THE EFFECT OF SUBSUMING CONCEPTS ON STUDENT ACHIEVEMENT AND THE INTERACTION EFFECT OF SUBSUMERS WITH HIGH AND LOW ORGANIZING ABILITY

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CHAPTER I

THE NATURE OF THE PROBLEM

Introduction

One of the earliest rationals for subsuming concepts was postulated by David Ausubel (1957). He hypothesized that learning and retention of unfamiliar material could be aided by providing the learner with an "advance organizer" that is more general, inclusive, and abstract than the material to be learned. In a recent book Ausubel (1968) outlines the three major ways in which he feels advance organizers operate. In the first place, they utilize the relevant anchoring concepts that are already established in the learner's cognitive structure and make them part of the subsuming entity. Secondly, they provide optimal anchorage by making subsumption under specifically relevant propositions possible. Finally, advance organizers, by providing key anchoring ideas, replace much of the rote memorization often utilized by students to learn the details of unfamiliar material.

Ausubel and Fitzgerald (1961, 1962) found that learners with low verbal ability profited more from the use of expository organizers than did learners with high verbal ability. Similar results were reported by Dawson (1965). In a study of elementary school science students, Schulz (1966) found a parallel situation with students of low analytical ability. Ausubel concludes that students who lack the ability to organize new material and relate it to their existing cognitive structure benefit most from the use of advance organizers. It has not been demonstrated, however, that the ability of a learner to organize new material on his own is correlated with either verbal or analytical ability.

The relative effectiveness of expository advance organizers is not well established in the literature. Dawson (1965), Merrill and Stolurow (1966), Grotelueschen and Sjogen (1968), and Kuhn and Novak (1970) have presented findings that tend to confirm Ausubel's (1960) study. However, Pella and Triezenberg (1969), Weisberg (1970), and Proger et al. (1970) have reported that other types of organizers are superior to expository organizers.

The position of the organizer relative to the learning passage has also been questioned. Woodward (1966), Davis (1969), and Bayuk et al. (1970) have reported no significant difference between advance and post organizers. Bauman and Glass (1969) reported that post organizers were significantly more effective than advance organizers.

Hypotheses

It was the purpose of this study to determine the effect of advance and post organizers on student achievement on a science-oriented learning passage, and to determine the interaction effect of both advance and post organizers with high and low organizing ability.

This study was designed to test the following null hypotheses:

1. Differences in types of subsumers (advance organizer, post organizer, and non organizer) will not differentially influence undergraduate chemistry students' levels of performance on a science achievement test.

2. Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science achievement test.

3. The science achievement test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

4. Differences in types of subsumers (advance organizer, post organizer, and non organizer) will not differentially influence undergraduate chemistry students' levels of performance on a science retention test.

5. Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science retention test.

6. The science retention test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

7. Differences in types of subsumers (advance organizer, post organizer, and non organizer) will not differentially influence high school physics students' levels of performance on a science achievement test.

8. Differences in organizing ability of high school physics students will not differentially influence levels of performance on a science achievement test.

9. The science achievement test scores of high school physics students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

Need for the Study

Considerable attention has been devoted to subsuming concepts but conclusive empirical research clearly delineating the superiority of one type of subsumer over another is not apparent in the literature. Evidence of this discrepency is found in various text books. Ausubel (1968), Ausubel and Robinson (1969), and DeCecco (1970) provide advance organizers in preference to chapter summaries. In contrast, Hilgard and Atkinson (1967) and Loree (1970) utilize chapter summaries, questions, and similar types of post organizers to facilitate the reader's learning and retention of the material.

Numerous studies have demonstrated that the organismic variables sex, achievement, analytical ability, and verbal ability relate differentially to the effectiveness of externally imposed subsuming concepts. The effect of external subsuming concepts on achievement of subjects who demonstrate innate differences in ability to subsume meaningful learning material, however, has not been demonstrated. The correlation between innate ability to organize learning material and the other organismic variables mentioned has not been determined.

Limitations of the Study

The external validity of this study is somewhat limited in that the results cannot be generalized beyond the populations from which the samples were drawn (the chemistry class and the physics class).

Definition of Terms

1. Mountain Organizing Test: The mountain organizing test (MOT) is the instrument utilized to determine the organizing ability of the

subjects (Ss) participating in the study. The entire MOT is reproduced in Appendix A.

2. Good Organizer: A good organizer is defined as any S who received a score of eighteen or less on the mountain organizing test.

3. Poor Organizer: A poor organizer is defined as any S who received a score of more than eighteen on the mountain organizing test.

4. Subsumer: A subsumer is any kind of organizer that facilitates the incorporation and retention of meaningful learning material.

5. Advance Organizer: The advance organizer is defined as an introductory paragraph or passage that is written on a higher level of abstraction, generality, and inclusiveness than the learning passage that follows it. The advance organizer is reproduced in Appendix E.

6. Post Organizer: The post organizer is defined as a summary paragraph or passage that is written on a higher level of abstraction, generality, and inclusiveness than the learning passage that preceeds it. The post organizer is reproduced in Appendix E.

7. Non Organizer: The non organizer is defined as an introductory or summary paragraph or passage of approximately the same length and reading difficulty as the advance and post organizers, but differing from the organizers in that it is primarily historical in nature and is not intended to provide any kind of ideational scaffolding for the learning passage that either preceeds or follows it. The non organizer is reproduced in Appendix F.

8. The Chemistry Class: The chemistry class refers to all students enrolled in Chemistry 1364 at Oklahoma State University during the second semester of the 1970-71 school year.

9. The Physics Class: The physics class refers to all students enrolled in the Harvard Project Physics class at Northeast High School in Oklahoma City, Oklahoma, during the 1970-71 school year.

10. Learning Passage: The learning passage utilized in this study was provided by Dr. David P. Ausubel and is the same one used in his 1960 study. The learning passage is reproduced in Appendix B.

11. Learning Passage Test: The learning passage test (LPT) is the instrument used to determine the extent to which the learning passage was assimilated by the Ss. The same instrument was utilized to determine both the achievement and the retention scores. The questions for this test were selected from a pool of forty-five multiple choice questions provided by Dr. Ausubel. The LPT is reproduced in Appendix C.

12. Achievement Score: The achievement score refers to the score made by an individual S on the learning passage test taken immediately after studying the learning passage.

13. Retention Score: The retention score refers to the score made by an individual S on the learning passage test three weeks after the achievement score was determined.

CHAPTER II

BACKGROUND FOR THE STUDY

Introduction

Readers of highly specific verbal material often encounter difficulty in extricating and interpreting the essence of the passage. Different text book authors have attempted to overcome this problem by providing the reader with subsuming concepts to help him organize within his mind the useful information presented in the learning passage being studied. The subsuming concept (subsumer) may consist of a brief summary, an introduction, key sentences dispersed throughout the learning passage, or strategically placed questions that, in effect, force the reader to focus his attention on certain aspects of the learning passage.

While there is some overlapping, essentially there are three general categories of subsumers. Included are those subsumers which provide internal organization (concurrent organizers), those which attempt to summarize the central ideas of the learning passage after it has been read (post organizers), and those which are designed to preceed the learning passage (advance organizers). Each of these categories can be further subdivided into either nonverbal or verbal organizers.

Nonverbal organizers include graphs, figures, maps, games, working models, and still and motion pictures. Their effectiveness is generally independent of the S's ability to read.

The emphasis in the literature, however, is on verbal organizers. The two major kinds of verbal organizers that have been reported are sentence outlines and paragraph abstracts. Sentence outlines may contain either declarative sentences or test-like questions. Paragraph abstracts may be expository, comparative, or historical. While the present study is primarily concerned with expository advance and post organizers, the following survey of the literature reviews research that elucidates the relative effectiveness of each of the categories and subcategories mentioned above.

Concurrent Organizers

Research on the effect of subsumers on learning and retention of meaningful material has been conducted by a number of investigators. Gagné (1969) examined the effects of context on the retention of propositional materials. He found that the retention of facts presented with a superordinate context (introduced by means of a topic sentence) was superior in retention to a context containing coordinate facts, which was in turn superior to one containing unrelated facts. In a later study Gagné and Wiegand (1970) found that the topic sentence improved the remembering of facts when it was presented just before the retention test.

The relative effectiveness of embedding test-like questions and declarative sentences in a learning passage has been examined by Rothkopf and Coke (1963). They found the test-like questions to be more effective than the declarative sentences, but that Ss who received both sentence and question review performed better than Ss who received either type of review alone.

Rothkopf (1966) attempted to ascertain whether adjunct test-like questions have general facilitating effects on learning of written passages and also whether it matters where the experimental questions are asked in the course of the reading. He found that test-like questions which are presented after reading the relevant text passage have both specific and general facilitative effects on post-reading performance. Test-like questions which were presented before the relevant text passage was read produced only question-specific facilitative effects. Rothkopf demonstrated that when a written passage is studied, Ss learn not only the specific content but also may acquire some general facilitative skills (mathemagenic behaviors). He concluded that test-like questions which are embedded in the written passage at intervals of approximately 1000 words are one of the environmental controls of these mathemagenic behaviors.

This finding has received support from other studies (Rothkopf and Bisbicos (1967), Frase (1968a, and 1968b), Bruning (1968), and Pyper (1969)). These investigators indicate that the effectiveness of the inserted questions is a function not only of placement of the questions, but of their difficulty, novelty, relevancy, and content as well. Gustafson and Toole (1969), however, found that adjunct questions failed to produce general facilitation and suggested that the effects found by other investigators were more germane to sequential reading than to careful study.

In a recent study Cashen and Leicht (1970) postulated that setting an item apart from other list items by underlining would facilitate recall of that specific item. They reported that the performance of a group of undergraduate psychology students on questions based on underlined material was superior to their performance on questions based on materials that was not underlined.

Post Organizers

The findings of Rothkopf and others concerning the relative effectiveness of concurrent organizers placed immediately after the section to be subsumed have led other investigators to pursue the post organizer concept. A post organizer differs from the type of concurrent organizer utilized by Rothkopf in that it occurs after the entire learning passage and it is usually in paragraph form. The concurrent organizer, however, is embedded in the learning passage itself (either before or after the particular section to be subsumed), and it is generally in either statement or question form.

In an early study Woodward (1966) utilized a 2 X 2 factorial design to determine the relative effectiveness of advance and post organizers. The second factor examined in the study was the relative effectiveness of an expository learning program and a discovery learning program. The Ss were undergraduates enrolled in a math education class and the learning passage subject was modulus arithmetic. The organizers were identical except for minor wording changes and were more general, inclusive, and abstract than the learning passage itself. Woodward found no significant differences between either the organizers or the programs.

Davis (1969) conducted a similar study with eighth graders. In his study, which used a matched design with a control group, he found no significant difference between treatments (organizer versus no organizer) and no significant difference between position (advance organizer versus post organizer).

Bauman and Glass (1969) tested the hypothesis that Ss receiving an organizer after a lesson would perform better on a test over the lesson than either those receiving an organizer before a lesson or those receiving no organizer at all. They conducted two separate but parallel studies utilizing undergraduate Ss and unfamiliar learning material. In each study they randomly divided the class of 21 Ss into three treatment groups. The control group received the lesson only, while a second group received the organizer before the lesson, and the third group received the organizer after the lesson. The criterion measure consisted of 20 questions and was administered immediately.

In both studies the post organizer group scored significantly higher than the advance organizer group. The average score of the two organizer groups, however, was not significantly different from that of the control group.

A recent study by Bayuk et al. (1970) attempted to incorporate the concepts of Ausubel and Rothkopf in one experiment. They utilized two types of organizers (declarative sentences in outline form and test-like questions) in both the advance and post positions. They hypothesized that advance organizers (both sentences and questions) would facilitate learning of the reading material more than post organizers.

The Ss were 123 high school senior English students who were stratified on the basis of their ability (high, medium, and low) and their previous knowledge of the learning material (those who had had a course in psychology and those who had not). The learning passage was a 2700 word excerpt from a college psychology text and the organizers included 28 factual items dealing with the concepts discussed in the learning passage. The declarative sentence organizer and the test-like question organizer contained the same information and were identically ordered.

The criterion measure included 28 items dealing with facts and concepts presented in the learning passage. None of the information presented in the organizers was included in the test and the order of the test items was randomized.

The authors reported no significant differences either for type of organizer or position of organizer. They found a significant difference only in the interaction effect between ability and type of organizer. The question organizer was significantly less effective than the sentence organizer for the low ability Ss only.

In discussing the results of this particular study, Bayuk et al. point out the necessity of a precise definition of the term organizer. In the studies of Rothkopf and Bisbicos (1967), Bruning (1968), and Frase (1968b), the criterion test material was identical to the organizer material. This conflicts with Ausubel's definition of an organizer which assumes no information or facts germane to the test are included in the organizer. The authors conclude that question-specific organizers are more effective than those which attempt general facilitation.

Advance Organizers

The rational for advance organizers originated with Ausubel (1960). He postulated that logically meaningful material becomes incorporated in the cognitive structure when it is subsumed under specifically relevant existing ideas. He argued that increasing the availability of specifically relevant subsumers in the cognitive structure should enhance the meaningful learning of such material.

He tested this hypothesis by asking 110 senior undergraduate Ss to study a 2500 word passage dealing with the metallurgical properties of plain carbon steel. This topic was chosen because it was generally unfamiliar to the Ss. Before the Ss received the learning passage the experimental group was allowed to read a 500 word introductory passage (advance organizer) on two separate occasions, once two days before and once immediately before the administration of the learning passage. The organizer was more abstract, general, and inclusive than the learning passage but was demonstrated to provide no answers on the criterion measure. The control group was given a similar 500 word passage on historically relevant background material that provided no subsuming concepts.

