School Review" a year later, he suggests for the supervision of elementary physical science, three practices, namely, answering thought questions; making outlines and summaries; framing questions the answers to which would summarize the problem (4:175).

Reeder carried on an investigation, reported by Woodring and Flemming, to determine the value of questions in the assignment in directing children's study of geography. The study questions used in this investigation closely paralleled the texts. The experimental coefficient of all schools was 1.62 in favor of the superiority of objectively scored questions (70: 609-17).

An experiment on questioning which differed in many respects from the foregoing is one on "The Use of Questions in Social Science Material," by John N. Washburne. In the first place it was a single, definite, clear cut experiment with a story of about three thousand words and a time limit of twenty-five minutes to read the story. In the second place it was used with a large number of children--860 out of the original 1,456 who had been selected. And finally, it investigated, not only the effectiveness of giving questions to direct the study of children, but aimed to determine the effect of the placement of those questions, differentiating
between the effect on boys and on girls. The author concludes as a result of the experiment that questions do affect learning, that placement has as great an effect, and that placement has a different effect on boys than it has on girls. His study likewise includes observation on the effect of thought-provoking or questions requiring generalization as distinct from the effect of factual questions (64:321-59).

Louise B. Wright performed an experiment, which is reported in the University of Pittsburgh Journal. Her purpose was to determine the difference in effect of an assignment in history in an elementary school:

1. when the assignment is not motivated;
2. when it is motivated either by
   (a) directing the children to prepare a list of questions covering the assignment, or
   (b) giving the class an outline prepared by the teacher for guidance in study.

The data show an increase in efficiency of 9.9 per cent on the part of the group who were required to write questions to be answered by the material studied, over the control group. An efficiency increase of 27 per cent was shown by the group to whom an outline had been given for guidance in study over the control group. Miss Wright concludes that the giving of an outline by which to study is three times as valuable for motivation purposes as the question method (72:64-67).

The findings of this last experiment indicate that the following of an outline is more effective than the making of questions in the direction of the study of history by elementary pupils. Had the making of an outline been paralleled with the making of questions, or the following of an out-
line with the following of questions, the data might have told a different story.

Wiley characterized as three distinct skills in the use of questions in reading for a definite purpose:

(1) selecting information accurately answering a specific question;
(2) listing the important questions which the selection answers; and
(3) anticipating questions which the author will answer. As for the relative difficulty of the first two skills we quote the author:

"Reading to determine what questions the author is answering requires a rare combination of selective reading and reflective thinking. These elements must be selected which point toward the questions or problems which the author has in mind. This selection must be guided and controlled by a high type of reflective thinking. Thinking is necessary in order to judge just what problems are important and which insignificant, which elements are dominant topics and which explanatory discussions, etc. Since many of the questions are not stated in so many words by the author, it is frequently necessary for the reader to formulate such questions. Now formulating good questions based upon a reading selection requires much keener mental activity than does finding the answer to a stated question" (67:158-59).

T. E. Shields in "The Art of Study" directs students to a use of the anticipatory question in these words: "Reflect on the title of the lesson and write out a brief forecast of the matter which it would contain. You have now succeeded in bringing together and organizing what knowledge you possess concerning the subject. You have gained a point of view of your own and are consequently in a position to take up a study of the text. There are a number of well defined questions in your mind, the answers to which you expect to find in the text. Compare the text, step by step, with the forecast. Wherever your own judgment has anticipated the author, the result will be an increase of self-reliance and a feeling of delight which is as healthful to the mental life as a laugh is to the physical life. When you find one of your questions answered, you will feel a distinct growth of power, and the new knowledge will readily assimilate with that which you already possess. And where you find something which you did not anticipate, it will be likely to open up new vistas and new interests" (53:11).

In general, then, experimental evidence points to the effectiveness of questions as an aid to study. The fact that the more intelligent pupil
did not need the initial urge of a question in the particular study situation involved, does not invalidate the conclusion, which holds true of course, only as far as the product of learning which can be measured by the particular type of test used, is concerned.

THE OUTLINE

The importance of the outline as an effective means of study, and the necessity of training pupils "to pick out the central thought of a selection and to organize the selection in terms of main points and supporting details" has been stressed by Gray (28:112-118), Monroe (37:1-16) and Cunningham (17:355-62) have likewise included the use of the outline as one of the necessary study habits which should be acquired by pupils. If the chief objective of study is to secure relational or functional thinking on the part of the pupil, then the use of the outline in directing study should be effective, in as far as it impels such activity. In "Diagnosis as a Basis for the Direction of Study," Woodring and Flemming state that the "outlining activity requires analysis for the selection of main and subordinate topics, with a comprehension of the relationships of the ideas expressed" (71:46-65).
According to Burton, "the preparation of outlines and briefs is an excellent training, exercising several problem-solving skills" (8:436). Deringer claims that "understanding a paragraph is like solving a problem in mathematics. It consists of selecting the right elements of the situation and putting them together in the right relations and also with the proper amount of weight and force for each. "The mind is assailed as it were by every word in the paragraph. It must select, repress, soften, emphasize, correlate, and organize all under the influence of the right mental set purpose or demand" (18:112-13).

Sandwick tells us we must "in order to remember effectively, outline to establish all connections and relations within the subject . . . . that all learning consists of establishing connections" (52:61). Basing his statement on the investigations of Alderman (1:11-21), and Germane (26:103-13), Yoakam states that "exercises in outlining and summarizing seem to help the reader to organize" (74:44). Parker maintains that the outline is not only a mechanical aid to attention, an aid to expression, but also a very valuable aid to reflective mastery of an assignment (48:410).

Wiley discusses the subject of outlining in detail. He maintains that "efficient reading and study is dependent upon the reader's skill in 'seeing through the relationships' involved in the reading selection. Although good general intelligence is the essential basis back of such insight into relationships, yet training in organizing materials into outlines which graphically express the inter-relationships and inter-dependencies existing among the reading elements is a crying need of most pupils and students today." He names seven activities which are involved in the skill of outlining. The processes of analysis, selection and synthesis are likewise involved, and the law of association, reflective thinking, long span of attention, and learning by reacting enter to facilitate this skill (67:236-42).
The "technic" of the outline may be discussed under two heads: the mechanics of form, and, the method of teaching the art of outlining. Under mechanics may come: (1) the types of outline, and (2) indentation, numbering, lettering, capitalization, etc. Stillman mentions the skeleton outline (55:81). This has been found a valuable device in preparing for an examination in science. After the material had been organized and outlined, a skeleton outline was made for testing purposes. This had simply the numbers and letters to indicate the number of divisions and sub-divisions involved.

