DOCUMENT RESUME

ED 121 757 SP 010 020

AUTHOR Carifio, James
TITLE The Relative Effects of Alternative Learning Structures on Attitudes and Achievements.
PUB DATE 76
NOTE 30p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, California, 1976)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage
DESCRIPTORS *Academic Achievement; *Education Courses; Education Majors; *Learning Processes; Measurement; *Sequential Approach; *Student Attitudes; Tests; Undergraduate Students

ABSTRACT

This study compared two learning structures for an introductory course in tests and measurements in terms of their relative effects on attitudes and achievement. The first structure represented a functionally arranged instructional sequence (FAIS). The second represented a psychologically arranged instructionel sequence (PAIS). The instructional sequencing effects were investigated in terms of a completely-crossed Treatment by Instructor by Aptitude design. The four instructors were male, well- trained in measurement, but with different degrees of experience in teaching this content. The subjects were 143 female and 14 male-undergraduate elementary education majors enrolled in a 16 week block course. Students were quasi-randomly assigned to treatment groups. Students constructed their achievement tests (the performance measure) at the end of their unit on Measurement Theory. For the FAIS group this was near the beginning of the term; for the PAIS group this was near the end of the term. At the end of the term post attitude and instructor evaluation data were collected. A final summative achievement measure on all course objectives was administered 10 days later. Under the FAIS treatment the most experienced instructor got high achievement but negative attitude gains, whereas under the PAIS treatment this instructor got both high achievement and positive attitude gains. The PAIS treatment produced consistent results regardless of instructor or level of aptitude. (RC)

THE RELATIVE EFFECTS OF ALTERNATIVE LEARNING STRUCTURES ON ATTITUDES AND ACHIEVEMENTS

James Carifio, Boston University

The present study compared two learning structures for an introductory course in tests and measurements. The first structure represented a functionally arranged instructional sequence (FAIS) for this curriculum; the second a psychologically arranged instructional sequence (PAIS). Hypotheses were investigated in a Sequence by Teacher by Aptitude design (2x4x2) in terms of eleven dependent variables. Multivariately, the PAIS treatment proved superior to the FAIS treatment.

Paper presented at the 1976 Annual meeting of the American Educational Research Association, San Francisco, California.

Responding to several surveys done on the needs of in-service teachers, Mayo (1967) conducted a four-year national study on training programs in educational measurement. The results of this four-year study (N=2,877) were as follows:

> Although pre-service training programs in educational measurement were extremely pervasive, the effectiveness of the types of training available was remarkably poor (means of less than 50% mastery in almost all of the groups observed). Gains in measurement competencies two years after pre-service training were also minimal regardless of whether the intervening experience was teaching, in-service training, or graduate study. It was therefore concluded that while the presence or absence of training had some effect on achievement, "whether a person had one treatment or another made little practical difference in observed measurement competencies (Mayo, 1967; p. 55)."

With regards to these findings, Mayo speculated that the negative attitudes of many students towards tests, evaluation, statistics, and mathematics might be important factors in their lack of initial or subsequent attainment of measurement competencies.

Working independently of Mayo, Goslin (1967) did a cross-sectional survey of public, private, and parochial school teachers (N=1,879) concerning their uses of and attitudes towards standardized tests. Goslin found that 40% of the teachers surveyed had minimal knowledges of standardized tests, and that there was a moderate correlation (r=+.44) between teachers' attitudes towards standardized tests and their amount of training in measurement. Goslin also found that teachers' knowledges of and attitudes towards tests influenced the types of information they utilized in decision-making as well as the quality of educational decisions they made. Like Mayo, Goslin concluded that explicit consideration needed to be given to developing successful teacher-training programs in educational measurement.

Purpose of the Present Study

The present study compared two learning structures for an introductory course in tests and measurement in terms of their relative effects on attitudes and achievement. The first of these two learning structures represented that instructional sequence most commonly employed for this curriculum as established by both the Mayo (1967) study and a more recent textbook survey conducted by this writer (Carifio, 1972). This traditional instructional sequence was taken to be representative of a functional learning structure, or the common-sense prescription that curriculum content needs only to be organized in some plausible developmental order for effective learning to occur. The second learning structure used in the present study was derived by the technique of task analysis (Gagne, 1970) and represented that instructional sequence which may have better maximized positive transfer between the knowledge elements of this curriculum. This latter instructional sequence was taken to be representative of a psychologically arranged learning structure for the content of this curriculum.

Description of Sequences

Figure I describes the functionally arranged (i.e., common or typical) instructional sequence employed for the measurement curriculum.[1] As can be

---

[1] Full explication of the theory and background of this topic is not possible within the confines of this short paper whose primary goal is to report the results of the experiment conducted. For a full discussion of this topic see Ausubel (1968) on rote versus meaningful instructional sequences, or Gagne (1970) on effective learning structures. In terms of general theoretical perspective, this writer feels that Ausubel's views are the most comprehensive in both scope and explanatory power of all those who have written on this subject. In terms of concretely applying Ausubel's views, however, this writer found Gagne's taxonomy of generalized learning types and technique of task analysis to be most helpful in identifying the subordinate-superordinate and transfer relationships that were inherent in the subject matter to-be-acquired.