The experimental and control groups were matched on the basis of ability to learn scientific material, major field, and sex. All Ss studied the learning passage for 35 minutes and took a 36 question multiple choice test over the material three days later. Statistical analysis revealed the experimental group's scores to be significantly higher than the scores of the control group beyond the 0.01 level of confidence.

In his discussion of the study Ausubel suggested that advance organizers must be at an appropriate level of inclusiveness to provide optimal anchorage. He defined the appropriate level of inclusiveness as "that level which is as proximate as possible to the degree of conceptualization of the learning task--relative, of course, to the existing degree of differentiation of the subject as a whole in the learner's cognitive background." Since the spontaneous availability of the most relevant subsuming concepts is unlikely, the most dependable way of facilitating retention is to provide the appropriate subsumers before administering the learning passage. Ausubel concludes that providing advance organizers would eliminate much of the rote methodology often employed in the learning process.

In a subsequent study conducted by Ausubel and Fitzgerald (1961), 155 Ss studied a 2500 word learning passage on Buddhism. Before the learning passage was administered the Ss were randomly assigned to three treatment groups each of which received a different type of introductory passage. The first group read a comparative organizer which pointed out the principal differences and similarities between Buddhist and Christian doctrines. The expository organizer read by the second group described the principal Buddhist doctrines at high levels of generality, inclusiveness, and abstraction. The control group read an introductory passage that was historical in nature but contained no ideational structuring. There was no information in any of the introductory passages that provided answers for the criterion measure.

Two days after studying their designated introductions, all Ss studied the learning passage for 35 minutes. One form of the criterion measure was administered three days later and an equivalent form was administered one week after the first test (ten days after the learning passage).

On the three day retention test, only the comparative organizer was effective in facilitating retention of the Buddhism material. On the ten day retention test, however, both the expository and the comparative groups scored significantly higher than the control group. In both cases most of the difference between organizer and control groups was derived from those Ss who had demonstrated a lack of knowledge about Christianity. The authors concluded that "both comparative and expository organizers appear to be effective only in those instances where existing discriminability between the two sets of ideas is inadequate as a consequence of the instability or ambiguity of the established concepts."

A second study by Ausubel and Fitzgerald (1962) provided further evidence that an expository organizer enhanced the learning of an unfamiliar passage for Ss who lack verbal ability.

By statistically controlling verbal ability, Ausubel and Youssef (1963) demonstrated that previously learned relevant background knowledge significantly facilitated the learning and retention of two sequential learning passages. They failed to demonstrate, however, that the low ability group was differentially aided by the advance organizer. In a recent text book Ausubel (1968) suggested that when the learning task is particularly difficult, "organizers may differentially benefit high ability students and those with more background knowledge by making it possible for them to learn material that would in any case be beyond the capacity of less able and less sophisticated students."

A study emphasizing the facilitation provided by organizers on retention of a learning passage was conducted by Billey (1969). He utilized undergraduate Ss and a learning passage on behavioral objectives which was preceeded by an expository organizer. After 25 days the experimental group performed significantly better on the criterion measure than did the control group. A parallel study with the same Ss and a learning passage on learning produced no significant difference between groups after 56 days.

Kuhn and Novak (1970), in a pair of studies utilizing biology learning passages and undergraduate Ss, found significant differences between experimental and control groups on three-week and six-week retention tests.

Most of the work done by Ausubel and his associates involved undergraduate Ss. Dawson (1965) reasoned that the effectiveness of organizers should extend to students as young as twelve years old. Accordingly he administered a 2000 word learning passage to 146 boys enrolled in an eighth grade industrial arts class. He utilized a 600 word advance organizer and found that it significantly benefited the experimental group on achievement tests administered immediately after the learning passage and three weeks later. There was no significant difference on a nine-weeks' retention test, however. He also reported differential benefits to lower ability students.

In a similar study with sixth grade science students, Schulz (1966) failed to find a significant difference between experimental and control groups, but concluded: "It appears that advance organizers do facilitate learning when pupils lack the processing skill (analytical ability) necessary to reorganize information independently into suitably clear, inclusive, and stable cognitive structure."

An application of Ausubel's theory to programed learning has been attempted by Merrill and his associates. Merrill (1965) demonstrated that in learning a hierarchically structured imaginary science, experimental groups receiving an advance organizer prior to the programed material performed as well as a group receiving more detailed advance instruction. The experimental group utilized only half the time required by the control group to learn the task. In a related study Merrill and Stolurow (1966) found that Ss who were given an advance organizer that was hierarchically organized made fewer errors during learning and subsequent testing than Ss who were given a problem oriented summary after each question.

Townsend (1969) attempted to determine whether the instructional effectiveness of programed materials could be enhanced by the use of an advance organizer instead of the more traditional historical introduction. He utilized a two (advance organizer versus historical introduction) by two (programed instruction versus lecture instruction) by three (low, medium, and high ability) factorial design with 137 undergraduate physics students. The learning topic was the graphical analysis of straight line kinematics. He reported that the advance organizer provided significant facilitation for the programed instruction group but not for the lecture group.

Nearly all of the studies conducted with advance organizers have utilized paragraph abstract formats. Recent efforts have been directed toward other types of subsuming concepts. Allen (1970) reported that both higher order and memory level review questions given at the end of an extended passage affect learning in a way similar to questions presented before learning material. When combined with advance organizers, however, the specific learning that resulted from review questions appeared to be more resistant to forgetting for students of average and below average intelligence.

Advance organizers in the form of brief (8-10 seconds) exposures to relevant video tape recordings were utilized in a study conducted by Hustuft (1969). The learning passage consisted of a 30 minute video taped lecture. He reported that such advance organizers presented immediately before the learning tape were more effective than the same organizers presented two days before the learning tape, which in turn were more effective than no organizers at all.

Pella and Triezenberg (1969) attempted to utilize the conceptual scheme of equilibrium as an advance organizer for a learning passage on ecological systems. They justified the use of a conceptual scheme as an organizer on the basis of the fact that, by definition, conceptual schemes are concepts stated in very abstract, general, and inclusive terms.

The Ss chosen for their study were seventh and ninth grade science students who were stratified into high, medium, and low ability groups on the basis of a pretest. The advance organizers were presented at three levels of abstraction (verbal, sketch, and mechanical model). The organizers preceeded a series of nine video tape recordings on the subject, ecological systems. The criterion measure, designed to ascertain achievement on three cognitive levels (knowledge, comprehension, and application) was administered at the end of the ninth lesson and again six weeks later.

The authors reported that the mechanical model organizer was significantly superior to both the verbal and sketch organizers as a facilitating agent at the comprehensive level. There was no significant difference due to these treatments at either the knowledge or application levels. They also reported a significant decrease in the ninth grade Ss' knowledge level achievement between the immediate and the retention tests. A smaller but still significant decrease occurred in both grades at the comprehension level, but there was no significant decrease at the application level.

Other researchers have found certain types of nonverbal organizers to be more effective than verbal organizers in subsuming highly abstract material. Scandura and Wells (1967) suggested that verbal organizers are not applicable to mathematical abstractions because presentation of such abstractions often involves the use of words or symbols having no referential meaning for the naive student. They reasoned that descriptions of concrete models of abstract mathematical ideas may be more readily interpretable than formal presentations of the corresponding abstract ideas in terms of the underlying definitions and axioms.

In two separate studies, Scandura and Wells administered abstract mathematical learning material to 104 undergraduate elementary education majors. In each study the control group received an introductory historical passage of about the same length (1000 words) as the learning passage. The experimental advance organizer was in the form of a game which demonstrated the principle concepts found in the learning passage. Statistical analysis revealed that in one study the performance of the Ss receiving the game organizer was significantly superior to that of the control group at the 0.05 level of confidence. The parallel study results, however, failed to reach significance.

In a similar study Weisberg (1970) compared the relative effectiveness of three types of advance organizers on the learning of a passage concerning the Continental Drift theory by 96 eighth graders. The Ss were stratified according to sex and three levels of prior knowledge (high, medium, and low). The organizers included a paragraph abstract organizer which consisted of a 500 word description of the ocean floor, a series of profiles across the Atlantic Ocean floor (graph), and a physiographic diagram of the Atlantic Ocean floor (map). The control group received no organizer at all.

Statistical analysis of the 40 question criterion measure revealed that the groups receiving the map organizer and the graph organizer scored significantly higher than the control group, but that the paragraph abstract failed to contribute significantly to the learning task.

Accepting the thesis that under certain conditions advance organizers could facilitate learning, Grotelueschen and Sjogren (1968) attempted to ascertain the mechanism involved in the transfer of the information obtained in the advance organizer to the new learning material. They conducted parallel studies to test the hypothesis that performance on a concept attainment task is positively related both to the degree to which the advance organizer is structured and to the degree to which the learning task is sequentially arranged. Their Ss for the first study were 24 paid adults of superior intelligence who were unfamiliar with the learning passage subject (number bases). The Ss engaged for the second study were 48 graduate students who were also unfamiliar with the subject matter.

Four different advance organizers were utilized. Each organizer consisted of a booklet containing a linear program. The topics of the programs included: history of measurement, base ten number system, base seven number system, and principles of number bases.

The learning task treatment consisted of three differentially sequenced (completely random, partially sequenced, and completely sequenced) sets of paired associates which corresponded to numbers in the base four number system.

The criterion measure was designed to measure both learning and transfer. The authors predicted that for both learning and transfer the principles' advance organizer would be most effective, followed by base seven, base ten, and history in that order. The predicted order for learning tasks was partially sequenced, completely sequenced, and random for Ss who had transferred information from the organizer to the learning task. If no transfer had occurred, however, the predicted order was complete, partial, and random.

These predictions were based on the rational that if the learning task was partially ordered to suggest the existence of a principle, the Ss might attempt to use the principle presented in the organizer. On the other hand, if the learning task was completely ordered so that a maximum amount of information was being presented, the Ss might be expected to resort to a rote memory strategy. A random presentation would force the Ss to rely on rote.

The results of the two studies generally supported the hypothesis that advance organizers can facilitate both learning and transfer of information.

A recent study by Proger et al. (1970) also utilized different types of organizers in an attempt to identify and describe the mechanisms by which advance organizers operate. They were particularly interested in determining the role of advance organizers in providing general facilitation.

They compared four different types of advance organizers: paragraph abstract, enumerated sentence outline, true-false pretest, and completion pretest. They wanted to compare the combined effectiveness of the "covert response" groups (paragraph abstract and sentence outline organizers) and "overt response" groups (true-false pretest and completion pretest organizers). They hypothesized that student achievement in the covert response groups would be less than achievement in the overt response groups. The 124 high school senior Ss were further stratified on the basis of sex and five levels of ability.

The criterion measure consisted of 20 multiple choice items, eight of which covered a like number of concepts stressed in each of the advance organizers, and 12 of which covered concepts not stressed in the organizers but covered in the reading passage itself. The authors reasoned that any differences found on the eight post-test items previously covered in the advance organizer can be attributed to specific conceptual facilitation and any differences found on the 12 concepts not stressed in the advance organizer could be attributed to general conceptual facilitation.

The learning passage was a 2600 word, highly detailed report on the nonreligious aspects of Amish customs and life. The criterion test was administered immediately.

Statistical analysis of the results revealed that for the eight specifically facilitated items the covert groups did significantly better than the overt groups. Boys and low ability Ss seemed to benefit most from the specific facilitation provided by the covert organizers. No significant differences were found for either organizers or sex on the 12 general facilitative effects questions. The authors concluded that more research needs to be done in the areas of general and specific facilitative effects of advance organizers.

Summary

Most researchers agree that concurrent organizers can provide both specific and general facilitation, but the effect appears to be somewhat dependent on extraneous factors. If the learning passage is studied carefully, the general facilitation effect tends to be obliterated. General facilitation is maximized when test-like questions are embedded in the learning passage in such a way that they come to the attention of the reader immediately after he has read the relevant section. On the other hand, questions or statements that come to the reader's attention before the relevant section tend to provide specific facilitation only.

The effectiveness of post organizers is problematical. While one research team found post organizers to be more effective than advance organizers, other investigators found no significant differences between advance and post organizers. The same investigators reported that neither category of organizer facilitated learning.

A number of researchers have reported that advance organizers provide general facilitation for learning passages, while others contend that only specific facilitation occurs. The advance organizer concept has been utilized with Ss ranging from mental retardate children to adults of superior intelligence. Advance organizers tend to be more effective for Ss of below average ability, unless the learning material is particularly difficult. There is evidence that if the learning passage is sufficiently difficult, advance organizers differentially assist Ss of above average ability.

Both verbal and nonverbal applications have been made. Nonverbal organizers have been demonstrated to be particularly effective in facilitating learning.

Determination of the exact role of subsuming concepts in the facilitation of learning has been the subject of two recent studies. The results, however, are inconclusive. While it has been demonstrated that there can be a transfer of information from the advance organizer to the learning passage, an attempt to demonstrate the general facilitation mechanism was unsuccessful.

CHAPTER III

METHODOLOGY AND DESIGN

Introduction

The purpose of this study was to determine the effect of advance and post organizers on student achievement and retention of a science-oriented learning passage. The study utilized a 3 X 2 factorial design. The levels of the independent variable were advance organizer, post organizer and non organizer; while the levels of the organismic variable were good organizers and poor organizers. The dependent variables were immediate achievement in Study A, retention in Study B, and immediate achievement in Study C. The following null hypotheses were tested.

Study A

1. Differences in types of subsumers will not differentially influence undergraduate chemistry students' levels of performance on a science achievement test.

2. Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science achievement test.

3. The science achievement test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

Study B

4. Differences in types of subsumers will not differentially influence undergraduate chemistry students' levels of performance on a science retention test.

5. Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science retention test.

6. The science retention test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

Study C

7. Differences in types of subsumers will not differentially influence high school physics students' levels of performance on a science achievement test.

8. Differences in organizing ability of high school physics students will not differentially influence levels of performance on a science achievement test.

