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ABSTRACT

This study was a sixth account of a longitudinal investigation of the effects of the operation of a curriculum engineering system in a school district. Specific objectives were to observe the effects of leadership, climate, and curriculum engineering on teacher attitudes and teacher performance in a curriculum system and on student achievement. A causal model and path analysis were used to demonstrate the effects of the research variable on each other and on student achievement. Where appropriate, the most recent data were compared with data from previous years and discussed in light of the longitudinal design of the study. (Author)

LONGITUDINAL STUDY IN CURRICULUM ENGINEERING - VI

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This is the sixth in a series of reports of the investigation of certain effects of the installation and operation of a particular system of curriculum engineering in a school district. The curriculum system was designed with two purposes in mind. One was to insure that the curriculum of the school district would be adequately implemented throughout the district, and the other was to bring the curriculum under constant surveillance for annual revision. The curriculum system thus consists of three major functions: planning, implementing, and evaluating. Treatment effects, therefore, were the procedures called for in the curriculum system, the specific actions taken by personnel in the execution of the planning and implementing functions, and leadership behaviors. The specific objectives of the study were to observe the effects of the organizational treatments upon climate, teacher attitudes, teacher performance, and student achievement.

The basic theoretical posture supporting this study is that there are causal relationships among various factors and processes in schooling and one of the results of schooling expressed as student achievement. Among the factors and processes of particular interest in this study are leadership, climate, curriculum functions and processes, and personal characteristics of teachers. The theory is that the use of a causal model will aid in the observance of the effects of specific variables upon student achievement. Of particular interest in this study are variables associated with a curriculum system.

This paper was presented at the annual meeting of the American Educational Research Association in San Francisco, California, April 1976.

Definition of Terms

Certain terms need to be defined. Some of these are important for the theory content in this paper, and others are used in explaining the model developed to illustrate demonstrated relationships among the variables.

A curriculum is a written product; it contains the plan for the total educational opportunities for students in the school where it is to be implemented.

Curriculum engineering refers to the curriculum system and its internal dynamics. It consists of all the processes necessary to make a curriculum system functional in schools; curriculum planning, implementation, evaluation, and revision.

Curriculum system refers to the organization for both decision making and action with respect to curriculum functions regarded as a part of the total operations of schooling.

Principal leadership effectiveness refers to the extent to which the principal carries out successfully the leadership process in the areas of representation, demand reconciliation, tolerance of freedom, role assumption, consideration, production emphasis, predictive accuracy, integration, and superior orientation.[1]

Productivity refers to the outcomes associated with teacher and principal behavior as measured by growth in student achievement.

Student achievement is the extent to which measurable growth in learning has taken place.

Causal relation is an assymetrical relation between two variables.

Effect coefficient, in exact use, refers to causal determinism; a weak causal order is assumed for purposes here, and the effect coefficient refers to the measure of expected difference between two groups which are different by one unit.[2]

Endogenous variables refer to those variables determined by forces operating within the scope of a particular model of reality while exogenous variables refer to those variables determined by forces operating outside.[3]

Exogenous variables are considered to be predetermined for the study of a particular system.

Model is used in this report to refer to the mathematical system

of equations that represents an abstract and simplified picture of a realistic process.[4]

Parameters are variables outside the system that present a plausible rival hypothesis concerning relationships among variables in the system.

Path coefficients are standardized regression coefficients, or beta values.

Data Source

The data source was a suburban elementary school district in Cook County, Illinois. There are approximately four thousand students enrolled in the school district, and they are housed in ten school buildings. One of the buildings is a junior high school for grades seven and eight, one is an intermediate school, three are primary units containing Kindergarten through grade three, and five are K-6 units. There are five principals; four of them have more than one building under their jurisdictions. There are approximately 140 classroom teachers in the ten schools. They are supported by approximately thirty specialist supervisors.

DESIGN

The present study was designed with two purposes in mind. The first purpose was to study the longitudinal effects of the curriculum engineering system upon teacher attitudes and teacher performance. The second purpose was to demonstrate causal linkages among such variables as principal leadership, teacher motivation, teacher performance in a curriculum system, and student achievement through the use of a causal model and path analysis. The first is a continuation of the design of the first three reports in this series of studies; the second is to continue the type of data analysis presented in the fourth report.

Data were collected for teachers, principals, and students. One type of teacher data consisted of such personal characteristics as assignment to schools, sex, marital status, grade level taught, amount of teaching experience, and professional preparation. Teacher motivation to participate in curriculum affairs was measured by the Curriculum Attitude Inventory.[5] Teacher performance in the curriculum system was assessed two ways: (1) by their self perceptions of themselves as measured by the Teacher Self-analysis Inventory (TSAI),[6] and (2) as seen by their

principals through the Principal's Version of the Teacher Self-analysis Inventory (PTSAI).[7] Teacher attendance was measured by the number of days of absence during the school year. Principal leadership was measured by the Leader Behavior Description Questionnaire - Form XII.[8] Climate was measured by the Halpin and Croft Organizational Climate Description Questionnaire - Form IV.[9] Student achievement was measured by the Stanford Achievement Test. The Kuhlmann-Anderson Intelligence Tests, 7th Ed. provided the student IQ scores. All teachers and principals participated in the study, and a thirty-five per cent random sample of students stratified by grade level was used. Some of these data have been collected recurrently since 1970; others in 1973, 1974, and 1975. Only data for grades one, three, and six are included in this report.

One-way analysis of variance was used to determine whether scores on the CAI, the TSAI, the PTSAI, the OCDQ, and the LBDQ were significantly affected by school assignment, by sex, by marital status, by grade level assignment, by teaching experience, and by professional preparation. The t-test was used to determine whether growth in the CAI, the TSAI, the PTSAI, and the LBDQ were significantly different from previous years.