Figure I

The Common or Functionally Arranged Instructional Sequence for an Introductory Course in Tests and Measurement

Topic 1: Measurement Theory (Operational Strategies)

1.1 Specification of Curriculum Outcomes: learning and behavioral objectives

1.2 Taxonomies of Educational Objectives: Bloom's taxonomy of the cognitive domain, Krathwohl's taxonomy of the affective domain

1.3 Task Analysis and the Planning of Assessment Procedures: universes, domains, tables of specification, representativeness, and sampling

1.4 Types of Assessment Procedures: objective, subjective, and performance measures

1.5 Measurement Principles Common to Different Assessment Procedures: comparability, sampling, procedures of scoring, etc.

1.6 The Construction and Scoring of Assessment Procedures

Topic 2: Descriptive Statistics (Concept Learning)

2.1 Organizing and Translating Information: coding, distributions, tables, sampling, and representativeness

2.2 Measures of Central Tendency: mode, median, mean

2.3 Measures of Variability: range, quartiles, standard deviation, variance

2.4 Normal and Skewed Distributions

2.5 Information Scales and Statistics Appropriate to Them: no minal, ordinal, interval, and ratio scales

2.6 Making Elementary Comparisons: standard scores and norms

2.7 Interpreting Descriptive Statistics: synthesis of concepts and principles

Topic 3: Correlation (First-Order Principle Learning)

3.1 Dependent and Independent (functional) Relationships

3.2 Scatter Plots and Correlation Coefficients

Figure I (continued)

3.3 Explained and Unexplained Variance

3.4 Prediction and Regression

3.5 Interpreting Correlation Coefficients

Topic 4: Reliability: Stability, Comparability, Consistency (Second-Order Principle Learning)

4.1 Definitions of and Relationships between Reliability and Validity

4.2 Error Theory, Sources of Error, and the Standard Error of Measurement

4.3 External Determinations of Reliability: test-retest, equivalent forms

4.4 Internal Determinations of Reliability: split-halves, odd-even, internal consistency

4.5 Interpretations of and Relationships between Reliability Estimates

Topic 5: Validity: Interpretability and Meaningfulness (Third-Order Principle Learning)

5.1 The Concept of Differential Evidence

5.2 Face Validity

5.3 Content Validity: expert, curricula

5.4 Predictive Validity

5.5 Construct Validity: convergent, discriminant, cross-validation

5.6 Interpretations of and Relationships between Different Kinds of Validity

5.7 Types of Measures and the Validities They Should Have

5.8 Instrument Revision Based on Empirical Data

---

seen from Figure I, the common instructional sequence seems to reflect the series of steps one goes through in developing a measuring instrument.[1] This is to say, first one constructs a test (Measurement Theory), then one collects some data on the test constructed (Descriptive Statistics), and then one determines the quality of both the instrument and information collected (Correlation, Reliability, and Validity). In this sense, the common instructional sequence seems to be both "logical" and highly "plausible." A learner-centered task analysis of this curriculum, however, presents a somewhat different picture.

When one begins to task analyze Measurement Theory (the first topic in the common instructional sequence) to determine its subordinate knowledge elements or relevant anchoring ideas, one begins to realize how heavily the topic relies on the concepts and principles of descriptive statistics, correlation, reliability, and validity.[2] Reliability and validity are reflected throughout the content of Measurement Theory as are the principles of distributiveness, sampling, and correlation. The common instructional sequence, then, begins by requiring students to acquire new and complex ideas which are based on other ideas (concepts and principles) they have not yet acquired. This beginning not only creates a rote learning situation, but it also drastically diminishes the affective impact of this content (which is the most

---

[1] No rationale has ever been stated for this instructional sequence to the best of this writer's knowledge.

[2] In addition to Gagne's question of "What must the learner be able to do to acquire this competency," this writer also kept asking the Ausubellian question of "What must the learner know to understand the rationale behind, the meaningfulness in, and value of this particular learning" throughout the course of analysis. It was from a continual answering of this second question that the alternative instructional sequence emerged.

controversial of the units in this curriculum) upon the learner (see Ausubel and Fitsgerald, 1963).

