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ABSTRACT

The Conceptual Level (CL) matching model describes the differential reaction of students varying in CL to educational environments varying in degree of structure. Models of teaching describe environments systematically varying in structure and therefore provide a specific basis for coordinated investigation of differential effects. The effects of different models of teaching (concept learning, "synectics," and role playing) on students of varying CL was indexed by recall, comprehension, synthesis, attitude, and model-relevant measures. Results from two investigations indicated differential CL model of teaching interactions as well as differentially specific model effects. Theoretical, methodological, and practical implications were considered. (Authors)

Student Conceptual Level and Models of Teaching: theoretical and empirical coordination of two models[1]

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I. Theoretical Rationale

Most earlier studies of the teaching-learning process have been piecemeal, either investigating teaching while disregarding students, or investigating only student characteristics. Investigations of the teaching-learning process require a theoretical framework which coordinates three components: student characteristics (person), characteristics of the teaching approach (environment), and learning outcomes (behavior). In the present framework, students are viewed in terms of Conceptual Level (Hunt, 1971) and teaching is viewed in terms of Models of Teaching (Joyce & Weil, 1972). The present work investigates the interactive effect of one or more models of teaching (Environment) upon students varying in Conceptual Level (Person) as indexed by a variety of learning outcomes (Behavior). The two models -- Conceptual Level matching model and Models of Teaching -- have been converging theoretically for some time, but these studies are the first empirical investigations based on the theoretical coordination of the two models.

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The Conceptual Level matching model (Hunt, 1971) describes the differential effects of educational environments varying in structure on students of varying Conceptual Level (CL): low CL students are likely to profit from high structure while high CL students should profit from low structure, or learn effectively in a variety of structures. Models of teaching (Joyce & Weil, 1972) describe a variety of teaching approaches in terms of their syntax, sequence, and structure, thus providing a systematic basis for describing educational environments of varying degrees of structure. For example, an advance organizer approach is considered highly structured, an inductive teaching approach moderately structured, and group investigation low in structure. The design of the present studies, therefore, was derived from a general B-P-E (Behavior-Person-Environment) analysis proposed by Hunt & Sullivan (1974) as shown in the following diagram.

Conceptual Level (Person)	Models of Teaching (Environment)	Learning Outcomes (Behavior)
Low CL (need much structure)	Inductive Teaching	Cognitive measures at different levels.
	Synectics	Model-specific measures.
High CL (need little structure)	Role Playing	Attitude measures.

The present investigations of the teaching-learning process are derived by selecting person-environment combinations to study their

effect on as wide a variety of behavior as possible. Student CL is considered an "accessibility characteristic" (Hunt, 1971) because it is coordinated with an environmental characteristic, degree of structure. Other accessibility characteristics such as student's need for affiliation (which is coordinated with effective learning through group discussion) have been identified, and will later be investigated as they interact with various models of teaching. Therefore, the coordinated theoretical framework is called MOTAC (Models of Teaching-Accessibility Characteristics).

The teaching-learning process does not occur in an abstract vacuum; investigations require content to be taught and learned. The content vehicles in the present MOTAC investigations have been adapted from information systems, or data banks, based on either cultures (Joyce & Joyce, 1970) or persons (Noy & Hunt, 1972). Therefore, the empirical studies combine instructional systems (models of teaching), conceptual systems (accessibility characteristics) and information systems (biographical and cultural data banks) to investigate their interactive effects. The three components will be described with special emphasis on their relevance to investigating the teaching-learning process and their compatibility to one another.

Models of Teaching

A model of teaching (Joyce & Weil, 1972) is defined as a complex of behavioral events in which a teacher carries out a sequence of activities designed to implement particular educational objectives and goals. Models of teaching operationalize a particular theory of learning

or philosophy of education into a teaching strategy by describing it in terms of four concepts: syntax, principle of reaction, social system, and support systems. Describing a teaching model in operational terms has been very useful as the basis for developing teacher-training programs (Joyce, Weil, & Wald, 1973) and deriving teaching skills necessary for utilizing a specific model of teaching (Weil, 1973). However, models of teaching are no less appropriate to research investigations of the teaching-learning process. In teacher training, models of teaching identify the objective, or dependent variable, and interest centers on the precision with which a trainee can learn to teach a specific model. In research on the teaching-learning process, models of teaching provide an operational description of the educational environment, or independent variable.