Dolch names two types, namely, the topic and the sentence outlines (19:61). Rinaker claims the sentence outline to be far superior to the topic outline in teaching organization, analytical power, and the power of clear thinking (51:1). Wallace and O'Neill name three types according as the items are simply enumerated and sub-divided; in chronological; or logical order. Time, cause and effect are the bases of division in the two latter types (61:284). Hall-Quest classifies outlines as (1) vertical, (2) oblique, (3) parallel, (4) brace or horizontal, and (5) interlacing (30:181-84). As Hall-Quest calls "parallel" outlines what are ordinarily considered "tables", so Craig (13:176) speaks of the diagram of a plot as a "graphic" outline.

A rather complete treatment of the rules governing the mechanics of outline making is given by Hall-Quest (30:179-80), by Williams and Tressler (68:58), by White (66:5-7), by Genung and Hanson (23:4-7), by Craig (13-176) and by Dolch (19:61).
Practically all those who have written on the technic of teaching the outline agree that the study should begin with the use of the ready-made outline, or the analysis of a paragraph in connection with an outline already made, and proceed by gradual steps to the more difficult art of outlining material or constructing an outline for original composition. Tryon (60:119), Rinaker (51:4), Branom (6:203), and Wiley (67:236), offer suggestions for developing the power of pupils to use outlines. Parker quotes the five steps which a certain geography teacher followed in teaching the art of outlining. They are as follows:

1. Teacher's blackboard outlines supplemented by pupils;
2. Class develops outline on board;
3. Individuals outline assignments independently;
4. Teacher assigns questions to direct the study;
5. Individuals devise questions covering main points (49:383-4).

The last two steps are curious. They seem to imply that the answering and asking questions requiring organization, form an advanced stage of outlining. Dolch makes a similar claim when he states that summarizing implies an outline (19:61). One of the most important elements in Morrison's technic is the assimilation outline which the pupils are required to make at the close of the assimilation period (42:230-1).

Yoakam outlines a course by which children learn to make simple outlines in the third grade, and continue with fuller and more accurate ones in fourth, fifth, sixth grades (74:354-395).

Germane was one of the first to investigate experimentally the relative effectiveness of reading, outlining, and summarizing in reading and
study. According to his findings, the making of a written summary outline as a preparation for the lesson is not an economical method of study for pupils who have not been trained in organization (27):

Beauchamp conducted an experiment in 1922 in which he gave to one group specific instruction and practice in outlining, in connection with the class work in general science. Parker reports that the class which received the specific instruction reproduced 8 per cent more of the material in a test, at the end of the first unit; 27 per cent more at the end of the second unit; and 73 per cent more at the end of the third unit. The experiment covered a period of three months (49:385).

McClusky and Dolch carried on an investigation at the University of Illinois in 1924, to discover "the ability of students to determine and label the structure of an author's thought in a series of paragraphs". Of the four steps which they proposed to themselves, only the first was reported on, namely, the procedure for devising a test to measure initial ability in outlining. The report includes a description of the procedure used in devising the test, an analysis of the difficulties which pupils have in outlining, and a suggested program for teaching this study habit. The test thus devised was published in 1926 (36:757-72).

Daringer made another attempt in 1929 to construct "an objective measure of ability to make topical outlines". The preliminary report seems to indicate a simpler test than that of McClusky and Dolch (18:112-118). Another outline test is included in the Iowa Silent Reading Tests published in 1927. This, too, is easier than the McClusky and Dolch test in that the coordinate and subordinate headings are given to the pupil
who is required to supply the number of the sentence in which that idea is expressed.

A preliminary report, made by Woodring and Flemming, of an experimental investigation by Barton to determine "The Value of Outlining in the Acquisition and Retention of Facts in Ancient History," states that after twelve weeks of instruction and practice the experimental group showed a gain of nine and one-half points over the control group as indicated by an objective test given to both sections. The significance of the gain had not as yet been determined at the time of publication (70:612).

Butterweck reports the data which he secured in the use of the outline during two class periods for the purpose of reviewing nine chapters of a general science text-book in preparation for an examination. The mean difference of the practice group over the control group which had not received any special instruction in preparing for an examination, either theoretic or practice by means of outlining, was 9.4 on the true-false test, and 6.7 on the essay test, with a significance of 3.9 and 4.1 respectively (9:35-42).

From another problem of the same study, Butterweck offers further data. During two months of instruction and practice, three sections were taught reading for the purpose of studying. To group "B" was given instruction in the method of outlining; to group "A" was given instruction and practice. Group "C" was the control group. The conclusions drawn are as follows: If the improvement in the ability to outline, when an outline is evaluated by the three selected criteria, is an index of improvement in reading habits, then--
"(1) The reading habits of high school pupils can be improved if pupils are specifically and definitely apprised of what they should do.

(2) The reading habits can be improved to a somewhat greater degree if instead of simply apprising pupils of what they should do, they are provided with systematic practice in the use of the elements comprising the particular reading habit to be developed.

(3) The ability of pupils in selecting essential facts is not improved by either method of instruction, but rather their ability to read with logical organization in mind.

(4) The practice technic is generally better for pupils of below average intelligence.

(5) The non-practice technic is probably equal to the practice technic for pupils of above average intelligence." The three criteria referred to were, briefly, the ability to recognize (1) Main divisions, (2) details, and (3) sub-divisions (9:47-65).