If one used Gagne's taxonomy or Ausubel's notions of meaningful learning as a guide, one would make Measurement Theory the last unit in this curriculum with the other topics retaining their original ordering (see Figure II).[1] Such an ordering of the content units of this curriculum would create most of the properties of an effective learning structure that are typically cited in the literature on this subject (see Ausubel, 1968; Briggs, 1968; Heimer, 1968; Gagne, 1970). The net effects of these properties should produce better overall achievement in the various competencies of this discipline in the psychologically arranged instructional sequence. The differential effects of encountering Measurement Theory last (i.e., after learning the concepts and principles of the discipline) should produce better attitude changes in the learner due to better cognitive readiness to evaluate the soundness of the subject-matter content, rationales, and arguments encountered at that point in time. Since Mayo (1967) cited attitudes towards tests, evaluation, and mathematics as being potentially critical factors in terms of this curriculum, these were the specific attitudes that were focused upon in this study.

Methodology

Instructional sequencing effects were investigated in the present study in terms of a completely-crossed Treatment (Sequence) by Instructor by Aptitude (high-low) design (2x4x2). The four instructors were male, well-trained

---

[1] Subtopics were vertically arranged to maximize transfer and held constant in both sequences in the present study; only the between topics structure was varied.

Figure II

The Alternative Learning Structures Used for the Introductory Tests and Measurement Curriculum

Functionally Arranged Sequence	Psychologically Arranged Sequence
Topic 1: Measurement Theory (OS)	Descriptive Statistics (C)
Topic 2: Descriptive Statistics (C)	Correlation (1st order P)
Topic 3: Correlation (1st order P)	Reliability (2nd order P)
Topic 4: Reliability (2nd order P)	Validity (3rd order P)
Topic 5: Validity (3rd order P)	Measurement Theory (OS)

C = Concept learning
P = Principle learning
OS = Operational strategies

in measurement, but with different degrees of experience in teaching this content (novice to expert). Prior to the experiment, the two novice instructors (instructors 1 and 2 in all tables) favored the functionally arranged instructional sequence (FAIS), while the two experienced instructors (Instructors 3 and 4 in all tables) favored the psychologically arranged instructional sequence (PAIS). Subjects were 157 undergraduate elementary education majors enrolled in a 16-week block course at Boston University in Semester I, 1972. The sample was comprised of 143 females and 14 male subjects. Mayo (1967) found no sex differences in the learning of measurement.

The dependent variables that were investigated in the present study are given in Table I. As can be seen from Table I, five achievement variables,

Table I

List of Dependent Variables Investigated

MT	=	Achievement in Measurement Theory
STAT	=	Achievement in Descriptive Statistics
CORR	=	Achievement in Correlation
RELI	=	Achievement in Reliability
VALI	=	Achievement in Validity
TCON	=	Standardized performance measure of student's ability to construct a classroom achievement test
CDAT	=	Cognitive Dimension of Attitude Towards Tests
ADAT	=	Affective Dimension of Attitude Towards Tests
CDAE	=	Cognitive Dimension of Attitude Towards Evaluation
ADAE	=	Affective Dimension of Attitude Towards Evaluation
CDAM	=	Cognitive Dimension of Attitude Towards Mathematics

one performance variable and three attitude variables were investigated. The attitude measures used in the present study were semantic differentials developed specifically to reflect Peak's (1955) two factor theory of attitude (cognitive and affective dimensions). Table II gives the factor structure of the semantic differential used to measure attitude towards tests.[1] The same bipolar pairs as given in Table II were used to measure attitude towards evaluation with the same type of factor structure resulting. McCallon's (1972) ATM

[1] All factor analyses reported in this paper are principle component solutions with varimax rotations.

Table II

Factor Structure of Attitude
Towards Tests Semantic Differential

PAIR	I	II	h^2
meaningful: meaningless	**.79**	.34	.73
concealing: revealing	**.74**	.28	.63
necessary: unnecessary	**.81**	.18	.69
useful: useless	**.82**	.34	.79
oppressive: liberating	.38	**.65**	.56
effective: ineffective	**.78**	.36	.74
boring: interesting	.28	**.68**	.53
beneficial: harmful	**.70**	.38	.63
frustrating: stimulating	.23	**.77**	.63
valuable: worthless	**.81**	.29	.75
pleasant: unpleasant	.25	**.78**	.67
sinister: intriguing	.25	**.75**	.50
important: unimportant	**.81**	.29	.74
repugnant: likable	.24	**.80**	.70
needed: unneeded	**.75**	.33	.67
helpful: hindering	**.72**	.40	.53
satisfying: unsatisfying	.48	.57	.55
N = 477	40%	26%	66%

I = Cognitive Dimension II = Affective Dimension semantic differential was used to measure attitude towards mathematics. This scale reduced to one factor (the cognitive dimension) for the experimental group used in the present study, thus the missing dimension on this measure. A simple sum of the scores divided by the number of items constituting the factor procedure was used to score the semantic differential data collected (see Dagenais and Marascuilo, 1973).

The classroom achievement test each student constructed (the performance measure) was blind-scored by two instructors using a 56 judgement analytical rating scale. The average score of the two judges was used as the score on this variable for the student. Table III presents the reliability data on the dependent variables investigated in the present study and Table IV presents the factor structure of these variables.

