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ABSTRACT

Lesson structure (organization in terms of meaningful relationships among ideas or concepts) is a low-inference indicator of lesson organization in that it can be observed and objectively quantified. It affects achievement positively, and students generally rate lessons higher when the structure of the lesson is relatively high. Teachers vary in the degree of structure of their lessons, a fact indicating that some teachers could profit by being trained to increase the degree of structure, or commonality of ideas and concepts, in their lessons. Problems have been identified in the training process and in analyzing lesson structure, but these problems can be resolved by expending time and by employing subject matter experts. The most relevant suggestion for teacher training and teacher evaluation is that trainers and evaluators focus on low-inference teacher behaviors that can be critiqued objectively. Clusters of such behaviors may provide a key for developing useful theories of instruction. (Author/JD)

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A Low-Inference Indicator of Lesson Organization

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Abstract

This article reviews research on a low-inference variable related to lesson organization, referred to as kinetic structure or commonality. Kinetic structure significantly affects student achievement as well as student perception of lesson effectiveness. Teachers vary greatly in terms of the degrees of kinetic structure their lessons contain. Training programs have been developed to help teachers increase the kinetic structure of their lessons, but such programs have been found to be quite time-consuming. Other results concerning kinetic structures are also discussed.

A Low-Inference Indicator of Lesson Organization

Research on teaching effectiveness indicates that the organization of lessons is an important variable. Bruner (1962, 1964) referred to organization in terms of meaningful relationships among ideas or concepts. He noted that major concepts in a subject matter area can be used to subsume related concepts. Ausubel (1960, 1963) related organization to the use of advance organizers that introduce subsuming concepts involving the subject matter. Taba (1962) discussed organization as the relationship between general goals and specific objectives, as well as the interaction between the content and the learning experiences. Skinner (1953) viewed organization in terms of a sequence or chain of stimuli, where each stimulus arouses a response and also reinforces the response that preceded the stimulus. Gagné (1970) studied organization as it relates to hierarchical arrangements of knowledge. Similarly, Bloom (1976) examined learning tasks according to whether they are related sequentially to other learning tasks. Bellack, Kliebard, Hyman, and Smith (1966) studied lesson organization as a series of pedagogical moves that affect subsequent teacher-student interactions.

While all of the above research has contributed to the development of the variable investigated in this paper, the work of Deese (1962) has a direct bearing on this variable. Deese examined word associations in terms of whether one concept elicits another concept. For example, the concept "piano" may elicit the association of the concept "symphony" and vice versa. Deese also studied concepts in terms of the word associations they have in common. For example, word associations for "piano" might be "note", "song", and "music". These same associations might also be made for "symphony". Deese noted that such concept associations exist in highly organized networks of communication and he stated that concepts that are associated should appear in communication together (or contiguously).

Lesson Structure

Two approaches have been used to study the teacher's organization of lessons. One approach has been to focus on high-inference classroom characteristics as independent variables (e.g., Rosenshine, 1971). High-inference variables are open to subjectivity of the observer. The second approach is to study low-inference variables that can be observed and objectively quantified. In this article a low-inference variable related to lesson organization is described and research concerning this variable is reviewed.

Based on research such as that previously mentioned in this paper, Anderson (1966a, 1966b, 1969a, 1969b, 1969c, 1970, 1971) defined a new method to determine the degree to which a lesson is organized. Anderson referred to lesson organization as "kinetic structure", as "commonality", or simply as "structure". In this paper, lesson organization is referred to as structure. Anderson studied structure according to the repetition of concepts presented in a lesson and the manner in which new concepts are presented. Following a technique similar to that of Deese (1962), Anderson's early 1966 research used a modified rank order correlation coefficient to determine the degree of organization of communication concerning the related concepts within a body of knowledge. Subsequent research (e.g., Anderson, 1969c) defined structure according to the following formula:

$$\underline{B}_1 = \frac{2\underline{n}_1}{\underline{n}_o + 2\underline{n}_1}$$

