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AN EXPERIMENTAL STUDY IN CURRICULUM ENGINEERING.

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DESCRIPTORS- *EDUCATIONAL EXPERIMENTS, *CURRICULUM DEVELOPMENT, DECISION MAKING, *INPUT OUTPUT ANALYSIS, HYPOTHESIS TESTING, INSERVICE PROGRAMS, GROUP BEHAVIOR, INTERACTION PROCESS ANALYSIS, CONCEPT FORMATION, CURRICULUM EVALUATION, *SYSTEMS APPROACH,

TO TEST THE APPLICATION OF THE GENERAL SYSTEMS APPROACH IN CURRICULUM DEVELOPMENT, A PROBLEM WAS PROPOSED IDENTIFYING THE PHENOMENA AND CONTINGENT VARIABLES OF THE CURRICULUM SYSTEM WITHIN THE INPUT-OUTPUT FRAMEWORK. WITH TEACHERS, SCHOOL ADMINISTRATORS, AND GRADUATE STUDENTS OF EDUCATION AS VOLUNTEER PARTICIPANTS, TWO EXPERIMENTAL GROUPS GIVEN INSERVICE TRAINING AND ONE CONTROL GROUP WITHOUT INSERVICE TRAINING YIELDED DATA PRIMARILY BY EVALUATION OF WRITTEN CURRICULA, VERBAL CONTENT ANALYSIS, AND INTERACTION PROCESS ANALYSIS. FINDINGS GENERALLY SUPPORTED THE EXPERIMENT'S MAIN HYPOTHESIS THAT INITIAL CURRICULUM ENGINEERING DECISIONS ON SELECTED DATA WILL SIGNIFICANTLY FACILITATE GROUP DECISIONMAKING IN CURRICULUM DEVELOPMENT. THIS PAPER WAS PRESENTED AT THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION CONFERENCE (CHICAGO, ILLINOIS, FEBRUARY 8-10, 1968). (JK)

AN EXPERIMENTAL STUDY IN CURRICULUM ENGINEERING*

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A favorite sport of diverse groups has been curriculum designing: some motivated by necessity, others by the intellectual challenge, a segment by profit, and some few by the desire to build a body of relationships leading to curriculum theory. Among the latter, models conceptualizing the curriculum system have been suggested which attempt to develop a structure for guiding curriculum research design. Beauchamp offered a structured approach to curriculum theory, devising a curriculum theory model.(3) Maccia, Maccia, and Jewett, in a series of papers, presented a number of models applicable to education.(5) Macdonald made use of general systems analysis as a model for the curriculum system.(6) Faix conceptualized the curriculum system through structural-functional analysis.(4) To date, none of the conceptual schemata have been tested experimentally. The purpose of the present study was to test a model for conceptualizing the curriculum system.

For this study, the general systems approach, describing a system as comprising an input, a content and process, and an output with feedback provisions was used as the basis for the model. The phenomena and contingent variables of the curriculum system were identified within the input-output framework. Figure 1 illustrates the curriculum system in perspective.(9) The input phase contains the source factors to the system. The content-process phase identifies the relevant input data selected and the processes involved in developing curricula. The output, a product of the content-process phase, is designated as a written curriculum. Since it is a description of a dynamic system, evaluation of the output serves as feedback. As the feedback information is adapted and integrated into the system, equilibrium of the system is maintained.

To test the model as a workable conceptualization of the curriculum system, a problem in curriculum development was proposed, utilizing the processes of curriculum engineering and curriculum group decision-making. Curriculum engineering referred to the initial decisions and activities undertaken by the experimenter, such as, making the necessary decisions for setting the committee decision-making process into motion and the selection of the relevant input data. Figure 2 shows the adaptation of the curriculum system model using the input-output analysis approach, to an experimental test.

The Input Phase

The input data include the total range of data necessary for developing curricula, from the personalities of the planners to knowledge about ways and means of evaluation. From the total possible input data, the experimenter distinguished six categories for classifying relevant content for the experimental test.

