THE COMPARATIVE EFFECTS OF LEVEL SPECIFIC ADVANCE ORGANIZERS ON THE ACHIEVEMENT OF STUDENTS OF DIFFERING ABILITY LEVELS

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CHAPTER I

A GENERAL STATEMENT OF THE PROBLEM

Introduction

Among the responsibilities charged to educational theorists is the development of theories of how learning is accomplised. With respect to these theories, methods and conditions under which learning may be expedited are formulated and empirically tested. Theories that do not succumb to the experimental process are eventually refined and presented to researchers and practitioners to be tried, ignored, denied, or further explored. Once such a theory is conceptualized as an abstract model upon which a philosophy of learning may find roots, procedures that adhere to and compliment the germinating ideology--and are implementable in a practical sense--are welcome additions to the pedagogical sphere. The nature of the present study is the empirical investigation of a small--but significant--portion of such a process. The philosophy is that of cognitive psychology. The associated theory is of the subsumption of knowledge by means of introductory organization. The application and measured examination are with a specific utilization in science education.

One problem encountered repeatedly by educational practitioners is how to make subject matter truly useful for the learner rather than something rotely encountered for the purpose of passing a forthcoming

examination. This promotes the disgust of many professional teachers who view educational theorists as playing games with pigeons, nonsense syllables and other short-term rote procedures that have little or no practical application beyond the early primary years. David P. Ausubel is one who has prompted the evolution of educational methods based on the belief that the most useful learning occurs when it is absorbed as a part of the cognitive structure. Cognitive structure has reference to the organization, clarity, and stability of one's intellect (Ausubel, 1963, p. 76). It is organized as a result of highly inclusive concepts under which more specific material may be subsumed (Ausubel, 1960). Cognitive structure as it exists for an individual is seen as the major component contributing to meaningful learning and retention (Ausubel, 1963, p. 25). New material becomes meaningful only to the extent that it may be subsumed under existing, more inclusive related concepts, and the degree of availability, stability, and discriminability of these concepts. Retention comes as new material is anchored to the conceptual scheme under which it is subsumed. In contrast, materials rotely encountered are separate from cognitive structure and easily influenced by the erosive effects of other rote experiences (Ausubel, 1962).

Any entity that allows new material to be more easily incorporated into existing cognitive structure may be referred to as a subsumer. This investigation includes the development and empirical examination of a particular type of subsumer referred to as an advance organizer. An advance organizer is introduced into a learning situation prior to the learning material itself. It is differentiable from common introductory passages which seek to motivate the learner with an historical

or factual preliminary warm-up to the main portion of a learning experience. Its make-up includes substantive material that is more abstract, general, and inclusive than the learning experience it preceeds. According to Ausubel (1963, p. 92) advance organizers facilitate meaningful learning in at least three ways. First, they "mobilize" any relevant subsuming concepts previously established in cognitive structure so that they may be incorporated as part of the subsuming process. Next, they provide an optimal anchoring focus around which new ideas are received and made resistant to forgetting. Then, they render rote learning procedures less necessary because students do not have to memorize the details of an undertaking before they have been able to fashion ample pertinent subsuming concepts.

Other types of subsumers have been suggested, created, and tested. Rothkopf (1966) has undertaken considerable experimentation with what he refers to as "mathemagenic behaviors" of students before, during, or immediately after a learning exercise. Mathemagenic behaviors include test-like experiences induced by structuring questions, or other provokers of thought processes, into the learning material. Frase (1970), Cunningham (1972), and Bayuk et al. (1970) have also contributed to this aspect of learning theory. Anderson (1966, 1967, 1969) has experimented with the effect of varying the structure of science teaching. But the advance organizer maintains a high degree of theoretical appeal, has not been subjected to sufficient appropriate investigation, and has not been adequately exploited for all that it may have to offer pedagogical undertakings.

This research project was undertaken for two main purposes. First, it was an attempt to determine if advance organizers may be

used to facilitate learning and retention for two related modern science programs. Previous research has shown that retention and learning may be enhanced by the use of appropriate advance organizers (Ausubel, 1960; Ausubel and Fitzgerald, 1961, 1962; Ausubel and Youssef, 1963; Grotelueschen and Sjogren, 1968; Allen, 1970), so this part of the study served as a test of the appropriateness of the advance organizers prepared by the researcher. Second, the researcher wanted to determine if the learning of a single set of concepts, presented at appropriate levels of abstraction to two groups with differing scholastic abilities, could be enhanced by different advance organizers that are selectively facilitative toward the group for which they are prepared. The literature related to this problem is unclear. Some reports indicate that only those with relatively low verbal ability or a low level of related knowledge are aided by the presence of advance organizers. Other learners, it is speculated, are capable of concurrently providing their own subsuming structure while undertaking the learning task (Ausubel, 1960; Ausubel and Fitzgerald, 1961, 1962). Other experiments suggest benefits may be realized by those of "superior intelligence" (Grotelueschen and Sjogren, 1968; Allen, 1970). By suggesting that advance organizers may have benefits for students of various ability levels, the current researcher has postulated that the content and presentation of an appropriate advance organizer is determined by the position of the learner relative to the topics and concepts contained in the learning task.

The science programs used are The Man-Made World (TMMW) and Technology---People---Environment (TPE). These programs were preferred because many of the concepts found in these courses are taken from

engineering and students are very unlikely to have had previous significant exposure to them. Also, TMMW and TPE students are predominantly non-science majors, and it is less likely that they would have extensive cognitive mastery of science related concepts. The criterion of unfamiliarity is very important when testing the subsuming quality of advance organizers (Ausubel, 1960).

Justification of the Study

Much educational research has had little or no impact on applied human learning or the solving of educational problems (Ausubel, 1963, pp. 4-6). More research needs to be done that can go beyond the psychological laboratory situation and have a direct influence on the structure of learning situations (Anderson, 1966, 1969). A general principle--such as that employed by advance organizers--with the potential to alter classroom procedures or structure curriculum projects in a manner that would increase learning, represents an effort in this direction. In many cases, teachers, and the learning materials they have to use, promote meaningful verbal learning as rote in character and use predominantly rote procedures. The proper application of subsumption theory could change much of this (Ausubel, 1962). Research related to advance organizers, however, has revealed conflicting results on their facilitative effects (Clawson and Barnes, 1972). Part of this may be due to the non-specific definition of an advance organizer (Cunningham, 1972). Ausubel has experimented only with the format of a written introductory passage. The present experiment, dealing with advance organizers in a more normal classroom setting, suggests expanding the practical boundary of an advance

organizer to another learning mode. It is also believed by the experimenter that the content of organizing subsumers may be more adequately defined in terms of the relative cognitive positions of the learner and the learning task.

Limitations of the Study

This study has investigated the specific application of a general principle that may be a valuable implement used to enhance learning. There is no attempt to investigate the motivational or methodological aspects of associated learning experiences. With respect to external validity, the enclosed nature of the classrooms from which experimental and control subjects were drawn will not permit the study to be generalized beyond those classrooms.

Terms Defined

1. Cognitive Structure. Cognitive structure is the organization, clarity, and stability of one's knowledge (Ausubel, 1963).

2. Cognitive Subsumption. Cognitive subsumption refers to the anchoring of new information to more inclusive concepts previously established in cognitive structure (Ausubel, 1963).

3. Meaningful Learning. Meaningful learning may be directly contrasted with rote learning. Rotely learned information is isolated from cognitive structure and easily forgotten as it becomes confused with other similarly learned information. Meaningfully processed information is subsumed under related general concepts and more resistant to forgetting because it becomes a part of concepts that are a part of existing cognitive structure (Ausubel, 1962).

4. Subsumer. A subsumer is any vehicle or procedure that allows new learning material to be more easily and more meaningfully incorporated into an individual's existing cognitive structure.

5. Advance Organizer. An advance organizer is an introductory experience that is more general, more abstract, and more inclusive than the principal learning material and administered just prior to it.

6. Concrete Level Students. This term is used to represent high school students who have much difficulty realizing academic success and are especially hindered by their inability to learn written materials. In this study they are all enrolled in the Technology---People---Environment course.

7. Abstract Level Students. This term is used to represent high school students enrolled in a college preparatory curriculum. In this study they are all enrolled in a class of The Man-Made World.

8. Abstract Advance Organizer. The abstract advance organizer refers to an introductory experience designed to aid the subsumption of new material by students who have previously demonstrated the ability to achieve success in a college preparatory academic setting. In this study it is a tape/slide presentation approximately nine minutes long that emphasizes the mathematics of the concept "feedback" and refers to examples of highly technical applications of the concept. As a point of reference it may be said to be much more abstract than the concrete advance organizer.

9. Concrete Advance Organizer. The concrete advance organizer refers to an introductory experience designed to aid the subsumption of new material by students who have previously demonstrated little ability to achieve success in a traditional academic setting. In this

study it is a tape/slide presentation approximately nine minutes long that emphasizes simple, familiar diagrams to introduce the concept "feedback" and refers to examples of the concept that are typical of everyday-life situations. As a point of reference it may be said to be much more concrete than the abstract advance organizer.

10. Advance Non-Organizer. The advance non-organizer refers to an introductory experience designed as a control for testing the abstract and concrete advance organizers. In this study it is a tape/slide presentation approximately nine minutes long that refers to the concept "feedback" and exposes many systems that utilize feedback but offers no substantive clues to its theory or practical application.

11. Experimental Control Groups. Experimental control groups are subjects similar to the experimental subjects who receive the non-organizer rather than an advance organizer prior to the principal learning experience.

12. Advance Organizer Control Groups. Advance organizer control groups are subjects similar to the experimental subjects who receive no principal learning experience between the introductory treatment and the performance test. They include a fourth category of subjects who receive no introductory experience of any kind prior to taking the performance test.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The use of advance organizers to aid the cognitive subsumption of new material has been tested for more than a decade. This review is basically a chronological account of these proceedings to the present time. It begins with the experiments of Ausubel and his associates followed by studies of others who have performed experiments in the same area. Also included are other investigations of meaningful learning and how they compare with the findings of--and theories advanced by--Ausubel. These include studies of the structure of learning materials by Anderson, the mathemagenic behavior of students by Rothkopf and by Frase, and the use of organizing experiences with higher order questions by Allen.

Next the previous studies are summarized and their collective implications for theoretical conclusions and practical applications are exposed. It is shown that previous research (1) suggests the need for a more specific model of advance organization and (2) supports the theoretical basis of the present experiment.

Previous Research

Initial recognition of Ausubel's work with advance organizers came from a study designed to determine if retention of unfamiliar

material could be facilitated by the use of advance organizers (Ausubel, 1960). The subjects were undergraduate students enrolled in an educational psychology course. The principal learning material was a 2500 word passage on the metallurgical properties of carbon steel. The unfamiliarity criterion was proven empirically by testing a group of students comparable to the experimental group. Their scores on the retention test, taken without exposure to the learning materials, did not vary significantly from chance. Prior to the study, two groups were equated on ability to learn from an unfamiliar scientific passage. The two groups in the study were each given 500 word introductory passages two days before and immediately before being given the principal learning passage. The control group received an historical introduction similar to that frequently found at the beginning of each chapter in many science texts. It included no conceptual details; only historical information such as the evolution of iron and steel processing was included. Introductory material was necessary for the control group in order to ascertain that any benefits realized by the experimental group could not be attributed to the mere presence of the introductory material. The experimental group received an introductory passage carefully constructed at a high level of abstraction, generality, and inclusiveness and designed to promote the formation of a structure around which relevant concepts about the steel-making process could be formed. Care was taken so that neither introduction could allow a direct advantage to answers on test questions. This quality was empirically demonstrated by determining that a group comparable to the experimental group did not score significantly better than chance after exposure to the introductory

material alone.

Statistical analysis of the test score means of the two groups revealed that the experimental group performed significantly better than the control group at a level of confidence between .01 and .05.

Ausubel suggests that two factors contributed to the apparent success of the advance organizer at facilitating meaningful learning. First, those concepts already existing in cognitive structure capable of providing a focus for the subsumption of new material were "mobilized." Second, carefully chosen new and relevant subsuming concepts allowed "optimal anchorage" for the internalization of new material. Ausubel concludes

> . . . that the greater use of appropriate (substantive rather than historical) advance organizers in the teaching of meaningful verbal material could lead to more effective retention. This procedure would also render unnecessary much of the rote memorization to which students resort because they are required to learn the details of a discipline before having available a sufficient number of key subsuming concepts.

In a follow-up study, Ausubel and Fitzgerald (1961) hypothesized that the learning and retention of unfamiliar material could be enhanced by the use of a comparative advance organizer. This type of organizer would relate precisely to differences and similarities existing between the new material and concepts already existing in cognitive structure. As differentiable properties are contrasted and compared, the established concept serves as a foci for the subsumption of related ideational material.

The experimenters used Christian doctrines as the concept existing in cognitive structure and a passage on Buddhist doctrines as the new learning material. Developmental, testing and experimental procedures were similar to those of the Ausubel (1960) study. Three

types of written introductions were used so that the effectiveness of different types of organizers could be compared. First, a comparative organizer as described in the above paragraph brought attention to the primary similarities of and differences between the two doctrines. A second experimental group received an expository organizer which related Buddhism in an abstract and general manner providing a conceptual basis for Buddhism with no comparisons to Christianity. The control group received a non-organizer containing only historical and human interest matter. The subjects were stratified across experimental groups according to whether they were above or below the median in the strength and intelligibility of their existing Christianity concepts. This completed a 3 x 2 factorial design.

One form of the Buddhism test was administered three days after treatment and a second form ten days after treatment. On the three-day test only the comparative organizer group scored significantly higher than the others. On the ten-day test, both the comparative and expository groups scored significantly higher than the non-organizer (control) group. It is difficult to imagine why the expository groups would increase retention 7 days later. Perhaps the presence of the expository organizer after a period of time allows the learner to make his own comparisons with Christian doctrines. Or, the expository introduction might have enhanced retention where the non-organizer did not.

The most revealing aspect of this experiment, however, is that all of the difference was found within those who scored below the median on the Christianity test. Ausubellian theory would suggest several possible reasons for this occurrence. It is possible that

those with a strong conceptual background in Christianity were able to provide their own cognitive subsumers concurrently without the aid of an advance organizer. The data supports this since, in each organizer group, those with Christianity scores above the median scored higher on the post-test but were not significantly different across treatment groups. Perhaps their superior knowledge of Christianity provided a basis for discriminability regardless of the introduction used. It is also possible that advance organizers realize more effectiveness when no strong conceptual background previously exists in cognitive structure. As the experimenters explained:

> . . . in the learning and retention of unfamiliar ideational material that is relatable to established concepts in the learner's cognitive structure, 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 established concepts.

In a second investigation by Ausubel and Fitzgerald (1962) an expository organizer was tested for ability to enhance sequential verbal learning. Using a general format similar to the previous two studies, treatment and control groups were given an expository organizer and an historical non-organizer respectively, two days before the introduction of principal written materials and again immediately prior to their use. Next each group was given a learning passage followed by a retention test and then a second related learning passage followed by a second retention test. The experimenters wanted to determine if increased learning on Part I materials as a result of the subsuming effects of the advance organizer would carry over and promote increased learning of Part II materials. If so, it might be

attributed to the more advantageous cognitive organization of subject matter related to Part I materials which would constitute pertinent concepts in cognitive structure around which concepts in Part II materials might be subsumed.