9. The science achievement test scores of high school physics students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

Study A

Phase I

This study was conducted on the campus of Oklahoma State University. The pool of Ss was the entire class (six sections) of a first course in chemistry. The Ss were enrolled in this particular class on the basis of their ACT scores. Their scores were intermediate (18-26 with a few exceptions) compared to the "slow" chemistry course (for students with ACT scores below 18) and the "advanced" chemistry course (for prospective chemistry majors).

The levels of the organismic variable were determined with an organizing test administered to the entire pool of 143 students present on the days of testing. The test consisted of a 750 word science-oriented reading passage and an outline structure to be completed by the S. Ss were allowed ten minutes to read the passage and, after handing in the passage, they were given an answer sheet which listed the key concepts covered in the passage and an outline structure. Each S was asked to organize the concepts into their proper sequence on the outline. This operation required about five minutes to complete. The scores were determined according to an instruction sheet written by the author. The test, key, and instructions for grading are reproduced in Appendix A. Two answer sheets were not scored because of incomplete answers and illegibility. The scores ranged from 0 to 78. The median score was 23.

The scores of the organizing test were rank ordered and the middle 44 scores were dropped from the study. The 48 Ss obtaining the lowest scores were classified as good organizers. Correspondingly, the 48 Ss obtaining the highest scores were classified as poor organizers. Each good organizer was randomly assigned to one of the three treatment groups (advance organizers, post organizers, and non organizers). The assignment was made according to the procedure described by Dayton (1970). In a similar manner each poor organizer was randomly assigned to one of the three groups. This procedure resulted in the formation of six experimental cells of 16 Ss each.

In order to avoid any possible Hawthorne effect, students who had been dropped from the study on the basis of their organizing ability (N = 48) were also assigned to the three treatment groups and participated in all phases of the study. Their scores, however, were not included in the analysis. Those Ss assigned to the two non organizer cells were arbitrarily assigned to receive the non organizer in either the advance or the post position.

Phase II

The second phase of the study was administered during a regular laboratory period, approximately one week after the completion of the first phase. When the students were seated in their usual places, the following instructions were read to them:

> The laboratory experiment for today will consist of a reading exercise that will require about 90 minutes of your time. You will need a pencil or a pen but are asked to use no scratch paper of any kind. The material you will be given will have your name on it and a set of directions. Check to make sure you have the material intended for you and proceed to read and follow the directions. If it is not clear what you are to do, re-read the directions. You will not all be doing the same thing at the same time so make sure you are following your own directions.

At this point the first stage of the materials (stage one) was distributed. Approximately one-half of the Ss received a passage with a red cover sheet and one-half received a passage with a green cover sheet. To avoid any possibility of confusion, each of these first passages had a small "1" printed in the upper right hand corner of the cover sheet to designate stage one. The red cover sheets were on the advance organizers and the advance non organizers. The green cover sheets were on the learning passage and were given to the Ss who were to receive the post organizers and the post non organizers.

After ten minutes the stage two materials were handed out. The stage two materials consisted of the learning passage for the Ss who had received the advance organizers and advance non organizers. These passages were identical to the learning passages administered in stage one except for a red cover sheet and a small "2" in the upper right hand corner (see Appendix B). The red stage one materials were retrieved at the same time the new materials were distributed. Since this stage involved only one-half the class, it was considered necessary to color-code the materials in addition to placing each S's name on the materials he received.

Stage three began when the green stage one Ss finished studying the learning passage. This was 45 minutes after the beginning of stage one or 35 minutes after the beginning of stage two. Stage three consisted of the post organizer (which was identical to the advance organizer except for minor changes in the wording of the instructions, see Appendix E) and the post non organizer. All of the stage three cover sheets were green and had a small "3" in the upper right hand corner in addition to the S's name plate. Stage three was completed ten minutes later when all materials were handed in.

Stage four consisted of a 32 item multiple choice test that was administered immediately following stage three (see Appendix C). The stage four materials had a white cover sheet and a small "4" in the upper right hand corner, but did not have the S's name since each S received exactly the same materials. Each answer sheet, however, was identified with the S's name. Stage four was not timed and the Ss were apprised by the written instructions that they could take as much time as needed. Most Ss required less than 20 minutes to complete the test.

The four stages of the second phase of Study A required a total of about 85 minutes. Since this phase of the study was administered at the beginning of a regularly scheduled three hour laboratory period, it was possible to administer the entire phase without a break. The entire procedure for Study A is shown schematically in Figure 1.

Both phases of Study A were administered by the graduate teaching assistants normally in charge of the classes. The first phase was conducted at the beginning of a quiz period, while the second phase was conducted approximately one week later during a laboratory period. The teaching assistants were provided with a complete set of instructions for administering each phase of the study (see Appendix G).

Study B

Study B was completed when the achievement test was readministered to the population used in Study A. At the beginning of the regularly scheduled laboratory period exactly three weeks after the completion of Study A, the achievement test was readministered to all Ss in all sections of the chemistry class in order to obtain a retention score for the Ss. The procedure used was identical to that utilized in stage four of Study A.

Study C

This study was conducted on the campus of Northeast High School in Oklahoma City. The pool of Ss was the entire class (five sections) of

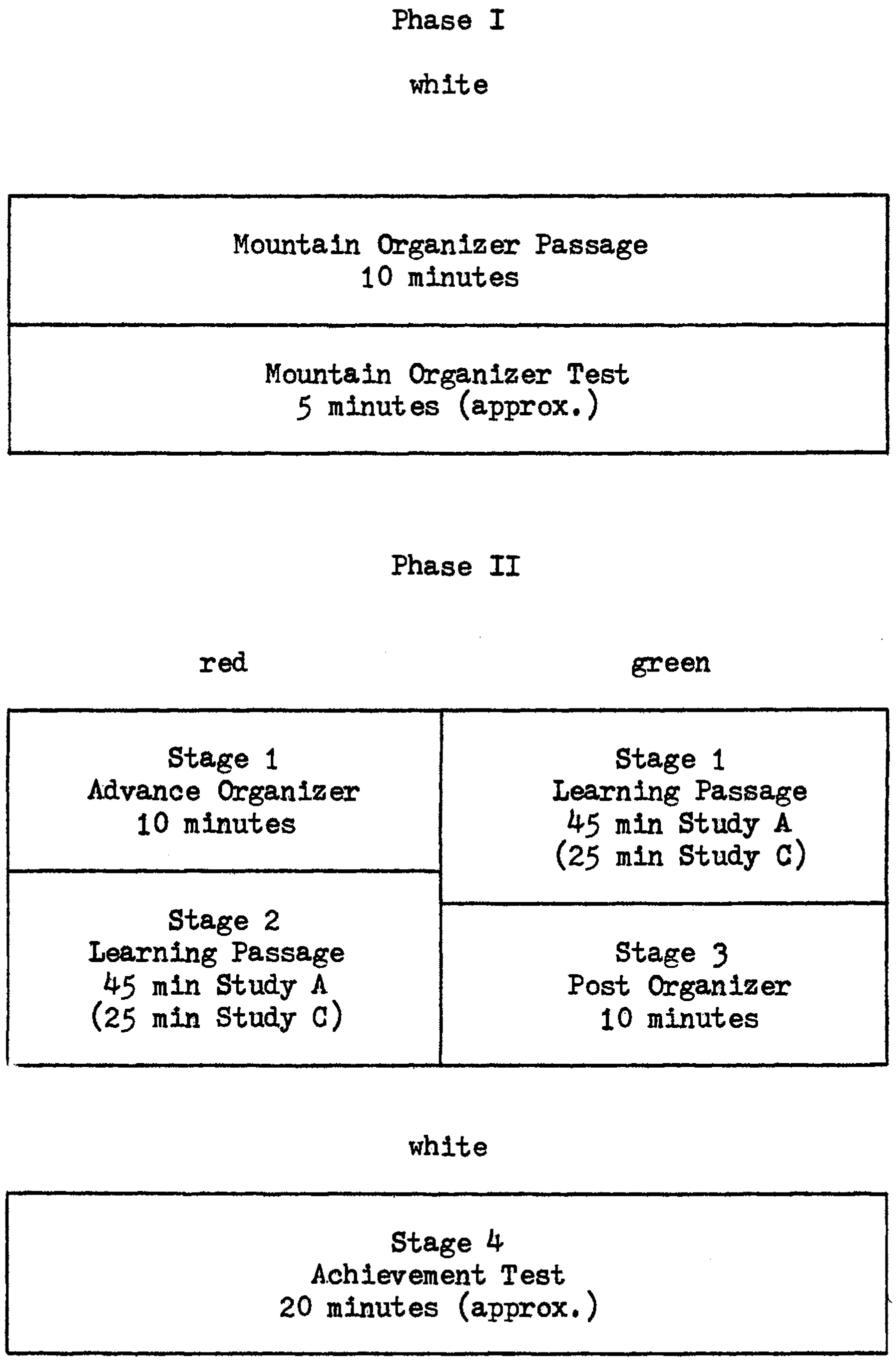

Figure 1. Block Diagram of the Procedure Utilized in Study A and Study C

juniors and seniors enrolled in a class referred to as the Harvard Project Physics class. The students in this class were all average or above average in both verbal and analytical ability.

Study C was conducted in exactly the same manner as Study A, with two modifications. While Study A was in progress it was observed that the majority of the Ss were not utilizing the full 45 minutes to study the learning passage. A few, however, studied diligently the entire time. It is plausable that the facilitating effect of the subsumers would be partially obliterated by over-learning of the learning passage and would be most apparent in those Ss who "studied" the learning passage by simply reading it through two or three times. In order to both reduce and equalize the amount of time that all Ss spent studying the passage, the learning time was reduced from 45 minutes to 25 minutes.

A further modification was necessitated by the fact that even though the original pool of physics students (N = 177) was larger than the original pool of chemistry students (N = 156), absenteeism and improperly completed answer sheets reduced the number of Ss completing the first phase of Study C to 78 as opposed to 143 for Study A. As a result the good organizers were distinguished from the poor organizers by dividing the class at the median score (18) and eliminating none of the students who had completed the first phase from the study. This procedure resulted in two groups of Ss: the good organizers (scores on the MOT ranging from 0 to 18), and the poor organizers (scores ranging from 20 to 54). Comparable groups in Study A had scores ranging from 0 to 18 (good organizers), and scores ranging from 30 to 48 (poor organizers).

Both phases of Study C were administered by the teacher normally in charge of the class. Complete instructions for administration were provided by the author (see Appendix G). The physics class met for two, 170 minute periods each week. The first phase of Study C was administered during the first 15 minutes of the first period of the week, and the second phase was administered during the first 70 minutes of the corresponding period the following week.

Statistical Analysis

The population in each study was divided into three treatment groups, each having two levels. The treatment groups and their corresponding levels were: (1) good and poor organizers receiving advance organizers; (2) good and poor organizers receiving post organizers; and (3) good and poor organizers receiving non organizers. The resulting six cells were assigned sixteen Ss each in Study A and Study B, and 13 Ss in Study C. A 3 X 2 factorial analysis of variance (ANOVA) was performed on each study. Experimental mortality resulted in unequal cell frequencies which was corrected for by the procedure described by Winer (1962).

In addition to the ANOVA, correlation studies were made comparing the MOT scores, ACT scores, LPT scores, GPA, and course grades for all Ss participating in Study A and Study B.

CHAPTER IV

RESULTS OF THE STATISTICAL ANALYSIS

Instrument Analysis

The initial phase of each study involved the identification of the organismic variable, good and poor organizers. This was accomplished with the mountain organizer instrument constructed by the author. Pilot studies with the instrument indicated that the organizer scores (MOT) correlated negatively with the course grades and other achievement scores ($r = -0.40$ to -0.50)[1]. The GPA, ACT, and course grade scores of the Ss who participated in Study A were available and were utilized in correlation studies with the organizer scores. The Pearson r coefficient for MOT and ACT was -0.36; for MOT and GPA, -0.70; and for MOT and chemistry grade, -0.26.[2]

The achievement and retention scores were obtained with the learning passage test (LPT) which consisted of 32 multiple choice questions selected from a pool of 45 such questions provided by Dr. Ausubel. The corrected split-half reliability of the LPT was 0.79. The Pearson r coefficient for MOT and LPT was -0.39.

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[1]Since a low score on the MOT indicates good organizing ability, the negative values listed here indicate positive correlations between organizing ability and the other parameters.

[2]An r value of at least 0.32 is necessary for significance at the 0.05 level.

The unfamiliarity of the material was demonstrated by administering the LPT to a comparable group of students who had not studied the learning passage. The mean score thus obtained was not significantly greater than chance (6.4).

Study A

Of the 96 Ss randomly assigned to participate in Study A, two were lost to experimental mortality. The raw scores on the LPT ranged from 6 to 26 and were found to be normally distributed (see Appendix D). Since unequal cell frequencies were analyzed, Cochran's technique was utilized to determine cell homogeneity. The analysis yielded an F ratio of 0.2287, a non significant value. The results of Study A were analyzed utilizing a 3 X 2 factorial analysis of variance (ANOVA) design. The analysis is summarized in Table I.

TABLE I

F TABLE FOR STUDY A

Source	SS	df	MS	F
Treatments	12.5248	2	6.2624	0.2973
Levels	230.9868	1	230.9868	10.9654 ***
Interaction	111.8865	2	55.9433	2.6558
Error	1853.7083	88	21.0649	
Total	2209.1064	93		

*** $p < .005$

Hypothesis 1

Differences in types of subsumers (advance organizer, post organizer, and non organizer) will not differentially influence undergraduate chemistry students' levels of performance on a science achievement test.

As is indicated in Table I, the ANOVA for differences in treatments (advance versus post versus non organizers) yielded an F ratio of 0.2973. Rejection of the null hypothesis at the 0.05 level of confidence with 2 and 88 degrees of freedom requires an F ratio of 3.15. The null hypothesis was accepted. There was no significant difference between the three types of subsumers.