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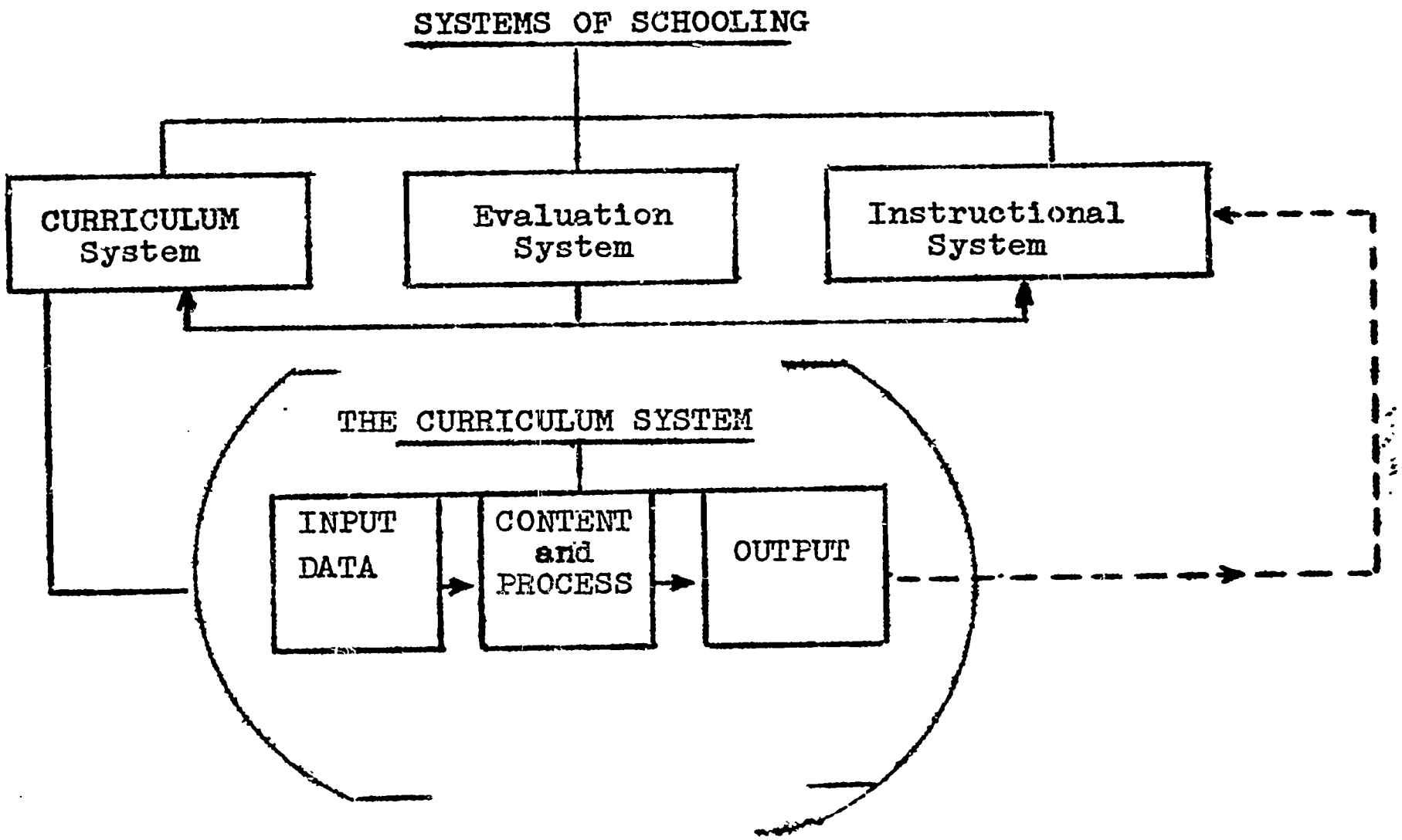