Similar to the previous study (Ausubel and Fitzgerald, 1961), the advance organizer's demonstrated ability to enhance performance on the Part I post test could be traced almost entirely to those students ranking in the lower third of the students in verbal ability. Again it was suggested that those with higher verbal ability possess the ability to organize concepts in a spontaneous fashion with no advance organizational aids. For those with less verbal ability the experiment suggests that learning and retention of new material may be enhanced by the presence of advance organizers which provide anchoring foci for the subsumption of new concepts. Attention must also be focused on the marginal level of significant difference between the experimental and control groups ($p = .07$). Ausubel and Fitzgerald (1962) suggest the subjects may not have had the scholastic background that would allow the benefits of advance organization to be realized. The advance organizer cannot facilitate the subsumption of new concepts if there is nothing in cognitive structure that can be organized. This illustrates a serious deficiency in the concept of an organizer. It is not adequately defined so that it is possible to determine exactly what constitutes an advance organizer. If a short passage is prepared, what determines whether it can function as an advance organizer?

Data from this investigation would not support the hypothesis that learning and retention of Part II materials would be facilitated

by the use of advance organizers prior to Part I. This suggests that significant facilitation of learning and retention on sequential materials would require the use of additional organizers. In this case learning unfamiliar materials might be enhanced by inserting a second advance organizer between Part I and Part II. Such a connecting organizer would be constructed to both promote ideational organization for new concepts in the second passage and point out similarities and differences existing between concepts found in the two passages.

A similar investigation by Ausubel and Youssef (1963) partially supports and partially disagrees with the previous studies. Experimental procedures were similar to those of Ausubel and Fitzgerald (1961) with one important difference. After receiving Buddhism materials (introduction, written passage, test), experimental and control groups received similar materials on Zen Buddhism. The experimental group received a comparative advance organizer for an introduction, while the control group received an historical non-organizer. Both groups received the same written passage on Zen Buddhism and were tested on the same.

As would be expected by the results of Ausubel and Fitzgerald (1961) the organizers significantly facilitated learning and retention on the first passage as indicated by the Buddhism retention test. For the second passage, however, advance organizers failed to significantly increase retention test scores of the Zen Buddhism passage. This is in conflict with the suggestion of Ausubel and Fitzgerald (1962) (after advance organizers for Part I failed to enhance the learning and retention of Part II materials) that sequential learning materials could be enhanced by the insertion of advance organizers

between major units. Ausubel and Youssef (1963) speculate that perhaps the recent exposure to reading and test material on Buddhism allowed a relatively easy vehicle for discriminating between the two. In effect, the Buddhism material would then constitute a comparative advance organizer for the Zen Buddhism material. If this is true, then one might wonder if the control group scores on Part II of the 1962 study were not inflated for the same reason. A conflict in explanation does exist between these two studies. Ausubel and Fitzgerald (1962) suggest that a second advance organizer in sequence between related materials might enhance learning and retention. In refuting this Ausubel and Youssef (1963) suggest that the Buddhism materials themselves may act as a subsuming entity for Zen Buddhism concepts. Neither has been empirically tested but could be. Subjects who have not seen the Buddhism material could be given an appropriate comparative advance organizer (compared to Christianity) on Zen Buddhism and compared with an experimental group such as that of Ausubel and Fitzgerald (1962).

The results of this study deviate from what was expected in another important way. No significant interaction was indicated between level of knowledge of Christianity and the Buddhism organizer for the first part of the study, or for level of knowledge of Buddhism and the Zen Buddhism organizer for the last part of the study. The organizers seemed to benefit each level about equally rather than favoring those with a lower level of knowledge of the discriminating doctrines. No explanation of this discrepant event was offered.

Investigation by Anderson (1967), however, would lend credence for the expectation that students at the lower level of knowledge

would benefit most from the utilization of a well structured subsuming organizer. He has shown that highly structured programmed lessons facilitate learning more so than programmed lessons with a low degree of structure. Subjects with higher IQ scores appear to suffer less from a reduction of structure, however. Perhaps they are more capable of the mental amendment of such materials with internal structure of their own. If an advance organizer can be seen as promoting structure, its benefits should be realized most by those unable to provide their own--those with less pertinent or discriminable knowledge, for example.

Additional research has further added to this controversy. Grotelueschen and Sjogren (1968) performed experiments to determine the effects of varying the structure of introductory materials and varying the sequence of learning tasks. They hypothesized that the degree of structure possessed by introductory materials and the degree to which the principal learning materials are sequentially arranged are positively related to performance on a related retention test. Subjects were paid adults of "superior intelligence." The topics of the introductory and principal learning materials were over the general concepts of number base systems. Experimental results offered support for the assertion that subjects from this population could have the learning of number base concepts facilitated by introductory material.

> Because the facilitative effects of introductory materials were observed with adults of superior intelligence, it appears that the observed differences between the findings of previous research . . . and the present experiments suggest that the complexity of the learning topic is a variable to consider in ascertaining the extent to which introductory materials facilitate subsequent learning and transfer. Moreover, given a

> complex learning task, those of high ability appear to benefit as much from introductory materials as those of low ability did in a less complex task (Groteluesch en and Sjogren, 1968).

This would suggest that the characteristics of an appropriate organizer may be determined by the nature and level of the learning task and the cognitive development of the learner.

Rothkopf (1970) has performed experiments on the mathemagenic behavior of students. Mathemagenic behavior refers to the behavior of students in a learning situation that is related to the attainment of specified instructional objectives. Basic to mathemagenic theory is the implication that behaviors exhibited by a learner are an important factor determining what is learned. It is not only the stimulus for learning that is important, but also the way a subject perceives and acts on the stimulus.

One important type of mathemagenic behavior studied has been the response to test-like events interspersed with learning materials. These events are usually in the form of questions to which students may or may not be asked to overtly respond. It has been determined that such events can have positive effects (Rothkopf, 1966; Rothkopf and Bisbicos, 1967) or negative effects (Rothkopf and Coke, 1963).

Rothkopf (1966) wanted to determine whether learning from written materials could be facilitated by adjunct, test-like questions; and also whether the position of said questions within the materials would be important. This study was particularly interested in the general facilitative effects as opposed to the effects on specific facts and concepts referred to by the adjunct questions. Therefore, the 25 item criterion test contained no items directly referred to by any of the 14 test-like questions used. Experimental treatments

differed mainly in the position of the questions within the written sequence. In one group prior to the learning passage, the subjects were given all 14 questions at once, directed to attempt an appropriate response, and then given the correct answer. For a second group associated questions were placed just prior to the beginning of each section of the material. Subjects were instructed to make a written guess at each question and were then given an appropriate correct answer. A third group was identical to the second except that correct answers were not provided. The fourth and fifth groups were similar to the second and third respectively, except that the questions came immediately after each section instead of before it. A control group received the written material with no interspersed questions. Since no specific transfer existed between the experimental questions and the general test, any significant gains of experimental groups over the control would be attributed to a "set-like factor" rather than to any instructional consequence brought about by the questions. A second criterion test relating specifically to the experimental questions was also given.

Results on the general test indicated that only those groups receiving experimental questions after the reading of relevant material realized any benefit from them. Their scores were significantly higher regardless of whether or not answers were supplied. Groups receiving questions before the written material scored significantly higher only on the question-specific test. These findings indicate that adjunct, test-like questions alone would not be effective advance organizers.

The failure associated with using pre-questions probably is due to their facilitative results being too question-specific. That is,

their effectiveness as a subsuming entity applies only to facts and concepts related directly to those questions. Even these apparent benefits may be detrimental in the long run. It would seem that a subject "keying" on specific test-like items (especially if he suspects that they will later appear on a test) would be more inclined to commit such items to rote memory for test taking purposes rather than to permit their cognitive subsumption--relating them to existing concepts in cognitive structure. Positive results are gained in the short run, but such material not subsumed into cognitive structure is likely soon forgotten. It is also possible that important concepts not mentioned by the adjunct questions would be totally ignored, since the subjects would be motivated to find clues to help answer the specified questions.

In Ausubellian terminology pre-questions are specific instead of general, refer to a specific example instead of a concept, and are exclusive rather than inclusive. All of this, of course, violates the limitations placed on advance organizers by Ausubel, and so the experimental results should not be surprising. Rothkopf's work is in general agreement with Ausubel's theories, and this experiment does not refute the concept of advance organizers. Interspersed pre-questions are not advance organizers but interspersed post-questions may serve as reinforcing agents for newly subsumed concepts or a motivating force that encourages students to comprehend learning material in a general manner (in anticipation of questions which could be from any part of the material).

The use of Ausubel's theory, or Rothkopf's, is an attempt to control student response in such a manner that would prompt the

mobilization of relevant concepts embedded in cognitive structure to facilitate the subsumption of related new concepts. If new material is perceived as unrelated to previously acquired concepts it may immediately serve as a negative motivating force. Material at a level perceived as impossible to acquire will usually not be acquired. If an advance organizer can solicit the necessary concepts, the learning task may appear more within the realm of a possible achievement.

Bayuk et al. (1970) combined Ausubel's concept of advance organizers with Rothkopf's concept of interspersing test-like events within the learning material. Two forms of advance organizers were utilized. One consisted of eight declarative sentences in outline form. The second type of advance organizer used eight test-like questions covering the same concepts found in the declarative sentence organizer and in exactly the same order. The authors hypothesized that the question-type organizer would facilitate learning to a greater extent than would the declarative sentence organizer.

The subjects were high school seniors and were stratified across groups according to their general academic ability level (high, medium, or low). The criterion measure was administered immediately after the instructional and organizer materials were collected. Questions on the test were not specifically related to anything presented in the advance organizers.

Of several factors investigated in this experiment (most of them are irrelevant to the present study and not reported in this review) significant differences were found only in one area of interaction. The declarative-sentence organizer appeared to be significantly more

facilitative than the question-mode organizer for the low-ability group only. No control group was utilized so it is not possible to say whether either type of advance organizer was more effective than none at all.

One must be cautious in drawing definitive conclusions from this investigation. The declarative sentence advance organizers were used and tested in the Ausubellian manner, but some important differences should be noted. Ausubel's advance organizers have generally been in prose or paragraph form incorporating a continuous dialogue and concepts arranged in some logical form. They also include highly inclusive concepts for the facilitation of the subsumption of more specific concepts and factual material. The organizing sentences in this study, however, contain conceptual material at essentially the same level of inclusiveness as that found within the principal learning passage along with definitions and specific facts. The authors concede that, "This alone may account for the lack of significant differences between treatments." This explanation is questionable however, since essentially the same information was included in all of the different treatments. Since there were no control groups, this aspect cannot be explained. The question-type organizers were not specifically related to criterion measures. Rothkopf (1966) has previously found that test-like questions produced facilitative results only for the specific questions used. If this is true, such questions may have negative effects for other facts and concepts within the learning passage due to test-wise subjects who concentrate on the questions previously presented and tend to ignore other ideas.

Frase (1970) has conducted considerable research in hope of determining how test-like events affect learning. He has proposed that various factors acting jointly determine learning success; they include the learner's motivational state, properties of textual materials as well as various modes of test-like occurrences (mathemagenic characteristics). He neglected to include existing cognitive structure. Post-questions are advocated, especially immediately following short passages. Pre-passage events are also seen as valuable if properly controlled. Simply informing the learner of the textual structure has been shown to increase recall. The use of pre-questions is explained as having only limited value. If the goal is short term retention, then pre-questions relating specifically to terminal subject behavior are shown to be effective. General facilitation is not common, however. Perhaps this is because pre-questions--at the time they are introduced--do not always relate to existing cognitive structure. Therefore, they could not function as subsumers because they would mobilize nothing in cognitive structure. This would force the individual to commit them to a rote memory exercise if any benefit at all is to be realized from them. Post-questions, on the other hand, would have some basis for subsuming qualities. If the passage itself was related to concepts previously attained, post-questions could further provide specific manipulative experiences with newly experienced concepts or facts.

Another more recent research project has sought to assess the effect of advance organizers containing higher order questions. The experimenter was interested in empirically testing the suggestion of Sanders (1966) that:

> . . . questions which demand cognitive processing above the level of mere factual recall will, through practice, develop intellectual skills and will not result in poorer learning of factual information (Allen, 1970).

Allen believed that the effects of advance organizers could be increased by the incorporation of such questions.

The materials used were social studies lessons prepared for the use of ninth grade students who typically experience difficulty learning from written exercises prepared at their own grade level. The subjects were 212 ninth graders from two junior high schools described as ". . . in an area of lower socioeconomic status . . . ." Subjects were stratified across groups as at the 60th percentile or above and between the 20th and 59th percentile on the Lorge Thorndike Verbal Intelligence Test. One experimental group received a written advance organizer which contained high order questions. These questions were designed to require students to consider given factual information pertinent to the memory question to which they were related. The other experimental group received a written advance organizer that included memory level questions. For each experimental group there was a control group that received advance non-organizers.

The written learning materials required four consecutive class periods (four days) for administration. Appropriate highly structured tests (consisting of five subtests each) were administered on the fifth day and again three weeks later.

No differences were found on the first retention test that could be claimed as due to the effects of advance organizers. On the delayed retention test, advance organizers seemed to facilitate retention for the higher ability students--perhaps by providing resistance to

forgetting--but not for those below the 60th percentile.

Again there is evidence that different categories of subjects do not benefit equally from the same advance organizer.

> While both categories of students may use hierarchically structured concepts as subsumers for new learning the less able students may utilize more concrete, specific, and less generalizable organizers. This is a reasonable expectation since the organizers can only be usable if they relate directly to existing cognitive structure (Allen, 1970).

Allen (1970) further speculates that students with different abilities may differ in the manner in which useful information is arranged in cognitive structure, and therefore different qualities are required of potential advance organizers if facilitation is to be realized in each case. For example, this research offers support for conjecturing that in a specific case it is possible that students of higher abilities for verbal learning would benefit most from prudently structured organizing subsumers; while lower ability students would realize more effective cognitive organization from sets of advance questions. This might account for the observation that the less able students appeared to have gained most from the advance organizers on areas of the tests related to specific questions found in the organizers; while the more able students appeared to gain more on more general portions of the tests.

Summary

The subsumption theory within cognitive psychology is clearly in its infancy. It is, of course, a model of the meaningful learning process, and its usefulness as such depends on its demonstrated ability to subsist in the face of empirical research. The careful

construction and use of advance organizers is an example of this abstract theory being applied to concrete practice. The testing of the effectiveness of the same will, hopefully, lend credence to or force the modification or rejection of subsumption theory.

As a theory put into practice, advance organizers have much to offer science education. The past fifteen years have witnessed a deluge of new science programs at every conceivable scholastic level. Large sums of money--much of it from public sources--have been spent in the development, promotion, and distribution of many new approaches to the study of science. If learning is shown to be affected by the type of introductory materials used, it would seem appropriate to structure written lead-in or suggested teacher centered introductions in the manner that is shown most effective. There is also something intuitively logical about the advance organizer concept; it allows a more gradual integration of new material into cognitive structure. In other words, it is a less formidable first step to take.

Programs such as The Man-Made World (TMMW) or the developing Technology---People---Environment (TPE), which are utilized in this investigation, are especially likely to benefit from appropriate organizers. The concepts utilized therein are, for the most part, foreign to a high school population. Concepts such as optimization, decision-making, systems, feedback, and stability--at the very heart of these programs--are seldom encountered elsewhere in a high school setting. The inherent unfamiliarity of these concepts suggests that the exposure to specially prepared subsumers would be particularly valuable. According to one of the developers of TPE (Dr. Tom Liao,

State University of New York, Stoney Brook) consideration is being given to the use of specially prepared introductory mini-films for some activities. Information that would suggest how this could best be accomplished would be valuable for those involved. The alien nature of these concepts also makes them ideal for the testing of advance organizers where the criterion of unfamiliarity is so vital (Ausubel and Fitzgerald, 1961).