Crawford reports the result of a series of six experiments. Three of them were time-limit experiments of ten, twelve, and fifteen minutes respectively in reading once, reading twice, and outlining an article on the "League of Nations". The results of these experiments were tested by the essay type of test. In the second or work-type experiment, the results were tested by both the essay and the short answer type of test. The article used was a reprint of "Training Research Workers". The subjects in this experiment were three hundred forty-six college students. Conditions and irrelevant factors were controlled as carefully as circumstances would permit. Groups were equated according to intelligence test scores in the smaller classes. A zero point was determined by giving the test to a class which had not been given the opportunity of reading the article at all. The data reveal no significant difference in any of the three experiments (16:434-38).
In all these experimental studies there has been an attempt to determine the effectiveness of training in outlining, or the relative effectiveness in study of outlining and reading. In Wright's experiment, to which reference has been made in the discussion of questioning, there has been an attempt to determine the relative effectiveness of outlining and questioning in preparing an assignment in history.
Chapter II

THE PROBLEM

The problem of the study is to determine the relative effectiveness of the outline and the question-telegram teaching physics. The problem has been delimited to the study of physics, not because either technique named is in any way peculiar to the teaching of physics. On the contrary, laboratory experimental work with its accompaniment, the preparation of a laboratory note-book and the solution of a comparatively large number of mathematical problems are the two major activities involved. But after all this, there must be a certain amount of study from a textbook, and there must be definite organization and review preparatory to examinations.

Now the general trend of opinion is that the more closely connected with the particular school subject, the more valuable is training in any desired study habit. Since opportunity of making investigation was limited to teaching physics, this field rather than one of social science was chosen, though the latter is perhaps better suited to this type of problem. However, those who are interested in the study problem are anxious that investigations of this type be carried on with each particular school subject, so that even should the results prove to be lacking in significance, the purpose of this study will still be accomplished, namely, to throw some light on the relative effectiveness of the two techniques, as far as they concern the teaching, and therefore, the learning of physics, if we may presume that teaching is directing learning.

The problem is delimited to the relative effectiveness of the two
technics in teaching physics to girls. While, according to the investigations of J. M. Hughes concerning factors of success in physics, the intelligence of the girls taking physics is approximately the same as the intelligence of the boys taking physics, the achievement of girls as measured by the tests used is inferior to the achievement of boys in physics in mechanics and heat, in electricity and magnetism. For this reason the median scores were compared with the standard median scores of girls, rather than of boys, when those scores were given, as they were in the Iowa Physics Tests by Harold Camp. It is likewise very probable that the re-action of boys to these two techics would be different than the re-action of girls.

There were three types of procedure available for the study. The first and simplest was the use of a set of standard questions and outlines, such as are found in work books, goal books, contracts, and assignment sheets. The second was to construct a cooperative outline in class under the direction of the teacher, and to make out a list of questions in a similar manner with the other group. The third was to require the groups to make the outlines and questions independently. Time did not permit anything but the first of these three procedures.

Regent's Question Book and Compton's Study Outlines were selected as the most suitable of eight similar books, four of which were question, and four outline books. These books were chosen as a matter of making constant one experimental factor, namely, the ability to make outlines and questions. The teacher might have been able to make better questions than outlines or vice versa, but in this way, not only was a standard type
secured, but a type similar to what might be expected in a work book or assignment sheet.

Regent's questions were chosen from the others because they aimed to be, "not a mere list of miscellaneous questions grouped by topics, but thought questions arranged so as to offer a topical development of the unit." They were not mere fact questions, but, in general, required an understanding of the essential principles. They, moreover, were short and few in number and could be considered pivotal questions. In this way another experimental factor was controlled, namely, the necessity for organization on the part of the group using questions, as well as the group using the outline.

Compton's Outlines were chosen because they showed good construction, were short, and did not contain definitions which could be memorized. They were mere topical outlines, such as a guidance outline would in all probability be. They might be used later as a skeleton for a summary outline should that seem desirable.
Chapter III

THE EXPERIMENT

Matching of Groups

In this investigation there were two groups of girls used. Since physics is taken by practically every girl in the eleventh grade of the school, the groups manifest no particular selective process. In each group there was a variety of nationalities, abilities, attitudes, outside interests, conditions of health, opportunities for study, and, out of school, duties and employments. There was strong group spirit in both and a little rivalry between them. The group, which we shall call "Group B," was more actively aggressive, asked more questions in class, brought into class more outside applications, and in general, were more interested in laboratory work than "Group A." On the other hand, "Group A" was more consistently studious and persevering. There seemed to be about equal home motivation and the same may be said of personal ambition in both groups. Therefore, though no attempt was made to equate the groups with reference to these unmeasureable entities, the writer thinks it safe to presume that no greater error would be caused by using two such groups than would occur from the practice if the two technics were applied consecutively to the same group, or even if the groups were rotated.

The teacher, classroom, laboratory, instruction and drill in other phases of the work, amount of time, tests were all the same for both groups. There was a slight difference in the time of day at which the groups met. "Group A" had the first two periods in the morning, and
"Group B" had the second two periods. The advantages and disadvantages consequent to such an arrangement again seem to the writer to balance each other, and, at any rate, make a smaller difference than would the arrangement of the same time of day but different teachers.

There was also a small difference in the size of the groups. In an attempt to equalize teacher load in the early part of the year, seven who would have been in "Group B" were transferred to another physics teacher. The selection of the seven was left to the pupils who volunteered to be transferred to the other physics section. As time proved, the seven included at least three of the actively aggressive type, and their going tended if anything to equalize the groups, at least in that respect.

On the basis of point scores in the Terman Intelligence Test, Form B, and the mean of first semester grades in physics, and the final grades in botany and geometry of the previous year, twenty-one from "Group A" were matched as closely as possible with twenty-one from "Group B". The grades from the previous year were from four different teachers, two in botany, and two in geometry. It was not thought necessary to secure derived scores for the final grades of these varied teachers, and this opinion was confirmed by the close correlation between the physics grades and the combined botany and geometry grades. This might have been expected but it seems to indicate quite definitely that such a procedure offers a good prognostic test of possible success in physics. This average was called the Achievement Average. The index of studiousness was secured by taking the mean of the achievement average and the Terman Point Score.
"Group B" consists of twenty-one pupils. Throughout the experiment they will use the outline technic.

"Group A" consists of twenty-one pupils matched as closely as possible with the twenty-one pupils in "Group B". Throughout the experiment they will use the question technic.