Figure 1. The Curriculum System in Perspective

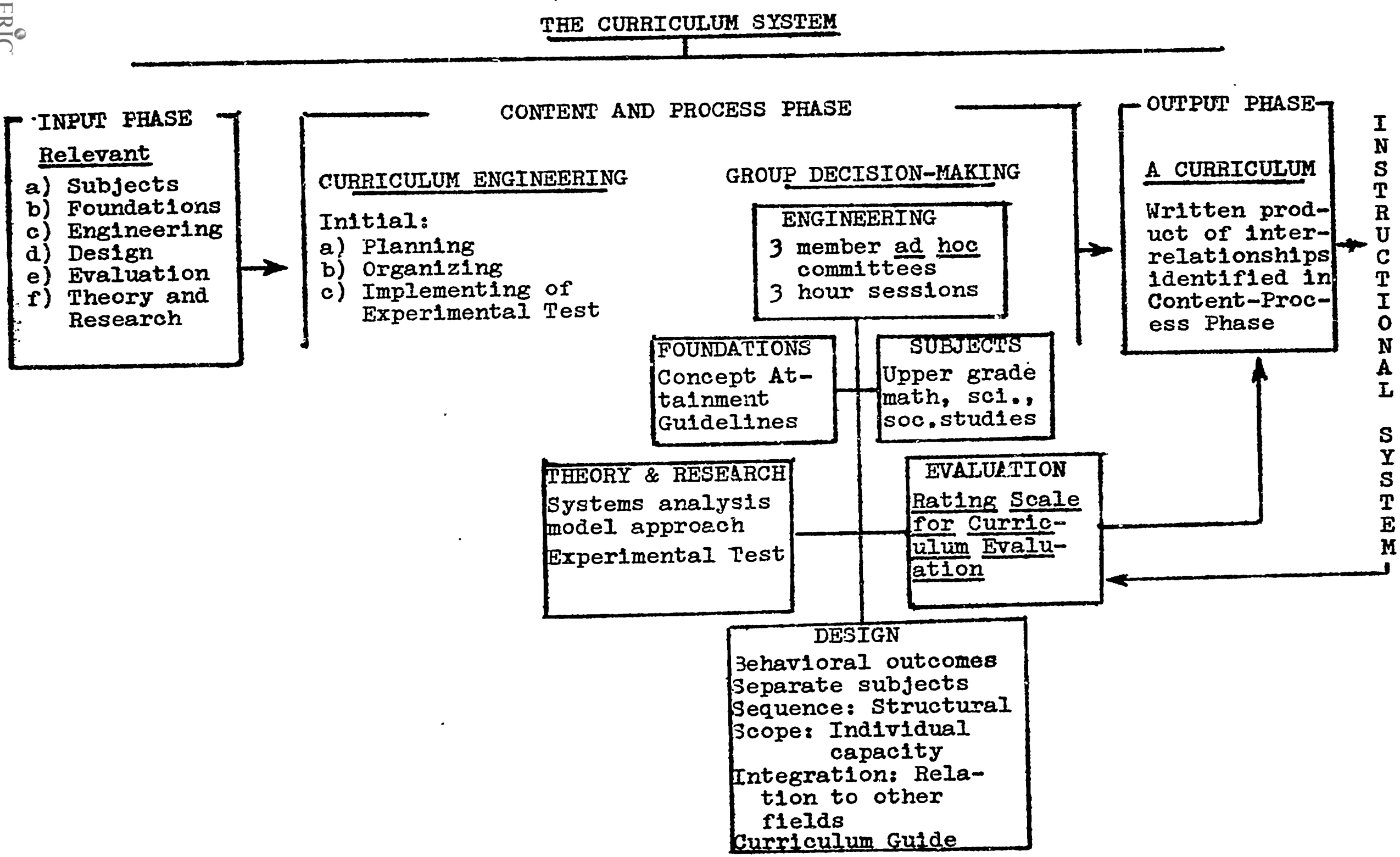

Figure 2. An Adaptation of the Curriculum System Model to an Experimental Test in Curriculum Engineering

The Content-Process Phase

The content used in curriculum development was selected from the six categories. These are shown in the Content-Process Phase under group decision-making. Two areas of decision-making were operative. The first represented the experimenter's decisions as she functioned as the curriculum engineer. The second decision-making activity leading to curriculum development involved committees engaged in group decision-making.

Output Phase

The Output Phase of the curriculum system is the product of the Content-Process Phase. A curriculum is now ready to leave the curriculum system through the Output Phase, entering the instructional system as an input. For the purpose of this study, the test ended with the evaluation of the completed portion of a curriculum.

Feedback

Feedback is represented by the assessment procedure devised for the experimental test to evaluate the effects of the selected input data upon the output.