Obviously there is much left to be substantiated where the concept of advance organizers is concerned. Of seventeen reported experimental cases investigated by the present researcher where material was tested as advance organizers, only eight (47 per cent) were able to indicate significant facilitation of learning within the .05 level of confidence. Casual consideration might lead an observer to the conclusion that the other nine (53 per cent) indicate serious doubt about the credibility of the advance organizer concept. This is one facit that makes the investigation of advance organizers an attractive research topic even though the concept has been scrutinized for over a decade; it is still a very controversial and unsettled issue. The present researcher sees reason to suspect the credibility of many introductory materials that have been tested as advance organizers. Attention needs to be given to the question of what does (and does not) constitute an advance organizer. It must solicit (from cognitive structure) pertinent, anchoring concepts, around which new material may be subsumed, but how can one determine whether a given bit of introductory material is capable of promoting such activity?

If advance organizers are to be useful, their developers and users need to know exactly what they are and whom they are for.

Ausubel (1963) has described advance organizers as introductory materials that are more abstract, general, and inclusive than the upcoming learning task. As was noted by Clawson and Barnes (1972), the concept is vague because no functional definition or explicit example is included. This may have had desirable effects, however, since ensuing investigations of a wide variety of potential organizers may help with the formation of a more precise definition. Many experiments employing organizational introductions that have failed to facilitate learning actually add support to Ausubel's subsumption theory because of their failure (Bayuk et al., 1970; Allen, 1970; Bertou et al., 1972; Clawson and Barnes, 1972; Graber et al., 1972). Ausubel (1960) did caution that appropriate advance organizers must be close to the learning task in the level of conceptualization, and that the degree of inclusiveness must be related to the learner's cognitive experience. By doing so, he demonstrated his awareness of this situation without passing judgment on experimenters who would see value in investigating somewhat deviant materials. If appropriately and carefully constructed, advance organizers should aid the process of meaningful learning including the subsumption of new concepts and long-term retention (Allen, 1970; Ausubel and Fitzgerald, 1961).

Who should be expected to benefit from the presence of appropriate advance organizers? At this point experimental evidence would seem to be contradictory. Some evidence indicates that adults of "superior intelligence" benefit from introductory organizers (Grotelueschen and Sjogren, 1968). Other evidence indicates that subjects with low verbal ability or a low level of knowledge of related concepts benefit most; while the same introductory organizers offer no significant

advantage for subjects with high verbal ability or a high level of knowledge of related concepts (Ausubel, 1960; Ausubel and Fitzgerald, 1961, 1962). Still other evidence suggests equal positive facilitation for all levels of related knowledge (Ausubel and Youssef, 1963). A postulation by Grotelueschen and Sjogren (1968) may come close to a likely explanation. Overgeneralizing can be misleading. By defining an advance organizer only as more general, more abstract, and more inclusive than the principal learning material, it is possible to present a wide variety of introductory passages as advance organizers. Perhaps it is essential to know something about the subject's ability, cognitive style and motivational preferences. Perhaps the complexity of the learning materials would determine the make-up of an effective organizer. Likely, both of the above are important and may have considerable interaction effects. For example, assume there are two subject groups. Group I is characterized by a relatively high ability for verbal learning, a generally successful academic background and has met with past success in abstract mathematics. Group II is characterized by a low adaption to verbal learning, frequent academic failure and only a very basic mathematical background. It is highly possible that either group could realize success at learning the same concept. However, the most efficient method for relating the concept to Group I would probably meet with little success with Group II. Group I would probably have success at an abstract level using previously subsumed mathematical principles as a basis for internal structure. It is unlikely that this approach with Group II would be successful. More concrete experiences would be more appropriate. If this is an acceptable assumption, then it should

follow that an advance organizer acceptable for Group I probably would be of little value to students in Group II. The same organizer applied to Group II would still fit the general criterion of the advance organizer. It could still be--as Ausubel (1963) has suggested--abstract, very general in nature, and highly inclusive. But thus applied, the organizer would demonstrate little value; it would be too abstract, too general, and too inclusive. The spatial distance between existing cognitive structure and the organizer would be so great as to provide only negative motivation. The new concept could be perceived as something unreachable by the students involved since it is unlikely to "mobilize" any conceptual framework at the student's command.

What would happen then, if the situation were reversed? A suitable advance organizer for Group II students would likely make reference to more commonly encountered concrete examples. Such an organizer--properly constructed--could relate to cognitive structure and enhance the learning and retention of more specific related activities for Group II students. What would it do, then, for Group I students in preparation of a more abstract learning activity on the same subject. If so constructed it could stimulate interest, and, therefore, provide some positive motivation; but it is unlikely to provide any anchoring foci around which new concepts could be subsumed that would not have been internally structured by the student in the course of the principal learning activity.

The most significant collective point of the preceding review of the literature is that a specific organizer can help a specific group perform a specific learning task and has therefore produced a

harmonious link between some element of cognitive structure (characteristic of the group) and some unfamiliar new learning material. An advance organizer, it is then proposed, can help any group if the new material represents a substantial (but not overwhelming) gain in knowledge or a significant addition to the conceptual structure of a substantial number of individuals within the group. If the upper one-third in Ausubel and Fitzgerald (1961), for example, had been presented with a more challenging, in-depth learning task, preceded by a more appropriate advance organizer, they may have realized as much benefit as the lower group.

The following model is proposed to illustrate the situation. A continuum might be imagined that is labeled "concrete preferences" and "low level of associated knowledge" at one end and "abstract preferences" and "high level of associated knowledge" at the other. A learner's position on the continuum would be determined by the interaction of the two factors. If the learner may be located at "h" and the learning task at "i" or "j" then it should be possible to utilize a properly constructed advance organizer to mobilize relevant concepts in cognitive structure and provide stable anchoring foci for the subsumption of new material. If the learning task is at "f" or "g" (or lower), then the learner should be able to provide his own subsumers and would realize few, if any, benefits from advance organizers. If the learning task is located at "m" or "n", it is unlikely that an organizer could be produced that could solicit necessary concepts from cognitive structure and at the same time relate to the learning task.

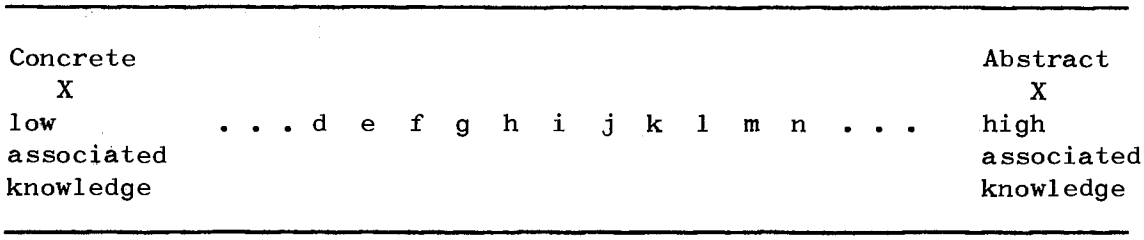

Figure 1. Model for Appropriate Advance Organizers

For the purpose of this study, proper advance organizers are viewed as more than just highly generalized, abstract, and inclusive introductory materials. They are also treated as topic specific, level specific, and learner specific. This does not imply an experience with "individualized" learning techniques; but the populations from which student subjects were selected are known to be of much different scholastic backgrounds and demonstrated achievement levels, while at the same time studying many of the same concepts.

Previous research has been directed on a large scale toward the following problems:

1. Can advance organizers facilitate learning and retention?
2. Are groups of differing ability or level affected differentiably by advance organizers?
3. How do the effects of advance organizers compare with other methods of structuring learning?

The present study is an attempt to determine if the learning of a single concept presented at appropriate levels to two groups of differing abilities can be facilitated by different advance organizers

for both groups. The organizers have been constructed with reference to the cognitive make-up of the differing groups and reference to the materials used in the respective learning situations.

CHAPTER III

METHODOLOGY AND DESIGN

Introduction

The purpose of this study was to determine the following: if two groups of students, differing in ability to learn classroom material, are about to undertake separate learning exercises involving the same general concept, can a different advance organizer be prepared for each group that would (1) facilitate the learning and retention of the group for which it is prepared, and (2) be selectively facilitative for the group for which it was prepared?

Null Hypotheses

The null hypotheses tested are as follows:

1. For abstract level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the advance non-organizer.

2. For abstract level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the concrete advance organizer.

3. For abstract level students there will be no significant difference in performance test scores between those who receive the concrete advance organizer and those who receive the advance non-organizer.

4. For concrete level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the advance non-organizer.

5. For concrete level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the concrete advance organizer.

6. For concrete level students there will be no significant difference in performance test scores between those who receive the concrete advance organizer and those who receive the advance non-organizer.

The null hypotheses were tested once with performance test scores and again using retention test scores.

Organismic Variable

The organismic variable for this experiment consists of two categories of students referred to as abstract subjects and concrete subjects. All of the subjects were non-science majors in either the tenth or eleventh grade. Placement into one category or the other was previously decided by the school district in the metropolitan area where the students attend high school. Placement was determined by the students' relative level of previous academic success and

performance scores on the Iowa Test of Basic Skills.

Abstract level students were enrolled in The Man-Made World (TMMW). This course was originally developed to help fulfill the needs of college bound high school non-science majors. The content of TMMW is centered on concepts that would increase the students' technological literacy. The course utilizes mathematics and abstract models of social systems, and students are generally required to have completed at least one year of algebra. For the purpose of this experiment, TMMW students may be referred to as operating at a more abstract level than Technology---People---Environment (TPE) students.

Concrete level subjects were enrolled in the TPE course. This course was developed for use with high school non-science majors who are not accustomed to academic success. As a group these students are characterized as poor readers, reading much below their grade level, and as having exposure to only basic mathematics. Students must fall into this category before being admitted into the TPE program. Essentially the same concepts are taught in the TPE course as in TMMW, but classroom experiences for TPE students are much more concrete as very little reading is required and mathematics is of a very basic nature. For the purpose of this experiment, TPE students may be referred to as operating at a more concrete level than TMMW students.

Independent Variables

The independent variables are referred to as an abstract advance organizer, a concrete advance organizer, and an advance non-organizer. All were introductions to the study of the concept "feedback." All were tape/slide presentations between eight and nine minutes long

(Transcripts in Appendix B). Written advance organizers were not used for a number of reasons. They are overwhelmingly the most tried and tested type of subsumer. Even so, they seldom could be described as representing a typical classroom situation. In addition, TPE students are generally very poor readers who would not receive maximum benefits from written organizers. TMMW students are generally adequate readers, but to use written introductions with them and tape/slide presentations with TPE students would have introduced undesirable confounding variables into the study. Each organizer was prepared and recorded by the experimenter who has had four years of association with various TMMW projects. Photographic work was also done by the experimenter.

The abstract advance organizer began with a short review of the systems approach to modeling a problem and made reference to an example previously used in the TMMW text. This was an attempt to help the student mobilize from cognitive structure the important relevant concepts used with the systems approach. Next, feedback was introduced as an additional element in systems analysis that would alter the function of a system. This was followed with a mathematical definition of feedback and an explanation of how feedback changes the mathematics of systems analysis. The abstract organizer ended with a technical example of how feedback is utilized in the operation of a modern electrical power plant.

The concrete advance organizer also began with a review of the systems approach to modeling problems. Knowledge of systems analysis is important to the understanding of feedback at any level and was also a part of previous undertakings in the TPE course. A much simpler example model was used, however, and more time was devoted

to explaining the integration of feedback into the systems approach. Mathematics was not used; instead more time was devoted to how the components of feedback affect a system's goal. The concrete organizer ended with two relatively simple examples of how feedback is used: one referred to the thermostatic control of a home heating system and the other referred to how a child uses feedback to keep a tricycle aimed in a straight path.

The advance non-organizer was used as a placebo treatment for the experimental control group. It was believed that this group had to experience some introduction so that any benefits realized by the experimental groups could not be attributed to the mere presence of treatment rather than from organizational characteristics of the introduction. The non-organizer contained general references to past experiences in the course but avoided relating them in any way to feedback. Reference was made to feedback and to examples of systems that utilize feedback, but no mention was made of the conceptual make-up of feedback, how it is utilized, or anything else of a substantive nature.

It was imperative that none of the introductory experiences alone could give a test-taking advantage to those receiving it. To demonstrate this empirically advance organizer control groups were employed. They were groups of subjects similar to the experimental subjects who were given the organizers alone (with no ensuing learning experience) followed by the performance test. A fourth group of subjects received no introductory experience at all--only the performance test. By comparing the performance test scores of these four groups it could be demonstrated that no experimental group enjoyed the advantage of test

answers being indicated by a specific organizer.

Testing Instruments

The dependent variable was test scores on a 19 item multiple-choice criterion test with five possible answers per item (Appendix C). The first nine items were experimenter-prepared and related directly to testing specific objectives of the TPE program. These objectives are primarily concerned with the relationships of feedback with communication skills. The last 10 items were taken from a TMMW standardized test (with some minor modification by the experimenter). These items were related to the testing of specific TMMW objectives and involved mathematical systems analysis and the application of feedback to relatively complicated systems. All items were conceptually oriented to minimize the benefits of rote learning procedures and contained no specific references to anything contained in the advance organizers.

The validity of the criterion test was verified as appropriate for the testing of feedback by a panel of three TMMW teachers and three TPE teachers. The reliability of the criterion test was checked using split-half techniques. Identical criterion tests were used for performance tests and later for retention tests.

Research Design

Five TPE classes were available in one high school district to provide the concrete level subjects. Three of these classes were randomly selected to serve as experimental groups. The remaining two classes were designated as advance organizer control groups.

One of the advance organizer control group classes was randomly selected to receive advance organizers followed by the performance test (with no learning experience between the two). This class was randomly divided into three groups. Each group was randomly assigned to receive either the abstract advance organizer, the concrete advance organizer, or the advance non-organizer. The purpose of these groups was to show that none of the organizers alone (without the ensuing learning experience) gave an advantage to subjects taking the performance test.

The remaining advance organizer control group class was given no advance organizers and no learning experience on the concept of feedback. They received only the performance test. The purpose of this group was for comparison with the other advance organizer control group class to show that none of the introductory experiences alone allowed subjects to score higher on the performance test than they would have without the introductory experience.

Subjects in each of the experimental classes were randomly divided into three groups. Each of these groups was randomly assigned to receive either the abstract advance organizer, the concrete advance organizer, or the advance non-organizer; the latter group was the experimental control group. Following the administration of organizers, subjects were given the principal learning experiences on the concept of feedback before receiving the performance test. The purpose of these groups was to compare the facilitative effects of the various introductory experiences. These subjects were also given a retention test to determine if comparative facilitative effects would subsist with passing time.

Four TMMW classes were available to provide abstract level students for the experiment. Two were being taught by one teacher and the other two were being taught by a second teacher in another city. For the convenience of the teachers involved it was decided that one would provide all of the experimental subjects and the other would provide all of the advance organizer control subjects. Next a random selection was made to determine which teacher would provide experimental subjects and which would provide control subjects.

The abstract subject groups then received the same treatment as their concrete group counterparts. Subjects from the experimental group classes were randomly selected to receive one of the three advance organizers. Following this they received the feedback learning experience, the performance test, and the retention test. Subjects from one advance organizer control group class were randomly selected to receive one of the three advance organizers followed by the performance test. The remaining control group class received only the performance test.