Twelfth-grade grade math and verbal SAT scores were used as estimates of aptitude. The median combined SAT score (993) was used to divide the sample into high and low aptitude scores. Pre-treatment attitude scores were gathered one week prior to treatment as part of a larger data gathering package for the entire block course. Students were told that all data collected would be used for block planning and evaluation purposes. This practice had been in use for two semesters prior to this experiment.

Students were assigned to treatments in a quasi-random manner; i.e., students with automobiles for field experience were randomly assigned to groups first and then the remainder of students were randomly assigned. This procedure was checked with the pre-treatment data available (attitude and SAT scores) and the groups were found to be equivalent. Treatments were administered to groups according to a counter-balanced timing schedule; namely, each group did not receive treatment at the same time of day or in the same room over the course of the semester, nor did any one group. At the end of

Table III

Reliability Coefficients for Dependent Variables

Variable	n_a	k	Alpha	n_{tt}	r_{tt}
TM	371	12	.46	62	.88
STAT	371	17	.66	62	.91
COR	371	13	.69	62	.93
RELI	371	10	.52	62	.89
VALI	371	13	.55	62	.90
TCON	50	56	.79	50	.87*
CDAT	377	10	.89	54	.91
ADAT	377	7	.81	54	.87
CDAE	377	10	.88	54	.90
ADAE	377	7	.76	54	.84
CDAM	377	13	.88	54	.94

k = number of items

Alpha = coefficient alpha

r_{tt} = test-retest reliability coefficient (14 day interval)

* = inter-rater reliability coefficient for 4 raters on a sample of 50 student test constructions

each instructional unit, students were given a criterion-referenced mastery test on the unit studied.[1] Review was given to students who did not reach criterion. Modular self-instructional material and practice exercises on each unit were distributed to each student at the beginning of each unit to be used as supplements to (or replacements of) the classroom instruction.

[1] Different forms of the same set of mastery tests were used in each sequence.

Table IV

Factor Structure of Dependent Variables

Variable	I	II	III	IV	V	VI	h^2
MATH APT	57	03	-16	55	16	-30	77
VERBAL APT	67	-08	-16	18	13	-39	69
PRE CDAT	07	77	10	18	-16	01	67
PRE ADAT	03	76	06	17	-04	-04	61
PRE CDAE	-02	03	87	05	21	-08	82
PRE ADAE	02	-02	86	-03	28	-01	81
PRE CDAM	14	18	04	89	-02	06	84
POST CDAT	13	78	-04	01	29	01	71
POST ADAT	13	81	-10	09	23	-07	75
POST CDAE	00	09	23	06	83	-05	76
POST ADAE	-04	09	25	05	80	04	72
POST CDAM	15	30	03	78	12	05	74
MT	71	12	22	06	-15	00	59
STAT	68	-08	06	29	01	22	60
COR	75	13	-21	-03	14	14	66
RELI	70	05	08	18	-15	-01	56
VALI	81	11	-05	-02	01	09	67
TCON	14	-10	-12	06	01	86	79
Percentages of total variance	19.8	14.8	10.1	10.8	9.6	6.1	71

Students constructed their achievement tests (the performance measure) at the end of their unit on Measurement Theory. For the FAIS group, this was near the beginning of term; for the PAIS group, this was near the end of term. At the end of term (15 weeks), post attitude data were collected, as well as instructor evaluation data (responded to anonymously) using an amended version of the Hildebrand (1972) scale (a sixth subscale dealing with assessment and evaluation was added). Ten days later, the final summative achievement measure (65 multiple-choice items) on all course objectives was administered. None of the treatment groups had previously seen any of the items on this measure.

Results

Table V presents the results of a Sequence by Instructor by Aptitude (2x4x2) multivariate analysis of variance (MANOVA) done on the pre-treatment attitude data collected in the present study.[1] As can be seen from Table V, significant pre-treatment differences were found between high and low aptitude students on the affective dimension of attitude towards tests and on the cognitive dimension of attitude towards mathematics. Table VI presents the means and standard deviations of high and low aptitude students on the pre-treatment attitude data collected in the present study. If Table VI is examined in relationship to Table V and the factor analytical information given in Table IV, the following findings should become manifest:

(1) Students' attitudes towards tests are independent of their attitudes towards evaluation, but slightly correlated to their attitudes towards mathematics (see Table IV). This is a finding that has been cross-validated by this writer in a larger

[1] All multivariate analyses were done with the University of Buffalo MANOVAC program; cell means are reported at the end of this paper.