"Group C" consists of thirty-one pupils, twenty-one of them constitute "Group A". The other ten are those who were left over after the matching of the groups. The entire group was considered separately for purposes of comparison and to be a check on the validity of the process of matching. "Group C" will use the question technic throughout the experiment.

There are three phases to the procedure. The first one constitutes the experiment properly so called. The second and third were added for purposes of comparison and for control.

In the first phase the question and outline technics were used with their respective groups to direct study, and the class discussion which followed. In other words, if questions were assigned, as they were to "Groups A and C," then the class discussion followed those questions. If the outline had been assigned, then the class discussion followed the topical sequence of the assigned outline. The results of this phase of the work are shown in Table III. This phase of the work occurred at the close of a unit and was used as a means of organization and review.

The second phase of the work took the form of a single study assignment, with each group using its respective technic. A test followed immediately on the forty minute study period. The study test was repeated
with the questions in different order, after the tests had been corrected, and the matter discussed keeping to their respective technic.

In the third phase of the work, the outline and questions were assigned as directed study exercises, but received very little attention in class. The class period was used in problem solving and in laboratory work.

The extent to which these three groups were equal at the beginning of the first phase of the work, with respect to studiousness, is shown by a comparison of the medians and means given in Table I; and with respect to chronological age, mental age, and initial ability in physics as indicated in two specific tests, by a comparison of the medians and means given in Table II.

"Group C" is slightly inferior both to "Group A" and to "Group B". This is true in spite of the fact that the twenty-one who were selected from "Group C" to form "Group A" were selected by eliminating from a frequency distribution the number in each interval which exceeded the number in the corresponding interval in "Group B". The fact that there were three who rated less than 100 on the Terman Test in "Group C," while there was but one in "Group B" may account for the inequality.
TABLE I

SCORES OF 52 ELEVENTH GRADE GIRLS IN SEVEN MEASURES OF ACHIEVEMENT AS THEY WERE MATCHED AT THE END OF THE FIRST SEMESTER OF STUDY IN PHYSICS

<table>
<thead>
<tr>
<th>Group</th>
<th>Botany</th>
<th>Geometry</th>
<th>B. &amp; G. Average</th>
<th>Physics I Achieve- ment Average</th>
<th>Terman Score</th>
<th>Studious Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>&quot;Group A&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>91.00</td>
<td>88.00</td>
<td>87.00</td>
<td>86.00</td>
<td>87.00</td>
<td>149.00</td>
</tr>
<tr>
<td>Mean......</td>
<td>90.20</td>
<td>86.10</td>
<td>87.90</td>
<td>85.00</td>
<td>86.10</td>
<td>143.30</td>
</tr>
<tr>
<td>OUTLINE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group B&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>87.00</td>
<td>86.00</td>
<td>85.00</td>
<td>88.00</td>
<td>87.00</td>
<td>149.00</td>
</tr>
<tr>
<td>Mean......</td>
<td>84.10</td>
<td>83.30</td>
<td>83.50</td>
<td>86.85</td>
<td>84.90</td>
<td>143.30</td>
</tr>
<tr>
<td>QUESTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group C&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>87.00</td>
<td>85.00</td>
<td>86.00</td>
<td>82.00</td>
<td>84.00</td>
<td>148.00</td>
</tr>
<tr>
<td>Mean......</td>
<td>87.10</td>
<td>85.80</td>
<td>85.20</td>
<td>81.00</td>
<td>82.90</td>
<td>140.90</td>
</tr>
</tbody>
</table>

* Final grades of the previous year.
** Mean of the Botany and Geometry grades.
*** Mean of the Physics grade for the first semester and the B.&G. Average.
**** Average of the Terman Score and the Achievement Average.
### TABLE II

The three groups as they were matched in age, intelligence and initial test scores at the end of the first semester of study in physics.

<table>
<thead>
<tr>
<th>Group</th>
<th>Chronological Age in years and months</th>
<th>Terman Test</th>
<th>I.Q.</th>
<th>Test on Initial Unit Mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Point Score</td>
<td>Mental Age</td>
<td>Problem Test</td>
</tr>
<tr>
<td>QUESTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group A&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>16-2</td>
<td>149</td>
<td>16-7</td>
<td>103</td>
</tr>
<tr>
<td>Mean......</td>
<td>16-1</td>
<td>143.5</td>
<td>16-3</td>
<td>103</td>
</tr>
<tr>
<td>OUTLINE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group B&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>16-6</td>
<td>149</td>
<td>16-7</td>
<td>103</td>
</tr>
<tr>
<td>Mean......</td>
<td>16-5</td>
<td>143.8</td>
<td>16-3</td>
<td>102.5</td>
</tr>
<tr>
<td>QUESTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group C&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median....</td>
<td>16-6</td>
<td>148</td>
<td>16-7</td>
<td>103</td>
</tr>
<tr>
<td>Mean......</td>
<td>16-3</td>
<td>140.9</td>
<td>16-2</td>
<td>101.3</td>
</tr>
</tbody>
</table>

Highest Possible Score

Standard Median Score for Girls

20.2
COLLECTING THE DATA

The Terman Test was given December 16, 1929. The observations were made at intervals from January to June 1930. During the first semester opportunity was given to both sections to adjust themselves to the new study, and to acquire some proficiency in laboratory work and in problem solving. No attempt was made to give any special instruction to either group with regard to the technics to be applied during the second semester. Seven of the ten periods every week were devoted to regular classroom work. The teacher was left free to use the three remaining study periods per week as she saw necessary to carry on the study in hand. The pupils were not made aware that anything out of the ordinary was being done, and every effort was made to keep one group from knowing that any different procedure was being carried on in one than in the other.

The tests given and the procedure followed may be summarized as follows:

(1) The Iowa Physics Test by Dr. Harold L. Camp on Mechanics was given on January 3, after a semester's work to determine to what extent the re-action to a short-answer standard test was the same as to problem tests.

(2) The Iowa Physics Test by Dr. Harold L. Camp on Heat was given on March 6, after using the outline with "Group B," and Questions with "Group A," for three class periods for the purpose of organization and review previous to a test at the end of the unit.
(3) A short answer test on Magnetism was given to both groups on March 7, after a study period of forty minutes directed by questions with "Group A," and outline with "Group B". There were twenty questions in the test.