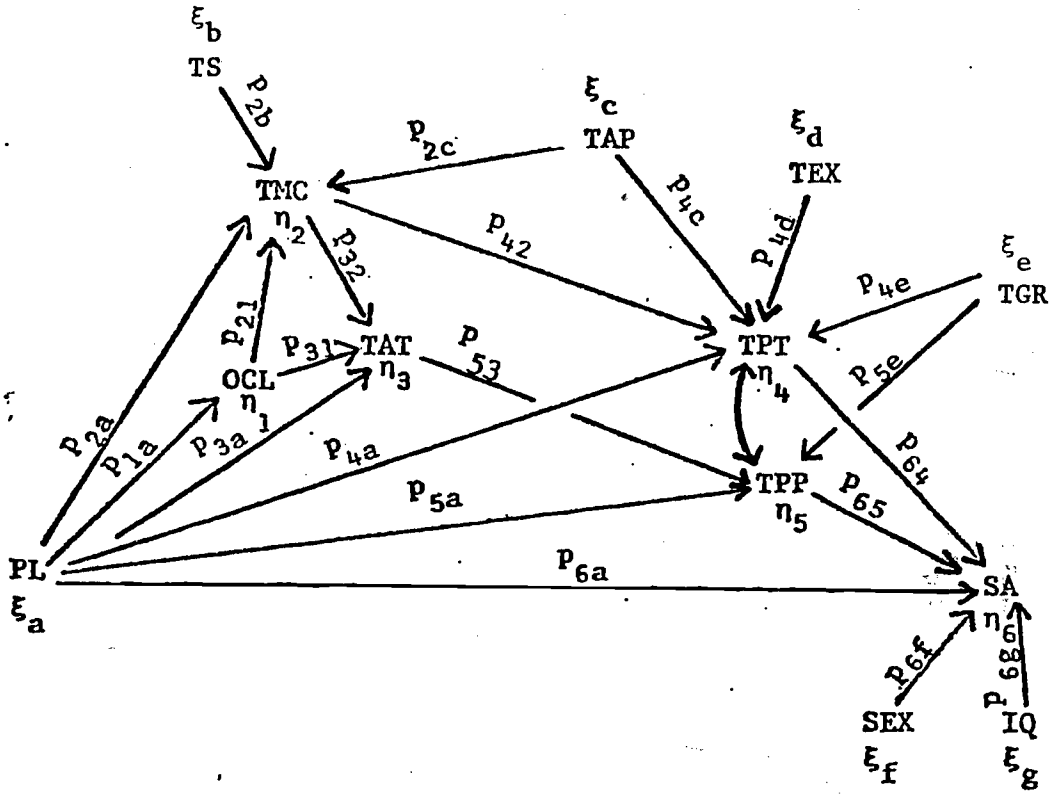
Analysis of variance was used to identify those teacher characteristics that were significantly related to other teacher variables, and t-tests were used to analyze longitudinal growth in teacher attitudes, and teacher performance. Correlation and regression analyses were used to demonstrate the magnitude of relationships among the various factors and variables. A preliminary step in establishing a causal model is to insure that all zero-order coefficients of correlation between all pairs of variables used in the model are non-zero. They were, but space limitation here will not permit the presentation of that data. The causal model used is shown in Figure 1. There are three classes of variable included in the model:

Endogenous variables

η_1 = OCL = School climate as measured by the OCDQ

η_2 = TMC = Teacher motivation or attitudes toward curriculum as measured by the CAI

η_3 = TAT = Teacher attendance as measured by the number of days absent



Structural Equations

$$SA = \eta_6 + p_{65}\eta_5 + p_{64}\eta_4 + p_{6a}\xi_a + p_{6f}\xi_f + p_{6g}\xi_g + R_x$$

$$TPP = \eta_5 + p_{53}\eta_3 + p_{5a}\xi_a + p_{5e}\xi_e + R_w$$

$$TPT = \eta_4 + p_{42}\eta_2 + p_{4a}\xi_a + p_{4c}\xi_c + p_{4d}\xi_d + p_{4e}\xi_e + R_v$$

$$TAT = \eta_3 + p_{32}\eta_2 + p_{31}\eta_1 + p_{3a}\xi_a + R_u$$

$$TMC = \eta_2 + p_{21}\eta_1 + p_{2a}\xi_a + p_{2b}\xi_b + p_{2c}\xi_c + R_t$$

$$OCL = \eta_1 + p_{1a}\xi_a + R_s$$

Figure 1. Causal model and structural equations.

η_4 = TPT = Teacher performance as self-perceived by the teachers through the TSAI

η_5 = TPP = Teacher performance as rated by principals through the PTSAI

η_6 = SA = Student achievement as measured by the various subtests of the Stanford Achievement Test

Exogenous variables

ξ_a = PL = Principal leadership as measured by the administration of the LBDQ to teachers in the district

Parameters to endogenous variables

ξ_b = TS = Sex of the teacher

ξ_c = TAP = Teacher ability according to the extent of a teacher's formal preparation for teaching

ξ_d = TEX = Teacher ability according to amount of teaching experience

ξ_e = TGR = Grade level taught

ξ_f = SEX = Sex of student specified as male or female

ξ_g = IQ = Student IQ as measured by the Kuhlmann-Anderson intelligence test

In the model, several causal relationships were assumed: (1) school climate (OCL) is determined by principal leadership and residual variables; (2) teacher motivation (TMC) is determined by school climate (OCL), principal leadership (PL), teacher's sex (TS), amount of professional preparation (TAP), and residual variables; (3) teacher attendance (TAP) is determined by teacher motivation (TMC), school climate (OCL), principal leadership (PL), plus residual variables; (4) teacher performance (TPT) is determined by teacher motivation (TMC), principal leadership (PL), professional preparation (TAP), teaching experience (TEX), grade level taught (TGR), and residual variables;

(5) teacher performance (TPP) is determined by teacher attendance (TAT), principal leadership (PL), grade level taught (TGR), and residual variables; and (6) student achievement (SA) is determined by teacher performance (TPP), teacher performance (TPT), principal leadership (PL), student sex (SEX), student IQ (IQ), and residual variables. These relationships are further described in the structural equations shown in Figure 1. The causal sequence was, therefore, assumed to be as follows: principal leadership has a causal relationship with student achievement. This effect is mediated through climate, teacher motivation and teacher performance in a curriculum system. The higher the ratings of principal leadership, teacher motivation and performance in curriculum work, the more positive the influence is upon student achievement as controlled for differing students' ability levels and sex.

Solutions for the structural equations for each of the three grades were sought through the use of regression analysis. Stepwise multiple regression was used for this purpose.

RESULTS

The means and standard deviations of teachers' scores on the five instruments administered to teachers and principals are shown in Table I. From Table I, it can be noted that assignment to administrative units significantly affected results on the PTSAI and the LBDQ. When all scores were compared with 1974 results, there were significant losses in scores for the total group of teachers and principals on the TSAI and the LBDQ.

A summary of F-ratios resulting from univariate analysis of variance of teachers' scores on the same five measures for the six teacher characteristic factors are shown in Table II. From these results, the parameters for the endogenous variables were identified, and they are shown in Figure 1. As will be shown later, not all of these parameters were maintained in the regression equations used, but they were included initially.

The means, standard deviations, and results of the univariate analysis of variance for student achievement and IQ scores by school for grades one, three, and six are shown in Tables III, IV, and V.