THE PROBLEM

The problem was to determine whether concept attainment inservice training, as selected input data, significantly aided committees in developing curricula. To test the problem experimentally, the effects of three treatments on three aspects of group performance were observed. The three treatments included two types of inservice training (Treatment A and B) and the control treatment, no inservice training (Treatment C). The committees were given a curriculum task, to write curriculum materials on topics in one of three school subjects. The effects of the three treatments and the three tasks on three aspects of group performance were observed. The observations included: 1) the curricula the committees produced; 2) the interaction behavior among the committee members in the course of writing the curricula; and 3) the verbal content emphasized by the members during discussion. Figure 3 diagrammatically illustrates the independent and dependent variables. The three treatments and the three school subjects permitted observations in nine test situations. (see Table I)

HYPOTHESES

An hypothesis was proposed for the theoretical problem. The hypothesis concerned the effects of initially selected data from the input to the curriculum system on the output of the curriculum system.

> Initial curriculum engineering decisions on selected input data can significantly facilitate group decision-making in curriculum development.

To test the hypothesis, the experimental test was carried out. Ten null-hypotheses were tested. Four major null-hypotheses tested the effects of the independent variables upon the developed curriculum materials. Six corollary null-hypotheses were tested concerning the effects of the independent variables upon the group interaction behavior and the verbal content emphasized by committees.