where $\underline{n}_1$ equals the number of concepts repeated in a pair of consecutive sentences and $\underline{n}_o$ equals the number of concepts in one of a contiguous pair of sentences, but not in both of the sentences. After each value of $\underline{B}_1$ is computed for each pair of consecutive sentences in the lesson, the mean for all the values of $\underline{B}_1$ is defined to be the structure of the lesson. Anderson (1972a) suggested that lesson structure higher than .40 represents a highly organized lesson, whereas a lesson structure of .25 or lower represents a lesson of relatively low structure. Theoretically, a lesson could have a structure of 1.00, but this would occur only if all sentences in the lesson discussed the same concepts and no new concepts were introduced after the first sentence. Such a lesson would be very redundant and would involve very little coverage of subject matter. The lowest possible value for lesson structure is 0.00, and this would occur only if no two consecutive sentences focused on the same concept, each sentence discussing concepts different from the concepts in the preceding sentence. Such a lesson might be difficult to follow because students could have trouble arranging ideas in a logical sequence. Anderson (1974) noted that repetition of substantive concepts is needed for effective lesson organization, but that new ideas must be introduced to maintain student interest and to increase student knowledge. Lamb and Davis (1979) and Smith (in press-b) have identified some lessons with structure lower than .10 and other lessons having structure higher than .80.

Table 1 shows two excerpts from lessons about the history and geography of Alaska. The key concepts for the excerpts are identified and the orders in which the ideas are presented are shown. Smith and Sanders (1981) defined a concept to be a word, phrase, or other symbol that refers to a group of one or more things having common characteristics. Therefore, phrases such as "fur traders" and "Aleutian Islands" are classified as concepts. However, such a definition indicates that phrases such as "southern coast" (sentence 2 of high structure excerpt) and "large amounts" (sentence 3 of high structure excerpt) also are concepts. Therefore, as suggested by Anderson (1969c), only key concepts (concepts that represent ideas pertaining to one or more of the lesson objectives) are used in the computation of each $\underline{B}_1$. In the excerpts shown in Table 1, concepts such as "southern coast" were not classified as key concepts, because they did not focus on any particular lesson objectives.

Insert Table 1 about here

Referring to the computations of structure in Table 1, the first segment of information in the high structure excerpt discusses two key concepts (Russia and Bering), which are concepts 1 and 2 in the list of key concepts. The second segment refers to two key concepts (Bering and Alaska), which are concepts 2 and 3. Therefore segments 1 and 2 have one key concept in common (concept 2), and two key concepts that appear in one of the segments but not the other (concepts 1 and 3). As shown in Table 1, the value of $\underline{B}_1$ for segments 1 and 2 is $\frac{2(\underline{n}_1)}{\underline{n}_0 + 2(\underline{n}_1)} = \frac{2(1)}{2 + 2(1)} = .50$.

In computing $\underline{B}_1$ for segments 2 and 3 of the high structure excerpt, concept 2 is common to both segments and concepts 3 and 4 appear in one of these segments but not the other. Therefore, the value of $\underline{B}_1$ for segments 2 and 3 is $\frac{2(\underline{n}_1)}{\underline{n}_o + 2(\underline{n}_1)} = \frac{2(1)}{2 + 2(1)} = .50$. Similarly, for segments 3 and 4, concepts 2 and 4 are common to both segments and concepts 1 and 5 appear in one segment but not the other. The value of $\underline{B}_1$ for segments 3 and 4 is $\frac{2(\underline{n}_1)}{\underline{n}_o + 2(\underline{n}_1)} = \frac{2(2)}{2 + 2(2)} = .67$. Readers who are not familiar with the structure variable are encouraged to verify the computations for the remaining values of $\underline{B}_1$ shown in Table 1. As mentioned previously, an overall measure for the structure of a lesson is determined by computing the mean of all the values of $\underline{B}_1$ in the lesson.