TABLE I

MEANS AND STANDARD DEVIATIONS OF TEACHERS' SCORES

ON FIVE INSTRUMENTS BY SCHOOL

School	N		CAI	TSAI	PTSAI	OCDQ	LBDQ
4	25	M	188.16	139.20	38.00	147.44	378.56
		SD	16.14	17.19	3.03	12.84	32.01
5	13	M	184.85	140.85	39.23	151.08	329.92
		SD	21.42	16.94	4.82	13.21	26.40
11	35	M	189.60	136.86	36.09	148.69	284.20
		SD	18.37	20.70	4.50	14.05	76.96
12	24	M	184.50	142.83	34.75	148.50	345.96
		SD	10.86	13.34	4.87	17.36	59.83
14	42	M	183.41	139.41	31.62	150.21	370.00
		SD	17.54	14.68	3.75	10.32	38.33
TOTAL	139	M	186.14	139.45	35.14	149.12	342.04
		SD	16.91	16.72	4.88	13.25	63.84

CAI - $F(4,134) = .801$
TSAI - $F(4,134) = .473$
PTSAI - $F(4,134) = 14.182$, $p < .01$
OCDQ - $F(4,134) = .260$
LBDQ - $F(4,134) = 16.493$, $p < .01$

TABLE II

SUMMARY OF F-RATIOS RESULTING FROM UNIVARIATE ANOVAS OF TEACHERS' SCORES ON FIVE CRITERION MEASURES FOR SIX FACTORS

FACTOR	CRITERION				
	CAI	TSAI	PTSAI	OCDQ	LBDQ
School (df = 4,134)	.801	.473	14.182**	.266	16.493**
Sex (df = 1,137)	7.668**	2.917	1.897	.878	11.162**
Marital Status (df = 2,136)	.070	2.918	.989	.296	.519
Grade Level (df = 2,136)	1.698	3.347*	3.613*	.045	26.318**
Experience (df = 2,136)	1.425	8.952**	.246	.117	2.577
Preparation (df = 3,134)	4.208**	5.374**	.167	.361	1.651

*p < 0.05
**p < 0.01

TABLE III

MEANS, STANDARD DEVIATIONS, AND RESULTS OF UNIVARIATE ANOVA OF STUDENTS' ACHIEVEMENT AND IQ SCORES BY SCHOOL FOR GRADE 1

School	N		VOC**	REA	REB	REC	WSS	MCONC**	MCOMP	LIC	TR	TM*	TA	TB	IQ
041	10	M	2.41	1.76	1.87	1.84	1.77	2.09	2.33	1.91	1.78	2.17	2.20	1.83	108.30
		SD	.71	.61	.98	1.14	.61	.85	.65	.71	.80	.72	.58	.89	14.19
042	11	M	1.85	1.85	1.89	1.85	2.01	2.03	2.15	2.34	1.92	2.01	2.07	1.75	120.27
		SD	.88	.59	.71	.79	.65	.79	.49	1.43	.68	.55	.92	.48	14.99
043	8	M	1.79	1.42	1.41	1.36	1.64	1.67	2.17	1.44	1.51	1.92	1.75	1.44	109.62
		SD	.73	.37	.51	.34	.13	.93	.62	.82	.12	.51	.58	.29	14.31
051	8	M	1.07	1.77	1.86	1.75	2.09	2.36	1.95	1.82	1.79	2.02	1.45	1.65	105.62
		SD	.79	.56	.78	.67	1.63	.81	.53	1.02	.88	.59	.57	.89	13.70
052	3	M	1.40	1.90	1.03	1.33	1.77	1.77	1.80	1.50	1.47	1.73	1.57	1.37	106.33
		SD	1.15	1.42	.38	.49	.72	.32	.20	.52	.55	.06	.58	.50	15.04
121	12	M	.85	1.86	2.15	2.00	1.24	.97	1.74	1.50	1.64	1.43	1.28	1.15	102.00
		SD	.70	.65	.86	.68	.37	.62	.84	.85	.52	.46	.48	.81	10.47
122	20	M	1.42	1.61	1.48	1.49	1.76	2.21	2.18	1.53	1.62	2.18	1.56	1.49	112.25
		SD	.83	.51	.68	.61	.52	1.02	.59	.83	.55	.77	.56	.60	12.37
141	69	M	1.56	1.69	1.58	1.64	2.21	2.30	2.36	1.95	1.82	2.29	1.76	1.70	108.10
		SD	1.00	.71	.76	.78	1.16	.77	.91	1.41	.92	.79	.84	.84	13.06
TOTAL	141	M	1.55	1.70	1.66	1.67	1.97	2.09	2.22	1.83	1.76	2.12	1.72	1.61	109.04
		SD	.95	.65	.77	.76	.99	.88	.79	1.20	.78	.74	.76	.77	13.45

*p < 0.05
**p < 0.01

TABLE IV

MEANS, STANDARD DEVIATIONS, AND RESULTS OF UNIVARIATE ANOVA OF STUDENTS' ACHIEVEMENT AND IQ SCORES BY SCHOOL FOR GRADE 3

School	N		VOC**	REC**	WSS**	MCONC**	MCOMP**	LI[illegible]*	TR**	TM**	TA**	TB**	IQ**
041	12	M	3.95	4.22	4.15	3.91	3.97	3.94	4.24	4.01	3.87	3.93	107.50
		SD	1.40	1.51	2.22	1.31	.90	1.92	1.89	.97	1.56	1.32	16.90
042	8	M	3.45	4.34	4.62	4.21	3.91	4.46	4.47	3.99	3.81	3.97	104.12
		SD	1.16	1.77	2.10	1.60	.99	1.81	1.96	1.37	1.23	1.42	13.91
043	9	M	3.83	4.51	5.31	4.37	4.10	4.04	5.00	4.09	3.79	4.21	118.11
		SD	1.13	1.26	2.25	1.60	.89	2.24	1.92	1.21	1.48	1.26	14.82
051	8	M	3.70	3.69	5.11	3.71	3.69	3.44	4.12	3.59	3.45	3.67	104.25
		SD	1.07	.75	1.80	1.17	.92	.90	1.21	.96	.87	.89	8.71
052	3	M	1.87	2.73	2.83	3.83	2.77	1.77	2.73	3.23	1.87	2.70	103.67
		SD	.99	1.16	.90	2.39	.70	.15	.93	1.70	.57	1.21	8.50
121	24	M	2.34	2.44	2.44	2.51	2.55	1.98	2.42	2.52	2.10	2.22	93.75
		SD	1.05	.86	.82	1.05	.91	1.05	.82	.86	.99	1.00	12.17
122	4	M	4.32	4.32	6.32	5.22	4.32	4.05	5.00	4.65	4.12	4.32	112.50
		SD	1.49	.79	1.97	.52	.53	.17	1.32	.38	.61	.25	6.45
141	74	M	3.61	3.67	4.28	3.76	3.48	3.73	3.90	3.66	3.64	3.70	108.36
		SD	1.28	1.45	1.84	1.42	1.09	1.51	1.57	1.22	1.36	1.34	16.65
TOTAL	142	M	3.42	3.60	4.12	3.67	3.45	3.47	3.80	3.55	3.38	3.51	105.99
		SD	1.33	1.44	1.96	1.46	1.09	1.65	1.65	1.22	1.41	1.37	16.05