Hypothesis 2

Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science achievement test.

Table I indicates an F ratio of 10.9654 for levels (differences between good and poor organizers). Rejection of the null hypothesis at the 0.005 level of confidence with 1 and 88 degrees of freedom requires an F ratio of 8.49. The null hypothesis was rejected. The scores made by good organizers were significantly higher than those made by poor organizers.

Hypothesis 3

The science achievement test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

An F ratio of 2.6558 is indicated in Table I for the interaction between treatments and levels. An F ratio of 3.15 is required to reject this hypothesis at the 0.05 level of confidence. Accordingly, the interaction hypothesis was accepted. The cell means and variances for Study A are given in Table II.

TABLE II

TABLE OF MEANS AND VARIANCES FOR STUDY A

Level	Advance	Post	Non	Sum	Mode
Good	19.9333	18.1250	19.8000	19.2609	Means
	15.9238	30.4500	26.4571	21.7971	Variances
Poor	14.5625	17.9375	15.8750	16.1250	Means
	27.0058	13.6625	18.6500	21.2181	Variances
Sum	17.1613	18.0316	17.7742	17.6596	Means
	28.8731	18.0958	25.6473	23.7538	Variances

Study B

Ninety-three Ss actually participated in Study B. Experimental mortality accounted for an additional S, bringing the total to three Ss lost from Study B. The raw scores from the LPT ranged from 5 to 24 and were found to be normally distributed (see Appendix D). Since unequal cell frequencies were analyzed, Cochran's technique was utilized to determine cell homogeniety. The analysis yielded an F ratio of 0.2022, a nonsignificant value. The results of Study B were analyzed utilizing a 3 X 2 ANOVA design. The analysis is summarized in Table III.

TABLE III

F TABLE FOR STUDY B

Source	SS	df	MS	F
Treatments	5.2337	2	2.6169	0.1539
Levels	20.1338	1	20.1338	1.1838
Interaction	33.2751	2	16.6376	0.9782
Error	1479.6374	87	17.0073	
Total	1538.2800	92		

Hypothesis 4

Differences in types of subsumers (advance organizer, post organizer, and non organizer) will not differentially influence undergraduate chemistry students' levels of performance on a science retention test.

As is indicated in Table III, the ANOVA for differences in treatments (advance versus post versus non organizers) yielded an F ratio of 0.1539. Rejection of the null hypothesis at the 0.05 level of confidence with 2 and 87 degrees of freedom requires an F ratio of 3.15. The null hypothesis was accepted. There was no significant difference between the three types of subsumers.

Hypothesis 5

Differences in organizing ability of undergraduate chemistry students will not differentially influence levels of performance on a science retention test.

Table III indicates an F ratio of 1.1838 for levels (differences between good and poor organizers). Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 87 degrees of freedom requires an F ratio of 4.00. The null hypothesis was accepted. There was no significant difference between the scores made by good organizers and those made by poor organizers.

Hypothesis 6

The science retention test scores of undergraduate chemistry students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

An F ratio of 0.9782 is indicated in Table III for the interaction between treatments and levels. An F ratio of 3.15 is required to reject this hypothesis at the 0.05 level of confidence. Accordingly, the interaction hypothesis was accepted. The means and variances for Study B are shown on Table IV.

Study C

Out of a total of 78 Ss assigned to treatment groups, only 63 were present on the day Study C was conducted. The raw scores from the LPT ranged from 7 to 28 and were found to be normally distributed (see Appendix D). Since unequal cell frequencies were analyzed, Cochran's technique was utilized to determine cell homogeniety. The analysis yielded an F ratio of 0.2548, a nonsignificant value. The results of Study C were analyzed utilizing a 3 X 2 ANOVA design. The analysis is summarized in Table V.

TABLE IV

TABLE OF MEANS AND VARIANCES FOR STUDY B

Level	Advance	Post	Non	Sum	Mode
Good	14.4667	12.6875	14.1333	13.7391	Means
	15.4095	13.8292	20.6952	16.4638	Variances
Poor	12.1333	13.2500	13.0000	12.8085	Means
	19.1238	18.7333	14.5333	16.8973	Variances
Sum	13.3000	12.9700	13.5484	13.2688	Means
	18.0793	15.8377	17.2559	16.7204	Variances

TABLE V

F TABLE FOR STUDY C

Source	SS	df	MS	F
Treatments	29.0494	2	14.5247	0.6736
Levels	31.2012	1	31.2012	1.4471
Interaction	24.1521	2	12.0761	0.5601
Error	1229.0158	57	21.5617	
Total	1313.4185	62		

Hypothesis 7

Differences in types of subsumers (advance organizers, post organizers, and non organizers) will not differentially influence high school physics students' levels of performance on a science achievement test.

As is indicated in Table V, the ANOVA for differences in treatments (advance versus post versus non organizers) yielded an F ratio of 0.6736. Rejection of the null hypothesis at the 0.05 level of confidence with 2 and 57 degrees of freedom requires an F ratio of 3.15. The null hypothesis was accepted. There was no significant difference between the three types of subsumers.

Hypothesis 8

Differences in organizing ability of high school physics students will not differentially influence levels of performance on a science achievement test.

Table V indicates an F ratio of 1.4471 for levels (differences between good and poor organizers). Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 57 degrees of freedom requires an F ratio of 4.00. The null hypothesis was accepted. There was no significant difference between the scores made by good organizers and those made by poor organizers.

Hypothesis 9

The science achievement test scores of high school physics students will not be significantly influenced by the interaction of organizing ability and types of subsumers.

An F ratio of 0.6501 is indicated in Table V for the interaction between treatments and levels. An F ratio of 3.15 is required to reject this hypothesis at the 0.05 level of confidence. Accordingly, the interaction hypothesis was accepted. The means and variances for Study C are shown on Table VI.

TABLE VI

TABLE OF MEANS AND VARIANCES FOR STUDY C

Level	Advance	Post	Non	Sum	Mode
Good	18.3077	15.2222	16.6364	16.9091	Means
	17.8974	22.1945	4.2546	15.2102	Variances
Poor	15.3636	15.3300	15.8000	15.5000	Means
	24.4546	30.5000	33.9555	27.4310	Variances
Sum	16.9583	15.2778	16.2381	16.2381	Means
	22.2156	24.8007	17.5904	21.1843	Variances

Summary

The Ss in each of the three studies were randomly assigned to three treatment groups. They were placed on one of two levels according to their ability to organize scientific reading material. A 3 X 2 factorial ANOVA design was utilized to test each set of three null hypotheses. All comparisons except the levels in Study A were found to be nonsignificant.

In addition to the three studies reported, a fourth similar study utilizing the same materials but designed to test only the effectiveness of advance organizers was conducted. The Ss were 74 undergraduates enrolled in a beginning biological science course at Oklahoma State University. The results of that study verified the findings presented here.

CHAPTER V

CONCLUSIONS AND DISCUSSION

Summary of the Study

The purpose of this study was to determine the effect of advance and post organizers on student achievement on a science-oriented learning passage, and to determine the interaction effect of both advance and post organizers with high and low organizing ability.

The overall study was conducted as three independent sub-studies, Study A, Study B, and Study C. The population for Studies A and B was the spring, 1971, Chemistry 1364 class at Oklahoma State University; and the population for Study C was the Harvard Project Physics Class at Northeast High School in Oklahoma City, Oklahoma.

The population in each study was divided into three basic categories, each having two levels as follows: (1) good and poor organizers receiving advance organizers, (2) good and poor organizers receiving post organizers, and (3) good and poor organizers receiving non organizers. This assignment procedure resulted in six cells, each of which were assigned 16 Ss in Studies A and B and 13 Ss in Study C.

The S's organizing ability was determined with an organizing instrument (MOT) designed by the author. A Pearson r correlation was determined for the MOT and various ability and achievement scores. The correlation for MOT and ACT was -0.36; for MOT and GPA, -0.70; and for MOT and chemistry grade, -0.26.

For each population the scores on the MOT were rank ordered. In Study A there were a total of 140 scores. The Ss receiving the 48 lowest scores (good organizers) and those receiving the 48 highest scores (poor organizers) were randomly assigned to the three treatment groups. The remaining 44 Ss were dropped from the study and were arbitrarily assigned to treatment groups in order to minimize the Hawthorne effect. In Study C the same procedure was followed except that all of the 78 Ss who had taken the organizing test were randomly assigned to groups (the 39 lower scoring Ss as good organizers and the 39 higher scoring Ss as poor organizers).

The texts of the advance and post organizers were identical. The organizers, the learning passage, and the criterion measure questions were supplied by Dr. David Ausubel. They were the same materials utilized by Ausubel in his 1960 study.

In Study A, the Ss were allowed to study the 500 word organizer for 10 minutes and the 2500 word learning passage for 45 minutes. This sequence was followed immediately by a 32 item, multiple choice test over the learning passage.

For Study B, the identical criterion measure was administered to the same Ss exactly three weeks after Study A.

Study C was conducted in the same manner as Study A except for the length of time the Ss were allowed to study the learning passage. In Study C, the Ss studied the learning passage for 25 minutes before taking the achievement test. In all three studies the Ss were given as much time as they required to complete the test.

A three (advance organizer, post organizer, and non organizer) by two (good organizers and poor organizers) factorial ANOVA design was utilized in analyzing the data from each study. All comparisons failed to reach significance at the 0.05 level of confidence except the good organizer-poor organizer comparison in Study A which reached significance at the 0.005 level.

Discussion of the Results

The results of this study indicate that neither advance nor post organizers effectively facilitate the learning of unfamiliar material by average undergraduate students and above average high school students. This is in direct contradiction to the findings of Ausubel (1960), who used the same materials to demonstrate that facilitation does occur with senior undergraduates. Several possibilities for this discrepency exist: (1) The Ss used in Ausubel's study were psychology students and as such were probably less familiar with the contents of the learning passage than were the science students utilized as Ss in the present study. (2) A subsequent analysis of the data from Studies A and B indicates that the scores produced by students under the supervision of one teacher were significantly higher than the scores produced by the other teacher's students. (3) The subject matter of the learning passage was too difficult for the Ss in the present study. (4) The Ss participating in the present study "overstudied" the learning passage and thereby obliterated the facilitating effect of the subsumers. (5) The Ss participating in the present study, as students of science, already possessed the appropriate ideational scaffolding and therefore were capable of subsuming the learning passage without the help of external aids.

Of these possibilities, only the fifth withstands close scrutiny. The first possibility is rejected because a pilot study with comparable science students who received only the LPT yielded a mean score of 7.0 (a mean score of 6.4 would be expected by chance). The possibility that confounding due to teacher differences occurred is rejected because random assignment produced cells that were evenly distributed between the teachers. Evidence that the learning passage was not too difficult is available in the means tables. Ausubel's study produced a grand mean of 15.4. The grand mean for Study A was 17.7; for Study B, 13.3; and for Study C, 16.2. The maximum possible score for Ausubel's study was 36; for the present study the maximum was 32. Finally, the fourth possibility is rejected because the replicating study (Study C), as well as an additional study not reported here, was designed to eliminate the possibility of overlearning and the results were consistent with those of Studies A and B.

The fifth possibility seems the most plausible explanation for the results obtained in the present study. In his study with Fitzgerald (1961), Ausubel states that "organizers appear to be effective only in those instances where existing discriminability between the two sets of ideas is inadequate as a consequence of the instability or ambiguity of the established concepts." It is assumed that this observation applies to post organizers as well as to advance organizers.

In the present study the organismic variable examined was organizing ability rather than either analytical or verbal ability. It was demonstrated that organizing ability correlates with ACT (a composite representing both verbal and analytical abilities). Organizing ability also correlates with achievement as represented by GPA and chemistry grades. It was demonstrated in this study that the poor organizers were not differentially benefited by either advance or post organizers. This was the expected result in view of the above discussion. Whether a S were a good or poor organizer would not affect his performance on an organizer-assisted task when, in fact, the organizer provided no ideational scaffolding for him. However, a good organizer would be expected to perform better than a poor organizer on any task, whether organizer-assisted or not, because of the high correlation between organizing ability and other abilities (verbal and analytical).

The good organizers in Study A did perform significantly better than the poor organizers. The same trend was observed for the retention test (Study B), although differences were not significant at the 0.05 level of confidence. This result is in agreement with those reported in other studies. The tendency for differences due to treatments to diminish with time has been reported by Dawson (1965), Kuhn (1967), Billey (1969), and Triezenberg (1969).

The good organizers in Study C scored higher on the criterion measure than the poor organizers, but the difference did not reach significance. This finding undoubtedly reflects the fact that the difference between good and poor organizers was not as distinct in Study C as it was in Study A. In Study A, 44 Ss of intermediate organizing ability were dropped from the study, leaving only distinctly good organizers and distinctly poor organizers. In Study C, the lower number of Ss necessitated placing Ss of intermediate organizing ability into the poor organizers group.

Implications of the Study

The results of this and similar studies completed recently seem to indicate that the general facilitating effect of subsuming concepts is easily confounded by extraneous variables. While specific facilitation has been reported a number of times, general facilitation by a subsuming concept has been much more elusive. Bayuk (1970), in evaluating his own study as well as others reported in the literature, stated, "When the discussion refers to the incidental or general facilitative effects of organizers, there are usually no positive results." He concluded by observing, "If one adheres to Ausubel's precise definition of the term 'organizer,' then much of the work in this area must be reinterpreted."

The results of the present study and similar previous ones indicate that subsuming conepts might be expected to facilitate learning under the following circumstances. (1) When the organizer contains information that was not previously part of the learner's cognitive background, but is of such a nature that it can either be learned and then transferred to the learning passage as a principle, or it can mobilize other information in the learner's cognitive background to transferable-principle status. (2) When the learning passage is completely unfamiliar to the learner. (3) When the difficulty level of the learning passage approaches but does not exceed the upper limit of the learner's capability. (4) When the circumstances are such that the learning passage cannot be studied thoroughly.