Student Achievement

Research on lesson structure shows overwhelmingly that structure significantly affects student achievement. Table 2 summarizes the results obtained in 14 studies involving the relationship between lesson structure and student learning. Twelve of the 14 studies are experimental in nature, in the sense that levels of structure were predetermined and then the lessons were prepared and presented in formats (such as tape-recorded lectures or programmed booklets) that preserved the structure. In these studies, students were assigned randomly to groups of varying degrees of structure. A lesson of low structure typically has a mean $\underline{B}_1$ of .30 or lower, a medium structure lesson typically ranges from .30 to .40, and a high structure lesson generally has a mean $\underline{B}_1$ higher than .40. In the 12 experimental studies reviewed in this article, care was taken to present the same content in the low structure lessons as in the high structure lessons.

Structure was varied by changing the order in which concepts were presented rather than changing the number of times concepts were mentioned in lessons.

Two of the 14 studies (Lamb et al., 1979, Smith, in press-b) are correlational or descriptive in design. In the Smith study, intact classes were presented a lesson on an algebra topic by their regular teachers, and then a posttest over this topic was administered. Although correlation does not imply causation, this study was necessary in that teaching was examined in natural settings involving typical classroom interactions. Similarly, Lamb et al. examined lessons in natural settings involving intact classes. Teachers taught lessons about swine flu and students were tested over the content. Then the teachers were trained to increase their lesson structure. Next, teachers taught lessons about swine flu to other intact classes and students again were tested.

The 12 experimental studies controlled the degrees of structure and established cause-and-effect relationships, but in doing so they resembled laboratory studies of teaching (e.g., tape-recorded lessons instead of "live" teaching) rather than naturalistic classroom research. Both approaches, experimental and correlational, present advantages and disadvantages in determining the relationships between structure and student achievement.

Insert Table 2 about here

An examination of Table 2 shows that the two earliest studies that were reviewed (Anderson, 1966b, 1967) researched seventh and eighth grade biology students and their ability to learn about fern morphology by reading programmed booklets. In the 1966 study, two groups were compared, one receiving a lesson with high structure and one receiving a lesson with low structure. The high structure group scored significantly higher on a posttest about ferns than did the low structure group. The 1967 study was conducted similarly, except that 10 levels of structure were determined. The high structure groups scored higher on a posttest than did the low structure groups. Groups that received medium levels of structure did not differ significantly on posttest results.

The study by Trindade (1972) studied eighth grade biology students and covered three lesson topics (digestive systems, bread mold, and scientific names). Three levels of lesson structure were prepared for each of the three topics. A teacher read each lesson to the students. For all three lesson topics, the high structure lesson was superior to the medium structure lesson and the medium structure lesson was superior to the low structure lesson in terms of inducing student achievement on a posttest immediately after the lessons were presented. Trindade also tested the students seven days after the lessons were presented to determine the effect of structure on longer-term retention. He reported that, for the digestive system lesson and the scientific names lesson, the high structure group and the medium structure group both retained significantly more information than did the low structure group. For both lessons, no significant differences in retention were found between the high structure group and the medium structure group. For the lesson on bread mold, retention was low for all three structure groups, to the point that no statistically significant differences were found.

Browne and Anderson (1974) designed tape-recorded lectures on bread mold at three levels of structure. They reported that ninth graders in the high structure group scored significantly higher on a posttest than did the students in the low structure group. Degree of structure was related linearly to achievement, as evidenced by posttest group mean scores of 14.3, 13.7, and 12.8 for the high structure, medium structure, and low structure groups respectively.

Anderson and Lee (1975) reported that ninth and tenth graders learned significantly more from a tape recorded lesson about African sleeping sickness when the lesson's structure was high rather than low. Similarly, junior high school students who were presented tape recorded lessons about ocean life scored significantly higher on a posttest when they received a high structure lesson rather than a low structure lesson.