Table V

Results Matrix for a Sequence by Instructor by Aptitude (2x4x2) MANOVA of Pre-Treatment Attitude Scores

Variable	Sequence	Instructor	Aptitude	SxI	SxA	IxA	SxIxA
Pre CDAT	NS	NS	NS	NS	NS	NS	NS
Pre ADAT	NS	NS	*	NS	NS	NS	NS
Pre CDAE	NS	NS	NS	NS	NS	NS	NS
Pre ADAE	NS	NS	NS	NS	NS	NS	NS
Pre CDAM	NS	NS	**	NS	NS	NS	NS
Multivariate F	NS	NS	**	NS	NS	NS	NS

* = $p<.05$ ** = $p<.01$

Table VI

Pre-Treatment Attitude Means for High and Low Aptitude Students

		CDAT		ADAT		CDAE		ADAE		CDAM	
	n	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
High Apt.	77	4.2	1.0	3.3	0.7	5.6	0.6	4.6	0.6	4.7	0.9
Low Apt.	79	4.1	1.1	3.0	0.8	5.6	0.7	4.6	0.6	3.7	0.9

(N=377) and more heterogeneous sample of people than those in this study, and it is not a finding that one would "logically" expect in terms of these attitudes;

(2) Students of high aptitude tend to enter the instructional situation in this subject matter with a very positive attitude towards evaluation, a somewhat negative attitude towards tests, and a somewhat positive attitude towards mathematics (see Table VI);

(3) Students of low aptitude tend to enter the instructional situation in this subject matter with a negative attitude towards tests, a positive attitude towards evaluation, and a negative attitude towards mathematics (see Table VI);

(4) Tests are a potent affective stimulus to students entering the instructional situation in this subject matter area (see Table VI);

(5) Both attitude towards tests and attitude towards mathematics are significantly related to achievement in this subject matter content (see Table IV and Table X).

The above findings would seem to (a) confirm Mayo's speculations about the existence and possible importance of attitudinal factors in the acquisition of this subject matter content (with the exception of attitude towards evaluation), and (b) suggest the possible importance of attending to affective factors in designing effective instructional programs (i.e., instructional sequences).

A Sequence by Instructor (2x4) multivariate analysis of variance was computed on the six subscales of the post-treatment teacher evaluation data collected in the present study. A significant treatment by instructor interaction was found with instructor 1 (least experience in teaching this content) being rated significantly higher in the PAIS treatment and significantly lower in the FAIS treatment than the other three instructors on all six subscales. The between-treatments and between-instructor ratings for the other three instructors were not significantly different from each other on any of the six subscales examined and the ratings of all instructors on all subscales were above 5.0 on a 7.0 scale. These results might be interpreted in more than one way, but this writer interprets them as being confirmatory of the hypothesis that these instructors delivered high quality teaching in both instructional sequences and did not consciously do anything to bias the results of this experiment.

Table VII presents the results of a Sequence by Instructor by Aptitude (2x4x2) multivariate analysis of covariance done on the eleven dependent variables investigated in the present study (see Table I) using the five pretreatment attitude measures as covariates. As can be seen from Table VII, the PAIS treatment produced superior results to the FAIS treatment at the .001 level on all of the dependent variables investigated except the cognitive and affective dimensions of attitude towards evaluation. Selected instructor differences were observed at the .001 level on five of the eleven dependent variables investigated. It is important to note in interpreting the results of the aptitude factor in Table VII that no significant posttreatment aptitude differences were observed in terms of the affective dimension of attitude towards tests or the cognitive dimension of attitude towards mathematics. The reason for this lack of differences may be best understood by examining the average attitude change scores (see Richards, 1975) given in Table VIII.

As can be seen from Table VIII, low aptitude students in the FAIS treatment became significantly more negative on the affective dimensions of attitudes towards tests and evaluation, while low aptitude students in the PAIS treatment became more positive in all attitudes at a rate equal to high aptitude students in the PAIS treatment and greater than high aptitude students in the FAIS treatment.[1] In fact, the overall profile of low aptitude students

[1] All students' attitudes on the cognitive dimension of attitude towards tests became significantly more positive, but this outcome was to be expected from Goslin's findings reviewed in the introduction of this paper.

Table VII

Results Matrix for Sequence by Instructor by Aptitude (2x4x2) MANCOVA on the Eleven Dependent Variables Investigated in the Present Study Using the Five Pre-Treatment Attitude Measures as Covariates

Variable	Sequence	Instructor	Aptitude	SxI	SxA	IxA	SxIxA
TTH	**	*	***	NS	NS	NS	NS
STAT	***	***	***	NS	NS	NS	NS
CORR	***	NS	***	NS	NS	NS	NS
RELI	**	NS	***	NS	NS	NS	NS
VALI	***	*	***	NS	NS	NS	NS
TCON	***	NS	NS	NS	NS	NS	NS
CDAT	***	***	NS	*	NS	NS	NS
ADAT	***	*	NS	NS	NS	NS	NS
CDAE	NS	NS	*	NS	NS	NS	NS
ADAE	NS	NS	NS	NS	NS	NS	NS
CDAM	**	NS	NS	NS	NS	NS	NS
Multi-variate F	***	***	***	NS	NS	NS	NS

* = p<.05 ** = p<.01 *** = p<.001

All results in expected direction; i.e., PAIS greater than FAIS

in the PAIS treatment given in Table VIII more closely resembles the overall profile of high aptitude students in the FAIS treatment than low aptitude students in the FAIS treatment.[1] This consistency of effects of the PAIS treatment is its distinguishing characteristic as may be observed from Tables IX and X.