Experimental Procedure

Each of the experimental classes followed a similar procedure. On a Thursday at the beginning of the class period, students were told that introductions had been developed for parts of the course and that they would receive one such introduction before studying feedback. They were also told that the developers of the introduction believed they were most effective when given to small groups. Each student was then directed to go to one of three rooms where the advance organizers were administered. Students were not informed whether or

not they were receiving equivalent treatments. No opportunity was given for discussion either before or after the advance organizer. After the administration of advance organizers, the class reassembled. For the rest of that class period--and during class the following Friday, Monday, and Tuesday--the class received instruction and participated in activities related to the concept of feedback. On Wednesday they received the performance test which was not previously announced. The subjects were not allowed to see the test results and had no opportunity to discuss the test. Three weeks later they received the retention test (also unannounced) which was identical to the performance test.

Teachers of the experimental classes were instructed to follow the same instructional procedure that would have been used if the advance organizers had never been given. They were also cautioned not to refer to any part of any organizer during the teaching procedure. If, during class discussions, a student referred to content from an organizer, the teacher was directed to acknowledge the appropriateness of the student's comment, but not to elaborate on it or promote further discussion of it. It was felt that this was necessary in order to minimize the effect of students from one experimental group benefitting from the organizing experience of those from another group.

The procedure for the advance organizer control groups receiving advance organizers was identical to that for the experimental groups except that subjects received no instructional activities on the concept of feedback prior to taking the performance test. Teachers of these groups were cautioned not to refer to or otherwise use the

concept of feedback prior to the administration of the performance test.

The procedure for the advance organizer control groups who received only the performance test was to simply administer the test without previously referring to the concept of feedback.

Statistical Analysis

For the advance organizer control groups, performance test scores were subjected to a 4 x 2 factorial analysis of variance (ANOVA). The independent variables were (1) abstract advance organizer, (2) concrete advance organizer, (3) advance non-organizer, and (4) no introductory experience. The organismic variables were (1) abstract level subjects and (2) concrete level subjects.

For the experimental groups, performance test scores--and later the retention test scores--were subjected to a 3 x 2 factorial ANOVA. The independent variables were (1) abstract advance organizer, (2) concrete advance organizer, and (3) advance non-organizer. The organismic variables were (1) abstract level subjects and (2) concrete level subjects. When a significant F was indicated, a separate 3 x 1 simple ANOVA was performed for each of the organismic variables.

CHAPTER IV

INTERPRETATION OF THE STATISTICAL ANALYSIS

Introduction

The following statistical analysis is divided into four main areas. First correlation coefficients were determined for the criterion test so that a measure of reliability could be determined. Next the advance organizers were tested to determine that specific organizers alone (without the principal learning material) did not pose a test-taking advantage. Then analysis of variance (ANOVA) techniques were utilized to determine the results of performance test scores; in this part of the statistical analysis, the null hypotheses advanced in Chapter III were tested. In the final area of analysis, the null hypotheses were tested with respect to the retention test scores in a manner similar to that employed for the performance test scores.

Criterion Test

Since the same criterion test was to be administered to two diverse groups of subjects, two separate split-half reliability tests were performed. Twenty-one subjects similar to the experimental abstract groups and 16 subjects similar to the experimental concrete groups provided the necessary data. In each case the criterion test

was administered to subjects without prior exposure to learning materials on the concept of feedback or to any of the introductory materials.

For the abstract subject test scores, a Pearson product-moment correlation coefficient was computed on the split-half scores and found to be $\underline{r} = .58$ (Spence et al., 1968, pp. 116-120). Correcting for the shortened form caused by the split-half procedure yielded a correlation coefficient of $\underline{r} = .73$ (Ebel, 1965, pp. 314-315). The same procedure followed for the concrete subjects yielded a correlation coefficient of $\underline{r} = .55$ which was corrected to $\underline{r} = .71$.

Advance Organizer Control Test

Advance organizer control groups were utilized to demonstrate that none of the advance organizers alone, without the principal learning experience, would give subjects a significant advantage over those who received no introductory experience. The results are shown in Table I.

TABLE I

PERFORMANCE TEST RESULTS FOR ADVANCE ORGANIZER CONTROL GROUPS

Subjects	Statistic	Abstract Organizer	Concrete Organizer	Advance Non-Organizer	No Organizer
Abstract Subjects	$\overline{X}$	8.33	8.00	7.14	7.10
	sd	3.04	2.75	2.41	2.17
	N	9	10	7	21
Concrete Subjects	$\overline{X}$	6.63	6.33	6.57	6.38
	sd	2.50	3.72	2.23	2.42
	N	8	6	7	16

A 4 x 2 factorial ANOVA was performed as shown in Table II. As anticipated, no significant differences are indicated at the .05 level of confidence for any of the treatment groups and no significant interaction is indicated. The only F-ratio approaching significance is the test between rows (F = 3.67) with a critical value (CV) of 4.00. This statistic is not crucial since it indicates only the difference that would be anticipated between the organismic variables (abstract subjects and concrete subjects). Simple ANOVA's were not computed since interaction effects were not indicated.

TABLE II

F TEST RESULTS FOR ADVANCE ORGANIZER CONTROL GROUPS

Source	df	SS	MS	F Ratio	p	Critical Value
Rows	1	24.23	24.23	3.67	$< .05$	4.00
Columns	3	5.94	1.98	0.30	$< .05$	2.76
Interaction	3	4.88	1.63	0.25	$< .05$	2.76
Within Cells	76	501.34	6.60			

Experimental Groups Performance Test Analysis

The results of the performance test scores are shown in Table III. Casual observation of this table indicates trends that would support the model earlier suggested in Figure 1. Abstract subjects who

received the abstract advance organizer tallied an average of 2.60 raw score points more than those receiving the advance non-organizer and 3.00 more than those receiving the concrete organizer. Concrete subjects who received the concrete advance organizer tallied an average of 1.68 raw score points more than those receiving the advance non-organizer and 3.15 more than those receiving the abstract advance organizer.

TABLE III

PERFORMANCE TEST RESULTS FOR EXPERIMENTAL GROUPS

Subjects	Statistic	Abstract Organizer	Concrete Organizer	Advance Non-Organizer
Abstract Subjects	$\bar{X}$	14.47	11.47	11.87
	sd	1.92	1.92	2.36
	N	15	15	15
Concrete Subjects	$\bar{X}$	8.20	11.35	9.67
	sd	2.33	2.47	2.58
	N	20	17	15

A 3 x 2 factorial ANOVA was performed as is shown in Table IV. The significant F-ratio indicated between rows ($p < .001$) may be attributed to the difference that would be expected between organismic variables. The non-significant F-ratio indicated between columns ($p < .05$) was also anticipated since this statistic was computed using

test scores from both of the organismic variables.

TABLE IV

F TEST RESULTS FOR PERFORMANCE TEST SCORES

Source	df	SS	MS	F Ratio		Critical Value
Rows	1	196.07	196.07	37.51	<.001	11.97
Columns	2	7.89	3.95	0.76	<.05	3.15
Interaction	2	156.47	78.23	14.97***	<.001	7.76
Within Cells	91	475.63	5.23			

The most important F-ratio is that computed for interaction effects which indicates a high level of significance ($p < .001$). This is evidence that the abstract subjects and the concrete subjects were affected differentiably by the various introductory experiences. This quality is graphically illustrated by Figure 2. The concrete organizer appears to have about the same point-total effect on the abstract subjects as the non-organizer. A slight advantage is indicated for concrete subjects receiving the concrete organizer over those receiving the non-organizer, however. Abstract subjects receiving the abstract organizer seem to have enjoyed a considerable advantage over those receiving the other introductions. For the concrete subjects, however, the abstract organizer appears to have been less facilitative than the concrete organizer or even the non-organizer.

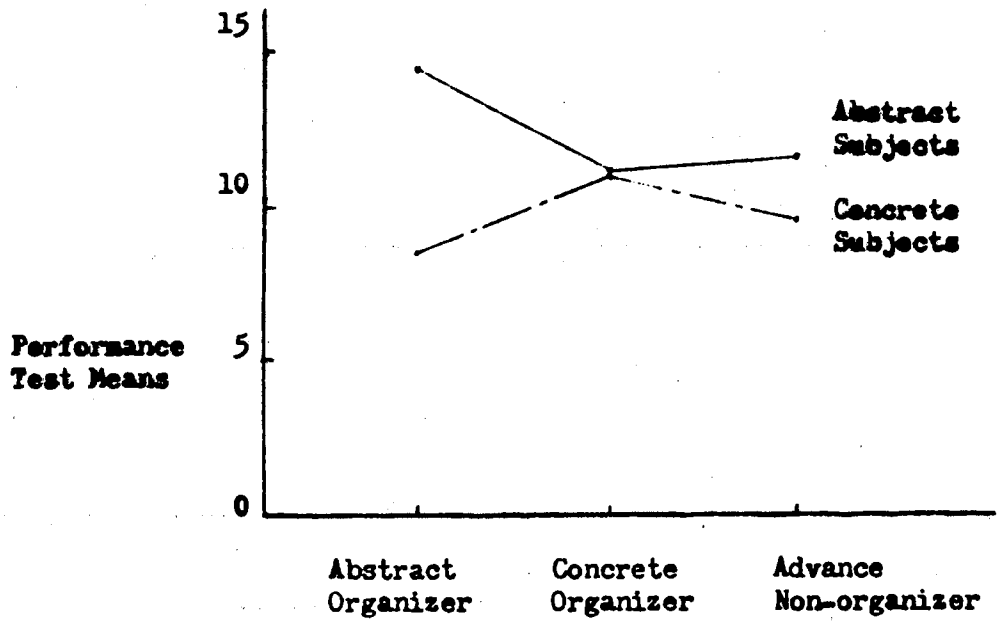

Figure 2. Illustration of Interaction for Performance Test Scores

To indicate the significance of the effects of the various introductions on the abstract subjects, a 3 x 1 simple ANOVA was performed on their performance test scores. The results are shown in Table V. Since a significant F-ratio was indicated ($p < .001$) a Scheffe test for multiple comparisons was performed to determine the source(s) of the significance. The results are shown in Table VI.

TABLE V

F TEST RESULTS FOR ABSTRACT SUBJECTS' PERFORMANCE TEST SCORES

Sources	df	SS	MS	F-Ratio	p	Critical Value
Between Groups	2	79.60	39.80	9.22***	< .001	8.25
Within Groups	42	181.20	4.31			
Total	44	260.80				

TABLE VI

SCHEFFE TEST RESULTS FOR ABSTRACT SUBJECTS' PERFORMANCE TEST SCORES

Organizers Compared	F-Ratio	p	Critical Value
Abstract / Non	5.88**	< .01	5.18
Abstract / Concrete	7.82**	< .01	5.18
Non / Concrete	0.14	< .05	3.23

Subjects who received the abstract organizer scored significantly higher ($p < .01$) than those who received the non-organizer; therefore, the first null hypothesis could be rejected. Subjects who received

the abstract organizer also scored significantly higher ($p < .01$) than those who received the concrete organizer; therefore, the second null hypothesis could be rejected. The scores of subjects who received the concrete organizer did not vary significantly from the scores of those who received the non-organizer; therefore, the third null hypothesis could not be rejected.

To indicate the significance of the effects of the various introductions on the concrete subjects, a 3 x 1 simple ANOVA was performed on the performance test scores. The results are shown in Table VII.

TABLE VII

F TEST RESULTS FOR CONCRETE SUBJECTS' PERFORMANCE TEST SCORES

Sources	df	SS	MS	F-Ratio	p	Critical Value
Between Groups	2	91.35	45.68	7.60**	<.01	5.18
Within Groups	49	294.42	6.01			
Total	51	385.77				

Since a significant F-ratio was indicated ($p < .01$), a Scheffe test for multiple comparisons was performed to determine the source(s) of the significance. The results are shown in Table VIII. The scores of subjects who received the abstract organizer did not vary

significantly ($p < .05$) from the scores of those who received the non-organizer; therefore, the fourth null hypothesis could not be rejected. Subjects who received the concrete organizer scored significantly higher ($p < .01$) than those who received the abstract organizer; therefore, the fifth null hypothesis could be rejected. The scores of subjects who received the concrete organizer did not vary significantly ($p < .05$) from the scores of those who received the non-organizer; therefore, the sixth null hypothesis could not be rejected.

TABLE VIII

SCHEFFE TEST RESULTS FOR CONCRETE SUBJECTS' PERFORMANCE TEST SCORES

Organizers Compared	F-Ratio	p	Critical Value
Non / Abstract	1.53	$< .05$	3.15
Concrete / Abstract	7.60**	$< .01$	5.18
Concrete / Non	1.89	$< .05$	3.15

Experimental Groups Retention Test Analysis

The results of the retention test scores are shown in Table IX. In each cell, fewer subjects took the retention test than took the

performance test because of experimental mortality. More subjects were lost than would normally be expected at least partially due to a flu epidemic present in much of the country at the time the experiment was performed.

TABLE IX

RETENTION TEST RESULTS

Subjects	Statistic	Abstract Organizer	Concrete Organizer	Advance Non-Organizer
Abstract Subjects	$\bar{X}$	12.79	11.71	11.57
	sd	1.63	2.09	2.85
	N	14	14	14
Concrete Subjects	$\bar{X}$	8.54	11.13	9.17
	sd	3.55	2.88	2.86
	N	13	15	12

Casual observation of Table IX indicates that the trends established by performance test scores continue with the retention test but are generally less pronounced. Abstract subjects who received the abstract organizer tallied an average of 1.22 raw score points more than those receiving the advance non-organizer (compared to 2.60 points more with the performance test scores) and 1.08 more than those

receiving the concrete advance organizer (compared to 3.00). Concrete subjects who received the concrete advance organizer tallied an average of 1.96 raw score points more than those receiving the advance non-organizer (compared to 1.68) and 2.59 more than those receiving the abstract advance organizer (compared to 3.15).

A 3 x 2 factorial ANOVA was performed on the retention test scores; the results are shown in Table X. The significant F-ratio between rows ($p < .001$) was expected and may be attributed to the difference between organismic variables. The non-significant F-ratio ($p < .05$ between columns was also expected since test scores from each of the organismic variables were joined for its computation.

TABLE X

F TEST RESULTS FOR RETENTION TEST SCORES

Source	df	SS	MS	F-Ratio	p	Critical Value
Rows	1	118.58	118.58	16.29	$< .001$	11.97
Columns	2	16.14	8.07	1.11	$< .05$	3.15
Interaction	2	45.69	22.85	3.14	$< .05$	3.15
Within Cells	76	553.28	7.28			

For interaction effects F = 3.14; with df = 2/76, this was almost significant ($p < .05$) using a table with df = 2/60 (CV = 3.15). This marginal significance at the .05 level of confidence was considered evidence that abstract subjects and concrete subjects may be affected

differentiably by the various introductory experiences and worthy of further consideration. A graphic representation is shown by Figure 3. The concrete organizer appears to have about the same effect on the abstract subjects as the non-organizer. For concrete subjects, however, an advantage is indicated for those receiving the concrete organizer over those receiving the other introductions. Abstract subjects receiving the abstract organizer appear to have some advantage over those receiving the other introductions, but concrete subjects receiving the abstract organizer appear to have suffered a disadvantage when compared to those receiving the other introductions.