Ferraro, Lee, and Anderson (1977) studied the effect of lesson structure on different student populations. They prepared tape-recorded lessons about the work of paleontologists. Three versions of the lessons were adjusted for difficulty level so that they would be suitable for second graders, normal adolescents, and educable mentally retarded adolescents. The second graders, as well as the educable mentally retarded students, scored significantly higher on a test over the lesson when they were in the high structure group rather than the low structure group. Although the normal adolescents in the high structure group had higher mean posttest scores than the normal adolescents in the low structure gruop, this difference was not statistically significant. The researchers conjectured that the nonsignificance for the normal adolescents occurred because the subject matter was relatively simple for these students.

Mathis and Shrum (1977) conducted their study with college students. They prepared tape-recorded lectures about the structure and function of biological cells and about the movement of materials in living organisms. They reported that students who were presented the high structure lesson scored significantly higher on a posttest over the material than did students who were presented the low structure lesson. Mathis and Shrum found these results to be consistent regardless of the verbal abilities of the students.

Simmons (1977) reported that ninth graders who received a high structure tape recorded lesson about the microscope learned significantly more than did those who received the low structure presentation. In addition they were rated as being significantly more competent in performing psychomotor skills involving the microscope than were the students who were presented the low structure lesson. Simmons also found that those who received the high structure lesson remained on task longer than those who received the low structure lesson.

Lamb et al. (1979) conducted a descriptive study of structure in which secondary school science teachers presented a lesson about swine flu to one of their regularly scheduled classes. Each lesson was tape recorded. Students were given a test over the content the teachers agreed to cover. The mean structure for the lessons was .28. The teachers then were trained to increase the level of structure of their lessons, after which they each presented another lesson about swine flu to a different intact class. Students again were tested. The mean structure for the second set of lessons was .45. Students who were presented the second set of lessons scored significantly higher than did students who were presented the first set of lessons.

Simmons (1980) revised the presentational format used in her 1977 study by preparing lessons via motion picture films. In the 1980 study, conducted with tenth graders, lessons on segmentation of annelid worms and on parasetic flatworms were presented. For both topics, students who received a high structure presentation scored significantly higher on posttests than did students who were presented low structure lessons.

To determine if structure is a variable that affects achievement in content areas other than science, Smith and Sanders (1981) studied fifth graders in social studies classrooms. They found that students who were presented a high structure lesson about the history and geography of Alaska achieved significantly higher on a posttest than did students who received a low structure lesson on this topic. As in the study by Mathis and Shrum (1979) involving college students, Smith and Sanders reported that structure affected lesson comprehension of the fifth grade students, regardless of their verbal abilities. Calculations of omega squared indicated that lesson structure accounted for 49% of the variance in achievement, whereas verbal ability accounted for 23% of the variance in achievement.

In a study involving high school mathematics students, Smith and Hodgin (in press) reported that students were significantly more able to apply geometry theorems if these theorems were sequenced so that the structure was high rather than low. However, structure accounted for only 7% of the variance in achievement. As in the studies by Anderson (1966b, 1967), lessons were presented in booklet form and students read the material individually.

Smith (in press-a) studied high school students and their ability to comprehend economics concepts. Three levels of structure were constructed and the lessons were presented by a teacher who read from prepared transcripts. Students in the high structure group and the medium structure group achieved significantly higher on a posttest than did students in the low structure group. Although the mean score for the high structure group exceeded the mean score for the medium structure group, the difference between the scores of these two groups was not statistically significant. A very small percentage of the variance in achievement was due to the structure variable. Additional analyses indicated a significant interaction between level of structure and student ability level. Structure significantly affected comprehension of students whose ability levels were above average, but students of average ability and below average ability were less affected by varying degrees of structure. Research studies by Aulls (1975) and Johnson (1964, 1967) support these findings in that students who had no experience in dealing with a particular body of content were not affected by the degree of organization of the content, whereas students who had some experience concerning a body of knowledge were significantly affected by the degree of organization of the content. These results apparently contradict the findings of Anderson (1967) in which students of higher intelligence were affected <u>less</u> by varying degrees of structure than were students of lower intelligence. Similarly, the results of Mathis and Shrum (1979) and of Smith and Sanders (1981) did not identify student ability level as a determinant of the effect of structure on student achievement. An additional significant finding of the Smith (in press-a) study is that structure significantly affected student achievement as measured by questions at the knowledge and comprehension levels of Bloom's taxonomy, but the effect of structure on achievement as measured by questions at the application and analysis levels of Bloom's taxonomy was not significant.