[1] Although several treatment by aptitude interactions approached significance (.10 level) none were actually observed in any of the analyses done.

Table VIII

Comparisons of Post-Treatment Means or Gains on Dependent Variables

Sequence	APT	n	CDAT	ADAT	CDAE	ADAE	CDAM
FAIS	HIGH	39	.76*	.23	.43	.10	-.07
	LOW	39	.59	-.41	.89	-.87	-.15
PAIS	HIGH	38	1.3	.73	.40	.18	.11
	LOW	40	1.4	.68	.27	.47	.51

* Average point change in attitude from pretest on a 1 to 7 scale.

Sequence	APT	n	MT	STAT	CORR	RELI	VALI	TCON
FAIS	HIGH	39	66**	70	77	65	66	83
	LOW	39	52	55	63	49	55	83
PAIS	HIGH	38	72	77	85	71	72	88
	LOW	40	61	68	75	57	64	87

** Percentage of total items answered correctly.

As can be seen from Table IX, the differences between treatments are greater for the inexperienced instructors than for the experienced instructors. Under the FAIS treatment, instructor effects are quite variable, whereas under the PAIS treatment the instructor effects are fairly homogeneous.[1] This pattern of instructor effects was observed across all of the dependent variables

[1] In this sense, the PAIS may be said to reduce or compensate for teacher effects.

Table IX

Sequence by Instructor by Aptitude (2x4x2) Analysis of Variance on Total Post-Treatment Achievement Scores

	FAIS				PAIS			
	n	Hi Apt	n	Lo Apt	n	Hi Apt	n	Lo Apt
I_1	9	42.2	9	33.3	9	48.6	10	40.8
I_2	10	43.9	10	34.2	10	49.2	10	41.3
I_3	10	45.7	10	37.6	10	49.3	10	43.5
I_4	10	48.1	10	39.4	10	49.5	10	44.5
	39	45.1	39	36.2	39	49.2	40	42.5

Source	df	MS	F	P
Sequence	1	1063.1	25.6	<.001
Instructor	3	132.7	3.2	<.03
Aptitude	1	237.4	57.3	<.001
SxI	3	24.2	0.6	>.05
SxA	1	46.3	1.1	>.05
IxA	3	11.2	0.3	>.05
SxIxA	3	3.0	0.1	>.05
Error	140	41.5	-	-

Table X

Correlations Between Aptitude,
Pre-Attitude and Post-Achievement Scores

	FAIS						
	MSAT	VSAT	CDAT	ADAT	CDAE	ADAE	CDAM
TTH	43	40	27	19	01	11	32
STAT	51	34	18	20	03	09	43
CORR	48	48	26	23	02	-09	19
RELI	46	43	19	14	07	05	39
VALI	46	37	19	11	-12	-08	40
TOTA	60	51	28	23	00	02	40
TCON	-08	02	01	-04	02	02	03

$r = .17 \quad p<.05$

	PAIS						
	MSAT	VSAT	CDAT	ADAT	CDAE	ADAE	CDAM
TTH	28	42	-04	11	04	16	21
STAT	44	27	06	10	03	13	33
CORR	28	24	00	03	-28	-20	13
RELI	37	27	04	-11	-03	-01	23
VALI	35	33	-02	-07	03	08	15
TOTA	50	44.	01	00	-05	05	31
TCON	13	-07	-09	01	-17	-06	10

$r = .17 \quad p<.05$

investigated. Under the FAIS treatment, the most experienced instructor got high achievement but negative attitude gains, whereas under the PAIS treatment this instructor got both high achievement and positive attitude gains (see cell means at the end of this paper). The PAIS treatment produced consistent results (higher achievement and positive attitude changes) regardless of instructor or level of aptitude. This consistency of effects is what most distinguished the PAIS treatment from the FAIS treatment, as can be seen from Tables IX and X.

Discussion

The results of the present study would seem to be fairly clear in terms of whether or not "functional" or "common sense" notions of subject-matter structure or instructional sequencing are sufficient for designing effective curricula or instructional programs in all situations. The results of the present study would also seem to be fairly clear in terms of the possible affective importance of instructional sequencing in many situations. This is to say, the learning of B might be placed before the learning of A for "meaningfulness" or affective reasons rather than for "prerequisite" learning reasons. There are a number of instructional situations where this point would seem to apply, which is to say no more than that the operations and effects of any given instructional sequence should be carefully analyzed and thought about in terms of what is known about learning in the broadest sense of the term. Thinking about instruction or instructional sequencing from a behaviorist or neobehaviorist point of view leads one logically to the position that all learnings are essentially of equal unit value as are all learning experiences. The results of the present study would seem to suggest that such a theoretical view does not adequately capture the phenomena in question, and that Ausubel's notions of meaningfulness and cognitive view of learning need to be integrated into the models of instruction presently available. In many respects, however, the results of the present study are not that clear and are in need of replication.