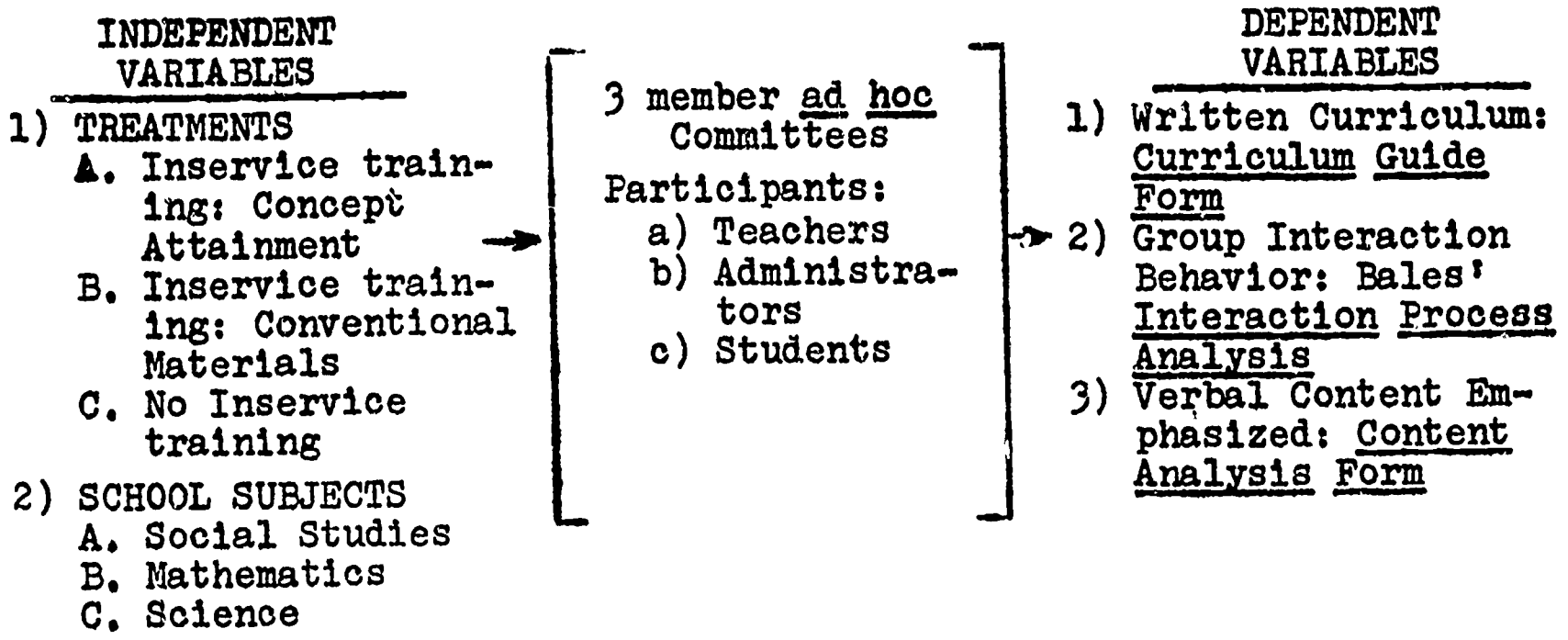

Figure 3. Independent and Dependent Variables in the Experimental Test

TABLE I

SCHEDULE OF COMMITTEE ASSIGNMENT BY CODED NUMBER

	TREATMENT A	TREATMENT B	TREATMENT C
SCHOOL SUBJECTS and Topics	Concept Attainment	Conventional Materials	Control
SOCIAL STUDIES "The Depression Years: 1930's"	001 002 003 004	005 006 007 ---	008 009 010 ---
MATHEMATICS "Area: Enclosed Surfaces"	011 012 013 ---	014 015 016 017	018 019 020 ---
SCIENCE "Motion"	021 022 023 ---	024 025 026 ---	027 028 029 030

Major Null-Hypotheses

The major null-hypotheses tested the effects of the independent variables, two forms of selected data from the input, upon the developed curriculum materials. These variables were the treatment a committee received prior to curriculum development and the assigned task. The major null-hypotheses tested were:

Treatments.

A. There are no significant differences between the curricula written by ad hoc curriculum committees given inservice training on concept attainment and the curricula written by ad hoc committees given conventional inservice training prior to curriculum development.
B. There are no significant differences between the curricula written by ad hoc committees given inservice training and curricula written by ad hoc committees without inservice training.

Assigned tasks.

C. There are no significant differences between the curricula written by ad hoc committees on one subject and the curricula written by ad hoc committees on another subject.
D. There are no significant differences between the curricula written on one subject following one type of treatment and the curricula written in the same subject following a different type of treatment

Corollary Null-Hypotheses

To determine whether the independent variables affected other factors having bearing on the development of curriculum materials, corollary null-hypotheses were tested. These pertained to group interaction behavior and the verbal content emphasized by the committees in the course of developing curriculum materials.

Null-hypotheses related to group behavior.

1. There are no significant differences between the group behavior related to curriculum development activities following one type of inservice training and the group behavior following another type of inservice training.
2. There are no significant differences between the group behavior related to curriculum development activities following inservice training and group behavior when engaged in curriculum development activities without inservice training.
3. There are no significant differences between the group behavior of committees assigned one school subject for curriculum development and the group behavior of committees assigned another subject for curriculum development.

Null-hypotheses related to verbal content emphasized.

4. There are no significant differences between the verbal content emphasized in committee discussions following inservice training on concept attainment and the verbal content emphasized following a conventional type of inservice training.
5. There are no significant differences between the verbal content emphasized in committee discussions for those receiving prior inservice training and the verbal content emphasized by the committees not receiving prior inservice training.

6. There are no significant differences between the verbal content emphasized in committee discussions for those assigned one school subject to develop and the verbal content emphasized by committees assigned another school subject.

PARTICIPANTS

The participants were volunteer teachers, school administrators and graduate students of education recruited from two colleges and three school systems. They formed three member ad hoc curriculum committees. Each group was randomly assigned to one of the nine test situations. Since participants were not randomly assigned to one of the thirty groups, it was determined statistically that the biographical differences of the participants* had been distributed among the nine test situations in such a manner as to reduce the biases these differences have been demonstrated to exert on group interaction behavior.

DATA COLLECTED

Data to test the hypotheses were obtained from five sources. 1) The Participant Personal Inventory, a questionnaire form, elicited data on the eight biographical differences. 2) A written curriculum as a solution to the curriculum task was obtained. A Curriculum Guide Form was constructed in order to structure the task, as well as aid in the evaluation of the task. (see Figure 4) 3) The Rating Scale for Curriculum Evaluation, Figure 5, a twelve-item rating scale, assigned quantitative value to the Curriculum Guide Form. Using Baker's(1) Reciprocal Averages Program (RAVE), programed through the CDC 3400 computer, new weights were assigned to each item in such a manner as to maximize the internal consistency reliability of the instrument. A reliability of .875 was observed, utilizing Hoyt's analysis of variance procedure. Three raters independently scored the Curriculum Guide Forms. Utilizing Kendell's W statistic, significant agreement was found among the raters ($W = .824$; $p < .01$). 4) Bales' Interaction Process Analysis observational technique was employed for observing and recording the interaction behavior among the committee members(2). 5) Frequency data on the verbal content emphasized by the committees were obtained through a content analysis based on an eight category definition of the total verbal content. The categories included: a) goal directives; b) content organization; c) cognitive behavioral outcomes; d) psycho-motor behavioral outcomes; e) affective behavioral outcomes; f) activities enhancing behavioral outcomes; g) reference to treatments; and h) expressed inadequacies.