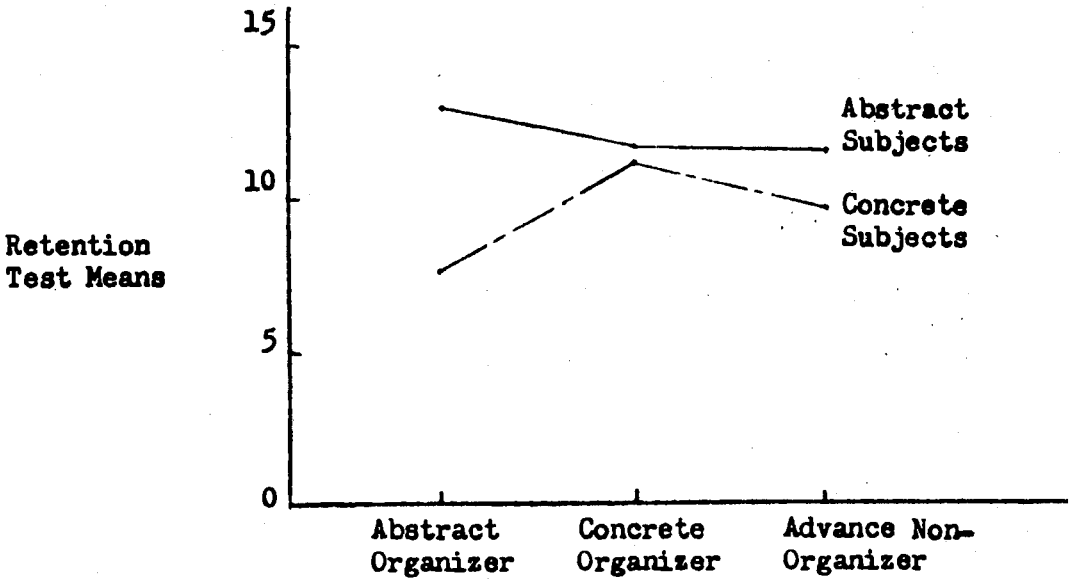

Figure 3. Illustration of Interaction for Retention Test Scores

With these trends noted, a 3 x 1 simple ANOVA was computed for the retention test scores of the abstract subjects to determine any significant differences. The results are indicated by Table XI. The resulting F-ration indicates no significant difference ($p < .05$) on retention test scores for abstract subjects receiving different introductory experience. Therefore, with respect to the retention test scores, the first, second, and third null hypotheses could not be rejected.

TABLE XI

F TEST RESULTS FOR ABSTRACT SUBJECTS' RETENTION TEST SCORES

Sources	df	SS	MS	F-Ratio	p	Critical Value
Between Groups	2	12.33	6.17	1.22	<.05	3.32
Within Groups	39	196.64	5.04			
Total	41	208.98				

To indicate the significance of the effects of the various organizers on the concrete subjects, a 3 x 1 simple ANOVA was performed on the retention test scores. The results are shown in Table XII. The resulting F-ratio indicates no significant difference at the .05 level of confidence on the retention test scores for concrete subjects receiving different introductory experiences.

TABLE XII

F TEST RESULTS FOR CONCRETE SUBJECTS' RETENTION TEST SCORES

Sources	df	SS	MS	F-Ratio	p	Critical Value
Between Groups	2	51.77	25.88	2.69	<.05	3.32
Within Groups	37	356.63	9.64			
Total	39	408.40				

Since the F-ratio of 2.69 would have been significant at the .10 level of confidence (CV =2.49, df = 2/30), a Scheffe test for multiple comparisons was performed to determine any source (and associated level) of significance. The results are shown in Table XIII. The scores of subjects who received the abstract organizer did not vary significantly ($p < .05$) from the scores of those who received the non-organizer; therefore, the fourth null hypothesis could not be rejected. The scores of subjects who received the concrete organizer were not significantly higher ($p < .05$) than those of subjects who received the abstract organizer; therefore, the fifth null hypothesis could not be rejected. The scores of subjects who received the concrete organizer were not significantly higher ($p < .05$) than those of subjects who received the non-organizer; therefore, the sixth null hypothesis could not be rejected.

TABLE XIII

SCHEFFE TEST RESULTS FOR CONCRETE SUBJECTS' RETENTION TEST SCORES

Organizers Compared	F-Ratio	p	Critical Value
Non / Abstract	0.13	$<.05$	3.32
Concrete / Abstract	2.43	$<.05$	3.32
Concrete / Non	1.34	$<.05$	3.32

With respect to the retention test, none of the six tested null hypotheses could be rejected at the .05 level of confidence. This was consistent with the proposed model for appropriate advance organizers (Figure 1) only for the third and fourth null hypotheses. Although the trends established when testing the null hypotheses with performance test data persisted, only the test of the fifth null hypothesis would have approached rejection at the .10 level of confidence ($F = 2.43$, $df = 2/37$; $CV = 2.49$, $df = 2/30$).

Summary

The present study was undertaken to determine the appropriateness of structuring advance organizers that are level specific--taking into account the learner's cognitive background and demonstrated ability--as well as topic specific. Two advance organizers on the topic of

feedback were therefore prepared. One was designed to facilitate learning for students enrolled in a college preparatory curriculum (abstract subjects), and the other was designed to facilitate learning for students enrolled in a basic curriculum who typically experience difficulty learning via written materials or mathematics (concrete subjects). The abstract advance organizer was administered to a randomly selected group of abstract subjects and to a randomly selected group of concrete subjects. The concrete advance organizer was administered to a randomly selected group of abstract subjects and to a randomly selected group of concrete subjects. To provide control groups, an advance non-organizer was administered to a randomly selected group of abstract subjects and to a randomly selected group of concrete subjects.

The preceding statistical analysis was performed to test the six null hypotheses advanced at the beginning of Chapter III. If maximum support for the suggested model of appropriate advance organizers (Figure 1) was to be gained, it was necessary that hypotheses 1, 2, 5, and 6 be rejected, and hypotheses 3 and 4 not be rejected. In the following paragraphs the status of each hypothesis is summarized as suggested by the statistical analysis. In each case the hypothesis is stated, evidence for or against rejection as indicated by performance test scores given, and evidence for or against rejection as indicated by the retention test scores given.

Hypothesis 1

For abstract level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the advance non-organizer.

Table VI indicates an F-ratio of 5.88 (df = 2/42) and a critical value of 5.18 ($p < .01$, df = 2/40). Therefore, with respect to the performance test, this hypothesis may be rejected at the .01 level of confidence giving an element of support for the model proposed by this study.

Table XI indicates an F-ratio of 1.22, df = 2/39 and a critical value of 3.32 ($p < .05$, df = 2/30). Therefore, with respect to the retention test, this hypothesis may not be rejected at the .05 level of confidence denying an element of support for the model proposed by this study.

Hypothesis 2

For abstract level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the concrete advance organizer.

Table VI indicates an F-ratio of 7.82 (df = 2/42) and a critical value of 5.18 ($p < .01$, df = 2/40). With respect to the performance test, this hypothesis may be rejected at the .01 level of confidence giving an element of support for the proposed model.

Table XI indicates an F-ratio of 1.22, df = 2/39 and a critical value of 3.32 ($p < .05$, df = 2/30). With respect to the retention test, this hypothesis may not be rejected at the .05 level of

confidence denying an element of support for the proposed model.

Hypothesis 3

For abstract level students there will be no significant difference in performance test scores between those who receive the concrete advance organizer and those who receive the advance non-organizer.

Table VI indicates an F-ratio of 0.14 (df = 2/42) and a critical value of 3.23 ($p<.05$, df = 2/40). With respect to the performance test, this hypothesis may not be rejected suggesting an element of support for the proposed model.

Table XI indicates an F-ratio of 1.22, df = 2/39 and a critical value of 3.32 ($p<.05$, df = 2/30). With respect to the retention test, this hypothesis may not be rejected suggesting an element of support for the proposed model.

Hypothesis 4

For concrete level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the advance non-organizer.

Table VIII indicates an F-ratio of 1.53 (df = 2/49) and a critical value of 3.15 ($p<.05$, df = 2/40). With respect to the performance test, this hypothesis may not be rejected suggesting, therefore, an element of support for the proposed model. The apparent trend toward significant difference may be misleading. As is shown in Table III, concrete subjects who received the abstract organizer actually scored an average of 1.47 points lower than those who received the non-organizer. This evidence of interaction may be viewed as much more

supportive of the proposed model than if the situation were reversed indicating an advantage for those receiving the abstract organizer.

Table XIII indicates an F-ratio of 0.13 (df = 2/37) and a critical value of 3.32 ($p < .05$, df = 2/30). With respect to the retention test, this hypothesis may not be rejected suggesting, therefore, an element of support for the proposed model.

Hypothesis 5

For concrete level students there will be no significant difference in performance test scores between those who receive the abstract advance organizer and those who receive the concrete advance organizer.

Table VIII indicates an F-ratio of 7.60 (df = 2/49) and a critical value of 5.18 ($p < .01$, df = 2/40). With respect to the performance test, this hypothesis may be rejected at the .01 level of confidence giving an element of support for the proposed model.

Table XIII indicates an F-ratio of 2.43 (df = 2/37) and a critical value of 3.32 ($p < .05$, df = 2/30). With respect to the retention test, this hypothesis may not be rejected at the .05 level of confidence denying, therefore, an element of support for the proposed model. Post-hoc investigation indicates that the F-ratio would have been almost significant at the .10 level of confidence (CV = 2.49, df = 2/30).

Hypothesis 6

For concrete level students there will be no significant difference in performance test scores between those who receive the concrete advance organizer and those who receive the advance non-organizer.

Table VIII indicates an F-ratio of 1.89 (df = 2/49) and a critical value of 3.15 ($p < .05$, df = 2/40). With respect to the performance test, this hypothesis may not be rejected at the .05 level of confidence denying, therefore, an element of support for the proposed model.

Table XIII indicates an F-ratio of 1.34 (df = 2/37) and a critical value of 3.32 ($p < .05$, df = 2/30). With respect to the retention test, this hypothesis may not be rejected at the .05 level of confidence denying, therefore, an element of support for the proposed model.

Analysis of Performance Test Scores

Of the six null hypotheses tested by analyzing performance test scores, five were supportive of the model for appropriate advance organizers proposed by the present study at the .05 level of confidence or better. Hypothesis 6, which compared concrete subjects who received the concrete organizer with those who received the non-organizer (F = 1.89, df = 2/49) would have been significant only between the .10 (CV = 2.44) and .25 (CV = 1.44) levels of confidence. An important element of support is suggested by interaction effects significant at the .001 level of confidence. This indicates that abstract and concrete subjects were affected differentiably by organizing experiences as would be predicted by the proposed model.

Analysis of Retention Test Scores

Of the six hypotheses tested by analyzing retention test scores, only two (Hypotheses 3 and 4) were supportive of the proposed model. The other four (all requiring rejection for support) fell short of rejection at the .05 level of confidence. Hypothesis 5, comparing concrete subjects who received the concrete organizer with those who received the abstract organizer, would almost have been rejected at the .10 level of confidence ($F = 2.43$, $df = 2/37$; $CV = 2.49$, $df = 2/30$). Another important element of support is suggested by interaction effects significant at the .05 level of confidence. This indicates that abstract and concrete subjects were affected differentiably by organizing experiences, even though specific tests did not show significant differences.

CHAPTER V

SUMMARY AND CONCLUSIONS

The Problem and Purpose of the Investigation

As was shown in Chapter II, there is considerable controversy over the merits of introductory learning experiences referred to as advance organizers. Ausubel (1963) has described an advance organizer as a brief introduction to a new learning experience that is more general, more abstract, and more inclusive than the principal material to be learned. The learning is made more meaningful because of the organizer in three ways. First, relevant subsuming concepts previously established in cognitive structure are recalled and prepared to accept new material. Second, an optimal anchoring focus is provided around which new ideas are received and made resistant to forgetting. Third, rote learning procedures are made less necessary because students do not have to memorize details before pertinent subsuming concepts are available.

The definition of an advance organizer has remained rather vague with only the principal learning material as a point of reference. Introductory experiences of a variety of descriptions have been tested as advance organizers with varying levels of success. Subsumption theory has also been tested by other modes of organizing experiences such as post organizers, structured procedures, and induced mathemagenic behaviors. The failure of many efforts to show significant

benefits for learners has made subsumption theory a controversial issue. Some of the unsuccessful efforts, upon careful consideration, actually support Ausubel's contentions by virtue of their failure (Allen, 1970; Bayuk et al., 1970; Bertou et al., 1972).

Another point of controversy exists concerning what type of learners actually benefit from the use of advance organizers. Ausubel (1960) and Ausubel and Fitzgerald (1961, 1962) suggest that learners with a low level of associated knowledge or low verbal ability benefit most. Grotelueschen and Sjogren (1968) have submitted evidence that learners of "superior intelligence" benefit from introductory organizers.

The purpose of the present study was to help resolve some of the controversy associated with advance organizers and subsumption theory, and to suggest a more definitive description of an advance organizer. It has been postulated, therefore, that advance organizers as described by Ausubel can be prepared that benefit a group of learners if a harmonious link is established between elements of existing cognitive structure and the new learning material. Further, any group may demonstrate benefits if the advance organizer represents a substantial (but not overwhelming) addition to the conceptual structure of a large number of individuals within the group. Also, advance organizers may be prepared that are level specific and selectively beneficial for the group of subjects (abstract or concrete) for which they are prepared.

Summary of Procedures

Two advance organizers were prepared on the topic of feedback. One was designated an abstract organizer and designed to facilitate learning for a group of high school subjects enrolled in The Man-Made World (TMMW) as part of a college preparatory curriculum. The other was designated a concrete organizer and designed to facilitate learning for a group of high school subjects enrolled in Technology---People---Environment (TPE) as part of a basic curriculum. To provide control groups, an advance non-organizer was prepared on the general topic of feedback, but containing no substantive material that would provide a basis for subsumption. Each of the subject categories (abstract or concrete) was randomly divided into three groups, and each resulting group was randomly assigned to receive one of the three introductory experiences. After the organizers were administered, subjects received four class periods of instruction on feedback with materials from either TMMW or TPE. Then the performance test was administered. Three weeks later a retention test, identical to the performance test, was administered.

Data supplied by performance test scores, and later by retention test scores, was subjected to a 3 x 2 factorial analysis of variance (ANOVA) to test for interaction effects. The independent variable was the introductory experience and the organismic variable was either abstract or concrete subjects. Significant interaction was indicated by performance test results at the .001 level of confidence. For the retention test results, however, only marginal significance was indicated at the .05 level of confidence. Separate 3 x 1 ANOVA's were performed for abstract subject and concrete subject results and,

when appropriate, they were followed by Scheffe tests for multiple comparisons to determine sources of significance.

Results and Conclusions

Performance Test

Abstract subjects who received the abstract organizer scored significantly higher on the performance test than abstract subjects who received the non-organizer ($p < .01$); null hypothesis 1 was, therefore, rejected. This rejection may be interpreted as evidence that the abstract advance organizer was an appropriate experience for the subjects for whom it was designed and support for the theory that such an organizer may enhance the process of subsumption for short-term retention. It is also supportive of the model proposed for appropriate advance organizers (Figure 1) suggesting that unfamiliar learning material located somewhat higher on the continuum than the relative position of the learner may be more readily subsumed with the aid of appropriate advance organizers that are more abstract and more general than the principal learning experience.

Abstract subjects who received the abstract organizer scored significantly higher on the performance test than abstract subjects who received the concrete organizer ($p < .01$); null hypothesis 2 was, therefore, rejected. If the abstract organizer was appropriate for the abstract subjects--as suggested by the rejection of null hypothesis 1--then this rejection may be considered evidence that the concrete organizer failed to enhance the process of subsumption for abstract subjects as indicated by short-term retention. This is supportive of the proposed model for appropriate advance organizers;

an introductory experience with a lower position on the continuum relative to the position of the learner should provide no organizing advantage for the learner.