(4) The study test was marked in class with both sections, and the matter discussed with "Group A," according to the questions which had been given in the assignment, and according to the outline given, with "Group B". The intention was to repeat the test giving the questions in different order. Time did not permit this with "Group A," but "Group B," of their own initiative asked that the test be repeated, and since there was time, this was done. A variable factor was thus introduced which makes the scores on the second test incomparable.

(5) A short answer test of twenty-five questions was given on electrostatics, following a laboratory period, home study directed by questions with "Group A," and outline with "Group B," and a class discussion following the technic given in the group assignment. This test was given on March 12.

(6) The Iowa Physics Test by Dr. Harold L. Camp on Magnetism and Electricity was given to both sections on April 25, to conclude their study of the unit, following organization and review according to their respective technics.

(7) A short answer test on magnetism and electricity from "School Science and Review" was given to both sections on April 27, to compare results with Camp's test.
(8) Outlines and Questions were given for direction of study, but were not followed in class discussion. The Michigan Instruction Tests were given. Part I, on Sound, was given on May 9.

(9) Procedure same as 8. Part II, on Sound, was given on May 14.

(10),(11) Procedure same as 8. Part I and Part II, on Light, were given on June 4.

(12) For purposes of diagnosis and comparison the scores of two problem tests on heat are included.

(13) The scores of the ten-problem test in mechanics is included for the purpose of comparison with the results in Camp's Test in Mechanics.

(14) Dolch Study Outline Test was given on May 2, to determine to some extent the effect of using an outline in developing the power to make an outline.

(15) Monroe Reading Test III, Forms I and II were given on April 28.
In Table III are given the results of Tests 2, 5, 6, and 7. These are the results of the first phase of the experiment, namely, that in which the outline was used with "Group B," and the questions with "Groups A and C," as a means of organization and review in preparation for an examination at the close of a unit which had been studies four weeks.

The results of the second phase of the experiment, namely, the use of the outline and questions as a lesson assignment are shown in Table IV. Since there was a difference in the interval of time elapsing between Tests 3 and 4, in "Groups A and C," no expression of relation can be made.

Table V gives the results of the third phase of the experiment, namely, the use of the outline and question as study guides with but occasional reference made to them during the class period.

In Table VI and Table VII, the comparative results of the three phases are summarized. The amount of gain, as well as its direction and significance is indicated for the use of the technics in "Group A" and "Group B," in Table VI, and for "Group C" and "Group B," in Table VII.

The effect that the different technics had on the upper and lower half in intelligence, in the first two phases of the experiment, are shown for "Group A" and "Group B," in Tables VIII and IX.

For purposes of comparison the mean scores made by the three groups in problem tests on the same matter which the experimental test covered, are shown in Table X.

As a possible check in the interpretation and evaluation of the data, the scores made in the reading and outline tests are given in Table XI.
### TABLE III

**MEAN SCORES MADE BY PUPILS USING THE OUTLINE AND QUESTION AS A MEANS OF ORGANIZATION AND REVIEW IN PREPARATION FOR AN EXAMINATION**

<table>
<thead>
<tr>
<th>Tests</th>
<th>No. 2</th>
<th>No. 5</th>
<th>No. 6</th>
<th>No. 7</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION &quot;Group A&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>45.19</td>
<td>68.47</td>
<td>39.02</td>
<td>67.10</td>
<td>41.60</td>
</tr>
<tr>
<td>S. D.</td>
<td>15.81</td>
<td>15.06</td>
<td>13.90</td>
<td>13.63</td>
<td>10.46</td>
</tr>
<tr>
<td>P. E. (mean)</td>
<td>2.50</td>
<td>2.21</td>
<td>2.06</td>
<td>2.00</td>
<td>1.50</td>
</tr>
</tbody>
</table>

| OUTLINE "Group B" |       |       |       |       |         |
| Mean | 54.80 | 74.50 | 45.67 | 67.25 | 46.57   |
| S. D. | 19.27 | 15.67 | 21.16 | 14.06 | 12.59   |
| P. E. (mean) | 2.80 | 2.36 | 3.20 | 2.10 | 1.95 |

| QUESTION "Group C" |       |       |       |       |         |
| Mean | 42.46 | 68.20 | 26.89 | 64.82 | 39.60   |
| S. D. | 13.96 | 15.81 | 16.65 | 12.88 | 9.93    |
| P. E. (mean) | 1.70 | 1.90 | 2.20 | 1.50 | 1.20 |

Highest Possible Score 100. 100. 100. 100. 100.

Standard Median for Girls 40.10 36.5

S. D. Standard Deviation of the Mean = \[ \sqrt{\frac{\sum fx^2}{N} - (\bar{c})^2} \]
where \( fx \) = the summation of deviations from an assumed mean squared, \( N \) the number of pupils, and \( c^2 \) the square of the correction of the assumed mean from the true mean.

P. E. Probable Error of the Mean \[ \frac{.67450 \cdot c}{\sqrt{N}} \]
TABLE IV

MEAN SCORES MADE BY PUPILS USING THE OUTLINE AND QUESTION IN THE PREPARATION OF A LESSON ASSIGNMENT AND IN THE RECITATION WHICH FOLLOWED.