PROCEDURES

The ad hoc committees each met for a three-hour consecutive time block. It was divided into three sessions: 1) inservice training and instruction; 2) discussion and decision-making; and 3) curriculum writing. Prior to the conclusion of the first session, each committee was given a task to be completed by the end of the third session. The task was defined as writing a portion of a curriculum on the Curricu-

* These biographical differences included: a) sex; b) age; c) years of teaching experience; d) level of teaching experience; e) curriculum committee experience; f) administrative experience; g) school subjects taught; and h) extent of education.

Subject _____

Topic _____

Committee No. _____
Upper Elementary

GOAL DIRECTIVES	ORGANIZATION SCOPE, SEQUENCE	COGNITIVE BEHAVIORAL OUTCOMES	PSYCHO-MOTOR BEHAVIORAL OUTCOMES	AFFECTIVE BEHAVIORAL OUTCOMES	ACTIVITIES ENHANCING OUTCOMES

Figure 4. Curriculum Guide Form

DIRECTIONS: Read the Curriculum Guide Form noting emphases, clarity, and general coherence. Consider each CGF as an instrument to be used in a school system by its teachers. Check (X) your rating of each item along the following scale:

1 item not included in the curriculum
2 item included but not developed or pertinent
3 item included with moderate development or pertinence
4 item fully developed or pertinent

ITEM	SCALE 1	2	3	4
1. The general goals serving as directives are incorporated into the curriculum.	___	___	___	___
2. The topic organization or rationale is developed.	___	___	___	___
3. The subject is broken down with a view to sequence.	___	___	___	___
4. The subject is broken down with a view to scope.	___	___	___	___
5. Cognitive behavioral outcomes complement the organization, scope, and sequence.	___	___	___	___
6. Cognitive behavioral outcomes are pertinent to the other expected behavioral outcomes.	___	___	___	___
7. The psycho-motor skills reflect the cognitive and affective outcomes.	___	___	___	___
8. The psycho-motor skills are pertinent to the rationale.	___	___	___	___
9. The affective learning behavior is pertinent to the rationale.	___	___	___	___
10. The affective behavior is pertinent to the other behavioral outcomes.	___	___	___	___
11. Suggested activities are pertinent to the rationale and behavioral outcomes.	___	___	___	___
12. Suggested activities are measurable in ascertaining expected outcomes in changed behavior.	___	___	___	___

TOTAL SCORE ____

Figure 5. Rating Scale for Curriculum Evaluation

lum Guide Form, in one of three assigned subjects. The two experimental groups were each exposed to inservice training prior to being given the task assignment. The control group was not exposed to any form of inservice training.

Treatment A

Treatment A referred to the experimental groups given inservice training on concept attainment during the first of three sessions.(7) The training consisted of a forty-minute illustrated talk by the experminter on the current findings on concept attainment that might have application to curriculum development. It included an introduction to the importance of concept attainment to learning and as possible guidelines for committee decision-making on curriculum. Next, general terminology related to concept learning was covered, followed by specific concept attainment terminology. Last, these terms were drawn up into a thirteen point guideline for directing curriculum decisions. Following the concept attainment information, the remaining ten minutes of the first session in Treatment A covered the task assignment and familiarization with the Curriculum Guide Form.

Treatment B

For the conventional inservice training, the experimenter devoted twenty minutes to discussion of an assortment of references displayed on the discussion table. These books, pamphlets, and curriculum guides covered the range of 'typical' materials available to curriculum committees. The committees assigned to this training spent the remainder of the session, other than that part used to explain the task and Curriculum Guide Form, scanning the materials individually. The final comment by the experimenter at the start of the second session was a reminder to feel free to use the reference materials at any time.

Treatment C

This treatment served as a control. No inservice training was given to these committees. Treatment C committees received only an explanation covering the use of the CGF for structuring their writing task. For Treatment C, the first session took only fifteen minutes. The second and third sessions remained the same for all three treatments.

Interaction Behavior

Collection of the interaction behavior data consisted of recording notations of the participants' interaction as defined by the twelve categories in Bales' analysis of small group interaction. A single observer was used. Playback of randomly selected tapes replicated the initial tabulations. A stability coefficient of .821 was obtained, well above the minimum coefficient set by Bales.