The most specific operational description of a model of teaching is a profile of the model in terms of an interaction-analysis pattern. A system of interaction analysis, specifically designed to index models of teaching (Joyce, Guillion, Weil, Wald, McKibbin, & Feller, 1972), portrays a teaching strategy according to several objective categories: structuring (e.g. negotiated, directive), information (e.g. low; middle; and higher-level),and feedback (e.g. positive, neutral, negative) applied to the statements and questions of teacher and students. These categories can be arranged into "model-relevant" indices, e.g. proportion of negotiated structuring, proportion of higher-level information processing, etc. For example, the synectics model is characterized by a great deal of higher-level information processing and very little evaluative feedback, especially negative feedback (Joyce, Weil, & Wald, 1973, p. 55). One of

the secondary results of the present work has been to obtain a more precise interaction analysis profile for those models employed in the investigations.

Models of teaching are also operationally described in terms of syntax or sequence. For example, the inductive teaching model (Taba, 1967) consists of three phases: enumerating, grouping, and labeling. This a priori specification of the nature of the teaching environment has an additional advantage of which we became increasingly aware during the initial MOTAC studies: it serves to identify the student skills required at each stage in the sequence. From a student perspective, inductive teaching requires skill in enumerating, grouping, and labeling. Such simultaneous specification of teaching method and learning skill is the basis for developing a better understanding of person-environment interaction or matching (Hunt, 1973).

Models of teaching can be objectively described, but they are also susceptible to "student pull". The reciprocal nature of teaching models was noted in observing different patterns for younger (K-3) and older (grades 4-6) students. For three models (Inductive Teaching, Synectics, and Group Investigation), teacher trainees who worked with younger students used fewer higher and middle-level information statements but used more negotiating statements than trainees with older students (Joyce, Weil, & Wald, 1973). If a model is completely susceptible to "student pull", then it loses the advantage of precision. The degree of susceptibility to "student pull" for a specific model was a major methodological issue in the present studies, and will be discussed specifically later.
As we learn more about the teaching-learning process, the variation in

pattern of a specific model of teaching as a function of specific student characteristics will become an indicator of reciprocal effects rather than imprecision in teaching.

Conceptual Level Matching Model

Originally based on a theory of personality development (Harvey, Hunt, & Schroder, 1961) Conceptual Level describes students in terms of their conceptual complexity or self-responsibility. Students low in Conceptual Level (CL) are dependent on external standards and have difficulty in complex information processing. High CL students are more capable of complex information processing and of self-responsible learning. The basic CL matching principle (Hunt, 1971), was derived from these different characteristics on the assumption that the less the student could be responsible for his own learning and the less effectively he could process complex information, the more he required a structured learning environment. Degree of structure refers to how much the student himself determines the environment and how much it is pre-organized. In high structure, the environment is highly organized and is determined by the teacher. In low structure, the student himself has more responsibility. The contemporaneous matching principle -- that low CL students profit more from high structure while high CL students profit more from low structure, or are unaffected by variations in structure -- describes this reciprocally inverse relation between CL and degree of structure. In describing how a person learns best, CL is considered to index learning style. CL, or learning style, describes how one learns, not how much or how well he has learned, and therefore is to be distinguished from IQ or ability. Although CL and ability are correlated in the .30's in younger children,

all of the experiments, including the present series, study CL effects by equating ability. CL is similar to, though distinct from, level of moral maturity and level of ego development (Sullivan, McCullough, & Stager, 1970).

In experiments designed to test the contemporaneous matching principle, low and high CL students were identified and then assigned to one of several experimental conditions which were designed to vary in terms of their degree of structure in order to investigate the pattern of differential effects. As predicted, when compared with high CL students, low CL students learned better with the high structure or a lecture than in a discovery mode (McLachlan & Hunt, 1973) or through the high structured rule-example order than example-rule sequence (Tomlinson & Hunt, 1971).