<table>
<thead>
<tr>
<th></th>
<th>Test No.</th>
<th>Test No.</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. 3</td>
<td>No. 4</td>
<td></td>
</tr>
<tr>
<td>QUESTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group A&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>66.19</td>
<td>98.50</td>
<td>32.31</td>
</tr>
<tr>
<td>S. D.</td>
<td>12.99</td>
<td>2.70</td>
<td></td>
</tr>
<tr>
<td>P. E. (mean)</td>
<td>1.90</td>
<td>.32</td>
<td></td>
</tr>
<tr>
<td>OUTLINE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group B&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>57.80</td>
<td>83.23</td>
<td>25.43</td>
</tr>
<tr>
<td>S. D.</td>
<td>14.83</td>
<td>9.38</td>
<td></td>
</tr>
<tr>
<td>P. E. (mean)</td>
<td>2.18</td>
<td>1.37</td>
<td></td>
</tr>
<tr>
<td>QUESTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Group C&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>63.30</td>
<td>93.70</td>
<td>30.40</td>
</tr>
<tr>
<td>S. D.</td>
<td>12.16</td>
<td>13.65</td>
<td></td>
</tr>
<tr>
<td>P. E. (mean)</td>
<td>1.40</td>
<td>1.80</td>
<td></td>
</tr>
<tr>
<td>Highest Possible Score</td>
<td>100.</td>
<td>100.</td>
<td></td>
</tr>
</tbody>
</table>
TABLE V

MEAN SCORES MADE BY PUPILS TO WHOM QUESTIONS AND OUTLINE WERE GIVEN FOR STUDY DIRECTION BUT NOT USED IN RECITATION

<table>
<thead>
<tr>
<th>Tests</th>
<th>No. 8</th>
<th>No. 9</th>
<th>No. 10</th>
<th>No. 11</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION &quot;Group A&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean .................</td>
<td>57.60</td>
<td>58.00</td>
<td>58.80</td>
<td>62.00</td>
<td>54.76</td>
</tr>
<tr>
<td>S. D. ................</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>12.06</td>
</tr>
<tr>
<td>P. E. ................ (mean)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1.70</td>
</tr>
<tr>
<td>OUTLINE &quot;Group B&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean .................</td>
<td>61.30</td>
<td>54.40</td>
<td>52.40</td>
<td>52.40</td>
<td>51.30</td>
</tr>
<tr>
<td>S. D. ................</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>17.29</td>
</tr>
<tr>
<td>P. E. ................ (mean)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>2.60</td>
</tr>
<tr>
<td>QUESTION &quot;Group C&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean .................</td>
<td>53.60</td>
<td>54.40</td>
<td>54.40</td>
<td>56.00</td>
<td>50.10</td>
</tr>
<tr>
<td>S. D. ................</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>13.44</td>
</tr>
<tr>
<td>P. E. ................ (mean)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1.60</td>
</tr>
<tr>
<td>Highest Possible Score</td>
<td>100.</td>
<td>100.</td>
<td>100.</td>
<td>100.</td>
<td></td>
</tr>
</tbody>
</table>
TABLE VI

CHANCES THAT THE SUPERIORITY IS IN THE DIRECTION
OF THE OBTAINED SUPERIORITY FOR
"GROUP A" AND "GROUP B"

<table>
<thead>
<tr>
<th>Tests</th>
<th>D.</th>
<th>SDD.</th>
<th>E. C.</th>
<th>SUPERIORITY</th>
<th>CHANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>9.61</td>
<td>24.92</td>
<td>.14</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>5</td>
<td>5.83</td>
<td>21.74</td>
<td>.10</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>6</td>
<td>6.65</td>
<td>25.32</td>
<td>.09</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>7</td>
<td>.15</td>
<td>19.58</td>
<td>.00</td>
<td>0 &gt; Q</td>
<td>---</td>
</tr>
<tr>
<td>2,5,6,7</td>
<td>4.97</td>
<td>16.37</td>
<td>.11</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>3</td>
<td>8.39</td>
<td>19.71</td>
<td>.15</td>
<td>Q &gt; 0</td>
<td>1.6:1</td>
</tr>
<tr>
<td>4</td>
<td>15.27</td>
<td>---</td>
<td>---</td>
<td>Q &gt; 0</td>
<td>---</td>
</tr>
<tr>
<td>8,9,10,11</td>
<td>3.46</td>
<td>21.08</td>
<td>.06</td>
<td>Q &gt; 0</td>
<td>1.6:1</td>
</tr>
</tbody>
</table>

\[ D = M_1 - M_2 \]
\[ SDD. = \sqrt{(S.D. M_1)^2 + (S.D. M_2)^2} \]
\[ E. C. = \frac{D_m}{2.76 \text{ SDD.}} \]
### TABLE VII

CHANCES THAT THE SUPERIORITY IS IN THE DIRECTION OF THE OBTAINED SUPERIORITY FOR "GROUP C" AND "GROUP B"

<table>
<thead>
<tr>
<th>Tests</th>
<th>D.</th>
<th>SDD.</th>
<th>E. C.</th>
<th>SUPERIORITY</th>
<th>CHANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>12.34</td>
<td>23.80</td>
<td>.19</td>
<td>0 &gt; Q</td>
<td>2.5:1</td>
</tr>
<tr>
<td>5</td>
<td>6.10</td>
<td>22.26</td>
<td>.10</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>6</td>
<td>18.78</td>
<td>26.94</td>
<td>.25</td>
<td>0 &gt; Q</td>
<td>2.5:1</td>
</tr>
<tr>
<td>7</td>
<td>2.43</td>
<td>19.33</td>
<td>.04</td>
<td>0 &gt; Q</td>
<td>---</td>
</tr>
<tr>
<td>2,5,6,7</td>
<td>6.97</td>
<td>16.03</td>
<td>.16</td>
<td>0 &gt; Q</td>
<td>1.6:1</td>
</tr>
<tr>
<td>3</td>
<td>5.50</td>
<td>19.18</td>
<td>.10</td>
<td>Q &gt; 0</td>
<td>1.6:1</td>
</tr>
<tr>
<td>4</td>
<td>10.47</td>
<td>19.90</td>
<td>---</td>
<td>Q &gt; 0</td>
<td>---</td>
</tr>
<tr>
<td>8,9,10,11</td>
<td>2.20</td>
<td>21.90</td>
<td>.02</td>
<td>0 &gt; Q</td>
<td>---</td>
</tr>
</tbody>
</table>
TABLE VIII
MEAN SCORES MADE BY UPPER AND LOWER HALF IN INTELLIGENCE OF "GROUP A" 
AND "GROUP B" IN USE OF OUTLINE AND QUESTIONS FOR PURPOSE OF 
REVIEW AND ORGANIZATION IN PREPARATION FOR AN 
EXAMINATION