Abstract subjects who received the non-organizer scored slightly, but not significantly, higher on the performance test than abstract subjects who received the concrete organizer ($p < .05$); null hypothesis 3, therefore, was not rejected. This result is supportive of the proposed model for appropriate advance organizers; if the concrete organizer may be located lower on the continuum than the position of the learner, then it should not aid the process of subsumption. Abstract subjects receiving such an introduction should have no organizing advantage over those receiving no organizing experience, i.e., the non-organizer.

Concrete subjects who received the non-organizer scored slightly, but not significantly, higher on the performance test than concrete subjects who received the abstract organizer ($p < .05$); null hypothesis 4, therefore, was not rejected. This, too, is supportive of the proposed model for appropriate advance organizers; if the abstract organizer may be located much higher on the continuum than the position of the learner, then it should not be capable of relating to the learner's cognitive structure. It should offer no more advantage to the learner than would no organizing experience, i.e., the non-organizer. The fact that concrete subjects receiving the non-organizer actually average 1.47 points higher on the performance test than those receiving the abstract organizer may be viewed as additional support for the proposed model. The associated F-ratio of 1.53 (Table VIII) would actually have been significant at the .25 level of confidence

(CV = 1.44). This difference is a primary source of the high level of interaction ($p < .001$) indicated by Table IV. There are at least three possible explanations for this occurrence. For concrete subjects, the abstract organizer may actually be disruptive of the organizing process of subsumption. It is also possible that the abstract organizer represented a source of confusion, providing negative motivation and a defeatist attitude toward the upcoming learning experience. Another possibility is that the non-organizer provided benefits that were not intended, and this possibility is more closely examined in the discussion of null hypothesis 6.

Concrete subjects who received the concrete organizer scored significantly higher on the performance test than concrete subjects who received the abstract organizer ($p < .01$); null hypothesis 5 was, therefore, rejected. This is also supportive of the proposed model for appropriate advance organizers. If the concrete organizer may be viewed as occupying a position on the continuum slightly higher than the position of the learner, then it should be more capable of enhancing the process of subsumption than an introductory experience positioned much higher on the continuum, i.e., the abstract organizer. Such an experience could not be related to existing cognitive structure, may actually disrupt organizing procedures and result in confusion which could provide only negative motivation.

Concrete subjects who received the concrete organizer failed to score significantly higher on the performance test than concrete subjects who received the non-organizer ($p < .05$); null hypothesis 6, therefore, was not rejected. This result is not supportive of the proposed model for appropriate advance organizers. According to the

model, an appropriately prepared organizer should have provided a significant advantage over the non-organizer by aiding the process of subsumption. There are at least three possible reasons for this discrepant occurrence.

It is possible that the proposed model for appropriate advance organizers is faulty. This possibility cannot be ignored, and there is nothing in this study to prove that it is not indeed the case, but there is considerable evidence that would suggest that the problem lies elsewhere. General support for the model as related to short-term retention is offered by the tests of the other five null hypotheses at the .01 level of confidence or better. The test of hypothesis 5 suggests that concrete recipients of the concrete organizer enjoy a significant advantage over those who receive an introductory experience located considerably higher on the continuum. Some support is offered for the model, then, with respect to the advance organizer in question.

It is possible that the concrete advance organizer is faulty. Preparing an introduction that requires by definition a characteristic element of abstractness to be used with subjects defined as "concrete" includes some built-in pitfalls. Some guesswork was necessarily a part of the organizer's construction, and its position on the continuum could be either too low or too high with respect to a substantial number of the concrete subjects causing a discrepancy. The organizer does adhere to the properties of an advance organizer as defined by Ausubel (1963) with the possible exception that the examples of thermostatic control and the girl on the tricycle may be seen by some as inserting too much specificity into the organizer.

If this were a serious deviation, however, it is unlikely that concrete subjects receiving the concrete organizer would have an advantage over those receiving the abstract organizer as was suggested by the rejection of null hypothesis 5.

It is also possible that the advance non-organizer was faulty. To effectively provide a placebo treatment, it was necessary that the non-organizer cover the same general topic as the other introductions. It could not, however, contain substantive conceptual information that would aid the process of subsumption. Ausubel generally described his non-organizers as historical or human interest material. The bulk of the non-organizer for the present study could accurately be described as human interest material and material not significantly related to feedback; no substantive information was included. Post-hoc examination of this introduction revealed a possible flaw apparently not encountered by previous experiments. In Chapter I of this study (p. 6) it is stated "There is no attempt to investigate the motivational . . . aspects of associated learning experiences." There is, however, an excellent chance that the non-organizer contained elements that could be motivational for some subjects. The term "feedback" was used frequently in the non-organizer and associated with a variety of systems, especially biological systems as affected by the processes of evolution. The way in which this was done--making frequent associations of many systems with feedback without actually disclosing the relationships (which would have been substantive information)--might have created a mysterious air about feedback, exciting the level of motivation for concrete subjects. If this were true, why were similar results not found with the abstract subjects? They benefitted

significantly more when receiving the abstract organizer instead of the non-organizer, but not significantly differently when receiving the non-organizer instead of the concrete organizer. It is reasonable to suggest that the difference could come as a result of the differing characteristics of the organismic variables. It should not be anticipated that an element of motivation would be equally effective with both (concrete and abstract) groups of subjects.

If the lack of a significant difference in testing null hypothesis 6 may be attributed to a faulty non-organizer, then it may be concluded that, for the purposes of short-term retention, advance organizers as described by Ausubel (1963) may be prepared within the constraints of the model proposed by this study (Figure 1) that would enhance the process of subsumption and meaningful learning. Also, it may be concluded that advance organizers so prepared are level specific and beneficial primarily for subjects with a cognitive frame of reference in accord with the content of the organizer. The level of interaction indicated ($p < .001$) suggests that prepared advance organizers appropriate for one group of subjects, may be of no help at all to a characteristically different group of subjects, and may even be less advantageous than no introductory experience at all. This would lead to the conclusion that when advance organizers are prepared, it is important that they be constructed not only as an abstract and general reference of substantive material for the concept to be studied, but also in close compliance with the cognitive make-up of the learner. If the learner has difficulty relating to abstract experiences (a concrete subject), then a highly abstract organizer should be avoided since its effect may be detrimental. Likewise, if the learner relates

well to an abstract experience (an abstract subject), then a relatively concrete organizer--beneficial to a concrete subject--may be no more beneficial than no introductory experience at all and should be avoided.

It must be remembered that the above conclusions rely on the assumption that the reason null hypothesis 6 could not be rejected was because of a faulty non-organizer. Though there is considerable evidence to indicate that this is so, it has not been empirically demonstrated and cannot be accepted without qualification until further experimentation is done. Also, the above conclusions refer only to results from short-term retention.

Retention Test

Abstract subjects who received the abstract organizer did not score significantly higher on the retention test than abstract subjects who received the non-organizer ($p < .05$); null hypothesis 1, therefore, was not rejected. This failure to reject may be seen as evidence that the abstract advance organizer was not an appropriate experience for the subjects for whom it was designed for the purpose of enhancing the process of subsumption with long-term retention. This result also offers no support for the model proposed for appropriate advance organizers.

The reason for this failure to reject at the .05 level of confidence, after the same procedure yielded rejection at the .01 level for performance test scores, is not immediately clear. It is possible that the abstract organizer was faulty, but if that were the case, abstract subjects who received it should not have exhibited a significant advantage on the performance test. It is not likely

that the unintentional elements of motivation suggested for the non-organizer with concrete subjects would be a factor; such elements were not sufficient to dampen the advantage apparent for abstract subjects receiving the abstract organizer on the performance test. Also, no advantage in any case is suggested for abstract subjects receiving the non-organizer over abstract subjects receiving the concrete organizer. It is possible that the model proposed for appropriate advance organizers and generally supported by the results of performance test analysis cannot be extended to long-term retention. It is difficult to understand how this could happen, but there is evidence to support the possibility. Most of the change between performance test results and retention test results may be traced to those receiving the abstract organizer. Their mean score was 1.68 raw score units lower with the retention test, while the raw score mean dropped only .30 points for those receiving the non-organizer. This is in conflict with Ausubel's explanation of the benefits gained by the use of advance organizers. The aid offered by advance organizers to the process of subsumption should enhance meaningful learning more so than rote learning. It is possible that those receiving the abstract organizer received some rote learning advantages and lost them before the retention test. This could have resulted if a significant portion of the advantage shown on the performance test was the result of some relatively sophisticated point for which a clue was given in the abstract organizer but not sufficiently anchored to avoid erosion by time. Or, perhaps the loss occurred through the natural process of obliterative subsumption. According to Ausubel (1963) obliterative subsumption occurs after new knowledge is subsumed under

a concept existing in cognitive structure. With time, the new knowledge becomes more and more a part of the existing concept until it becomes indistinguishable from that concept at which time the details of the new knowledge are lost--at least temporarily. Certainly, as was shown after the performance test, this group would have had much more to lose than those who received the non-organizer.

Abstract subjects who received the abstract organizer did not score significantly higher on the retention test than abstract subjects who received the concrete organizer ($p < .05$); null hypothesis 2, therefore, was not rejected. This is not supportive of the proposed model and may be seen as further evidence that the abstract organizer was not an appropriate introductory experience for enhancing the process of subsumption with long-term retention.

Abstract subjects who received the concrete organizer scored slightly, but not significantly, higher on the retention test than abstract subjects who received the non-organizer ($p < .05$); null hypothesis 3, therefore, was not rejected. This result is supportive of the proposed model; if the concrete organizer is located lower on the continuum than the position of the learner, then it should not aid the process of subsumption. Abstract subjects receiving such an introduction should have no organizing advantage over those receiving no organizing aid, i.e., the non-organizer.

Concrete subjects who received the non-organizer scored slightly, but not significantly, higher on the retention test than concrete subjects who received the abstract organizer ($p < .05$); null hypothesis 4, therefore, was not rejected. This is supportive of the proposed model; if the organizer is much higher on the continuum than the

learner, then it should not relate to the learner's cognitive structure, and should offer no advantage to the process of subsumption over no organizing experience, i.e., the non-organizer.

Concrete subjects who received the concrete organizer did not score significantly higher on the retention test than concrete subjects who received the abstract organizer ($p < .05$); null hypothesis 5, therefore, was not rejected. This is not supportive of the proposed model and suggests that the concrete organizer was not an appropriate aid for the subsumption process with long-term retention. An organizer occupying a slightly higher position on the continuum should enhance the process of subsumption to a higher degree than an organizer positioned much higher on the continuum, i.e., the advance organizer.

Concrete subjects who received the concrete organizer failed to score significantly higher on the retention test than concrete subjects who received the non-organizer. This result does not support the proposed model and suggests that the concrete organizer may not be an appropriate subsumer for the purpose of long-term retention. According to the model, an appropriate organizer should have provided an advantage over the non-organizer by aiding the process of subsumption. The effect of a motivational non-organizer, discussed at length for performance test results, is of little consequence here since there are other elements of non-support for the proposed model as it relates to long-term retention.

Of the six null hypotheses tested above, only hypotheses 3 and 4 support the proposed model for appropriate advance organizers for long-term retention, and both of them required a failure to reject

to show support. None of the other four, all requiring rejection to show support, could be rejected at the .05 level of confidence even though three of the four were rejected at the .01 level when tested with performance test scores. It must be concluded, therefore, that the organizers may not be appropriate subsumers for the goal of long-term retention.

There is an important element of support from retention test results for the model proposed in the present study for appropriate advance organizers. The significant level of interaction indicated (Table X) suggests that the overall concept of the model may be extended to long-term retention, even though individual comparisons of organizers failed to demonstrate significant differences.

Further Discussion of Results

The general level of support indicated by performance test results for the advance organizers used in the present study is consistent with previous research. Ausubel (1960) and Ausubel and Fitzgerald (1961, 1962) used the same experimental organizer for all experimental subjects but stratified subjects by some demonstrated ability such as performance on a verbal learning ability test. The significant differences were then traced to those subjects in the lower ability group. This led to implications that advance organizers were beneficial primarily to those subjects with low verbal learning ability or a low level of knowledge of important associated concepts. The general support indicated by performance test results for a proposed model for appropriate advance organizers suggests that Ausubel's higher ability subjects might also have benefitted

if the organizers and the learning materials were constructed to represent a substantial conceptual gain for them. The model may also explain the failure of some introductory experiences tested as advance organizers. If they were too far removed (either higher or lower) from the position of a substantial number of subjects on the continuum, their potential facilitative effects may not be realized.

The retention test results of the present study are more difficult to compare with experiments performed by Ausubel. His criterion tests were typically given three days after the organizers were administered. Ausubel and Fitzgerald (1961) used three-day and ten-day retention tests and found significant advantages for those receiving an advance organizer in each case, but retention was never tested for a longer period of time.

The closest parallel to the situation of the present study came from Ausubel and Fitzgerald (1962). Advance organizers were administered followed by Part I learning materials which were then followed by Part II learning materials. It was shown that learning and retention was enhanced by organizers on Part I materials but that the advantage did not carry over to Part II materials. This suggested that significant facilitation of learning and retention on sequential materials would require the insertion of additional organizers. The present study would suggest adding that the significant facilitation may be lost if retention time is extended to three or four weeks.

Another question raised by the results of the present experiment remains as yet unresolved. Theoretical and experimental work with advance organizers initiated by Ausubel links their advantage to aiding the process of subsumption. Subsumption theory is concerned

primarily with operations that enhance meaningful learning and, therefore, long-term retention. The use of appropriate introductory organizers should reduce the need to rely on rote procedures and inhibit the rate of obliterative subsumption (Ausubel, 1960). In the present study, however, introductory organizers with demonstrated significant effectiveness six days after their administration (performance test) appear to lose their statistical significance when tested nearly four weeks after their administration (retention test). This may seem to imply that benefits derived from advance organizers are rote in nature. It has been empirically shown by the present study with advance organizer control groups that such benefits could not be attributed to the organizers alone (Table II). This does not dismiss the possibility that the organizers enhanced rote procedures with the principal learning materials, however. But Ausubel's experiments have generally indicated facilitation of meaningful learning by advance organizers.

Implications

The enclosed nature of the classrooms from which experimental and control subjects were drawn will not permit the study to be generalized beyond those classrooms. Some valuable implications may be shown, however.

The results of the statistical analysis on the performance test scores implies that audio visual advance organizers may be prepared for abstract subjects, and administered just prior to a learning experience on the topic of feedback, that will facilitate learning and retention immediately following the learning experience (six

days after the organizer is administered). The same may be true for concrete subjects, but this was not shown at the .05 level of confidence--probably because of a faulty (motivational) non-organizer.

The results of the statistical analysis on the retention test scores imply that facilitative benefits gained by the use of such introductory organizers may diminish with time (three weeks after the learning experience--twenty-seven days after the administration of the organizer).

The significant level of interaction--shown by the results of both performance and retention tests--implies that different organizers on the same general topic may be prepared that are significantly more facilitative for abstract subjects than concrete subjects, or significantly more facilitative for concrete subjects than abstract subjects. The degree of facilitation would depend upon the relative position of the organizer and the learner on the continuum of the model for appropriate advance organizers proposed by the present study. Maximum facilitative benefits should be realized when the position of the organizer is high enough to represent a substantial gain, but not so high as to be overwhelming.

Recommendations

Previous research has demonstrated that short written advance organizers inserted just prior to longer written learning passages may facilitate learning and retention of those passages. The present research study suggests that the concept of introductory organizing experiences should also be considered for use in more normal classroom procedures. Short audio visual experiences that relate to previous

classroom experiences--or otherwise relate to concepts in the learner's cognitive structure--could enhance the learning of unfamiliar material. People involved in the development or modification of curriculum projects could add a positive element to programs by providing advance organizers that could be appropriately inserted by classroom teachers.