Verbal Content

A tape recording was taken of the discussion leading to decision-making and curriculum writing. For each committee, a 1½ hour tape was made covering the two forty-five minute sessions. The tapes were later played back in five minute intervals, yielding timed-frequency data of the eight categories of verbal content. Replication of initial content analysis tallies were obtained through playback of selected tapes following a minimum of a month's interval between the initial and stability check tallies. A scorer stability coefficient of .898 was obtained.

RESULTS

To test the effects of the three treatments and tasks upon the curricula produced by the committees, a two-way partially nested analysis of variance design for computing F ratios was utilized. This permitted determination of the significance of the two main effects (treatments and school subjects) as well as the interaction effects on the curricula. Through a partially nested design, the possible differential effects of the school subjects within the treatments were observed. A significant F ratio (4.23; df = 8,21; $p < .01$) was observed for the mean square ratios between and within the cells, indicating significant differences in the sum of squares between the nine cells and the sum of squares within the cells.

Further analysis of the sum of squares between groups along the two main effects yielded a significant F (13.01; df=2,21; $p < .01$) on the Treatment level. A nonsignificant F (1.97; df=2,21; $p > .05$) was observed for the second main effect, School Subjects. The interaction effect was also nonsignificant (F=0.97; df=4,21; $p > .05$). (see Table II)

To examine further the sum of squares, the school subjects were partially nested within each of the treatments. The mean squares between each of the treatments and within the school subjects were computed to obtain an estimate of the differential effects of the school subjects on the treatments. Nonsignificant Fs' ($p > .05$) were obtained in all instances. It was concluded that the differences between the variance of each treatment and that of the nested school subjects were attributable to chance.

Since a significant F was obtained for the Treatment main effect, the differences between the means of the treatments were tested using the Newman-Keuls Studentized Range Statistic (10:79-82). The observed differences between the means of Treatments A and C, and between Treatments A and B were significant ($p < .01$). The observed differences between the means of Treatments B and C were not significant ($p > .05$). Table III shows the critical values and the corresponding Studentized Range Statistic.

The twelve items on the Rating Scale for Curriculum Evaluation were broken into six areas by grouping common items. To observe the effects of the treatments by areas, on the total score, six one-way anova were used, as shown in Table IV. Significant differences ($p < .01$) were observed among the treatments in the areas labeled Cognitive and Psycho-motor Behavioral Outcomes. In the areas designated as Goal Directives and Affective Behavioral Outcomes, significance at the 5 per cent level of confidence was observed. To further probe the nature of the differences among the treatments, in the areas found to be significantly different, the Newman-Keuls method for obtaining the Studentized Range Statistic was utilized. The effects of Treatment A on Psycho-motor and Cognitive Behavioral Outcomes on the RSCE were observed to be significantly different from Treatments B and C ($p < .01$). The effects of Treatment A on Goal Directives and Affective Behavioral Outcomes were significantly different from Treatments B and C at the .05 level of confidence. Treatments B and C were not significantly different ($p > .05$) in the effects they exerted on any of the four areas tested. Through these findings, the areas on the RSCE contributing to the significantly higher scores for Treatment A groups were established.

TABLE II

SOURCE TABLE FOR THE TWO-WAY PARTICALLY NESTED ANOVA

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F
Within Groups	580.6	21	27.6	
Between Groups	934.4	8	116.8	4.23 **
Between Treatments	718.1	2	359.1	13.01 **
Between Subjects	108.9	2	54.4	1.97
Interaction	107.4	4	26.8	0.97
Total	1515.0	29		
Nested Subjects in Treatment A				
Between the Three Subjects	165.1	2	82.6	2.51
Within the Three Subjects	230.1	7	32.9	
Nested Subjects in Treatment B				
Between the Three Subjects	35.1	2	17.6	1.08
Within the Three Subjects	114.2	7	16.3	
Nested Subjects in Treatment C				
Between the Three Subjects	18.8	2	9.4	3.61
Within the Three Subjects	233.9	7	34.0	