<table>
<thead>
<tr>
<th>Tests</th>
<th>Group</th>
<th>Upper Half</th>
<th>Lower Half</th>
<th>Whole Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,5,6,7</td>
<td>Outline &quot;B&quot;</td>
<td>57.12</td>
<td>39.97</td>
<td>46.57</td>
</tr>
<tr>
<td>2,5,6,7</td>
<td>Question &quot;A&quot;</td>
<td>49.44</td>
<td>33.06</td>
<td>41.60</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>7.68</td>
<td>4.91</td>
<td>4.97</td>
</tr>
</tbody>
</table>

TABLE IX
IN PREPARATION OF A LESSON ASSIGNMENT

<table>
<thead>
<tr>
<th>Tests</th>
<th>Group</th>
<th>Upper Half</th>
<th>Lower Half</th>
<th>Whole Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Outline &quot;B&quot;</td>
<td>67.50</td>
<td>48.10</td>
<td>57.80</td>
</tr>
<tr>
<td>3</td>
<td>Question &quot;A&quot;</td>
<td>73.00</td>
<td>60.00</td>
<td>66.19</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>5.70</td>
<td>11.90</td>
<td>8.39</td>
</tr>
</tbody>
</table>
TABLE X
MEAN SCORES MADE BY GROUPS IN PROBLEM TESTS IN THE THREE UNITS STUDIED
WHILE USING THE QUESTION AND OUTLINE TECHNIC

<table>
<thead>
<tr>
<th>Group</th>
<th>Mechanics</th>
<th>Heat</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;A&quot;</td>
<td>74.00</td>
<td>86.70</td>
<td>75.00</td>
</tr>
<tr>
<td>&quot;B&quot;</td>
<td>66.50</td>
<td>77.50</td>
<td>75.00</td>
</tr>
<tr>
<td>&quot;C&quot;</td>
<td>64.20</td>
<td>76.70</td>
<td>65.00</td>
</tr>
</tbody>
</table>

Highest Possible Score 100.

TABLE XI
MEDIAN SCORES MADE BY PUPILS IN READING AND OUTLINE TESTS

<table>
<thead>
<tr>
<th>Group</th>
<th>Reading Comprehension</th>
<th>Rate</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;A&quot;</td>
<td>46.50</td>
<td>141</td>
<td>9</td>
</tr>
<tr>
<td>&quot;B&quot;</td>
<td>48.00</td>
<td>135</td>
<td>9</td>
</tr>
<tr>
<td>&quot;C&quot;</td>
<td>49.50</td>
<td>130</td>
<td>7</td>
</tr>
</tbody>
</table>

Monroe Reading Test III, Forms 1 and 2.
Dolch Outline Test.
Chapter IV

Conclusion

Interpretation and Evaluation of the Data

The data seem to indicate a small gain on the part of the group which used the outline for review and organization for an examination. Though the gain is small, the direction of the gain is the same for all four tests. What seems to make it more probable that the gain though small is real, is the fact that "Group B," which shows the gain, was slightly inferior to "Group A" in the scores which were used for matching the groups, and they likewise had lower scores in the problem tests, so that the gain in all probability is not due to a slight tendency to superiority on the part of the group using the outline. The Question "Group A" retain their superiority in problem solving throughout the first two phases of the experiment. This would seem to indicate that though the technics used do affect that which is measured by such tests as were used in the experiment, namely, the Iowa Physics Test, and Objective Short Answer Tests, they do not affect that which is measured by problem tests. Since the tests used in the experiment call not only for information, but for relations and applications, it may be that the only difference between the two types of tests as measuring instruments, is the mathematics involved in the problem test. This is one question which the study raises and is not prepared to answer.

The data likewise indicate that questions make a better assignment, at least for those not trained in using an outline, in the preparation of a lesson. It is not clear whether the result is due to lack of practice
on the part of the pupils to whom the outline was given, though in the first phase of the experiment they had been given seven class periods in using an outline for purposes of review and organization, or whether the question has more power to arouse interest, focus the attention and overcome initial inertia. A question is certainly a more definite assignment, and other things being equal, the more definite the assignment, the better the results as far at least as high school students are concerned. While the results of Test 4 cannot be compared with respect to the two groups, one fact seems to be evident from the results shown by both groups, namely, that when pupils know they are to be tested on certain definite points, they can acquire considerable information in an incredibly short time, and the results will vary, other things being equal, with the amount of time available for study up to a certain point.

In the third phase of the experiment a small gain in the average for all four tests indicates a preference for the question technic. However, since the results oscillate back and forth in the separate tests, this gain may be attributed to other factors than the experimental factor, for instance, to the fact that "Group B" were at this time managing a dance, the business details of which were consuming a considerable share of their time and attention.

The results shown in Table VIII seem to indicate that the technic which was more effective for the group was likewise more effective for both the upper and lower half of the group. At first this seems to be at variance with the findings of Butterweck and Beauchamp, but in their work, it was a case of the presence or absence of direction or practice
in study which proved to be of greater value to the lower than to the upper half in intelligence, whereas, in this case, it is a comparison of two different study technics.

The data on the problem tests seem to indicate that the question group lost while the outline group gained in power to work problems. This result is in all probability due likewise to other factors than the experimental factors, such as competition between the groups, which was especially keen when it came to the problem tests; and probably to an increase of mathematical difficulty in the problems.

It is not possible to make a statement concerning the effect that the technic had on reading ability and skill in making outlines, since no initial measure was taken. It seems clear, however, that merely using an outline does not develop skill in outlining to any perceptible degree.

Limitations of the Data

The chief limitations of the data are as follows:

1. A control group would have been a check on the presence of any irrelevant factors, over which there was no possible control.

2. An intelligence test other than the Terman Test would have been of value, as a check in determining the intelligence score in equating the groups.

3. Likewise, another standard test other than the Camp Test would have been a check, especially so since in the Camp Test the weight given to each question is based on the difficulty due to the unusual nature of
the question rather than its importance.

4. The chief limitation was lack of time necessary to carry out the experiment through the second and third procedure, namely, that of making outline cooperatively and independently. Problem solving and laboratory work consumed so much time that only the first and what would seem to be the least significant of the procedures was reached.