*p < 0.05
**p < 0.01

TABLE V

MEANS, STANDARD DEVIATIONS, AND RESULTS OF UNIVARIATE ANOVA OF STUDENTS' ACHIEVEMENT AND IQ SCORES BY SCHOOL FOR GRADE 6

School	N		VOC**	REC**	WSS*	MCONC**	MCOMP**	MAPP**	SP*	LAN**
041	29	M	7.48	7.77	8.06	7.53	7.98	7.82	7.03	7.98
		SD	1.91	2.10	2.15	1.65	1.72	2.08	2.08	2.10
052	1	M	3.80	7.60	4.00	4.20	7.20	6.20	5.40	5.50
		SD	----	----	----	----	----	----	----	----
121	10	M	3.88	4.08	4.92	4.37	5.33	4.68	4.52	4.42
		SD	.84	.97	2.15	1.52	.93	1.46	1.19	.83
122	18	M	6.32	6.59	6.65	6.87	7.09	6.31	6.51	6.66
		SD	1.92	2.28	3.00	2.25	1.97	2.24	2.54	2.53
142	81	M	6.05	6.66	6.63	6.41	7.15	6.41	6.56	6.87
		SD	2.06	2.42	2.95	2.08	2.01	2.27	2.27	2.61
TOTAL	139	M	6.21	6.70	6.79	6.54	7.19	6.57	6.50	6.89
		SD	2.12	2.39	2.84	2.11	1.97	2.29	2.26	2.53

School	N		SSC**	SCI**	LIC**	TR**	TM**	TA**	TB**	IQ**
041	29	M	7.70	8.04	8.38	8.00	7.96	7.49	7.74	111.86
		SD	2.20	1.86	2.23	2.06	1.83	1.78	1.81	16.47
052	1	M	4.50	4.40	3.90	6.10	6.00	3.90	5.20	78.00
		SD	----	----	----	----	----	----	----	-----
121	10	M	4.28	4.33	4.00	4.46	4.88	3.96	4.42	83.70
		SD	.70	1.28	1.08	1.29	1.14	.83	.65	9.15
122	18	M	6.76	6.41	6.52	6.61	6.84	6.27	6.51	110.72
		SD	2.12	1.93	2.01	2.50	2.12	1.66	2.16	22.41
142	81	M	6.49	6.24	6.16	6.67	6.77	5.95	6.52	108.15
		SD	2.34	2.29	2.39	2.53	2.07	1.90	2.24	15.81
TOTAL	139	M	6.61	6.48	6.50	6.78	6.88	6.15	6.61	107.28
		SD	2.33	2.28	2.49	2.48	2.09	1.98	2.19	17.89

*p < 0.05
**p < 0.01

In the first grade, there were significant differences in achievement among schools for the subtests Vocabulary, Mathematical Concepts, and Total Mathematics. In grade three, there were significant differences on all subtests that were included in the data analysis. Similarly in grade six, all subtests showed significant differences among schools. The growth in ranges among mean scores on both IQ and achievement scores as students progress from grade one to grade six should be noted.

The results of the regression analysis for student achievement in grade one are shown in Table VI. In Table VI, the small letter b represents the non-standardized regression coefficient. SE stands for the standard error of the regression coefficient, and the symbol β stands for the normalized regression coefficient. The normalized regression coefficient is also the path coefficient. You will note that significant multiple regression coefficients appeared for the subtests Vocabulary, Mathematical Computation, Mathematical Concepts, Listening Skills, Total Mathematics, Total Auditory, and Total Battery. You should note that these subtests are the ones that are most likely to have been affected by schooling. Some of the others may not have been affected as much either because of curriculum neglect or lack of external background of pupils.

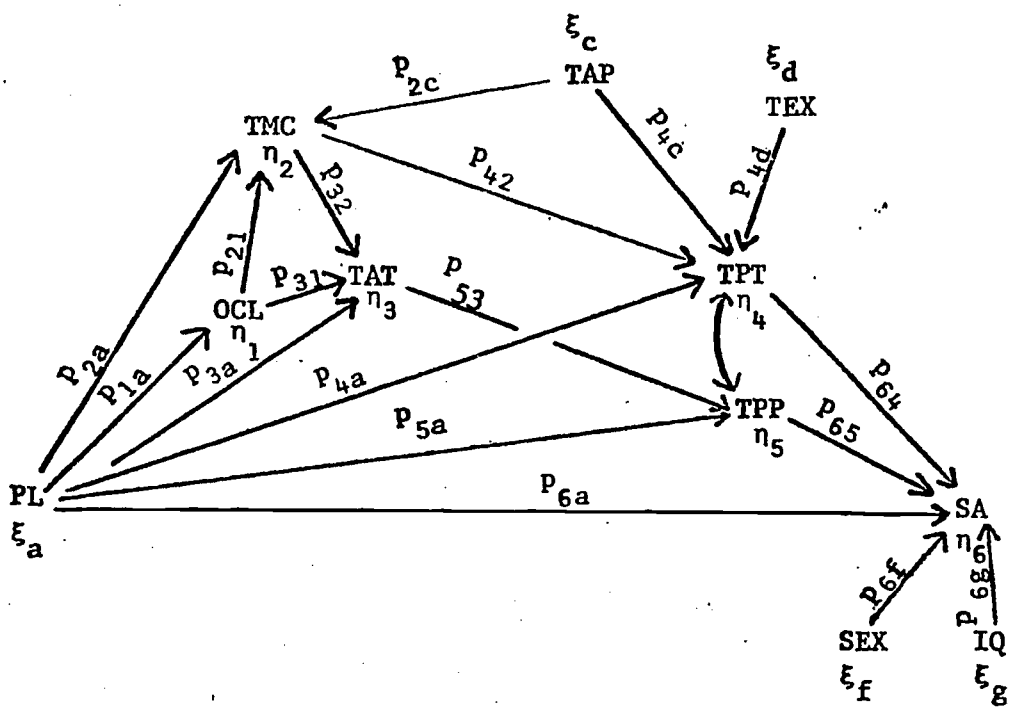
The model derived from the regression analysis for grade one is shown in Figure 2. Grade level taught and sex of the teacher were eliminated from the basic model shown in Figure 1. The structural equations shown in Figure 2 are modified accordingly. Solutions to those structural equations are shown in Figure 3. The path coefficients indicated in Figure 3 are the same as the beta coefficients indicated in Table VI. The most consistently positive and the largest effect of all upon the subtests was IQ. The residual effects were high. Other effects as revealed through the direction and magnitude of the path coefficients were low and mixed in direction.