** $p < .01$

TABLE III

SUMMARY OF THE CRITICAL VALUES AND CORRESPONDING STUDENTIZED RANGE STATISTIC FOR THE TREATMENTS

TREATMENTS	CRITICAL VALUE	DF	NEWMAN-KEULS $Q_{.99}$
Treatment A > C	6.68 **	(3,21)	4.615
Treatment A > B	5.71 **	(2,21)	4.005
Treatment B > C	0.97	(2,21)	4.005

** $p < .01$

TABLE IV

SOURCE TABLE FOR THE SIX ANOVA FROM THE SIX AREAS IN THE RATING SCALE FOR CURRICULUM EVALUATION

AREAS	AMONG GROUPS MEAN SQUARE (df = 2)	WITHIN GROUPS MEAN SQUARE (df = 27)	F
Goal Directive Item: 1	1.90	0.40	4.75*
Topic, Scope, Sequence Items: 2,3,4	8.25	4.05	2.03
Cognitive Behavioral Outcomes Items: 5 and 6	11.35	1.36	8.34**
Psycho-motor Outcomes Items: 7 and 8	34.50	2.74	12.59**
Affective Behavioral Outcomes Items: 9 and 10	14.70	3.09	4.76*
Enhancing Activities Items: 11 and 12	4.30	2.90	1.48

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

Effects of Independent Variables on Group Interaction

Frequency data collected through the use of Bales' Interaction Process Analysis observational technique were categorized into three behavioral dimensions: 1) group maintenance; 2) task solution; and 3) decision-making. Chi-Square statistic was utilized for observing differences between observed and expected frequencies in each behavioral category by school subjects and treatments. No significance ($p > .05$) was observed in any instance.

Effects of Independent Variables on Verbal Content

Eight categories defined the sum of the verbal content during the course of committee discussion and decision-making activities. Through a content analysis, a frequency count of the verbal emphasis by category was obtained. Using Chi-Square tests of significance, the frequency data was compared between Treatments A and B, A and C, B and C, School Subjects, and each of the verbal content categories. No significant differences were observed ($p > .05$) between the two types of inservice training and the eight categories. In only one instance was significance obtained, between inservice training and no training on the Cognitive Outcomes category (Treatments A x C; $p < .05$: Treatments B x C: $p < .10$). No significant differences ($p > .05$) were observed among the school subjects on any of the eight categories.

CONCLUSIONS

On the basis of the results observed from the experimental test, it was concluded that the hypothesis proposed for the theoretical problem should be accepted. It stated:

> Initial curriculum engineering decisions on selected data will significantly facilitate group decision-making in curriculum development.

By eliminating the eight participant variables, group interaction behavior, the verbal content the committees emphasized, the school subjects as factors facilitating decision-making in curriculum development, the effects of concept attainment inservice training on curriculum development were evident.* Therefore, initial curriculum engineering decisions, relative to selection of relevant data from the input, can be said to have differential effects on a curriculum developed by a committee, under the conditions set up in the present study.

The following postulates are proposed:

1. Different selected data from the input phase of the curriculum system will produce (statistically) significantly different results in the output phase of the curriculum system.
2. Effects of choices from the selected input data on the developed curriculum, engineered through curriculum planning, can be tested experimentally.
3. Selection of input data based on current experimental findings in psychology and education, as a basis for

* Table V summarizes the status of the major and corollary null-hypotheses.

inservice training prior to curriculum development, will enhance the quality of subsequent curricoulum.

Thus, the use of the model in future studies would help in selecting the input variables, controlling those variables not under examination, and testing particular input data for their value to curriculum development committees.

TABLE V

SUMMARY OF THE STATUS OF THE MAJOR AND COROLLARY NULL-HYPOTHESES

NULL-HYPOTHESES	SIGNIFICANCE TESTS	STATUS
Major Null-Hypothesis A	F ratio; Newman-Keuls	Rejected
Major Null-Hypothesis B	F ratio; Newman-Keuls	Partially Rejected
Major Null-Hypothesis C	F ratio	Not Rejected
Interaction Behavior		
Corollary # 1	Chi-Square	Not Rejected
Corollary # 2	Chi-Square	Not Rejected
Corollary # 3	Chi-Square	Not Rejected
Verbal Content Emphasized		
Corollary # 4	Chi-Square	Not Rejected
Corollary # 5	Chi-Square	Not Rejected*
Corollary # 6	Chi-Square	Not Rejected

* Not rejected in 6 of the 7 categories

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