Since it is difficult to meet all of these conditions concurrently, it is quite possible that the facilitating effect of a single subsumer will be obliterated. A further problem is associated with the fact that an organizer is a very personal thing. By definition, an organizer is an organizer when it facilitates learning. If it does not facilitate learning it is a non organizer. It is quite possible and very probable that what serves as an organizer for one individual may be a non organizer for another individual.

In the light of the observations above, future research in this area needs to move in two directions. On the one hand, greater effort needs to be directed toward isolating organismic variables that respond to the three categories of organizers; and on the other, more attention needs to be given to the possibility of combining the categories of organizers in order to increase their overall effect.

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APPENDIX A

MOUNTAIN ORGANIZING TEST

DIRECTIONS

This is a test of how well you can learn the substance of typical scientific material. You will have ten minutes in which to study this material.

When I give the signal, turn the page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance of the selection in your memory, but do not take any notes or make any marks on the reading material.

You will be examined on this material by means of a short test. Success on the test depends on your ability to comprehend the material and to pick out the most significant information.

MOUNTAINS

Although mountains are often referred to as eternal peaks, they are born and grow and they crumble and die in processes that involve great periods of geologic time. Folded mountains occur when part of the earth's crust is compressed, causing the surface to wrinkle and buckle. In faulted mountains, underground pressures force a great mass of rock to break along a fault or crack in the earth's crust, elevating the rocks on one side of the break.

Mountains are also created when volcanic material is spewed upward from large, molten pockets beneath the surface of the earth. These pockets are called batholiths. Volcanic cone mountains are built of layers of lava and ash deposited on the earth's surface. Volcanic dome mountains appear when the molten material cannot find an exit but pushes up a layer of overlying rock to form a dome. Combinations of these mountain-building processes are responsible for the creation of the principal ranges found in the United States--the Appalachians, the Rockies, and the long stretch that includes the Sierra Nevadas and the Cascades.

Because of the way mountains are constructed virtually every kind of climate can be found between the base of a mountain and its summit. The high, dry air holds less of the sun's warmth than the moist air usually found at lower altitudes. As a result, the temperature decreases as the altitude increases. On the average, temperatures drop three to five degrees for every one thousand feet increase in altitude.

Temperatures fall, but wind velocities rise as the summit is approached. Increased altitude itself is associated with increased velocity but winds may also travel faster when forced through narrow channels such as those formed by two adjoining peaks. On the summit of Mount Washington, the average velocity over a twenty-four hour period has reached one hundred twenty-nine miles per hour. This same summit is the scene of the world's highest recorded wind velocity, over two hundred thirty miles per hour.

Clouds are often seen hovering around the mountains, settling on the peaks in towering white mounds of every possible shape. The clouds are produced when moisture-laden air rises from the lowlands and condenses in the cooler upper regions. As a result, mountain climates tend to be quite wet, ranging from intermittent rain and sunshine on the lower slopes to frequent snows at higher altitudes.

Variations in mountain climate have resulted in distinctly different types of plant life, found in sequential horizontal zones arranged from the bottom of the mountain to the top. The location of equivalent zones may vary from mountain to mountain and from east slope to west slope but the sequence of the zones is the same for all mountains.

Nearly every range has several zones. In the Sierra Nevadas, the foothills gradually melt into a belt of western pine, called the Transition Zone. Here summers are warm and dry and some snow falls in the cool winter. Beginning somewhere between fifty-five hundred to eight thousand feet (depending on the location of the slope) is the Canadian Zone, a belt of lodgepole pine and red fir. This zone is characterized by cool summers and heavy, persistent snow in the cold winter. Above seven or eight thousand feet is the Hudsonian Zone which is also known as the sub-alpine belt. Here the forests are sparse and killing frosts may occur in any month.

At about nine or ten thousand feet the trees become smaller and lower and in some places they grow horizontally. The timberline, an uneven boundary between the last trees and the treeless slopes beyond, marks the beginning of the Alpine Zone. This is a place of rolling, high-mountain meadows and naked rocks. Even in this desolate region mosses, lichens, sedges, and miniature flowering plants flourish. On some mountains these growing things climb to the very top, or are halted only when they encounter perpetual ice and snow.

NAME ____________________

ORGANIZATION EVALUATION

The learning passage you just studied was written from an outline. The words or phrases representing the main topics and sub topics as well as some less important words and phrases are listed in scrambled order on the left side of the page. Please complete the out-line by inserting the words or phrases in the proper order. Do not write out the word or phrase--simply enter the number in the appropriate spot.

1. Cold	I. ______
2. Rain	A. ____
3. Transition Zone	
4. Western Pine	B. ____
5. Hudsonian Zone	C. ____
6. Canadian Zone	D. ____
7. Mountain Building	
8. Batholiths	
9. Mountain Climates	II. ______
10. Red Fir	A. ____
11. Combined Processes	
12. Folding	B. ____
13. Dome Mountains	C. ____
14. Mountain Zones	D. ____
15. Mount Washington	
16. Volcanic Action	
17. Wet	III. ______
18. Cloudy	A. ____
19. Faulting	
20. Windy	B. ____
21. Alpine Zone	C. ____
	D. ____

NAME KEY

ORGANIZATION EVALUATION

The learning passage you just studied was written from an outline. The words or phrases representing the main topics and sub topics as well as some less important words and phrases are listed in scrambled order on the left side of the page. Please complete the outline by inserting the words or phrases in the proper order. Do not write out the word or phrase--simply enter the number in the appropriate spot.

1. Cold
2. Rain
3. Transition Zone
4. Western Pine
5. Hudsonian Zone
6. Canadian Zone
7. Mountain Building
8. Batholiths
9. Mountain Climates
10. Red Fir
11. Combined Processes
12. Folding
13. Dome Mountains
14. Mountain Zones
15. Mount Washington
16. Volcanic Action
17. Wet
18. Cloudy
19. Faulting
20. Windy
21. Alpine Zone

		Distracters
I.	7	
A.	12	8
B.	19	13
C.	16	
D.	11	
II.	9	
A.	1	2
B.	20	15
C.	18	
D.	17	
III.	14	
A.	3	4
B.	6	10
C.	5	
D.	21	

Instructions for grading the Mountain Organizing Test.

1. Blanks. Go through all the answer sheets and check for blank spaces. Any answer sheet with blanks cannot be graded and should be discarded.

2. Main Headings. Check the main headings (I, II, and III) next. The corresponding numbers are 7, 9, and 14 and they must be in that order. Score 15 points for each incorrect entry. If two entries are correct but in reversed order (i.e. 7, 14, and 9), score 10 points only.

3. Subheadings. Each section has four subheadings designated A, B, C, and D respectively. The correct subheadings are indicated on the key. Incorrect subheadings are assigned a deviation score. This score is the square of the number of positions by which the incorrect score deviates from its correct position. For example, the correct responses under main heading I. 7 are:

   A. 12

   B. 19

   C. 16

   D. 11

   A student might have incorrectly entered the subheadings as follows:

   A. 11 -- 9

   B. 19 -- 0

   C. 12 -- 4

   D. 16 -- 1

   In this case, the number 11 has been entered in the first or A. position, while the correct position for 11 is the fourth or D. position. This is an error of 3 positions ($4 - 1 = 3$). Since this number may be either positive or negative, the score is always the square of the deviation--in this case, $3^2 = 9$ so the score for this error is 9 as indicated.

   The B. entry is 19 which is correct. The deviation ($2 - 2 = 0$) and consequently the score ($0^2 = 0$) are both zero as indicated.

   The C. or third entry is 12 which is incorrect. Since the correct position for 12 is the A. or first position, the deviation is -2 ($1 - 3 = -2$) and the score is 4 ($-2^2 = 4$).

   The D. entry is calculated as follows: $3 - 4 = -1$, $-1^2 = 1$.

The subheadings are always graded on the basis of their position within the section, even though the entire section may be in the wrong position as indicated in 2. above.

4. Distracters. Each section of subheadings has two distracters as indicated on the key. If an appropriate distracter instead of the correct response is chosen, the score is 10 for that entry. The appropriate distracters are 8 and 13 for section I, 2 and 15 for section II, and 4 and 10 for section III, as indicated on the key.

   If an inappropriate distracter (i.e., <u>any</u> number other than the correct main and subheadings or appropriate distracters for that section) is chosen, a score of 15 is assigned that incorrect entry.

5. Other Errors. There are several special cases that are not covered in the general rules. If a number is used twice, each is scored separately without regard to the other. There is no additional penalty.

   Sometimes a main heading (7, 9, or 14) is incorrectly chosen as a subheading within the <u>same</u> section. When this happens, it is scored as an appropriate distracter. If a main heading is chosen as a subheading for a <u>different</u> section, it is scored as an inappropriate distracter.

   Any time it is possible to score an entry in two different ways, the lowest score should be used. This can only happen when two main headings are reversed. Usually when the main headings are reversed the correct subheadings appear under the appropriate main headings, i.e., according to the main heading rather than according to the section. In other words, not only are the main headings reversed, but the entire sections are also reversed. The correct scoring of this situation is indicated in 2. and 3. above.

   When the main headings are reversed, but the subheadings are placed in the correct section, a decision must be made. It is usually best (lowest score obtained) when the main headings are scored as <u>incorrect</u> and the subheadings are scored normally. The alternative is to score the main headings as <u>reversed</u> and the subheadings as inappropriate distracters.

6. Overall Score. The total score is determined by summing all the individual entry scores. A perfect paper has a score of zero and any score of ten or less indicates a good organizer. A score of twenty is about average and a score of more than forty indicates a very poor organizer.

   The attached sample illustrates the various possible errors and the reason for assigning each score.

NAME SAMPLE

ORGANIZATION EVALUATION

The learning passage you just studied was written from an outline. The words or phrases representing the main topics and sub topics as well as some less important words and phrases are listed in scrambled order on the left side of the page. Please complete the outline by inserting the words or phrases in the proper order. Do not write out the word or phrase--simply enter the number in the appropriate spot.

1. Cold
2. Rain
3. Transition Zone
4. Western Pine
5. Hudsonian Zone
6. Canadian Zone
7. Mountain Building
8. Batholiths
9. Mountain Climates
10. Red Fir
11. Combined Processes
12. Folding
13. Dome Mountains
14. Mountain Zones
15. Mount Washington
16. Volcanic Action
17. Wet
18. Cloudy
19. Faulting
20. Windy
21. Alpine Zone

I.	8	--15	wrong main heading
A.	13	--10	appropriate distracter
B.	19	-- 0	correct
C.	12	-- 4	$1-3=-2,\ -2^2=4$
D.	11	-- 0	correct
II.	14		
A.	3	-- 0	correct
B.	6	-- 0	correct
C.	5	-- 0	correct
D.	21	-- 0	correct
		--10	reversed order
III.	9		
A.	17	-- 9	$4-1=3,\ 3^2=9$
B.	18	-- 1	$3-2=1,\ 1^2=1$
C.	16	--15	inappropriate distracter
D.	1	-- 9	$1-4=-3,\ -3^2=9$
Score		73	

APPENDIX B

LEARNING PASSAGE

2.

student's name

DIRECTIONS

This is a test of how well you can learn the substance and details of typical scientific material at the college level. You will have forty-five minutes in which to study this material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and details of the selection in your memory, but do not take any notes or make any marks on the reading material.

You will be examined on this material by means of a multiple choice test. The ability to provide correct answers to these questions will presuppose adequate comprehension of the material as well as precise knowledge of the details. In approximately four weeks you will be examined on this material again in order to determine how much of the information you have retained.

(This page was color coded--red.)

1.

student's name

DIRECTIONS

This is a test of how well you can learn the substance and details of typical scientific material at the college level. You will have forty-five minutes in which to study this material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and details of the selection in your memory, but do not take any notes or make any marks on the reading material.

You will be examined on this material by means of a multiple choice test. The ability to provide correct answers to these questions will presuppose adequate comprehension of the material as well as precise knowledge of the details. In approximately four weeks you will be examined on this material again in order to determine how much of the information you have retained.

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THE PROPERTIES OF PLAIN CARBON STEEL

Steel as an Alloy

An alloy is a metallic substance obtained by combining two or more elements at least one of which is a metal. Depending on its temperature it may be either a solution of its constituent elements or a homogeneous mixture resulting from the cooling of such a solution. When examined under a powerful microscope it is found to have a uniform internal structure from one portion to another.

If a metal merely contains other elements, for example, impurities, embedded within it non-homogeneously in scattered pockets or inclusions, it is not considered an alloy. Most alloys, however, do contain small residual percentages of impurities, usually derived from the metal ore, which are not completely removed by the refining process. In these instances the amount of impurities in the alloy is so small that it does not materially impair the usefulness of the metal. Complete removal of all impurities is not feasible because of the prohibitive expense of such a procedure.

A relatively simple metallic grain structure is predictable as long as the constituent elements of an alloy do not interact chemically. The grains resulting from the cooling of a solution of bronze (an alloy of copper and tin), for example, are metallic grains comparable to grains of pure metal except for having two metallic constituents instead of one. All of the grains are alike: each grain is a grain of bronze. And although the copper and tin components of the grain are not chemically united they are no longer distinguishable as separate metals.

A somewhat different situation prevails when the constituent elements of an alloy enter into chemical combination. In the case of steel (an alloy of iron and carbon), for example, carbon and small amounts of iron interact chemically forming a compound of the two elements (iron carbide), and particles of this compound are then uniformly dispersed among the grains of metal. Thus we do not have a solution or homogeneous mixture of a simple type of metallic grain such as bronze, the components of which are indistinguishable from each other. We have instead a solution or homogeneous mixture of two structurally distinct and identifiable components, namely, metallic grains (iron) and particles of an iron-carbon compound (iron carbide) distributed within and around the grains of iron. This opens up a whole new variety of more complex grain structures that cannot be achieved in the case of simple metallic grain alloys and/or pure metals, thereby making possible such procedures as hardening by "heat treatment." Of all the thousands of alloys, only iron alloys containing small amounts of carbon, and certain alloys of magnesium and aluminum may be "heat treated."