The results of the regression analysis for achievement in grade three are shown in Table VII. The multiple regression coefficients were all statistically significant in size. This is in contrast to the results shown for grade one. The magnitude of the non-normalized regression coefficient for IQ was statistically significant for almost all of the

TABLE VI.
REGRESSION COEFFICIENTS FOR THE PATH TO SA (η_6) GRADE 1 IN 1975

	b	SE	β	b	SE	β	b	SE	β	b	SE	β
	VOC			REA			REB			REC		
TPP	-.170	.302	-.084	.107	.255	.082	-.182	.275	-.132	---	---	---
TPT	-.248**	.082	-.434	---	---	---	-.122	.747	-.310	-.028	.735	-.072
PL	.044*	.021	.319	-.029	.018	-.322	-.030	.191	-.320	-.038*	.018	-.399
SEX	-.622	1.668	.139	1.310	1.462	.162	-.203	1.519	.024	.408	1.552	.047
IQ	.432**	.100	.615	.172	.086	.377	.109	.091	.226	.153	.093	.313
	R^2 = .572	MR = .757**		R^2 = .187	MR = .433		R^2 = .251	MR = .501		R^2 = .195	MR = .442	
	WSS			MCONC			MCOMP			LIC		
TPP	-.166	.329	-.103	-.281	.378	-.177	.123	.260	.093	-.295	.451	-.122
TPT	-.072	.089	-.158	.096	.102	.154	.081	.071	.201	-.212	.122	-.310
PL	-.020	.228	.185	.049	.026	.329	.015*	.018	.155	-.016	.031	-.100
SEX	-.861	1.814	-.086	-3.631	2.084	.267	-.619	1.437	-.070	----	----	---
IQ	.226*	.109	.400	.279*	.125	.362	.212*	.086	.425	.465**	.148	.550
	R^2 = .215	MR = .463		R^2 = .443	MR = .666*		R^2 = .366	MR = .605*		R^2 = .312	MR = .558*	
	TR			TM			TA			TB		
TPP	.065	.250	.053	-.091	.258	-.058	-.110	.249	-.072	---	---	---
TPT	-.046	-.068	-.134	.104	.070	.237	-.165	.674	-.381	-.049	.062	-.134
PL	-.011	-.017	-.128	.030	.179	.282	.015	.017	.145	.012	.015	.135
SEX	---	---	---	-1.660	1.424	-.173	-.367	1.372	-.039	---	---	---
IQ	.177*	.822	.417	.226*	.854	.416	.351**	.082	.656	.239**	.781	.526
	R^2 = .167	MR = .409		R^2 = .477	MR = .691**		R^2 = .500	MR = .707**		R^2 = .313	MR = .560*	

*p < 0.05
**p < 0.01



Structural Equations

$$SA = \eta_6 + p_{65}\eta_5 + p_{64}\eta_4 + p_{6a}\xi_a + p_{6f}\xi_f + p_{6g}\xi_g + R_x$$

$$TPP = \eta_5 + p_{53}\eta_3 + p_{5a}\xi_a + R_w$$

$$TPT = \eta_4 + p_{42}\eta_2 + p_{4a}\xi_a + p_{4c}\xi_c + p_{4d}\xi_d + R_v$$

$$TAT = \eta_3 + p_{32}\eta_2 + p_{31}\eta_1 + p_{3a}\xi_a + R_u$$

$$TMC = \eta_2 + p_{21}\eta_1 + p_{2a}\xi_a + p_{2c}\xi_c + R_t$$

$$OCL = \eta_1 + p_{1a}\xi_a + R_s$$

Figure 2. Causal model and structural equations for grade 1.

$$OCL = \eta_1 + .662\xi_a + .749R_s$$

$$TMC = \eta_2 + .471\eta_1 + .423\xi_a - .658\xi_c + .667R_t$$

$$TAT = \eta_3 - .681\eta_2 + .099\eta_1 + .036\xi_a + .781R_u$$

$$TPT = \eta_4 - .419\eta_2 + .848\xi_a - .707\xi_c - .180\xi_d + .888R_v$$

$$TPP = \eta_5 - .093\eta_3 + .369\xi_a + .920R_w$$

$$SA_{VOC} = \eta_6 - .084\eta_5 - .434\eta_4 + .319\xi_a - .050\xi_f + .615\xi_g + .654R_y$$

$$SA_{REA} = \eta_6 + .082\eta_5 - .322\xi_a + .162\xi_f + .377\xi_g + .901R_y$$

$$SA_{REB} = \eta_6 - .132\eta_5 - .310\eta_4 - .320\xi_a - .024\xi_f + .226\xi_g + .866R_y$$

$$SA_{REC} = \eta_6 - .072\eta_4 - .399\xi_a + .047\xi_f + .313\xi_g + .897R_y$$

$$SA_{WSS} = \eta_6 - .103\eta_5 - .158\eta_4 + .185\xi_a - .086\xi_f + .399\xi_g + .886R_y$$

$$SA_{MCONC} = \eta_6 - .127\eta_5 + .154\eta_4 + .329\xi_a - .267\xi_f + .362\xi_g + .746R_y$$

$$SA_{MCOMP} = \eta_6 + .093\eta_5 + .201\eta_4 + .155\xi_a - .070\xi_f + .425\xi_g + .796R_y$$

$$SA_{LIC} = \eta_6 - .122\eta_5 - .310\eta_4 - .099\xi_a + .550\xi_g + .830R_y$$

$$SA_{TR} = \eta_6 + .053\eta_5 - .134\eta_4 - .128\xi_a + .417\xi_g + .913R_y$$

$$SA_{TM} = \eta_6 - .058\eta_5 + .237\eta_4 + .282\xi_a - .173\xi_f + .416\xi_g + .723R_y$$

$$SA_{TA} = \eta_6 - .072\eta_5 - .381\eta_4 + .145\xi_a - .039\xi_f + .656\xi_g + .707R_y$$

$$SA_{TB} = \eta_6 - .134\eta_4 + .135\xi_a + .526\xi_g + .829R_y$$

Figure 3. Solutions to structural equations for grade 1.