The results of the present research suggest that a more extensive effort would be justified. It is therefore recommended that the study be repeated with a number of modifications.

A number of changes are recommended for the introductory organizers themselves. Foremost is the recommendation that the non-organizer undergo general revision to remove those elements that may be motivational. It would be relatively easy to replace them with historical or anecdotal material. Without this revision, benefits realized as a result of appropriate organizers are statistically cloaked. It is also suggested that all three introductions be shortened from eight or nine minutes to about five minutes. Each organizer contains more information than is necessary for purposes of relating existing cognitive structure to unfamiliar learning material. The part of the abstract organizer that elaborates extensively on the role of feedback in the operation of a power plant was probably not necessary. That part of the concrete organizer explaining the role of feedback for a home heating system probably added nothing that was not already conceptually presented. The addition of appropriate background music to the tape/slide presentation would provide a more pleasant setting for the administration of organizing experiences. The use of narrated movie films could also be beneficial.

It is also recommended that efforts be made to make the study more generalizable. A larger population of TMMW and TPE classes could now be identified and experimental groups randomly selected from them.

The experiment would be further enhanced if experimental groups could be made more homogeneous. The procedures of the present study could not insure that some subjects were not inappropriately placed in either the abstract or concrete group. The effect of such misplacement is the masking of significant differences that might otherwise be shown between experimental groups. If the results of a standard test of scholastic skills (such as the Iowa Test of Basic Skills) were available, subjects inappropriately placed in a college preparatory or a basic curriculum could be identified and eliminated from the study. If such test results were not available, appropriate tests could be administered prior to the study.

A larger number of experimental subjects would also offer some advantages. It would then be possible to further stratify the abstract and concrete groups to see if more level-specific results could be obtained. This additional information would be of little practical benefit to the classroom teacher, but might add significantly to theoretical aspects of appropriate advance organization.

Another recommendation for modification of the present study is the lengthening of the criterion test. The 19-item test used in this experiment was an attempt to test each of the cognitive objectives of the TMMW and TPE programs related to the concept of feedback. The results would be more conducive to meaningful statistical analysis if a longer test were used, perhaps one in which each objective was tested twice.

The comparative statistical results of the retention test scores and performance test scores used in this study suggest a re-examination of the philosophy under which null hypotheses are or are not rejected. It is generally accepted that retention decreases with time and that those who have gained the most from some experimental procedure also have more to lose. If it is appropriate to test null hypotheses with respect to performance test scores at the .05 level of confidence, then it should be equally appropriate to test null hypotheses with respect to longer-term retention test scores at a lesser level, perhaps the .10 level of confidence.

The present research also suggests the need for other experiments to be performed. Respect for the advance organizer concept could be more properly placed in focus if the facilitation attributed to advance organizers could be compared to the benefits derived simply from additional exposure to the principal learning materials. This could be readily tested by exposing experimental subjects to a previously tested organizer followed by the principal learning experience. Control subjects would receive, instead of the organizer, a substantive portion of the principal learning experience followed by the complete learning experience.

It is also recommended that an experiment be undertaken to compare the facilitation of meaningful learning by advance organizers with the facilitation of rote learning. This could be accomplished by structuring a criterion test to contain approximately equal numbers of both conceptually oriented items and rote items. It would represent an empirical test of Ausubel's contention that benefits gained by the use of advance organizers are primarily in the area of

meaningful learning.

The use of advance organizers may also have significant benefits for the area of primary education. Introductory subsumers can be valuable only when cognitive development is sufficiently substantive to permit the recall of pertinent general concepts. It is possible that organizers, carefully prepared in compliance with the model proposed by this study, could provide an indirect indication of whether or not a child has reached a level of cognitive development that would justify the undertaking of particular learning tasks. Such a process would make it possible to avoid expecting a child to excel in tasks for which he is not mentally or physiologically equipped. It is recommended, therefore, that substantial development and testing of subsumptive aids for younger children be undertaken.

The level of difficulty encountered with the generation of appropriate advance organizers is primarily due to the desire to test them empirically. For purposes of experimentation, introductory subsumers must avoid motivational, historical, anecdotal, and human interest elements; or they might interfere with the interpretation of results. No research has indicated that it would be faulty for a classroom teacher to use advance organizers that are basically substantive but also contain material to otherwise appeal to the learner. It is recommended, therefore, for purposes of practical application, that teachers devise and utilize introductory experiences with a substantiated theoretical basis but containing other modes of interest as well; perhaps therein is the recommendation for another study.

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APPENDIX A

CORRESPONDENCE WITH DAVID P. AUSUBEL

November 26, 1973

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

Dear Dr. Ausubel:

I am a graduate student in education at Oklahoma State University. Recently I completed the proposal for my dissertation research which I hope will be a significant addition to work that has been done with advance organizers. Your reaction to what is proposed and any suggestions or aids you could offer would be considered valuable and very much appreciated.

Briefly, my hypothesis is that any group may increase learning and retention with the use of advance organizers if the new material represents a substantial but not overwhelming gain in knowledge, and the advance organizer is constructed at a level which can relate to both the new material and the learners' cognitive structure. I have further hypothesized that appropriately constructed organizers will be selectively facilitative only for the ability group for which it was prepared.

To test these hypotheses I will use students enrolled in one of two high school science projects which teach essentially the same concepts. The Man-Made World students study engineering concepts applied to social systems at a relatively abstract level. Technology-People-Environment (T-P-E) students investigate the same concepts, but with much more concrete experiences.

For a single concept, I will attempt to construct two advance organisers--one for each of the above groups. Because of the difficulty encountered by most T-P-E students with reading material, the organizers (and control group non-organizer) will be presented from video tapes. All three sets of introductory materials will be given to randomly selected groups within <u>each</u> course.

If the project is successful, the demonstrated applicability of the concept of advance organizers would be increased beyond the boundaries of "beneficial only for certain ability levels" that has often been implied.

I am somewhat apprehensive about my own ability to produce appropriate advance organizers. Therefore, I would appreciate any examples you could provide that would allow me to compare advance organizers with associated principal learning materials.

Sincerely,

Edward E. Jones

DAVID P. AUSUBEL, M.D., Ph.D.
255 W. 88th St.
New York, N. Y. 10024

"212" 787-0173

Jan. 9, 1974

Mr. Edward E. Jones
Department of Education
Oklahoma State University
Stillwater, Oklahoma 74074

Dear Mr. Jones:

Thank you for the copy of your letter of November 27. I did not receive the original.

I was interested to learn that you are contemplating research on advance organizers for your dissertation. The hypotheses and research design you outline impress me as sound and feasible. I regret that I no longer have copies of organizers and learning passages.

I have retired from the City University of New York because of ill health.

With best wishes for the success of your research.

Sincerely,

(s) David P. Ausubel

APPENDIX B

TRANSCRIPTS OF ADVANCE ORGANIZERS

ABSTRACT ADVANCE ORGANIZER

Earlier we learned how to use the systems approach as a method to analyze specific problems. We learned that a systems viewpoint using an input-output model has broad applications for the study of natural and man-made systems.* You may recall this model of a system used to supply fish for food. Each input into the system has some effect on the system which in turn effects the output (in this case the supply of fish for food).

We will now consider another aspect of the systems approach where a system's output* becomes a part of the input. This new element of input is referred to as feedback.* Feedback engineering is a major part of technology.* It allows the system to exhibit purposeful behavior as opposed to mechanistic behavior.* Without feedback, the supply of fish for food system we looked at earlier continues the same operation even when production falls off.* Awareness of this deficiency--a form of feedback--may lead to changes in other inputs to again optimize production. In this case, it might lead to a chemical analysis that indicates we need to decrease pollution.*

When feedback is utilized, a system or a machine is permitted to display goal seeking characteristics.* The general goal of a feedback system is the elimination of error. The use of feedback involves the addition of an important component to the system--a comparator.* The comparator compares a system's output with its goal.* Its reasoning may be described mathematically as follows. If we let X = inputs and Y = outputs, then Error may be described as X - Y.* If (X - Y) is very small, then goals are realized and changes in the system input are uncalled for.* If (X - Y) is large, the

comparator indicates that input must be changed in some positive manner.* This allows a system to become automatic, permitting control over unwanted inputs.*

A modern electric power plant can provide hundreds of examples of feedback automatically controlling the decision-making process.* While it is operating and synchronized with the distribution system, this steam-driven turbine-generator must continually rotate exactly sixty times each second.* One turbine-generator rotating a little faster or slower than 60 revolutions per second (rps) would cause serious electrical disturbances, perhaps even blackouts.

Maintaining the goal of sixty rps would be a relatively easy accomplishment if the amount of power required by customers remained constant. But, as you know from your own homes, this is not the case.* We want lights and appliances to operate only when we need them; and we want to conserve energy by shutting them down when their use is not required. When the lights in this room are turned on, power is drawn from the system.* This means that more energy is being put out by the generator in the form of electricity* than is being received by the turbine in the form of steam. The immediate tendency is for the turbine-generator to slow down (just as you would if your daily output of energy exceeded your intake of nourishment). What must happen, then, to keep the turbine-generator from slowing down?* To answer this question, let us look at a diagram of our system.

The goal of this system is for the turbine-generator to maintain sixty rps. Feedback allows the comparator to sense and "learn" the direction and magnitude of any error.* The comparator sends signals to the controls that regulate steam flow.

As an example, let us make the assumption that our act of turning on the light pulls enough power from the distribution system to slow down the turbine-generator. What happens to the system? First the system output is registered as too low. Feedback relays this information to the comparator which computes the error from the desired goal.* A signal caused by this imbalance orders the valves that control steam flow to allow more high pressure steam to deliver its energy to the turbine* which in turn, has its rate of rotation increased.* If feedback is continuous and the controls operating smoothly, our output should increase rapidly and methodically.* As the output approaches 60, this feedback too is utilized so that any decrease in steam valve opening necessary for a smooth return to the desired goal may also be effected. Other disturbances would be compensated for in a similar manner as is shown on this recovery graph.* Of course, in this example, feedback has been continuous and the system has approached perfection. Sometimes instability accompanies feedback.* If the turbine-generator system received feedback only once every one-half minute, its disturbance recovery graph might look like the second curve.* If feedback is continuous but the compensating controls sluggish, the disturbance recovery graph would look more like the third. If we have both intermittant feedback and sluggish controls . . .* well, things might get just a little bit "wild." Perhaps you can see that it is easier for a system to maintain its goals when feedback is continuous and response is instantaneous.

*The system we have investigated is actually a small part of a much larger network of interconnected systems where feedback takes

many forms. As more steam is supplied to the turbine, the steam pressure in the boiler is decreased.* This information serves as feedback to a system with the goal of a constant boiler pressure. Its comparator then calls for more water to be pumped into the boiler. This water is relatively cold causing the steam temperature to drop.* This temperature decrease serves as feedback to a system with a goal of constant steam temperature. Its comparator calls for more fuel to be burned. The subsequent opening of fuel valves causes fuel oil pressure to drop.* This information is feedback to a system whose goal is a constant fuel oil pressure. Its comparator orders fuel pumps to work harder or calls for more pumps to begin operating to keep fuel oil pressure up. Whew! We could go on and on like this for the rest of the day, but perhaps you get the idea!

*We have seen how the behavior of a system can be made purposeful (that is, guided by desired goals) rather than mechanistic (governed only by past causes). Your understanding of other feedback systems will be enhanced if you take the time to ask yourself three questions.

*1. What is the goal of the system?

2. What does the system's comparator "learn" from feedback and how does the system's comparator change the mathematics of analyzing the system?

3. How does this help the system approach perfection?

(Asterisk (*) designates a change of slide during presentation.)

CONCRETE ADVANCE ORGANIZER

Earlier this year we learned how to model something from the real world and how to use the model with a systems approach. As you may recall, a systems approach model looks something like this. A system has both input and output.* Many systems have a large number of each. Often man is concerned with a system with several inputs and only one important output.* A modern egg farm is such an example.* Inputs would include hens, food, water, energy and maybe you could think of more. The output, of course, is fresh eggs.* The farmer hopes to optimize his egg production by carefully controlling the inputs. Too much or too little of any item may cause his system to produce fewer eggs.

We will now add something else that will make it easier for a system to reach its goals.* The new addition will be called feedback. Look at the word and see if it suggests a meaning to you.* Well, this isn't exactly it.* And neither is this!* Feedback represents a major change in our model of a system. When it is used, the output becomes a part of the input; you might want to think of it as output that is recycled. Knowledge of how the output compares with the goal of the system is provided by feedback.* For our egg producing system knowing how many eggs are produced each day is the feedback.* Without feedback the farmer would not know if the goal was being reached. If the actual output was much less than the goal (and there was no feedback) the farmer would not know that the system was not optimizing. He would not know that the inputs need to be changed.* By counting his eggs every day he can add feedback to the system.* Each feedback

system has a comparator. Its purpose is to determine any error between actual output and the system's goal. Feedback, then, adds learning to a system.* As long as the output is close to the goal, error is small and there is no need to change the input.* When error becomes large the system can realize that the output is much different from the goal. The amount of error, then, determines if the input needs to be changed before goals can be reached.

*As you can see, the use of feedback has added some important advantages to our use of a systems approach. It allows the system to seek a goal, to learn if the goal is reached, and to make the system more perfect.

This man is adjusting the flame level in his home furnace. Experience has helped him to learn about how much flame will give enough heat to insure a comfortable night's sleep. Sometimes he makes a good guess, but what happens when an unexpected winter storm moves in during the night? * *There was not enough heat, the house is cold, and everyone wants a spot next to the furnace. It could also work the other way.* Anticipating a cold night, the man adjusts the furnace for extra heat.* If a warm front moves in instead, the room temperature could soar to a very uncomfortable level.

Let us look at a model of this system. Of the inputs, the man can control only the amount of fuel being burned. The other inputs may be considered outside disturbances. If the outside temperature or wind speed (or both) change in a manner that was not predicted, the house may be too cold or too hot. Here the lady of the house suggests that the man of the house do something about this situation (it looks like Dad is getting some feedback.)* So he

modifies his heating system to include thermostatic control. You know, set it at a desired temperature and forget it! How does this change the system? *The thermostat is the comparator. It receives feedback information about the room temperature. The outside disturbances are still there but as they change, feedback can control their effect. Can you see how it can be used to make a system operate automatically?*

This three-year-old girl has been asked to ride her tricycle keeping the front wheel on the line.* By watching the front wheel and the line, she can operate with continuous feedback* and does pretty well.* Here is a trace of her path. What happens when feedback is not continuous?* Here she is blindfolded (interrupting her feedback) and allowed to see where she is only after every time she complete five pedals.* Oops! *Now we're on the other side, *pretty good anyway! *Here is a trace of this trip. *Let's do it again, only this time she will get to peek only after every ten pedals. *Uh-oh! *Well, we'll fix that! *How'd I get way out here?* Again!* See how the three paths compare? Perhaps you can see some advantage to continuous feedback.

We have seen how a system can be made to learn, to seek a goal, and acquire perfection with the addition of feedback. During the next few days you will see some examples of feedback. They will be easier to understand if you try to answer three questions about each:

1. What is the goal of the system?*
2. What does the system "learn" from feedback?*
3. How does learning from feedback help the system to become more perfect?*

(Asterisk (*) designates change of slide during presentation.)

ADVANCE NON-ORGANIZER

During this year you have participated in a science course that is probably unlike any you have seen before. You have used concepts not found in other courses, probably because the roots of these concepts are found in engineering and technology rather than in pure or natural science. Even so, you have seen that they have found application in social, political, ecological, business and economic systems as well as technological systems.