For our purposes, steel may be defined as an alloy of iron with a small percentage of carbon, usually from 0.10% to 1.5%, but never more than two per cent. It may also contain one or more other alloying elements (in addition to carbon) to confer such properties as increased hardness, strength, toughness, flexibility, and resistance to corrosion. But most steel made today, as well as most steel in use, is plain carbon steel.

Relation of Internal Structure of Steel to Temperature

The properties of steel vary with its temperature. The most obvious property change related to a change in temperature is the transition from a solid to a liquid state as steel is heated above its melting point. The reverse transition occurs when molten (liquid) steel is cooled below its melting point and solidifies into grains (crystals), much like water freezing into ice.

At normal atmospheric temperatures, the grains of iron and the iron carbide particles in solid steel are fixed in position, that is, immobilized in a definite structural arrangement. As heat is applied to this steel, however, many changes in internal structure take place while it is still in the solid state and below the melting temperature. Generally such changes take place at definite temperatures known as "critical temperatures." Solid steel at high temperatures (i.e., above its upper critical temperature) is actually a solid solution.

It may seem odd to think of a solid material as being a solution. Yet steel, while in the solid state below the melting point but above its upper critical temperature, has a uniform internal structure that varies within wide limits. This is the definition of a solution. Glass is probably the best known solid solution.

Characteristic of steel as a solution (liquid or solid), therefore, is its variability of internal structure. The iron carbide breaks up into tiny, hard and brittle particles which more or less float throughout the grains of iron. The particles have a great amount of freedom to form and reform, change size and relationship to each other, and otherwise rearrange themselves; at any given temperature they assume the size, shape and relationship most normal at that temperature. As steel cools through its lower critical temperature and ceases to be a solid solution, this freedom is lost and its internal structure becomes fixed or invariable.

The lower critical temperature of steel is that temperature at which the carbide starts going into solution when steel is heated. As the temperature is raised, more and more carbide goes into solution. The upper critical temperature represents the point at which all carbide present in the steel is in solution. The lower critical temperature is always the same for all carbon steels, namely, 1350°F. The upper critical temperature, however, decreases as the carbon content increases. It decreases from 1600°F. for 0.10% carbon to 1350°F. for 0.80% carbon. Thus for 0.80% carbon steel (and above), the upper and lower critical temperatures are the same, and all of the carbide goes into solution at 1350°. When less than 0.80% carbon is present, the carbide in steel is only partially in solution between the upper and lower critical temperatures. Beyond 0.80% carbon, greater carbon content in steel does not lower the upper critical temperature below 1350°F.

Relation of Internal Structure of Steel to its Carbon Content

The second important factor that determines the internal structure of steel is the amount of carbon (in the form of carbide) it contains. At 0.80% carbon (and below), all of the carbide is located within the grains of iron. If steel contains 0.80% carbon, sufficient carbide is available to saturate all of the iron grains. In 0.40% carbon steel, one-half of the grains are saturated with carbide; the remaining half are grains of pure iron. In 0.20% carbon steel, one-quarter of the grains are saturated with iron carbide and three-quarters of the grains are pure iron. Intermediate amounts of carbon are distributed proportionately. Any amount of carbon over 0.80% also saturates all of the iron grains with iron carbide particles; the excess carbide forms a shell-like layer around the grains.

Since the tiny carbide particles are extremely hard, the higher the carbon content of the steel is, the harder the steel will be. This statement is unequivocably true up to 0.80% carbon steel. Above this figure, the relationship between the carbon content of steel and its hardness depends on the rate at which it is cooled (this will be discussed further below).

Relation of Internal Structure of Steel to Rate of Cooling

The precise type of fixed internal structure that steel assumes as it changes from a solid solution, while passing through its upper and lower critical temperatures, depends on the rate at which it is cooled through these temperatures.

In the solid solution condition, as already pointed out, the carbide particles in steel are mobile, almost floating, and are free to rearrange themselves in a manner most normal for a particular temperature. When the metal is cooled through its upper and lower critical temperatures, however, the carbide assumes a fixed size and position in and around the iron grains. If a solid solution of steel is cooled slowly through its two critical temperatures, the carbide particles have sufficient time to rearrange themselves and thus become fixed in an orderly structure natural for lower temperatures. If cooled rapidly, on the other hand, sufficient time is not available for this orderly and normal rearrangement to take place, and the resulting fixed structure is strained and unnatural.

Slow Cooling

It is clear, therefore, that when a piece of steel is cooled very slowly through its critical temperatures, it assumes a natural and unstrained internal structure. The carbide particles have time to collect into spheres within all or some grains and into layers around the grains depending on whether the percentage of carbon in the steel is 0.80%, or below or above this figure. (How the internal structure varies with the amount of carbon in steel, has already been described in a previous section.)

When plain carbon steel is heated above its critical temperatures and then cooled slowly, the natural internal structure it assumes makes it relatively soft and tough. Hence steel treated in this fashion is quite easily formed, but by the same token is also easily bent or stretched without cracking or breaking. The carbide spheres do have some influence, however, since higher carbon steels emerge slightly harder than lower carbon steels from the same slow-cooling procedure. This relationship between carbon content and hardness holds true even beyond 0.80% carbon in the case of slow-cooled steels. When 1.2% carbon steel is cooled slowly, for example, it becomes slightly harder than when 0.90% carbon steel is cooled slowly.

Rapid Cooling

Rapid cooling of steel from a solid solution traps the tiny carbide particles in a fixed structure before they have time to reform and collect in spheres within, and in layers around the grains of iron.

Faster and faster cooling results in the carbide being trapped in a fixed condition in ever finer particles more completely dispersed within the iron grains. This particular unnatural structure makes for greater and greater hardness and brittleness, which properties also increase proportionately with the amount carbon present, up to 0.80% carbon. At this point maximum hardness is achieved. Rapidly cooled 1.0% carbon steel, for example, is not harder than rapidly cooled 0.80% carbon steel.

If a piece of steel is cooled through its critical temperatures in less than one second, the carbide particles are trapped in a completely dispersed structure. This is a spiny, needle-like network resembling pine leaves. The spines act as interlocking reinforcing rods do in concrete, locking the iron grains in a very hard, rigid arrangement. The higher the carbon content (up to 0.80%), the more spines, and consequently the greater hardness. High carbon steel treated in this way is very hard and brittle--even more brittle than glass. It will break before bending.

This process of hardening steel by first heating it above its critical temperatures, and then taking advantage of the particular unnatural internal structure that develops as it is cooled rapidly through these temperatures, is known as "heat treatment." It should be borne in mind, however, that heat treatment accomplishes nothing in the way of hardening unless the carbide is first in solution. This only begins to occur above the lower critical temperature. Hence even very rapid cooling from any temperature less than 1350°F. will not increase hardness.

Although excess carbon beyond 0.80% does not increase the hardness of "hardened" steel, it does serve a useful purpose by increasing the wear resistance of such a piece. In wearing away this piece of steel, one would have to wear down both the hard grains of steel as well as the much harder layers of carbide particles around each grain. A major disadvantage of high carbon steels, however, is the fact that the brittle shell of iron carbide around the iron grains increases brittleness. Hence these steels are more likely to fracture on impact or bending than tougher low carbon steels.

An important complicating factor in heat treatment arises from the fact that steel is chemically more active at high temperatures. If it is heated in an ordinary air, oxygen actually burns carbon out of the surface of the steel, thereby lowering its carbon content. Atmospheric oxygen also oxidizes (i.e. rusts) the iron itself at a very rapid rate when steel is hot. If heated in an atmosphere of carbon gases, on the other hand, steel absorbs carbon into its surface. Special precautions, therefore, must be taken to prevent oxidation, burning out of carbon, or the absorption of carbon while finished parts are heat treated. In some instances, however, a finished part (made of low carbon steel) may be deliberately heated in an atmosphere of carbon gases so that it may absorb carbon and thus acquire a hard outer case.

Tempering

Hardness alone is seldom desired in a piece of steel. Any given piece must have the most desirable combination of properties possible for its particular use--whether hard and brittle, soft and tough, flexible, etc. Theoretically it should seem possible to control the degree of hardness that results from heat treating steel, by regulating the rate of cooling through its critical temperatures. If, for example, we wanted a relatively soft and tough piece of steel we should simply have to cool it less rapidly than if we wanted a harder and stronger piece. Actually, however, it is very difficult to regulate the rate of cooling with sufficient precision so as to achieve the desired degree of hardness. In practice, therefore, steel is cooled at the fastest possible rate during hardening or heat treatment, and any undesired amount of hardness and brittleness is then removed later from the fully hardened piece by tempering, a process of reheating steel to a temperature below the lower critical temperature. The hardness of steel is so closely related to its other properties, that if we achieve the correct degree of hardness in a piece after heat treatment and tempering, we can rely on its having the desired other properties.

The unnatural needle-like formations of trapped carbide particles in hardened steel generate structural stresses, thereby exerting an internal force toward reforming into a more natural structure. At ordinary room temperature, however, modification of this unnatural structure is impossible. But as the fully hardened piece of steel is reheated, some of the trapped carbide spines do reform into spheres. This reforming starts as low as 212°F. As each higher temperature below the critical is reached, additional spines break down and reform into spheres, thus making the metal softer and tougher (less brittle). The highest temperature to which the hardened piece of steel is subjected during the reheating operation determines its final degree of hardness and brittleness (or softness and toughness), and is the important factor in tempering.

A tool such as a file, for example, is reheated to 212°F. This modifies some needles, thereby removing some of the brittleness but retaining practically all of the hardness. Cutting tools and wearing parts are tempered at about 400°F. This removes most brittleness and, of necessity, a little hardness. Battering tools are reheated to about 500°F.; still more needles are removed resulting in a loss of hardness, but more important, the tools are tougher and less apt to break under a blow. Springs are tempered at about 750°F. to obtain the best balance between hardness, toughness and flexibility. Parts reheated to 900° - 1000°F. lose additional hardness but gain in toughness (or the ability to withstand a blow by bending before breaking). Each higher tempering temperature modifies an additional portion of the spiny structure. If a part should be over-heated for any reason (thereby becoming too soft), it must be rehardened (i.e. heated above its critical temperatures and then cooled rapidly) and then tempered to the proper temperature.

APPENDIX C

LEARNING PASSAGE TEST

DIRECTIONS

The questions on the following pages test your knowledge of the material that you have just studied. You will have all the time you need to answer the questions.

These questions are all of the multiple-choice type. For each question choose the lettered alternative that is most appropriate. If two or more answers seem appropriate, choose the one that seems most correct to you. Only one answer should be chosen for each question. Answer all questions even if you do not feel completely certain of your answer in a particular case.

When you have decided which of the five lettered answers is correct for each question, blacken the corresponding space on the answer sheet with pencil or pen. Make sure that the number of each question you answer on the answer sheet corresponds to the same numbered question on the question sheet. You can avoid errors by answering each question as you come to it. Do not skip around from one question to another.

You will have an opportunity before the end of the semester to learn both your own score and the range of scores for the entire class.

PLEASE MAKE NO MARKS ON THE QUESTION BOOKLET

The Properties of Plain Carbon Steel

Question Booklet

1. The primary purpose of tempering steel is to reduce:
   (a) hardness;
   (b) brittleness;
   (c) wear-resistance;
   (d) toughness;
   (e) softness.

2. An alloy is a substance composed of two or more elements:
   (a) which has metallic properties;
   (b) which has at least one metal constituent;
   (c) which do not interact chemically;
   (d) "a" and "b";
   (e) "b" and "c".

3. The most reliable method of making the first of two identical pieces of steel harder than the second is to:
   (a) cool the first piece more slowly during heat treatment;
   (b) cool the first piece more rapidly during heat treatment;
   (c) heat the first piece to a higher temperature during heat treatment;
   (d) temper the first piece at a higher temperature;
   (e) temper the first piece at a lower temperature.

4. In 0.60% carbon steel:
   (a) All of the iron grains are saturated with carbide;
   (b) one-quarter of the iron grains are saturated with carbide;
   (c) one-half of the iron grains are saturated with carbide;
   (d) three-quarters of the iron grains are saturated with carbide;
   (e) carbide forms in a shell-like layer around the grains of iron.

5. A kitchen knife made of which of the following would remain sharp the longest?
   (a) .20% carbon steel;
   (b) .40% carbon steel;
   (c) .80% carbon steel;
   (d) .95% carbon steel;
   (e) 1.5% carbon steel.

6. To be able to get maximum hardness in steel, it must contain:
   (a) at least 0.10% carbon;
   (b) at least 0.40% carbon;
   (c) at least 0.80% carbon;
   (d) not over 1.5% carbon;
   (e) not over 2.0% carbon.

7. Which of the following events do <u>not</u> occur as steel is transformed from a mixture to a solution?
   (a) the carbide particles become more highly dispersed;
   (b) the metal becomes a liquid;
   (c) the carbide particles become smaller;
   (d) the grain structure varies with changes in temperature;
   (e) the carbide particles acquire greater freedom to reform.

8. By knowing the hardness of a piece of steel we do <u>not</u> know:
   (a) its toughness;
   (b) its tensile strength;
   (c) its corrosion resistance;
   (d) its ability to withstand impact;
   (e) its ability to withstand bending without breaking.

9. When any alloy is examined under a powerful microscope, it can be demonstrated that:
   (a) it has a uniform internal structure throughout the piece;
   (b) all grains have the same general appearance;
   (c) all grains have the same size and general appearance;
   (d) its internal components are not distinguishable from each other;
   (e) "b" and "d".