Smith (in press-b) conducted a correlational study of structure. Nineteen high school algebra teachers agreed to teach a lesson on direct variation to one of their regularly scheduled classes. The teachers were given a list of the key concepts they were to cover. Each teacher's lesson was tape recorded and a posttest was administered to each class over the key concepts. Student posttest scores were adjusted for ability level by use of an analysis of covariance, and then the adjusted mean posttest scores for each class were computed. Structure was positively correlated with mean class achievement. In this study, all 19 teachers had relatively high degrees of lesson structure, ranging from .48 to .82, because the material covered in the lesson required a great deal of repetition and practice. But, in spite of these consistently high levels of structure, the degree of structure was significantly related to achievement. Furthermore, 26% of the variance in achievement was attributed to structure.

Student Perception of Instruction

Those who question the value of student evaluations of instruction suggest that the student lacks the experience and the perspective to assess instructional effectiveness. For example, Sheehan (1975) identified factors that may bias student ratings of instruction. Rodin and Rodin (1972) reported a negative correlation between student ratings and student achievement. Smith, Smith, and Staples (1982) reported that achievement and ratings of instruction were not always positively related.

On the other hand, research by Frey (1973), Marsh, Fleiner, and Thomas (1975), Braskamp, Caulley, and Costin (1979), and Marsh and Overall (1980) showed that when instructors of the same course gave a common final examination, the classes that rated their instructors high (low) made high (low) examination scores. Cohen (1981) conducted a meta-analysis that provided strong evidence that student ratings are valid measures of teacher effectiveness.

A review of the literature on lesson structure identified four studies that examined the effect of lesson structure on student perception of lesson effectiveness. Browne and Anderson (1974) found that student evaluations of lessons showed ninth graders were generally unable to discriminate between lessons of high structure and lessons of low structure. Browne and Anderson therefore caution that student evaluations of instruction may not be a valid indicator of teacher effectiveness.

On the other hand, Butterworth (1974) reported that college biology student evaluations of instruction discriminated significantly between lessons of high structure and those of low structure. Butterworth noted that lessons of high structure were rated significantly higher in terms of student ease in understanding the content, student satisfaction in studying the material, and student rating of the lesson as being valuable and relevant.

Simmons (1980) used lesson rating items similar to those of Butterworth and obtained results for tenth graders that were nearly identical to the results of the Butterworth study. Simmons dealt with biology students in this study.

Smith and Hodgin (in press) found that high school mathematics students rated a high structure lesson significantly higher than a low structure lesson in terms of their understanding of the material being presented and in terms of their overall rating of the quality of the lesson. Thus, in three of the four studies of lesson structure and student perception, significant differences in lesson ratings in favor of high structure over low structure were reported.

Other Results Concerning Structure

To determine whether structure varies significantly for a teacher from lesson to lesson and to compare degrees of structure from teacher to teacher, Sharp (1972) tape recorded college physics teachers as they taught their regularly scheduled classes. Sharp found that each teacher's structure remained quite stable from one lesson to the next. However, Sharp discovered that degrees of structure of different teachers varied significantly. In a study of college biology professors, Muehlke (1973) reported results very similar to those of Sharp. Based on the results of these two studies, it is evident that, at least at the college level, some teachers organize their lessons well whereas others present lessons that are poorly organized. This result does not appear to be surprising, except that the conclusion was reached by use of a low-inference variable.