Kingsley and Stelzer (1973) have written quite cogently on the context conditioned nature of all subject-matter learning and instructional situations. In Kingsley and Stelzer's view, one cannot generalize about subject-matter learning qua subject-matter learning because the nature of what is learned is relative to the objectives of the specific learning situation in question. Change the nature of the instructional objectives and the nature of the instructional problem might change quite drastically. The present writer not only holds the Kingsley and Stelzer view to be correct but also feels that it is particularly true of the instructional sequencing question. This is to say, there seems to be a set of conditions (if one carefully reviews the literature on this subject) under which instructional sequencing can be expected to effect instructional outcomes, and the importance of sequence as an instructional variable seems to be relative to these condition. These conditions as identified from the literature seem to be:

(1) that the subject matter to-be-learned is complex, difficult, and unfamiliar to the learner (Tobias, 1971);

(2) that there is a high degree of interdependency or relatedness between the knowledge elements (concepts, principles, ideas, or operational strategies) of the subject matter to-be-acquired (Gagne, 1965; Ausubel, 1968);

(3) that the subject matter to-be-learned has an a priori potential for being structured (i.e., temporally arranged) in terms of its own internal logic, subsuming ideas, cognitive anchors, or needed or facilitory "prerequisite learning" (Briggs, 1968);

(4) that the subject matter to-be-learned is controversial and in conflict with the leaner's attitudinal bias (Ausubel and Fitsgerald, 1961);

(5) that the learner lacks certain characteristics (e.g., high aptitude, special abilities, or various mathemagenic behaviors) which facilitate the learning desired independent of any particular kind or type of instruction or learning structure (Ausubel, 1968; Rothkopf, 1970; and Salomon, 1973); and,

(6) that the duration of instruction is sufficient for structuring effects to manifest themselves (Roe, 1961).

Under the above set of instructional condition, "equally plausible" modes of subject-matter organization will not have equal effects as the present study has demonstrated in terms of the "experimental instance." In terms of exactly specifying what PAIS treatments will be like for different subject matter areas and instructional problems, this writer feels that we are no closer to the algorithm Heimer (1969) desires than previously, and that the derivation of PAIS treatments will still be a matter of astute _learner-centered_ analysis of both the subject-matter content and the instructional situation in question until we better conceptualize both instructional sequencing and instructional systems. In the end, however, it may turn out that instructional theory is no more than a methodology for analyzing instructional situations and problems in terms of what is known about learning and its facilitation. If this latter point is true, then we will need a construct called the conditions of instruction if only to bound our models and theorizing about this protean phenomena.

References

Ausubel, D. P. Educational Psychology: A Cognitive View. New York: Holt, Rinehart and Winston, Inc., 1968.

Ausubel, D. P. and Blake, E. Proactive inhibition in the forgetting of meaningful school material. Journal of Educational Research, 52, October, 1961, 266-274.

Ausubel, D. P. and Fitsgerald, D. The role of discrenability in meaningful verbal learning and retention. Journal of Educational Psychology, 52, No. 5, 1961, 266-274.

*Briggs, Leslie J. Sequencing of Instruction in Relation to Hierarchies of Competence. Pittsburgh, PA: American Institute of Research, 1968.

Dagenais, F. and Marascuilo, L. The effects of factor scores, Guttman scores, and simple sum scores on the size of the F-ratio in an analysis of variance design. Multivariate Behavioral Research, October, 1973, 491-502.

Gagne, Robert. The Conditions of Learning. New York: Holt, Rinehart, and Winston, 1970.

Goslin, David. Teachers and Testing. New York: Russell Sage Foundation, 1967.

Heimer, Ralph T. Conditions of learning in mathematics: Sequence theory development. Review of Educational Research, 39, No. 4, October, 1969, 493-508.

Kingsley, E. H. and Stelzer, J. An Axiomatic Theory of Subject Matter Structure. Alexandria, Virginia: Human Resources Research Organization, 1973.

Mayo, Robert. Pre-Service Preparation of Teachers in Educational Measurement. U. S. Department of Health, Education, and Welfare, 1967.

Richards, J. M., Jr. A simulation study of the use change measures to compare educational programs. American Educational Research Journal, 12, No. 3, Summer, 1975, 299-311.

Tobias, S. Sequence, familiarity, and attribute by treatment interaction in programmed instruction. Journal of Educational Psychology, 1973, 64, No. 2, 133-141.