Learning style (CL) has also been used as an organizing basis for applications of the matching principle through homogeneous classroom grouping (Hunt, Greenwood, Brill, & Deineka, 1972) and through alternative secondary schools of varying structure (Hunt, Greenwood, & Watson, 1973). When applying matching ideas it becomes very important to re-state the environmental prescriptions in developmental terms. Thus, if the contemporaneous principle were applied to a low CL student through continually providing highly structured "spoon-feeding" experiences, he would be unlikely to develop self-responsibility or acquire new learning styles. The developmental goals for all students is to become more self-responsible (Hunt, 1973), and the contemporaneous matching principle simply describes different means for different students to reach this goal. Just as the major long-term goal for teachers is to learn a wider variety of models of teaching, so the goal for students is to acquire a wider variety of learning styles, or to learn on their own. In present

terms this goal could be operationally stated as the capability of learning from a wide variety of models of teaching.

Relation between Models of Teaching and Matching Models

In addition to providing one operational basis for specifying the developmental goal of the CL matching model in educational terms, models of teaching are compatible with matching models in several ways. First and foremost, the sixteen models of teaching have been described in terms of their degree of structure, and therefore provide the ideal companion model for the coordinated study of the teaching-learning process. For example, an advance organizer approach (high structure) should be more effective with low CL students than a group investigation approach (low structure). One of the models of teaching, sensitivity training, was found to have the predicted differential effects on teacher trainees (Heck, 1971): high CL trainees showed greater improvement in the adaptability of their teaching under sensitivity (low structure) training while low CL trainees improved more with the Human Development Institute (high structure) approach. In discussing the degree of structure of models of teaching (Joyce & Weil, 1972, p. 305), it should be noted that these classifications of degree of structure were made on a logical, not an empirical, basis so that the MOTAC studies will also serve to verify or correct the classification of models of teaching in terms of degree or structure (or perhaps force a more differential, multi-dimensional system to replace degree of structure).

Second, the system for interaction analysis to describe models of teaching has been devised with an aim to detecting CL-relevant responses. Thus, the various levels of information-processing in the objective coding

system have the same theoretical basis as the different levels of conceptual development. Third, CL of the teacher trainee was found to be related to the overall capability which trainees exhibit in learning three models of teaching, though CL did not predict capability in any one single model (Joyce, Weil, & Wald, 1973, p. 50). Thus, at a teacher trainee level, CL seems to be an index of flexibility in teaching or "learning to learn" models of teaching.

Finally, models of teaching have been classified into four "families" (Joyce & Weil, 1972): information processing, social interaction, personal sources, and behavior modification, and it may turn out that certain accessibility characteristics of students are more relevant to certain families. For example:

Accessibility Characteristic	Model of Teaching Family
Cognitive orientation	Information processing
Motivational orientation	Social interaction Behavior modification
Value orientation	Personal sources

Although this diagram is speculative, it may serve to guide the selection of specific combinations of models of teaching and accessibility characteristics in future MOTAC studies.

II. General Design and Procedure

The B-P-L diagram presented earlier was the basis for the general MOTAC design. The basic procedure consisted of (1) pre-selecting a group of students who were similar in a particular accessibility characteristic e.g. low in CL who were then (2) provided with information on a topic after which (3) the students worked on the topic through a specific model of teaching and (4) completed various outcome measures. Thus the general procedure consisted of a three phase sequence, information - teaching - outcome.

Formation of Teaching Groups

All students in the present series were at junior high school, Grade 7, 8, or 9. Teaching groups were small consisting of 6, 8, or 12 students always containing half girls and half boys. Teaching groups in MOTAC I and MOTAC II were selected on CL; therefore, a specific teaching group consisted of all low CL students or all high CL students, but each group was equated for ability. The attempt was to define teaching groups similar in all respects (grade, sex, ability) except CL.

Models of Teaching

To maximize the precision with which the models were taught, all models were taught by one of the two authors of Models of Teaching, Bruce Joyce and Marsha Weil. Teaching sessions in MOTAC I were 50-60 minutes, and somewhat longer in MOTAC II. Teachers generally attempted to teach the model in a constant fashion to each group with a minimum of "student pull". When a model was modified (as in MOTAC II), there was still an attempt to maintain similarity between groups. Since all sessions

were both live-recorded and video-taped, the degree to which a specific model was taught in a similar fashion from group to group could be objectively determined. Teachers were initially unaware of the CL group, but usually became aware of the nature of the CL group through students' behavior. In some cases, a teaching group received only one session with one model; in some, students received one session with several models; and in others, several sessions with one model. Also, some control groups received no teaching while others received neither teaching nor information.