You have studied the elements of decision making and found that there are different categories of decisions; some decision making processes are enhanced by the use of appropriate algorithms, and some problems have no solution at all. You have seen that the process of optimization involves the give and take of a compromising procedure.

Modeling is a concept you have probably used before,* but now you have seen how systems can be modeled electronically.* You have also seen how an analyst can use a systems approach to find solutions to many different categories of problems. Proper control of a system requires a firm understanding of everything that influences the system.

For the next several days you will use some of what you know about each of these concepts in the investigation of feedback. Feedback is important. Without it, technology would be totally ineffective, and even primitive life could not have evolved. Look at the word and see if it suggests a meaning. Well, this isn't exactly it.* And neither is this.

The broad and conscious application of feedback did not come until the Second World War. The increasing sophistication of war has

been behind many advances in technology. Guided missiles and artillary use feedback to pinpoint a target with uncanny accuracy.* This hunter uses feedback to help bring home the game, especially when a second or third shot is needed.* Radar systems used to track war planes and projectiles could not function without it. Radar, of course, has found many peaceful applications. This commercial jetliner uses it to navigate across country and to make safe and accurate landings through dense fog, snow or rain.

Other navigation systems use feedback too, even simple ones. Without it these canoeists would have trouble avoiding rocks in the rapids, or, for that matter moving through calmer water without going around in circles.

Automobiles are another example of multiple feedback systems. Feedback plays an important role in their design, styling, and operation;* and the more luxurious the automobile, the more numerous and complex the feedback systems involved.

*Metropolitan areas display patterns of growth that are very much influenced by feedback. New office buildings are built; public services such as schools, libraries, parks, and utilities are established. *Modern airports make the city easily accessible to the rest of the world. *Hotels and convention centers make it attractive to the business and professional world. None of this has occurred without the influence of feedback.

*A modern power plant can provide hundreds of examples of how technology is guided by feedback. Here feedback helps to control the spinning turbine, the steam temperature, water purity, furnace operations, and the electrical distribution.

*The influence of feedback is not limited to its effects on modern man or advancing technology. It is felt in all segments of wild and natural life. This hare's close resemblance to his surroundings is the result of feedback. And so is his ability to change color with the seasons. *These ducks are of the same species, but one is more highly colored than the other. The hen is comparatively dull in appearance and blends in more readily with the environment. When predators are near, she can stay with the nest with less chance of being detected. The more brightly colored drake can leave the nest with more chance of being seen and followed by the predator thus taking attention away from the nest and the hen. But what caused the situation to come about? You can be sure that feedback played an important role.

*A few weeks before this picture was taken, all the leaves were bright green. Now brown, bright red and yellow are dominant. Where did the new colors come from? Are they new ingredients, or were they there all the time? And what happened to the green? Feedback's hand in such matters is not always direct or obvious, but it is still there.

*This wary game fish uses feedback to help him survive and to help secure his dinner. *Knowledge of how the fish reacts to certain kinds of feedback can help the fisherman bring him to the hook. *Another kind of feedback will help the fisherman bring him to the creel;* or provide a proud moment like this.

*This handsome buck senses that something is not quite right. Perhaps an intruder is near. The timidness of the deer has helped him to survive and prosper in the presence of hunting pressure from

both man-made and natural elements. This ability, too, is the result of feedback. Notice the bland colors that blend in with the background. He is especially well hidden in the shadows of a forest. Notice also the forward angle of the antlers. Chance could just as easily have had them angled backward, but, * of course, then they might not have been quite as useful; so perhaps something other than chance was involved.

*During the next few days you will have the chance to gain an understanding of this concept that has such universal application. (Asterisk (*) designates change of slide during presentation.)

APPENDIX C

CRITERION TEST

FEEDBACK QUIZ

Directions: Read each test item carefully. Then circle the letter of the best answer.

Example questions:

1. The energy crisis is mostly concerned with a shortage of

   A. clean water

   B. clean air

   (C.) oil and petroleum products

   D. trees and paper products

   E. beef

1. A batter hits a fly ball. Outfielder Hank Aaron runs to where he thinks the ball will land. This is an example of feedback in which

   A. man is communicating with himself.
   B. man is communicating with man.
   C. man is communicating with machine.
   D. machine is communicating with machine.
   E. there is no communication.

2. More electrical power is automatically supplied to an elevator when it is nearly full than when it is nearly empty. This is an example of feedback in which

   A. man is communicating with himself.
   B. man is communicating with man.
   C. man is communicating with machine.
   D. machine is communicating with machine.
   E. there is no communication.

3. A boy is bicycle riding with some friends. He pulls over and stops because his front wheel starts to "wobble." This is an example of feedback in which

   A. man is communicating with himself.
   B. man is communicating with man.
   C. man is communicating with machine.
   D. machine is communicating with machine.
   E. there is no communication.

4. Two men are jogging (running). The first man suggests stopping for a rest when he sees a second man sweating, panting, and slowing down. This is an example of feedback in which

   A. man is communicating with himself.
   B. man is communicating with man.
   C. man is communicating with machine.
   D. machine is communicating with machine.
   E. there is no communication.

5. Ted's older brother tells him he should ask Betty Lou to the party because she's good-looking and a "great" dancer. His sister tells him he should ask Mary Jane because everyone likes her. She also has lots of money and a new sports car. Ted can't make up his mind. In this example

   A. delayed feedback has caused confusion.
   B. delayed feedback has caused instability.
   C. conflicting feedback has caused confusion.
   D. interrupted feedback has caused confusion.
   E. continuous feedback has caused instability.

6. A basketball player would probably improve his game faster if

   A. the coach made suggestions all during practice.
   B. the coach made suggestions after each practice only.
   C. the coach made suggestions before each practice only.
   D. the coach made suggestions before a game only.
   E. the coach made suggestions once each week.

7. A man notices that his car is not running very well. He wants to find out what is wrong. Everytime he takes it to a mechanic, though, it quits acting up and runs fine before he gets there. He would find the trouble sooner if

   A. feedback was interrupted.
   B. feedback was continuous.
   C. feedback was delayed.
   D. feedback was not delayed.
   E. feedback did not exist.

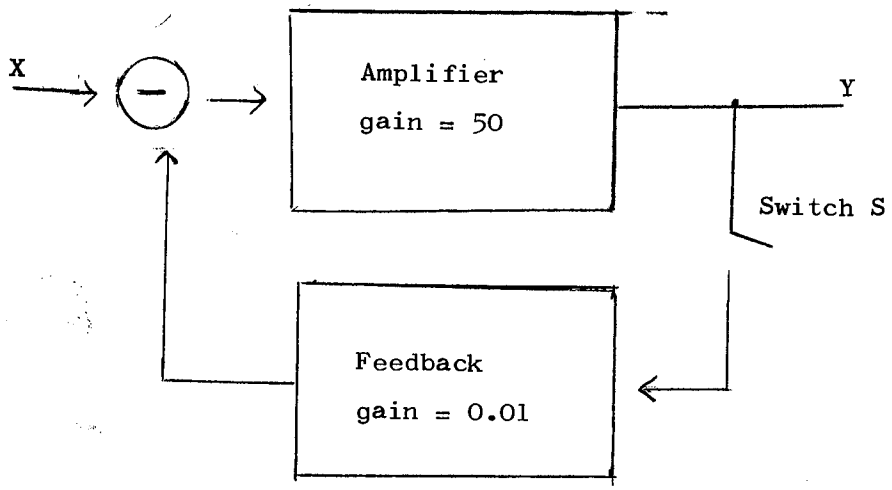
8. Using worms for bait, a fisherman tries to catch catfish. He does not get a single "bite." After three days of failure, he sees another fisherman who is using minnows for bait. This fisherman catches five large catfish in just a few minutes. So he buys some minnows and begins catching fish too. Which of the following is most likely true?

   A. Minnows cause continuous feedback.
   B. The worms caused feedback to be delayed.
   C. He might have caught more fish if feedback had not been delayed.
   D. He might have caught more fish if feedback had not been interrupted.
   E. He should have known better than to use worms in the first place.

9. A man is trying to cross an unfamiliar desert at night. He uses the stars to help him decide which direction to walk. Sometimes large clouds float across the sky. Then he gets confused and walks the wrong way. His trip would be easier if

   A. feedback was not delayed.
   B. the feedback was not conflicting.
   C. he had no feedback.
   D. the feedback was not continuous.
   E. the feedback was not interrupted.

Use this drawing to find answers to questions 10 and 11.



10. If the switch S is open and the magnitude of the input X = +0.1, then the magnitude of the output Y is

A. 50.1
B. 49.9
C. 5.1
D. 5.0
E. 0.5

11. If S is closed and the magnitude of X = +0.1 as before, the magnitude of Y can be computed by

A. Y = (0.1 - 0.01Y) 50
B. Y = (5.0 - 0.01Y) 50
C. Y = (0.1 + 0.1Y) 50
D. Y = (0.1 - 0.01) 50
E. Y = (0.1) 50 - 0.01Y

12. A famous biologist has said: "Farmers are hooked on nitrates like a junkie is hooked on heroin. The more nitrates they use, the more they have to use to maintain profitable yields." This statement is an ecological example of

A. feedback resulting in instability.
B. feedback resulting in stability.
C. resonance in agricultural systems.
D. the dynamic nature of farming.
E. the fact that farmers and junkies have something in common.

13. "Planning for the future is difficult in a democratic country." One cause of the difficulty mentioned in the quoted sentence is that

A. the laws passed by state legislatures are seldom resonant with those passed by the Congress.
B. there is not enough feedback from the Congress to the state legislatures.
C. politicians often receive feedback which is out of phase with reality.
D. democracy, as a form of government, has always proved stable.
E. since we cannot know the future, there is no point in attempting to do anything about it.

14. Which of the following would be the LEAST significant input signal to consider in planning the control of a black plague epidemic?

A. The economy of a country.
B. The population of rat fleas.
C. The rat population density.
D. The human population density.
E. The number of people immune to the disease.

15. Intermittent feedback

A. always results in oscillation.
B. usually makes too large a correction each time it acts.
C. usually makes too small a correction each time it acts.
D. has no control over its system between its active moments.
E. uses an average error signal.

16. The traffic stream on a limited-access divided highway

A. becomes unstable at each place where more cars can enter.
B. is stable if cars do not have to stop, even though they may have to travel very slowly.
C. is stable even if the speed is low if nobody has to stop for more than a few seconds at a time.
D. is stable if cars can all be driven steadily at the speed limit.
E. all of the above are true.

17. Which of the following is the most important problem to be studied before designing a high-speed train if the interaction between passenger and train is the primary consideration?

A. The highest speed a train can travel.
B. The number of seats.
C. The fee passengers are willing to pay.
D. Ths distances passengers wish to travel.
E. The maximum accelerations passengers can be expected to tolerate.

18. Which of the following systems exhibits the tendency toward instability frequently present in feedback systems?

A. The relation between lack of sleep and illness.
B. A wage increase for members of a union.
C. A nuclear armament race.
D. Communication between friends.
E. All of the above.

19. A homeostatic system not described in the text is that for maintaining the water concentration of the blood. In this system the following steps have been recognized: (1) Heavy exercise induces sweating, which (2) lowers the water concentration in the blood, which (3) is detected by receptors in the brain, which (4) stimulate a gland to produce a hormone, which (5) is carried by the blood to the kidneys and (6) stimulates them to reabsorb water from the urine and (7) return it to the bloodstream. In this feedback system

A. (7) is the output.
B. (6) is the goal sought by the process.
C. (5) is the input.
D. (4) is the feedback loop.
E. (3) is the error signal.

APPENDIX D

CRITERION TEST SCORES

RAW SCORES

Split-Half Reliability Scores for Criterion Test

Abstract Subjects	Odd	Even	Concrete Subjects	Odd	Even
1	4	3	1	2	1
2	4	4	2	4	3
3	3	5	3	4	5
4	2	2	4	4	3
5	4	5	5	4	4
6	6	4	6	4	2
7	3	3	7	1	1
8	3	4	8	5	3
9	5	4	9	4	6
10	4	3	10	4	3
11	3	2	11	3	5
12	2	1	12	3	3
13	5	4	13	4	3
14	6	4	14	3	1
15	5	3	15	4	4
16	5	4	16	2	0
17	3	4			
18	5	3			
19	2	1			
20	4	4			
21	2	2			

RAW SCORES

Advance Organizer Control Group
Criterion Test Scores for
Abstract Subjects

Abstract Organizer		Concrete Organizer		Non Organizer		No Organizer	
Subject	Score	Subject	Score	Subject	Score	Subject	Score
1	10	1	5	1	8	1	7
2	12	2	5	2	8	2	8
3	10	3	12	3	7	3	8
4	7	4	11	4	3	4	4
5	7	5	8	5	9	5	9
6	4	6	6	6	5	6	10
7	12	7	6	7	10	7	6
8	9	8	10			8	7
9	4	9	11			9	9
		10	6			10	7
						11	5
						12	3
						13	9
						14	10
						15	8
						16	9
						17	7
						18	8
						19	3
						20	8
						21	4

RAW SCORES

Advance Organizer Control Group
Criterion Test Scores for
Concrete Subjects

Abstract Organizer		Concrete Organizer		Non Organizer		No Organizer	
Subject	Score	Subject	Score	Subject	Score	Subject	Score
1	7	1	2	1	7	1	3
2	8	2	9	2	8	2	7
3	10	3	11	3	7	3	9
4	8	4	6	4	6	4	7
5	7	5	8	5	5	5	8
6	7	6	2	6	3	6	6
7	4			7	10	7	2
8	2					8	8
						9	10
						10	7
						11	8
						12	6
						13	7
						14	4
						15	8
						16	2

RAW SCORES

Experimental Abstract Subjects' Criterion Test Scores

Abstract Organizer Subjects	PTS	RTS	Concrete Organizer Subjects	PTS	RTS	Non Organizer Subjects	PTS	RTS
1	13	11	1	10		1	10	10
2	12	14	2	12	13	2	13	
3	12	13	3	11	13	3	8	12
4	18	14	4	14	13	4	14	12
5	14	9	5	13	14	5	11	11
6	16	14	6	11	12	6	10	11
7	14	12	7	7	9	7	14	17
8	14	13	8	13	11	8	11	9
9	15	14	9	14	14	9	15	16
10	15	15	10	11	8	10	12	10
11	11	14	11	12	10	11	13	15
12	17	13	12	12	12	12	16	10
13	15	12	13	10	10	13	11	9
14	16		14	13	10	14	8	7
15	15	11	15	9	15	15	12	13

(PTS = Performance Test Scores; RTS = Retention Test Scores)

RAW SCORES

Experimental Concrete Subjects' Criterion Test Scores

Abstract Organizer Subjects	PTS	RTS	Concrete Organizer Subjects	PTS	RTS	Non Organizer Subjects	PTS	RTS
1	13	8	1	11	8	1	8	8
2	9	8	2	12	10	2	14	10
3	7		3	9		3	8	
4	6		4	11	10	4	8	3
5	9		5	12	11	5	10	8
6	6	14	6	14	14	6	12	11
7	9	7	7	15	15	7	12	12
8	7		8	13	15	8	7	7
9	8	2	9	14	9	9	4	
10	7	7	10	13	14	10	11	13
11	10	5	11	10	12	11	9	
12	12	10	12	5	5	12	13	12
13	8	10	13	13	14	13	9	8
14	8	12	14	10	10	14	11	7
15	11	12	15	8	9	15	9	11
16	4	12	16	11	11			
17	8		17	12				
18	4							
19	10	4						
20	8							

(PTS = Performance Test Scores; RTS = Retention Test Scores)

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