10. Cooling a piece of steel rapidly from the tempering temperature will:
   (a) completely reharden the piece;
   (b) partially reharden the piece depending on the tempering temperature;
   (c) partially reharden the piece depending on the carbon content;
   (d) partially reharden the piece depending on both tempering temperature and carbon content;
   (e) have no effect whatsoever.

11. A steel part with a tough center and a hard, wear-resistant surface (such as an axle) could be produced by:
   (a) hardening a high carbon steel part and then reheating only the surface;
   (b) hardening a low carbon steel part and then reheating only the surface;
   (c) hardening and tempering a low carbon steel in a carbon atmosphere;
   (d) hardening and tempering a high carbon steel in an ordinary air atmosphere;
   (e) hardening and tempering a low carbon steel in an ordinary air atmosphere.

12. Which of the following statements is <u>not</u> true?
    (a) the carbide in 0.60% carbon steel starts to go into solution at the same temperature as the carbide in 0.40% carbon steel;
    (b) the carbide in 0.60% carbon steel is all in solution at a lower temperature than the carbide in 0.40% carbon steel;
    (c) the carbide in 1.5% carbon steel is all in solution at a lower temperature than the carbide in 0.80% carbon steel;
    (d) the carbide in 1.5% carbon steel begins to go into solution at the same temperature as the carbide in 0.80% carbon steel;
    (e) the carbide in 0.60% carbon steel begins to go into solution at the same temperature as the carbide in 0.80% carbon steel.

13. Which tempering temperature is best for battering tools?
    (a) 300°F.;
    (b) 400°F.;
    (c) 500°F.;
    (d) 750°F.;
    (e) 950°F.

14. If a broken spring has been repaired by welding (joining the two pieces by remelting the metal at the break):
    (a) the heated section must be cooled slowly;
    (b) the heated section must be cooled rapidly;
    (c) the entire piece must be retempered;
    (d) the entire piece must be rehardened and retempered;
    (e) the entire piece must be retempered and cooled rapidly.

15. Steel is an alloy of iron:
    (a) which contains less than 2% carbon;
    (b) which always contains one or more alloying elements in addition to carbon;
    (c) which may contain one or more alloying elements in addition to carbon;
    (d) "a" and "b";
    (e) "a" and "c".

16. To make a steel maximally hard its temperature at the time of cooling must be:
    (a) above the upper critical;
    (b) below the upper critical;
    (c) at the melting point;
    (d) below the lower critical;
    (e) between the upper and lower critical.

17. Springs are tempered at:
    (a) 300°F.;
    (b) 400°F.;
    (c) 550°F.;
    (d) 750°F.;
    (e) 920°F.

18. The carbide in steel begins to go into solution:
    (a) at 212°F.;
    (b) at 500°F.;
    (c) at 1000°F.;
    (d) at 1350°F.;
    (e) at none of the above.

19. Steel with a carbon content over 0.80% is used where it is important to have:
    (a) extra hardness;
    (b) increased flexibility;
    (c) high corrosion resistance;
    (d) great toughness;
    (e) high wear resistance.

20. The upper critical temperature of steel:
    (a) is the temperature above which steel melts;
    (b) is the temperature at which all of the carbide in steel is in solution;
    (c) is the temperature at which the carbide in steel begins to go into solution;
    (d) is the temperature above which steel must be heated for tempering to take place;
    (e) is the temperature below which steel solidifies.

21. When a piece of high carbon steel is cooled rapidly from a solid solution, the piece will be:
    (a) soft;
    (b) hard;
    (c) soft and tough;
    (d) hard and brittle;
    (e) brittle.

22. The most important consideration in choosing the tempering temperature of a finished steel part is:
    (a) its desired mechanical properties;
    (b) the rate at which it was cooled;
    (c) the maximum temperature during heat treatment;
    (d) the carbon content of the part;
    (e) the internal grain structure of the part.

23. Which of the following alloys may be heat treated?
    (a) iron-chromium;
    (b) iron-carbon-tungsten;
    (c) copper-zinc;
    (d) iron-nickel-chromium;
    (e) copper-tin.

24. Which of the following statements is not true?
    (a) Slowly cooled 1.5% carbon steel is harder than slowly cooled 1.0% carbon steel;
    (b) Slowly cooled 0.75% carbon steel is harder than slowly cooled 0.60% carbon steel;
    (c) Rapidly cooled 0.70% carbon steel is harder than rapidly cooled 0.50% carbon steel;
    (d) Rapidly cooled 0.80% carbon steel is harder than slowly cooled 0.80% carbon steel.
    (e) Rapidly cooled 1.5% carbon steel is harder than rapidly cooled 1.0% carbon steel.

25. When tempering a cutting tool that is to be driven with a hammer (e.g., a chisel), the following tempering temperature should be used:
    (a) 212°F.;
    (b) 400°F.;
    (c) 550°F.;
    (d) 700°F.;
    (e) 900°F.

26. The effect of tempering steel first becomes noticeable at:
    (a) its upper critical temperature;
    (b) its lower critical temperature;
    (c) 212°F.;
    (d) 900°F.;
    (e) 1200°F.

27. As the tempering temperature increases steel becomes:
    (a) tougher;
    (b) harder;
    (c) softer;
    (d) tougher and harder;
    (e) tougher and softer.

28. The higher the carbon content of steel:
    (a) the lower the temperature at which all of the carbide is in solution;
    (b) the higher the temperature at which all of the carbide is in solution;
    (c) the higher the temperature at which the carbide starts going into solution;
    (d) the lower the temperature at which the carbide starts going into solution;
    (e) the higher its melting point.

29. The most reliable way of having a piece of low carbon steel acquire a hard outer case during heat treatment is to:
    (a) use a particularly high maximum temperature during heat treatment;
    (b) cool the outside of the piece more rapidly than the inside during heat treatment;
    (c) heat treat and temper the piece in an atmosphere of ordinary air;
    (d) heat treat and temper the piece in an atmosphere of carbon gases;
    (e) harden the piece and then reheat only the surface.

30. Which of the following statements about 0.80% carbon steel is not true?
    (a) Its lower and upper critical temperatures are the same;
    (b) It is more brittle than 0.40% carbon steel;
    (c) Its carbide starts going into solution at a lower temperature than the carbide of 0.40% carbon steel;
    (d) It may be hardened at a lower temperature than 0.40% carbon steel;
    (e) It is harder than 0.60% carbon steel.

31. Steel is:
    (a) a compound of iron and carbon;
    (b) a solution of iron and iron carbide;
    (c) a solution or mixture of iron and iron carbide;
    (d) a solution or mixture of iron and carbon;
    (e) a solution of iron and carbon.

32. Before a soft carbon steel can be hardened it must be changed:
    (a) from a mechanical mixture to a solid solution;
    (b) from a liquid solution to a mechanical mixture;
    (c) from a mechanical mixture to a solid solution and back to a mechanical mixture;
    (d) from a solid solution to a mechanical mixture;
    (e) from a solid solution to a mechanical mixture and back to a solid solution.

NAME ____________________

ANSWER SHEET

	A	B	C	D	E		A	B	C	D	E
1.	( )	( )	( )	( )	( )	17.	( )	( )	( )	( )	( )
2.	( )	( )	( )	( )	( )	18.	( )	( )	( )	( )	( )
3.	( )	( )	( )	( )	( )	19.	( )	( )	( )	( )	( )
4.	( )	( )	( )	( )	( )	20.	( )	( )	( )	( )	( )
5.	( )	( )	( )	( )	( )	21.	( )	( )	( )	( )	( )
6.	( )	( )	( )	( )	( )	22.	( )	( )	( )	( )	( )
7.	( )	( )	( )	( )	( )	23.	( )	( )	( )	( )	( )
8.	( )	( )	( )	( )	( )	24.	( )	( )	( )	( )	( )
9.	( )	( )	( )	( )	( )	25.	( )	( )	( )	( )	( )
10.	( )	( )	( )	( )	( )	26.	( )	( )	( )	( )	( )
11.	( )	( )	( )	( )	( )	27.	( )	( )	( )	( )	( )
12.	( )	( )	( )	( )	( )	28.	( )	( )	( )	( )	( )
13.	( )	( )	( )	( )	( )	29.	( )	( )	( )	( )	( )
14.	( )	( )	( )	( )	( )	30.	( )	( )	( )	( )	( )
15.	( )	( )	( )	( )	( )	31.	( )	( )	( )	( )	( )
16.	( )	( )	( )	( )	( )	32.	( )	( )	( )	( )	( )

NAME KEY

ANSWER SHEET

	A	B	C	D	E		A	B	C	D	E
1.	(X)	( )	( )	( )	( )	17.	( )	( )	( )	(X)	( )
2.	( )	( )	( )	(X)	( )	18.	( )	( )	( )	(X)	( )
3.	( )	( )	( )	( )	(X)	19.	( )	( )	( )	( )	(X)
4.	( )	( )	( )	(X)	( )	20.	( )	(X)	( )	( )	( )
5.	( )	( )	( )	( )	(X)	21.	( )	( )	( )	(X)	( )
6.	( )	( )	(X)	( )	( )	22.	(X)	( )	( )	( )	( )
7.	( )	(X)	( )	( )	( )	23.	( )	(X)	( )	( )	( )
8.	( )	( )	(X)	( )	( )	24.	( )	( )	( )	( )	(X)
9.	(X)	( )	( )	( )	( )	25.	( )	( )	(X)	( )	( )
10.	( )	( )	( )	( )	(X)	26.	( )	( )	(X)	( )	( )
11.	( )	( )	(X)	( )	( )	27.	( )	( )	( )	( )	(X)
12.	( )	( )	(X)	( )	( )	28.	(X)	( )	( )	( )	( )
13.	( )	( )	(X)	( )	( )	29.	( )	( )	( )	(X)	( )
14.	( )	( )	( )	(X)	( )	30.	( )	( )	(X)	( )	( )
15.	( )	( )	( )	( )	(X)	31.	( )	( )	(X)	( )	( )
16.	(X)	( )	( )	( )	( )	32.	( )	( )	(X)	( )	( )

(The score for this test is the number correct.)

APPENDIX D

LEARNING PASSAGE TEST SCORES

RAW SCORES

Good Organizers--Chemistry Class
(Study A and Study B)

Advance			Post			Non		
S	A	B	S	A	B	S	A	B
1	20	15	17	19	16	33	17	14
2	22	19	18	19	14	34	18	9
3	20	14	19	18	10	35	21	17
4	19	19	20	20	13	36	26	18
5	19	14	21	14	14	37	15	12
6	--	--	22	9	9	38	6	9
7	8	8	23	12	13	39	--	--
8	19	14	24	21	8	40	17	8
9	26	17	25	17	14	41	19	16
10	20	13	26	10	6	42	23	10
11	24	15	27	18	9	43	24	14
12	20	21	28	18	17	44	23	16
13	21	12	29	25	12	45	24	23
14	17	10	30	24	14	46	26	20
15	23	18	31	25	21	47	20	17
16	21	8	32	21	13	48	18	9

RAW SCORES

Poor Organizers--Chemistry Class
(Study A and Study B)

Advance			Post			Non		
S	A	B	S	A	B	S	A	B
49	18	11	65	19	13	81	15	12
50	9	11	66	24	16	82	16	10
51	12	10	67	22	16	83	9	13
52	11	10	68	20	16	84	13	9
53	13	14	69	16	14	85	17	14
54	11	6	70	15	5	86	16	12
55	7	10	71	20	22	87	8	8
56	26	24	72	14	8	88	18	12
57	9	12	73	20	17	89	21	21
58	16	9	74	19	17	90	15	14
59	21	--	75	12	9	91	17	13
60	18	12	76	22	16	92	20	12
61	9	7	77	20	12	93	11	10
62	20	16	78	17	10	94	14	10
63	17	14	79	16	12	95	20	17
64	16	16	80	11	9	96	24	21

RAW SCORES

Good Organizers--Physics Class (Study C)

Advance		Post		Non	
S	C	S	C	S	C
1	25	14	21	27	18
2	16	15	17	28	16
3	15	16	9	29	16
4	20	17	18	30	--
5	18	18	15	31	13
6	22	19	18	32	17
7	22	20	--	33	17
8	18	21	--	34	18
9	21	22	--	35	--
10	17	23	--	36	15
11	8	24	13	37	21
12	16	25	19	38	15
13	20	26	7	39	17

RAW SCORES

Poor Organizers--Physics Class (Study C)

Advance		Post		Non	
S	C	S	C	S	C
40	18	53	9	66	11
41	9	54	16	67	28
42	18	55	--	68	13
43	--	56	--	69	--
44	--	57	13	70	--
45	15	58	--	71	24
46	22	59	23	72	18
47	18	60	21	73	12
48	12	61	15	74	13
49	7	62	21	75	--
50	11	63	13	76	11
51	18	64	7	77	15
52	21	65	--	78	13

APPENDIX E

ADVANCE/POST ORGANIZER

1.

student's name

DIRECTIONS

This is some introductory background material pertaining to a longer and more detailed selection in the same general subject-matter area that you will be studying shortly. You will have ten minutes in which to study this introductory material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and the details of the selection in your memory, but do not take any notes or make any marks on the reading material.

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3.

student's name

DIRECTIONS

This is some summary material pertaining to the longer and more detailed selection that you have just studied. You will have ten minutes in which to study this summary material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and the details of the selection in your memory, but do not take any notes or make any marks on the reading material.

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Metals and Alloys

Metal has certain unique advantages over other substances as a material for tools and implements. It is hard, strong, durable, and can be molded to any desired shape. When no longer required for a particular use it can be melted and made into a new product. But even more important, perhaps, is the fact that it has a wide diversity of properties under the control of man.