Outcome Measures

Learning outcome measures in as many levels of the taxonomy as possible were collected. Model-specific measures were also obtained both during and after the teaching. Attitudinal measures were collected after every teaching session.

Content Vehicles: Information Systems

The importance of subject matter or content is often underplayed in research, yet the content dealt with in the teaching-learning process is a central component. The development of content vehicles for the MOTAC studies was considered to be as important as the specification of the student characteristics and the teaching environments. The appropriateness of a content vehicle should be considered in relation to the design, to the students, to the models of teaching, and to the learning outcomes. From the design viewpoint, the content should be in a form communicable in the 45-60 minutes of the information phase. For the junior high school students in MOTAC I and II, it should be both novel and interesting. From the model standpoint, it should be sufficiently

versatile to lend itself appropriately to a variety of models (not to deny that there may be topics more appropriate for certain models than others, but some content may have a wider area of model applicability). In terms of learning outcomes, the content should lend itself to consideration at a variety of outcome levels. The central criterial content characteristic is that it should be complex, multi-dimensional, and open to a diversity of interpretations. Although the content vehicle should be potentially multi-dimensional and complex, it should be presented to the students initially in a form which is factual, non-interpretive, and "flat".

Content in such form was available in the biographical information systems, or data banks, assembled by Noy. Using a specifically designed category system (essentially, a taxonomy of a person's life), she has organized information about a person into a random-access-and-retrieval system similar to those developed by Joyce & Joyce (1970) for cultures. Biographical information systems have been used to assess and train students in information processing (Noy and Hunt, 1972; Noy and Hunt, 1973; Noy and Hunt, 1974). The first biographical data bank on Sigmund Freud consisted of 283 topics classified into 34 categories. The second bank on Ernest Hemingway was more extensive consisting of 446 topics in 36 categories.

The life and work of Hemingway was chosen for the content vehicle in the present studies. Material from the original data bank was revised to MOTAC requirements, i.e. a "mini-bank" was developed from the original "maxi-bank". Several versions of the content materials were pilot tested before completing the MOTAC I version. Devising outcome measures was

facilitated by the existing bank of 44[illegible] objective items, one for each topic in the original bank. The "mini-bank" was slightly revised for MOTAC II, and an additional set [illegible] materials describing his work was added. The information and outcome measures are more specifically described in the MOTAC I and MOTAC II experiments.

In addition to decisions about design, a decision must also be made about what content vehicle to use in a MOTAC study. Therefore, we are presently developing alternate content vehicles of other persons (Freud) and cultures (Banbury, England) to serve as mini-banks meeting MOTAC requirements. A rough version of a Banbury bank was tried out in the last teaching sessions of MOTAC II. In addition to providing alternative sources of information, other content vehicles will permit investigation of transfer effects.

III. MOTAC I[2]

The first studies in the series, referred to as MOTAC I, were intended primarily to give a foundation to design subsequent studies. They yielded a considerable amount of useful information bearing on such questions as what model to use, how many teaching sessions were necessary, how many students to include in a teaching group, whether to use an intra-individual (same students/different models) or inter-individual (different students/different models) design, how flexible the model should be in relation to "student pull", and perhaps most important, what outcomes to observe and how to measure them.

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2. We appreciate the assistance of the following colleagues in conducting MOTAC I: Margo Biersdorf, Dean Flood, Robert Gower, Karen Haak, and Nancy Watson.

Two studies were conducted, a Grade 7 study in which all students experienced three different models (intra-individual) and a Grade 9 study in which each student experienced either one or no model (inter-individual). Apart from this difference, the studies were almost identical. Teaching groups consisting of either low or high CL students who (1) received information about Hemingway, (2) were taught by an inductive teaching and/or synectics model (plus a role playing model in Grade 7), and (3) completed a similar battery of learning and attitude outcome measures.