As a result of analyses of science lessons in natural settings (rather than in laboratory settings where recorded lessons are used), Anderson (1972b) concluded that teacher communication in the classroom typically contains a higher degree of structure than does student classroom communication. Anderson also noted that classroom incidents in which the teacher responds to students or builds on student ideas produce higher degrees of lesson structure.

Lamb et al. (1979) conducted a study of secondary school science teachers in which they found that teachers can be trained to increase the structure of their lessons. They reported that training was based on a typical microteaching format in which teachers were videotaped as they presented a lesson, then they were presented the theory of lesson structure, next they analyzed the structure of their videotaped lesson, and then they retaught the lesson. Unfortunately, Lamb and Davis (1979) conducted further research on training teachers to increase lesson structure and identified several problems that are yet to be resolved. One problem is that teachers appeared to be unable to increase their lesson structure simply by studying this variable; teachers needed to complete a microteaching program before they were able to increase their lesson structure (from a mean $\underline{B_1}$ of .25 to a mean of .42 for pre-service teachers and from .28 to .45 for inservice teachers). However, when those who microtaught presented lessons in actual classrooms, their mean structure was .37, compared to a mean structure of .29 for teachers in a control group. Thus, extensive training did increase lesson structure, but this increase was not great enough to produce a statistically significant difference in structure between teachers who were trained and teachers in the control group. A further problem noted by Lamb and Davis is that an accurate analysis of lesson structure required that a lesson be tape recorded and then transcribed. The transcription and subsequent structure analysis required up to 10 hours for a one hour lesson. Lamb and Davis suggested that these time constraints are reason for determining more efficient ways to train teachers to increase lesson structure. For example, further research may show that segments of a lesson can be analyzed and used as reasonable estimates of total lesson structure.

Smith (in press-b) also identified problems in determining structure of "live" algebra lessons. Although key concepts were identified beforehand for the lessons Smith analyzed, many teachers focused their lessons on material that was only partially related to the lesson objectives. Thus, more concepts were introduced into the lessons, and many of these concepts were added to the list of key concepts before structure analyses were begun. Smith noted that problems existed in obtaining reliable ratings of lesson structure. These problems were resolved only when subject matter experts (in this case, mathematics majors) were used as coders. Because of the time required to analyze lesson structure and the meticulous care necessary to obtain reliable structure ratings, educators might be wise to reserve training in improving structure to those teachers who have been identified as needing help in planning and presenting well-organized lessons. Such identification could be based on student evaluations of instruction as well as on observations by experts in subject matter areas.

SUMMARY

This article has reviewed research on lesson structure, a low-inference indicator of lesson organization. Lesson structure has been shown to affect achievement positively, and students generally rate lessons higher when the structure of the lessons is relatively high. Teachers vary in the degree of structure of their lessons, thus indicating that some teachers could profit by being trained to increase the degree of structure of their lessons. Problems have been identified in the training process and in analyzing lesson structure, but these problems can be resolved by expending time and by employing subject matter experts.

The most relevant suggestion for teacher training and teacher evaluation is that trainers and evaluators focus on low-inference teacher behaviors that can be critiqued objectively. According to Gage (1978), clusters of such behaviors may provide a key for developing useful theories of instruction.

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Table 1. - Excerpts from High and Low Structure Lessons

Key Concepts

1. Russia
2. Bering
3. Alaska
4. Fur (traders, otters, seals)
5. Aleutian Islands
6. Alaskan settlements
7. United States