TABLE VII

REGRESSION COEFFICIENTS FOR THE PATH TO SA (η_6) GRADE 3 IN 1975

	b	SE	β	b	SE	β	b	SE	β	b	SE	β
	VOC			REC			WSS			MCONC		
TPP	-.390	.363	-.159	.585	.354	.217	.282	.515	.071	.115	.361	.044
TPT	.126	.134	.140	.122	.130	.124	.298	.190	.205	.184	.133	.191
PL	.039	.032	.206	.030	.033	.147	.031	.045	.103	.067*	.032	.330
SEX	----	----	----	-.685	2.877	-.035	----	----	----	----	----	----
IQ	.446**	.152	.497	.568**	.175	.579	.889**	.215	.613	.398*	.151	.413
	R^2 = .440	MR = .664**		R^2 = .576	MR = .759**		R^2 = .569	MR = .754**		R^2 = .521	MR = .722**	
	MCOMP			LIC			TR			TM		
TPP	.649*	.261	.344	-.265	.449	-.084	.586	.408	.178	.244	.293	.116
TPT	-.035	.096	-.050	.280	.165	.244	.167	.151	.138	.104	.108	.134
PL	.021	.024	.145	.073	.041	.301	.037	.036	.146	.041	.027	.255
SEX	2.327	2.122	.172	1.882	3.651	.084	----	----	----	1.918	2.380	.126
IQ	.310*	.129	.450	.444	.222	.387	.727**	.170	.603	.341*	.145	.441
	R^2 = .532	MR = .729**		R^2 = .499	MR = .707**		R^2 = .608	MR = .780**		R^2 = .531	MR = .728**	
	TA			TB								
TPP	-.362	.379	-.136	.278	.321	.112						
TPT	.196	.139	.201	.067	.118	.073						
PL	.059	.035	.288	.038	.030	.199						
SEX	.997	3.084	.052	.322	2.611	.018						
IQ	.424*	.187	.436	.543**	.159	.596						
	R^2 = .503	MR = .709**		R^2 = .593	MR = .770**							

*p < 0.05
**p < 0.01

subtests.

The causal model and structural equations derived from the regression analysis for grade three are shown in Figure 4. Grade level taught and teacher sex were eliminated in the regression analysis for consideration in the causal model as well as the influence of professional preparation upon teacher attitudes. Solutions to these structural equations are shown in Figure 5. Two things should be noted in Figure 5. One is that the size of the residual effects were lower than they were for grade one. The effects of IQ in grade three were higher than they were in grade one.

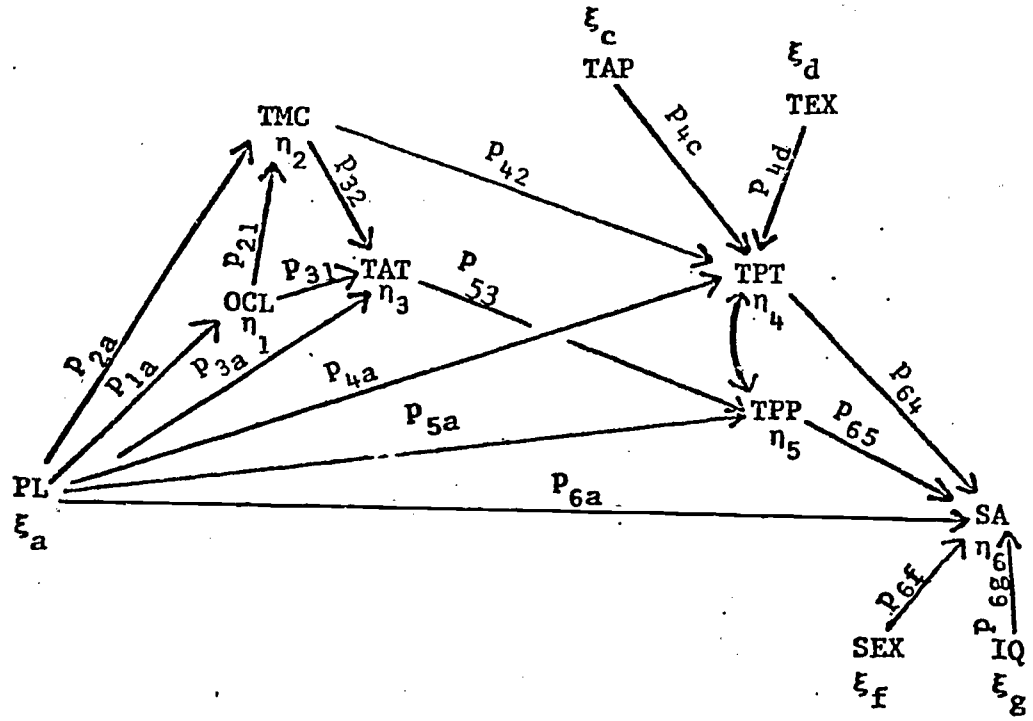
The results of the regression analysis for achievement in grade six are shown in Table VIII. The magnitude of the multiple regression coefficients were all significant for grade six, and they were higher than they were for grade three and grade one. In the regression analysis, teacher performance as measured by the PTSAI had no effect upon the results of the vocabulary test. Other effects were similarly eliminated from the regression equations at various spots throughout Table VIII.

The causal model and structural equations for grade six are shown in Figure 6. In Figure 6, grade level taught was eliminated from consideration as well as the path from principal leadership to teacher performance as measured by principals. The structural equations were amended accordingly. Solutions to the structural equations for grade six are shown in Figure 7. The magnitude of the residual effects were lower than in grade three, and the effect of IQ upon the variance for the various subtests was greater.

DISCUSSION

We are concerned with the losses incurred in scores on the TSAI and the LBDQ. We feel that they are attributable to lack of emphasis upon curriculum affairs by the central office of the school district.

The increase in ranges from grade one to grade six on the subtests of the achievement tests and a similar increase in ranges in IQ scores are an interesting observation. We suspect that since both test instruments measure verbal behavior, the effects of schooling have a corresponding impact upon both. Nonetheless, it would appear that



Structural Equations

$$SA = \eta_6 + p_{65}\eta_5 + p_{64}\eta_4 + p_{6a}\xi_a + p_{6f}\xi_f + p_{6g}\xi_g + R_x$$

$$TPP = \eta_5 + p_{53}\eta_3 + p_{5a}\xi_a + R_w$$

$$TPT = \eta_4 + p_{42}\eta_2 + p_{4a}\xi_a + p_{4c}\xi_c + p_{4d}\xi_d + R_v$$

$$TAT = \eta_3 + p_{32}\eta_2 + p_{31}\eta_1 + p_{3a}\xi_a + R_u$$

$$TMC = \eta_2 + p_{21}\eta_1 + p_{2a}\xi_a + R_t$$

$$OCL = \eta_1 + p_{1a}\xi_a + R_s$$

Figure 4. Causal model and structural equations for grade 3.