Many important physical properties of metal depend upon its internal grain structure. We can, therefore, alter the properties of a given metal by changing its internal structure. Both heat and various mechanical processes modify the internal structure and hence the properties of metals. Heat, for example, changes the grain structure of metals in such a way as to soften them, and hammering at room temperature changes their grain structure in such a way as to harden them.

Nevertheless, despite the possibility of modifying the internal structure of metals by heat and mechanical means, the range of properties available among pure metals is obviously limited by the existence of only a small number of pure metals. Hence, if man restricted himself to the use of pure metals he would only have a limited variety of grain structures and a correspondingly limited range of physical properties at his disposal.

It is true, of course, that pure metals do have certain unique functions that alloys cannot perform, especially in laboratory instruments. For most practical purposes, however, it is expedient to alloy a metal with other metals or non-metals, and thus take advantage of the much wider selection of grain structures and physical properties which thereby becomes available. Generally speaking, other elements are alloyed with metals to confer such properties as increased hardness, strength, toughness, and flexibility. Almost any desired combination of physical properties can be developed to meet the specific requirements of a metal part by selecting an appropriate metal, by choosing suitable kinds and percentages of alloying elements, and by subjecting the resulting alloy to appropriate mechanical and/or other procedures.

It is clear from the foregoing, therefore, that the properties of a given alloy, like those of a pure metal, are (within certain limits) determined by its distinctive grain structure. This structure in turn depends upon the particular metal and the specific type and amount of alloying substance used. Alloys also resemble pure metals in the fact that their internal structure also varies with temperature. Unlike pure metals, however, the grain structure (and hence the properties) of some alloys are modified by the rate at which they are cooled.

Hence, before we could predict the grain structure and properties of an alloy belonging to the latter category of alloys, we would not only have to know (a) its temperature, and (b) its principal metal component, and the type and amount of alloying substance used, but also (c) the rate at which it was cooled.

APPENDIX F

NON ORGANIZER

1.

student's name

DIRECTIONS

This is some introductory background material pertaining to a longer and more detailed selection in the same general subject-matter area that you will be studying shortly. You will have ten minutes in which to study this introductory material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and the details of the selection in your memory, but do not take any notes or make any marks on the reading material.

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3.

student's name

DIRECTIONS

This is some summary material pertaining to the longer and more detailed selection that you have just studied. You will have ten minutes in which to study this summary material.

When you have finished reading the directions, turn this page and read the entire selection at your customary reading speed. During the first reading, concentrate on grasping the general features of the material and becoming generally familiar with it. During the remainder of the available time, use whatever method you prefer to fix the substance and the details of the selection in your memory, but do not take any notes or make any marks on the reading material.

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Iron and Iron Alloys

Iron and iron alloys have a long and interesting history. The wide range of iron derivatives available today occupies an intermediate position in both time and complexity between the ancient art of the metalsmiths and our modern science of metallurgy. Although modern methods of mass-producing iron and iron alloys are only about one-hundred years old, iron products have been used for about 4000 years, and many of the basic processes employed today are several hundred years old.

Meteoric iron was probably the first iron alloy used by man in most parts of the world. This type of iron accounts for the existence of many iron tools in areas where iron smelting was unknown. It has a high nickel content peculiar to meteoric iron; no known iron ore shares this characteristic. Although this alloy could not be melted with charcoal fires, it could be softened and formed into tools far superior to those of bronze or copper.

Wrought iron was in use before the first written records and was the primary iron product made by man until about 100 years ago. It is almost pure iron that contains strips and pieces of slag throughout, and is fairly strong and easy to work.

Wrought iron was produced in a crude charcoal-burning furnace similar to that used in the refining of copper and tin. Wood charcoal and ore were placed in the tube-like furnace, and the charcoal was ignited from the bottom. The natural draft of air in such a furnace, however, was insufficient for the charcoal to burn fast enough to produce the necessary heat and temperature. To overcome this difficulty, the furnace was made higher and hand-operated bellows were used to increase the available air flow.

Although this type of furnace was hot enough to melt tin and copper ores, it was not hot enough to reduce iron ore to a molten (liquid) state. In the case of iron ore it only yielded a black, spongy material with no obvious use and hardly resembling a metal. Before this spongy mass could be converted into a usable metal, it had to be alternately heated and hammered to force the particles of iron together and to squeeze out the slag. This was a long, arduous process that yielded only very small quantities of wrought iron. This process, however, produced practically all of the known iron products from about 1350 to 1850 A. D.

The mass production of iron, therefore, was delayed until about 1850 A. D., when a furnace was invented that produced a temperature sufficiently high to reduce large quantities of ore to molten metal. This was the blast furnace utilizing coke as a fuel, as well as a vastly augmented air blast from a steam engine. The product of this blast furnace is pig iron. It contains many impurities, cannot be worked, and must be refined further before it becomes a useful product.

Prior to about 1830, all good steel had to be fabricated from laboriously made wrought iron. The introduction of the blast furnace and the mass production of pig iron from iron ore, however, soon led to large-scale methods in the manufacture of steel. Steel is made today by refining molten pig iron in either a Bessemer Converter or an open hearth furnace.

APPENDIX G

INSTRUCTIONS FOR ADMINISTERING STUDY

Instructions for Administering Phase one of Study A and Study C

(1) After the students are seated in their usual places, inform them that their work for the day will consist of a short test and will require only about 20 minutes of their time. Say nothing more unless they pursue the matter. Be as noncommittal as possible and proceed with the next step.

(2) Distribute the stapled passages marked DIRECTIONS on the front. When each student has received a copy, ask them to read silently while you read the directions aloud and then proceed to do so. Answer no questions. Note the time on your watch and tell them to begin. After exactly 10 minutes tell them to stop and ask them to pass the booklets in.

(3) Proceed immediately to distribute the answer sheets marked ORGANIZATION EVALUATION. Tell them to enter their name, read the directions, and fill in the blanks. Give them as much time as they wish (they should require no more than 5 minutes), but ask them to sit quietly until everyone has finished. If they ask questions, tell them to re-read the directions. When everyone has finished, collect the answer sheets and dismiss the class. If they ask, tell them that they will be told their scores at a later date.

Note: Make sure there is one answer per line and that all lines are filled. Otherwise answer no questions. Just about any question can be answered by referring the students to the directions.

Instructions for Administering Phase two of Study A

(1) After the students are seated in their usual places, read the following introduction to the students:

"The laboratory experiment for today will consist of a reading exercise that will require about ninety minutes of your time. You will need a pencil or pen but are asked to use no scratch paper of any kind. The material you will be given will have your name on it and a set of directions. Check to make sure you have the material intended for you and proceed to read and follow the directions. If it is not clear what you are to do, re-read the directions. You will not all be doing the same thing at the same time so make sure you are following your own directions."

(2) Proceed to distribute the materials in exactly the same order they occur in the bundle you have received. The materials are coded so you should have no difficulty, but you will have to watch what you are doing.

There are four stages in this phase of the study. The stage number is located in the upper right corner of the name label or on the upper right corner of the booklets without labels. To start you simply hand out the booklets to the appropriate people until you run out of ones. At this point everyone should have a booklet, approximately half of which should have a red cover and half a green cover.

As nearly to ten minutes as possible after you hand out the materials, you should start handing out stage two. This is the thicker red booklet and it goes to the same students who were given red booklets previously. Be sure to collect the old booklets as you distribute the new ones. No student should ever have two booklets at the same time.

Thirty-five minutes later (forty-five minutes after the stage one booklets were handed out), you will collect the green booklets and hand out the new green ones. This should give you no trouble because all of the booklets have name labels and the number three appears in the upper right corner of the label.

After a carefully timed ten minutes, announce to the entire class that they may stop reading and collect all the booklets. After you have all the booklets, proceed directly to the next step.

(3) Distribute one stage four booklet to each student. These are all white and do not have name labels but they are identified with a small four in the upper right corner. Tell the students to begin reading the instructions as soon as they receive the test. Give each student an answer sheet and remind them to enter their name before they begin filling out the answer sheet. Give them as much time as they wish to answer the questions and allow them to leave when they have finished, but do not let them stand around the room.

Instructions for Administering Phase two of Study C

<u>MAKE SURE YOU READ THIS BEFORE DOING ANYTHING</u>

(1) After the students are seated in their usual places, read the following introduction to the students:

> "This exercise will consist of a reading assignment that will require about one hour of your time. You will need a pencil or pen but are asked to use no scratch paper of any kind. The material you will be given will have a set of directions. When you get the first booklet, proceed to read and follow the directions. If it is not clear what you are to do, re-read the directions. You will not all be doing the same thing at the same time so make sure you are following your own directions. This is a test and it is important that you do your own work. There will be no talking until this exercise is completed. Are there any questions?"

(2) Answer any questions and proceed to distribute the materials in exactly the same order they occur in the bundle you have received. The materials are coded so you should have no difficulty, but you will have to watch what you are doing.

There are four stages in this phase of the study. The stage number is located in the upper right corner of the name label or on the upper right corner of the booklets without labels. To start you simply hand out the booklets to the appropriate people until you run out of ones. At this point nearly everyone should have a booklet, approximately half of which should have a red cover and half a green cover. Give each student who does not have a booklet a red one with a one (1) on the label but no name.

As nearly to ten minutes as possible after you hand out the materials, you should start handing out stage two. This is the thicker red booklet and it goes to the same students who were given red booklets previously, including the ones who did not get a booklet with a name on it. Be sure to collect the old booklets as you distribute the new ones. No student should every have two booklets at the same time. Again, the extra students get the booklets without names but with a two (2) on the label.

Fifteen minutes later (twenty-five minutes after the stage one booklets were handed out), you will collect the green booklets and hand out the new green ones. This should give you no trouble because all the green booklets have name labels and the number three (3) appears in the upper right corner of the label.

After a carefully timed ten minutes, announce to the entire class that they may stop reading and collect all the booklets. After you have all the booklets, proceed directly to the next step.

(3) Distribute one stage four (4) booklet to each student. These are all white and do not have name labels but they are identified with a small four (4) in the upper right corner. Tell the students to begin reading the instructions as soon as they receive the test. Give each student an answer sheet and remind him to enter his name before he begins filling out the answer sheet.

Give the students as much time as they wish to answer the questions. It is important that the test be monitored. The test must represent the individual's effort only, not his neighbor's. The room should be kept quiet while the stragglers finish. If someone in the study (i.e. with his name on a booklet) comes in late, he should be timed separately. Other late comers can participate or not at your convenience.

APPENDIX H

AUSUBEL CORRESPONDENCE

105-12 North University Place
Stillwater, Oklahoma 74074
February 24, 1971

Dr. David P. Ausubel
Division of Teacher Education
33 W. 42nd Street
New York, New York 10036

Dear Dr. Ausubel:

As an Ed.D. candidate at Oklahoma State University, I am interested in doing some research on subsuming concepts. I plan to use a 2 x 3 factorial S-O-R design. The organismic variable will be good and poor organizers which I plan to identify by asking the entire population to read a short passage and then to arrange central ideas, represented by words and phrases, into logical order.

The subjects will be randomly assigned to three groups: those receiving advance organizers, post organizers and no organizers. I plan to give a learning passage to all three groups (six cells) and follow it with an immediate post test and an equivalent post test in six weeks.

There will be two groups of subjects and therefore two separate experiments. One group is a very homogeneous college freshman chemistry class of about 290 students. These students have achieved a score of 16 or less on the ACT. The other group is a high school physics class of about 200 students. This group is also homogeneous but above average in ability.

My reason for writing you is twofold: I wish to invite your comments and ask permission to use the steel passage, organizer and test, you utilized in your early work with advance organizers. I believe the steel passage would be appropriate for my populations. I am, of course, anxious that I have an organizer of proven worth. Would you object to your advance organizer being used as a post organizer also? And do you feel it is necessary to utilize a placebo non-organizer for the control group?

I would appreciate any comments and a copy of the materials if you are agreeable to my using them.

Sincerely

Richard Graber

The City University of New York, ***Division of Teacher Education***

Center for Advanced Study in Education

33 West Forty-Second Street, New York, New York 10036

212/790-4204

March 1, 1971

Mr. Richard Graber
105-12 North University Place
Stillwater, Oklahoma 74074

Dear Mr. Graber:

Thank you for your letter of February 24. I think your proposed study would shed some light on what type of student (inherently good or poor organizer) benefits most from the use of advance organizers. I am enclosing the materials you requested and you are, of course, free to use them in any way you choose. I recommend the use of a control introduction for the non-organizer group so as to preclude a Hawthorne effect.

Best of luck on your study!

Sincerely,

D. P. Ausubel

David P. Ausubel
Professor and Program Head

DPA:ba

VITA

Richard Allen Graber

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECT OF SUBSUMING CONCEPTS ON STUDENT ACHIEVEMENT AND THE INTERACTION EFFECT OF SUBSUMERS WITH HIGH AND LOW ORGANIZING ABILITY

Major Field: Higher Education

Biographical:

Personal Data: Born at Pretty Prairie, Kansas, March 16, 1935, the son of Ben A. and Esther Graber.

Education: Attended public schools in Kansas; graduated from Central Christian High School, Hutchinson, Kansas, in May, 1953; received the Bachelor of Arts degree from Tabor College, Hillsboro, Kansas, in May, 1957, with a major in chemistry; attended Kansas State University, Manhattan, Kansas, 1959-1960; received the Master of Science degree from Kansas State Teachers College, Emporia, Kansas in August, 1961, with a major in physical science; completed the requirements for the Doctor of Education degree at Oklahoma State University, Stillwater, Oklahoma, in May, 1972.

Professional Experience: Secondary science teacher at Atchison High School, Atchison, Kansas, 1960-1961; secondary science teacher and head of the science department at Woodstock School, Mussoorie, U. P., India, 1962-1965; science department head and Administrative Assistant at Wichita Collegiate School, Wichita, Kansas, 1966-1970; Acting Head of the Department of Education at Illinois College, Jacksonville, Illinois, 1971.