High Structure Lesson	Key Concepts	B_1
1. The Russian government sent Bering to explore the northern part of the Pacific Ocean.	1,2	—
2. Bering landed on the southern coast of Alaska in 1741.	2,3	$\frac{2(1)}{2+2(1)} = .50$
3. Bering told of large amounts of sea otters and fur seals.	2,4	$\frac{2(1)}{2+2(1)} = .50$
4. Because of Bering's news, Russian fur traders began coming to the Aleutian Islands.	1,2,4,5	$\frac{2(2)}{2+2(2)} = .67$
5. Russia soon founded settlements in Alaska.	1,6	$\frac{2(1)}{4+2(1)} = .33$
6. Later, Russia offered to sell Alaska to the United States.	1,3,7	$\frac{2(1)}{3+2(1)} = .40$
Low Structure Lesson		
1. The Russian government sent Bering to explore the northern part of the Pacific Ocean.	1,2	—
5. Russia soon founded settlements in Alaska.	1,6	$\frac{2(1)}{2+2(1)} = .50$
2. Bering landed on the southern coast of Alaska in 1741.	2,3	$\frac{2(0)}{4+2(0)} = 0$
6. Later, Russia offered to sell Alaska to the United States.	1,3,7	$\frac{2(1)}{3+2(1)} = .40$
3. Bering told of large amounts of sea otters and fur seals.	2,4	$\frac{2(0)}{5+2(0)} = 0$
4. Because of Bering's news, Russian fur traders began coming to the Aleutian Islands.	1,2,4,5	$\frac{2(2)}{2+2(2)} = .67$

Table 2. - Studies of Structure and Achievement

Reference	Number of Students	Grade Level	Subject Matter	Presentational method	Level of Structure	Effect of structure on achievement	Significance Level
Anderson (1966b)	161	7	Biology: Fern morphology	Programmed booklets	2 (High, Low)	High > Low	.01
Anderson (1967)	160	7-8	Biology: Fern morphology	Programmed booklets	10	Very high > Very low	.01
Trindade (1972)	60	8	Biology (3 topics); a. Human digestive system b. Life cycle of bread mold c. Scientific names	Lecture (read from prepared manuscripts	3 (High, Medium, Low)	For all 3 lesson topics, High > Medium > Low	.01 to .05
Browne & Anderson (1974)	191	9	Biology: Bread mold	Tape recorded lecture	3 (High, Medium, Low)	High > Low	.05
Anderson & Lee (1975)	61	9-10	Biology: African sleeping sickness	Tape recorded lecture	2 (High, Low)	For both lesson topics, High > Low	.01
	41	7- 8	Life in the ocean				
Ferraro, Lee, & Anderson (1977)	80 41 (Normal) 60 (EMR)	2 6- 7 6- 7	Biology: Work of a paleontologist (3 lessons adjusted for grade level and IQ)	Tape recorded lecture	2 (High, Low)	For 2nd graders and for EMR students, High > Low	.05
Mathis & Shrum (1977)	101	College	Biology: Cells and living organisms	Tape recorded lecture	2 (High, Low)	High > Low	.05
Simmons (1977)	80	9	Science: Parts of the microscope	Tape recorded lecture	2 (High, Low)	High > Low	.01

Table 2.- Studies of Structure and Achievement (continued)

Reference	Number of Students	Grade Level	Subject Matter	Presentational method	Level of Structure	Effect of structure on achievement	Significance Level
Lamb et al. (1979)	299	8-12	Science Swine flu	Live classroom presentations	No fixed levels	Structure positively related to achievement	.01
Simmons (1980)	70	10	Biology: a. Segmentation of annelid worms b. Parasetic flatworms	Motion picture film	2 (High, Low)	For both lessons, High > Low	.01
Smith & Sanders. (1981)	72	5	Social Studies: Alaska	Tape recorded lecture	2 (High, Low)	High > Low	.001
Smith & Hodgin (in press)	84	11-12	Mathematics: Geometry theorems	Booklets	2 (High, Low)	High > Low	.05
Smith (in press a)	144	11-12	Economics: Free market systems	Lecture (read from prepared manuscripts)	3 (High, Medium, Low)	High > Low Medium > Low	.05
Smith (in press b)	337	9-11	Mathematics: Direct variation	Live classroom presentations	No fixed levels	Structure positively related to achievement	.05