$$OCL = \eta_1 - .041\xi_a + .999R_s$$

$$TMC = \eta_2 - .142\eta_1 + .130\xi_a + .980R_t$$

$$TAT = \eta_3 - .084\eta_2 + .025\eta_1 - .355\xi_a + .926R_u$$

$$TPT = \eta_4 + .708\eta_2 - .192\xi_a + .497\xi_c - .351\xi_d + .576R_v$$

$$TPP = \eta_5 - .133\eta_3 + .025\xi_a + .989R_w$$

$$SA_{VOC} = \eta_6 - .159\eta_5 + .140\eta_4 + .206\xi_a + .497\xi_g + .748R_y$$

$$SA_{REC} = \eta_6 + .217\eta_5 + .124\eta_4 + .147\xi_a - .035\xi_f + .579\xi_g + .651R_y$$

$$SA_{WSS} = \eta_6 - .071\eta_5 + .205\eta_4 + .103\xi_a + .613\xi_g + .657R_y$$

$$SA_{MCONC} = \eta_6 + .044\eta_5 + .191\eta_4 + .330\xi_a + .413\xi_g + .692R_y$$

$$SA_{MCOMP} = \eta_6 + .344\eta_5 - .050\eta_4 + .145\xi_a + .172\xi_f + .540\xi_g + .684R_y$$

$$SA_{LIC} = \eta_6 - .084\eta_5 + .244\eta_4 + .301\xi_a + .084\xi_f + .387\xi_g + .708R_y$$

$$SA_{TR} = \eta_6 + .178\eta_5 + .138\eta_4 + .146\xi_a + .603\xi_g + .626R_y$$

$$SA_{TM} = \eta_6 + .116\eta_5 + .134\eta_4 + .255\xi_a + .126\xi_f + .441\xi_g + .685R_y$$

$$SA_{TA} = \eta_6 - .136\eta_5 + .201\eta_4 + .288\xi_a + .052\xi_f + .436\xi_g + .705R_y$$

$$SA_{TB} = \eta_6 + .112\eta_5 + .073\eta_4 + .199\xi_a + .018\xi_f + .596\xi_g + .638R_y$$

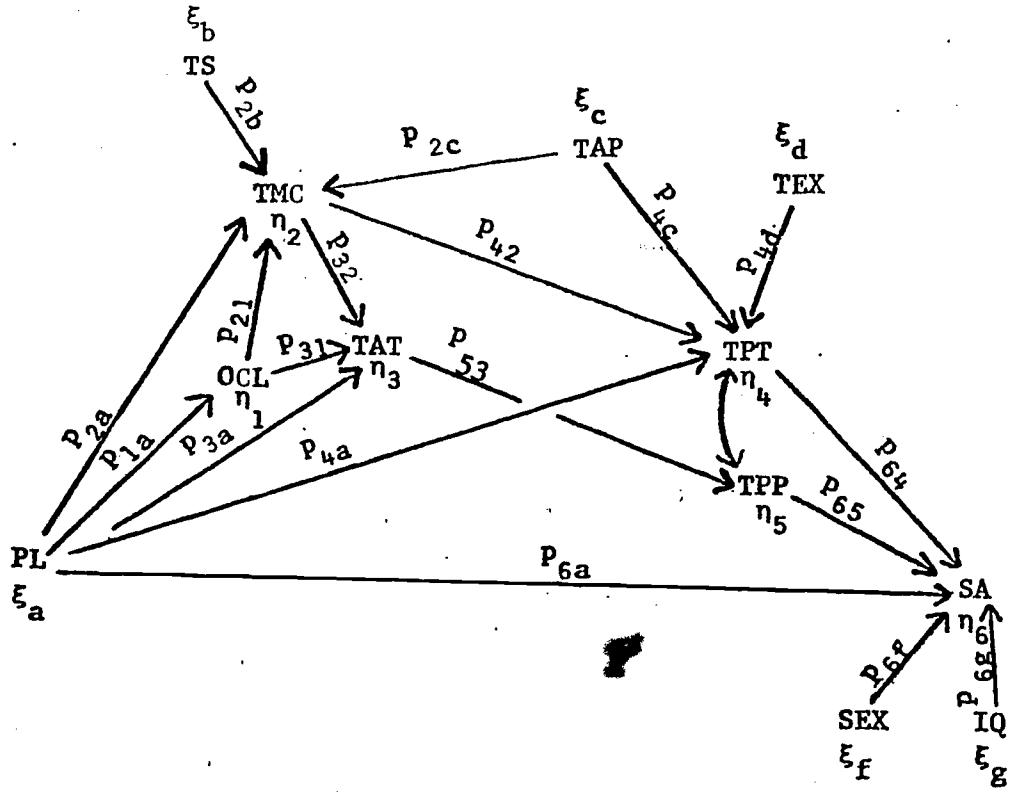
Figure 5. Solutions to structural equations for grade 3.

TABLE VIII

REGRESSION COEFFICIENTS FOR THE PATH TO SA (η_6) GRADE 6 IN 1975

	b	SE	β	b	SE	β	b	SE	β	b	SE	β
	VOC			REC			WSS			MCONC		
TPP	---	---	---	-.253	.344	-.108	-.088	.357	-.031	.165	.211	.077
TPT	.161	.170	.150	.340	.191	.328	---	---	---	.182	.116	.191
PL	-.861	.051	-.254	-.088	.056	-.270	-.048	.051	-.120	-.047	.034	-.158
SEX	-3.659	3.710	-.124	.607	4.024	.021	4.438	4.300	.128	---	---	---
IQ	.981**	.167	.895	.940**	.180	.889	1.058**	.168	.824	.969**	.110	1.005
	R^2 = .657	MR = .810**		R^2 = .585	MR = .765**		R^2 = .660	MR = .812**		R^2 = .806	MR = .898**	
	MCOMP			MAPP			SP			LAN		
TPP	---	---	---	.042	.334	.020	-.134	.287	-.051	-.452	.313	-.171
TPT	.162	.121	.208	.301	.185	.321	.257	.159	.220	.307	.174	.261
PL	-.006	.037	-.026	-.107	.054	-.362	-.040	.047	-.109	-.116*	.051	-.315
SEX	2.230	2.652	.104	-2.186	3.902	-.085	5.808	3.355	.181	5.729	3.665	.178
IQ	.692**	.119	.872	.818**	.175	.858	1.129**	.150	.947	1.119**	.164	.937
	R^2 = .665	MR = .816**		R^2 = .520	MR = .721**		R^2 = .774	MR = .879**		R^2 = .731	MR = .855**	
	SSC			SCI			LIC			TR		
TPP	-.102	.369	-.039	.153	.388	.064	.375	.440	.136	-.185	.309	-.077
TPT	.204	.204	.175	---	---	---	---	---	---	.203	.171	.189
PL	-.089	.060	-.242	-.066	.056	-.198	-.078	-.063	-.202	-.077	.050	-.227
SEX	-1.632	4.311	-.051	-1.407	4.676	-.048	-4.096	5.293	-.122	2.267	3.618	.077
IQ	1.047**	.193	.884	.751**	.183	.692	.866**	.207	.695	1.007**	.162	.920
	R^2 = .621	MR = .788**		R^2 = .438	MR = .662**		R^2 = .454	MR = .674**		R^2 = .687	MR = .829**	
	TM			TA			TB					
TPP	.115	.241	.059	.135	.324	.060	-.066	.259	-.030			
TPT	.206	.133	.238	.122	.180	.123	.176	.144	.183			
PL	-.052	.039	-.189	-.082	.053	-.263	-.068	-.042	-.225			
SEX	---	---	---	-3.745	3.794	-.138	.915	3.035	.036			
IQ	.838**	.126	.950	.859**	.170	.850	.938**	.136	.954			
	R^2 = .694	MR = .833**		R^2 = .597	MR = .773**		R^2 = .727	MR = .853**				