Though the experimental coefficient is so small that the results are not to be considered significant statistically, they, nevertheless, are consistent and indicate that:

1. Questions make the better form of lesson assignment, especially for those who are not trained in the use of an outline.

2. The value of an outline depends on the amount of use made of it during the class period.

3. The value of the outline as indicated by the experiment is sufficient to warrant that it be included in a Physics Work Book.

The psychology of the "question" has been discussed directly and indirectly by philosophers from Socrates and Plato even to Dewey. The writer has not been able to find any discussion of the psychology of the outline, any analysis of the logical relations, more than a mere category of the types of relations involved. Such an analysis might explain why an outline is more effective for organization of knowledge than a list of questions so logically arranged that they almost form an outline.

It is just this little difference between a set of logically arranged questions and an outline that makes the difference found in this experiment. Spearman's theory of the measurement of human intelligence
may help to explain this difference, and the same theory may indicate the necessity and the possibility of teaching outlining as well as the relations if there be any between the processes which take place in outlining and those which occur in problem solving.


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* Works not directly referred to, but used in the preparation of the thesis.
HEAT AND ITS PRINCIPLES


II. Basic Laws of Heat:
   A. Principle of the Conservation of Energy
   B. Principle of the Dissipation of Useful Energy
      (Carnot's Principle)

III. Attributes of Heat:
   A. Temperature
   B. Specific Heat
   C. Latent Heat
   D. Measurement of Heat

IV. Effects of Heat on Matter:
   A. Expansion and Contraction
      a. In Solids
      b. In liquids
      c. In gases
   B. Change of Physical State
      a. Change from solid to liquid
      b. Change from liquid to gas
      c. Change from solid to gas
   C. Transmission of Heat.
   D. Machines for transforming Heat into work.
HEAT

Temperature and Thermometers

1. What is the Kinetic Theory of Heat?

2. Define: (a) Temperature, (b) Thermometer... (c) Upon what principle do most thermometers operate?

3. Describe the construction of a mercury thermometer including method of determining the fixed points.

4. (a) What are the fixed points of a thermometer? (b) Why are fixed points necessary?

5. (a) What are the limitations of the common mercury thermometer? (b) Mention some forms of thermometers that might be used where the mercury thermometer is not practical.

6. (a) State two differences between the centigrade and Fahrenheit scales of temperature. (b) Change 20°C into the corresponding reading Fahrenheit.

7. (a) Name and define the unit of heat. (b) Define and illustrate specific heat. (c) How does the specific heat of water compare with that of other substances?

8. (a) Describe a laboratory experiment for determining the specific heat of a metal. (b) Make clear what use is made of the law of heat exchange in this determination. (c) What is the water equivalent of the calorimeter?

9. A piece of metal weighing 1000 grams is taken from water at 100°C and immersed in a calorimeter containing 8800 grams of water at 10°C.; if the water equivalent of the calorimeter is 40 grams and the temperature of the water is raised by the hot metal to 21°C., what is the specific heat of the metal?

10. Explain how the high specific heat of water affects the climate of land near large bodies of water.

11. (a) Define latent heat. (b) Define and illustrate heat of fusion. (c) Define and illustrate heat of vaporization.

12. (a) What is the temperature of ice while being distributed on a hot summer day? (b) Explain how the low temperature may be maintained in a refrigerator by means of the melting ice supplied. (c) What are freezing mixtures?
13. A cup of hot tea is cooled by ice; describe in detail the temperature changes and the heat exchanges that result. (in the description, ignore changes due to radiation or absorption.)

14. Three beakers contain equal masses of water at 80°C. To the first are added 20 grams of water at 0°C.; to the second, 20 grams of ice at 0°C.; and to the third, 20 grams of lead at 0°C. In which will the resulting temperature be (a) the lowest, (b) the highest? Explain.

15. (a) Distinguish between evaporation and boiling. (b) State and illustrate the laws of evaporation.

16. What is meant by the dew point? How may the dew point be found in the laboratory?

17. (a) Define humidity. (b) What is meant by a relative humidity of 50%? (c) How are clouds, fogs, rain, snow, etc. caused?

18. State the law of ebullition (boiling).

19. Describe an experiment to show that water can be made to boil at a temperature (a) lower than 100°C., (b) higher than 100°C.

20. (a) Why is the temperature of the steam used for running a steam engine higher than 100°C.? (b) Can the temperature of water in an uncovered kettle be raised above the boiling point by increasing the temperature of the fire under it? Explain.

21. Describe laboratory experiments to show the disappearance of heat at (a) the melting point, (b) the boiling point.

22. A block of ice weighing 1000 grams is heated from -10°C. to plus 112°C. Compute the quantity of heat absorbed in each change of state and in each change of temperature. (Assume the heat of fusion to be 80 calories, the heat of vaporization of steam to be 537 calories, the specific heat of ice and of steam to be .5 each.)

23. Name and define each of the following methods of heat transmission: (a) conduction, (b) convection, (c) radiation, (d) state wherein radiation differs from conduction and convection.

24. A piece of oilcloth and a piece of carpet have the same temperature. (a) Which appears the warmer to the feet? (b) Explain. (c) Should the handle of a soldering iron be made of metal or of wood? (d) Explain.
REFEREES' REPORTS

It is the practice of the Graduate School to have theses read by three referees. If the first two votes are favorable, the third reading is sometimes omitted. The Graduate Council regularly recommends for the degree all students who have a majority of favorable votes.

Students are frequently required to rewrite portions of their theses because of the referees' criticisms. This will explain why references to pages are sometimes inaccurate and why shortcomings concerning which comment is made in the reports are found not to exist.
THESIS: RELATIVE EFFECTIVENESS OF QUESTION vs. OUTLINE TECHNIC IN TEACHING PHYSICS

This is a concise, orderly and truly scientific piece of research. Her experimental technic is very well handled; the exploration of her literature is clearly indicated and all mechanical details have been carefully adhered to.

I recommend its acceptance with honors.

Howard Egan
I would recommend the acceptance of this Master's Thesis.

The writer has done a careful piece of work of an experimental type. She has carefully avoided dogmatic statements and has acknowledged frankly the limitations of her conclusions.

Wm. H. Johnson