Table XI

FAIS Treatment Cell Means on Attitude Variables

		n	CDAT	ADAT	CDAE	ADAE	CDAM
			PRE-TREATMENT				
I_1	High Apt	9	4.1	3.2	5.6	4.8	4.8
	Low Apt	9	4.0	2.9	5.7	4.7	3.6
I_2	High Apt	10	4.4	3.3	5.6	4.6	5.0
	Low Apt	10	3.8	2.8	5.6	4.7	4.0
I_3	High Apt	10	4.4	5.5	4.5	4.5	4.5
	Low Apt	10	4.1	3.2	5.6	4.5	3.9
I_4	High Apt	10	4.0	3.3	5.2	4.5	4.4
	Low Apt	10	4.1	3.2	5.6	4.6	4.0
			POST-TREATMENT				
I_1	High Apt	9	5.1	3.5	6.2	4.8	4.9
	Low Apt	9	4.7	2.8	5.8	4.5	3.6
I_2	High Apt	10	5.2	3.6	6.0	4.7	4.8
	Low Apt	10	4.6	3.0	5.6	4.6	4.0
I_3	High Apt	10	5.5	3.9	6.0	4.8	4.4
	Low Apt	10	4.9	3.3	6.0	4.4	3.9
I_4	High Apt	10	4.2	3.1	5.4	4.2	4.5
	Low Apt	10	4.2	2.8	5.5	4.5	3.9

Table XII

FAIS Treatment Cell Means for Achievement Variables

		n	TTH	STAT	CORR	RELI	VALI
I_1	High Apt	9	7.9	10.1	10.1	6.5	7.8
	Low Apt	9	6.1	7.6	7.6	5.1	6.9
I_2	High Apt	10	7.3	12.5	9.8	6.2	8.1
	Low Apt	10	5.8	9.0	7.7	4.7	7.0
I_3	High Apt	10	8.2	12.0	9.9	6.1	9.5
	Low Apt	10	6.8	10.0	8.5	4.7	7.6
I_4	High Apt	10	6.7	10.9	9.0	5.3	7.5
	Low Apt	10	6.7	10.9	9.0	5.3	7.5

		n	TOTA	TCON
I_1	High Apt	9	42.4	85.2
	Low Apt	9	33.3	82.2
I_2	High Apt	10	43.9	79.5
	Low Apt	10	34.2	82.9
I_3	High Apt	10	45.7	84.5
	Low Apt	10	37.6	84.4
I_4	High Apt	10	48.1	82.6
	Low Apt	10	39.4	83.3

Table XIII

PAIS Treatment Cell Means on Attitudes Variables

		n	CDAT	ADAT	CDAE	ADAE	CDAM
		PRE-TREATMENT					
I_1	High Apt	9	4.1	3.3	5.8	4.6	4.9
	Low Apt	10	4.0	2.9	5.6	4.6	3.4
I_2	High Apt	9	4.3	3.1	5.2	4.6	4.9
	Low Apt	10	4.1	3.0	5.3	4.5	3.7
I_3	High Apt	10	4.0	3.5	5.7	4.6	4.6
	Low Apt	10	4.3	3.2	5.6	4.6	3.9
I_4	High Apt	10	4.3	3.2	5.6	4.5	4.7
	Low Apt	10	3.8	2.9	6.0	4.7	3.5
		POST-TREATMENT					
		n	CDAT	ADAT	CDAE	ADAE	CDAM
I_1	High Apt	9	5.0	3.6	6.3	4.8	4.9
	Low Apt	10	5.3	3.4	5.7	4.7	4.9
I_2	High Apt	9	5.5	4.2	5.8	4.7	5.1
	Low Apt	10	5.5	3.7	5.8	4.7	4.2
I_3	High Apt	10	5.9	4.4	5.9	4.7	4.7
	Low Apt	10	5.6	4.0	5.9	4.6	4.5
I_4	High Apt	10	5.4	3.9	6.1	4.9	4.8
	Low Apt	10	5.1	3.7	6.0	4.8	4.2

Table XIV

PAIS Treatment Cell Means on Achievement Variables

		n	TH	STAT	CORR	RELI	VALI
I_1	High Apt	9	8.7	12.8	11.3	6.4	9.4
	Low Apt	10	7.1	10.5	9.7	5.6	7.9
I_2	High Apt	9	7.7	13.5	11.2	7.3	9.4
	Low Apt	10	7.0	11.4	9.6	5.4	7.6
I_3	High Apt	10	9.1	12.6	10.9	6.8	9.9
	Low Apt	10	7.5	11.4	9.9	5.8	8.8
I_4	High Apt	10	8.8	13.5	10.4	7.7	9.1
	Low Apt	10	7.7	12.6	9.6	5.8	8.9

		n	TOTS	TCON
I_1	High Apt	9	48.7	85.5
	Low Apt	10	40.8	85.1
I_2	High Apt	9	49.2	91.8
	Low Apt	10	41.0	87.6
I_3	High Apt	10	49.3	87.1
	Low Apt	10	43.5	86.6
I_4	High Apt	10	49.5	87.6
	Low Apt	10	44.5	89.3