*p < 0.05
**p < 0.01



Structural Equations

$$SA = \eta_6 + p_{65}\eta_5 + p_{64}\eta_4 + p_{6a}\xi_a + p_{6f}\xi_f + p_{6g}\xi_g + R_x$$

$$TPP = \eta_5 + p_{53}\eta_3 + R_w$$

$$TPT = \eta_4 + p_{42}\eta_2 + p_{4a}\xi_a + p_{4c}\xi_c + p_{4d}\xi_d + R_v$$

$$TAT = \eta_3 + p_{32}\eta_2 + p_{31}\eta_1 + p_{3a}\xi_a + R_u$$

$$TMC = \eta_2 + p_{21}\eta_1 + p_{2a}\xi_a + p_{2b}\xi_b + p_{2c}\xi_c + R_t$$

$$OCL = \eta_1 + p_{1a}\xi_a + R_s$$

Figure 6. Causal model and structural equations for grade 6.

$$OCL = \eta_1 + .200\xi_a + .980R_s$$

$$TMC = \eta_2 + .044\eta_1 + .394\xi_a - .274\xi_b + .043\xi_c + .862R_t$$

$$TAT = \eta_3 - .055\eta_2 + .242\eta_1 - .347\xi_a + .916R_u$$

$$TPT = \eta_4 + .440\eta_2 + .365\xi_a + .310\xi_c + .373\xi_d + .639R_v$$

$$TPP = \eta_5 - .097\eta_3 + .995R_w$$

$$SA_{VOC} = \eta_6 + .150\eta_4 - .254\xi_a - .124\xi_f + .895\xi_g + .586R_x$$

$$SA_{REC} = \eta_6 - .109\eta_5 + .328\eta_4 - .270\xi_a + .021\xi_f + .889\xi_g + .644R_x$$

$$SA_{WSS} = \eta_6 - .031\eta_5 - .120\xi_a + .128\xi_f + .824\xi_g + .583R_x$$

$$SA_{MCONC} = \eta_6 + .077\eta_5 + .191\eta_4 - .158\xi_a + 1.001\xi_g + .440R_x$$

$$SA_{MCOMP} = \eta_6 + .208\eta_4 - .026\xi_a + .104\xi_f + .872\xi_g + .579R_x$$

$$SA_{MAPP} = \eta_6 + .100\eta_5 + .321\eta_4 - .362\xi_a - .085\xi_f + .858\xi_g + .692R_x$$

$$SA_{SP} = \eta_6 - .051\eta_5 + .220\eta_4 - .109\xi_a + .181\xi_f + .947\xi_g + .476R_x$$

$$SA_{LAN} = \eta_6 - .171\eta_5 + .261\eta_4 - .315\xi_a + .178\xi_f + .937\xi_g + .519R_x$$

$$SA_{SSC} = \eta_6 - .039\eta_5 + .175\eta_4 - .242\xi_a - .051\xi_f + .884\xi_g + .615R_x$$

$$SA_{SCI} = \eta_6 + .064\eta_5 - .198\xi_a - .048\xi_f + .692\xi_g + .750R_x$$

$$SA_{LIC} = \eta_6 + .136\eta_5 - .202\xi_a - .122\xi_f + .695\xi_g + .739R_x$$

$$SA_{TR} = \eta_6 - .077\eta_5 + .189\eta_4 - .227\xi_a + .077\xi_f + .920\xi_g + .559R_x$$

$$SA_{TM} = \eta_6 + .059\eta_5 + .238\eta_4 - .189\xi_a + .950\xi_g + .553R_x$$

$$SA_{TA} = \eta_6 + .060\eta_5 + .123\eta_4 - .263\xi_a - .137\xi_f + .850\xi_g + .635R_x$$

$$SA_{TB} = \eta_6 - .030\eta_5 + .183\eta_4 - .225\xi_a + .035\xi_f + .954\xi_g + .522R_x$$

Figure 7. Solutions to structural equations for grade 6.

schooling does make a difference.

Another interesting observation is the reduction in residual effects upon achievement between grades one and six. The reduction in residual effects is accompanied by an increase in positive effects of IQ upon achievement.

Effect coefficients for student sex were low and mixed in direction throughout the grades and from subtest to subtest. Perhaps sex differences among pupils no longer need be the concern they once were.

We cannot explain the directional shift to negative of effects of principal leadership in grade six after being positive in grade three and mixed in grade one.

There continues to be directional conflict between the effect coefficients for teacher performance as seen by teachers themselves and as seen by principals. We suspect this to be a lack of communication between leadership personnel and teachers on curriculum matters. A summer workshop was held last summer to concentrate on this problem and certain others coming out of this data.

Despite our dissatisfaction with certain elements of our design, we are convinced that the theoretical framework in which this design has been cast is a useful one. We hope that the discovery of new variables that significantly affect schooling will guide us in better representing the real world of schooling. From the work thus far, we are encouraged that the presence of a curriculum engineering system can be related to teacher behaviors and student achievement. There seems to be little doubt as to the critical character of principal leadership upon the variates studied. In the future, we hope to add to the schooling effects studied thus far variables having to do with the instructional processes. We feel that effects of instructional variables would supplant some of those being used and cause further reduction in residual effects.

FOOTNOTES

[1]Ralph M. Stogdill, "Manual for the Leader Behavior Description Questionnaire - Form XII: An Experimental Revision," (Columbus, Ohio: Bureau of Business Research, College of Commerce and Administration, The Ohio State University, 1963), p. 3.

[2]The distinction is made by Jae-On Kim and Frank J. Kahout in an unpublished paper, "Special Topics in General Linear Models" (University of Iowa, 1974), pp. 33-34.

[3]Michael J. Brennan, Preface to Econometrics (3d ed.; Cincinatti: South-Western Publishing Co., 1973), p. 212.

[4]Lawrence R. Klein, An Introduction to Econometrics (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962), p. 11.

[5]Michael Langenbach, "The Development of an Instrument to Measure Teachers' Attitudes Toward Curriculum Use and Planning" (unpublished doctoral dissertation, Northwestern University, 1969).

[6]George A. Beauchamp, The Teacher Self-analysis Inventory, Northwestern University, 1970.

[7]George A. Beauchamp, Principals' Version of the Teacher Self-analysis Inventory, Northwestern University, 1974.

[8]Leader Behavior Description Questionnaire - Form XII (Columbus: Bureau of Business Research, College of Commerce and Administration, The Ohio State University, 1962).

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