Both samples of students were selected from schools which are applying educational arrangements based on CL matching principles. Grade 7 students were selected from a junior high school in which students are homogeneously grouped on the basis of CL, or learning style (Hunt, Greenwood, Brill, & Deineka, 1972) and Grade 9 students were selected from two schools varying in their structure to serve students with different learning styles (Hunt, Greenwood, & Watson, 1973). Thus, the MOTAC studies were reciprocally related to cooperating schools in that video-tapes of the teaching sessions were made available to the teachers in the three schools for purposes of in-service training related to student learning style, models of teaching, and their interaction. Among several considerations in selecting the models to be used in MOTAC I, therefore, was that they be comprehensible to the teachers (cf. Joyce, Weil, & Wald, 1972).

Therefore, the MOTAC I studies essentially provide an analytic frame consisting of student characteristics (low - high CL), models of

teaching (inductive, synectics, and role playing) and a content vehicle (Hemingway) within which to view learning, attitudinal and model-specific outcomes as well as teacher-student interaction as indexed by interaction analysis.

MOTAC I - Grade 7

The Grade 7 study was conducted during a three-day period in May 1973.

Method

Formation of CL groups

Two groups of twelve students each, one low in CL and one high in CL, were selected on the basis of their scores on the Paragraph Completion Method (Hunt, Greenwood, Noy, and Watson, 1973) from approximately 250 Grade 7 students in a suburban Ontario junior high school. Twelve high CL students, six boys and six girls, were first selected on the basis of their CL score (1.7 or above). The low CL group was selected by pairing each high CL student with a student of the same sex and score on the Canadian Test of Basic Skills (CTBS), but with a low CL score (1.0). An alternate low CL student was selected,and because there were no absences,the low CL group consisted of 13 students. Mean CTBS scores (administered in May 1972) in grade equivalents were identical for both groups, 6.8. Mean CL scores were 1.0 for the low CL group and 1.9 for the high CL group.

Content materials

Hemingway's life was summarized in a brief two-page chronology and a short "mini-bank" containing information about his life, e.g.

family, life, interests, health, friendships, writings, philosophy of life. His writings were illustrated by (1) "The Killers", (2)"Judgment of Manitou" and (3) "El Sordo's Stand" from For Whom the Bell Tolls.

Models of teaching

Three models were used: inductive teaching (Joyce and Weil, 1972, 123-136; Joyce, Weil, and Wald, 1972, pp. 3-66), synectics (Joyce and Weil, 1972, pp. 233-252) and role playing (Joyce, Weil, and Wald, 1972, pp. 139-178). Bruce Joyce taught each of the six teaching sessions, using Hemingway as content, for a period of 50-60 minutes.

Interaction analysis

All sessions were live-coded by experienced coders using the system devised by Joyce, Guillion, Weil, Wald, McKibbin and Feller, 1972. All sessions were video-taped which provided a basis for later re-coding when necessary. The major scoring categories of the system are structuring, information, and feedback. Structuring moves are considered either directive or negotiating; information at low, middle, or high level; open, or opinion; feedback as positive, neutral, negative, or corrective. Each statement by the teacher and by each student is coded. Following is the definition of the fifteen indices:

1. Teacher talk (proportion of all responses).
2. Structuring (proportion of all responses).
3. Information (proportion of all responses).
4. Sanctions (proportion of all responses).
5. Teacher negotiations (proportion of teacher structuring).
6. Student negotiations (proportion of student structuring).
7. Teacher middle information (proportion of teacher information).

8. Student middle information (proportion of student information).
9. Teacher higher information (proportion of teacher information).
10. Student higher information (proportion of student information).
11. Teacher opinion (proportion of teacher information).
12. Student opinion (proportion of student information).
13. Teacher positive sanctions (proportion of teacher sanctions).
14. Teacher neutral sanctions (proportion of teacher sanctions).
15. Teacher negative sanctions (proportion of teacher sanctions).

Inter-coder reliability was .85.

Outcome measures

To obtain an accurate representation of effects, affective measures and cognitive measures at differing levels were obtained. Data was also collected on some model-specific measures for exploratory purposes.

1. Attitudes: Students were asked to answer the question, "How well did you like the method of teaching today?" by circling a number from 1 (very little) to 5 (very much), and indicating their reasons. They were also asked "How much did you feel you learned by the method of teaching used today?" by responding on a five-point scale and giving reasons.

2. Recall: Students completed a 25-item objective test on the Hemingway material (ten true-false, ten multiple choice, and five fill-in items).

3. Essay (Causal inferences). Students were asked to write an essay with the following instructions "A writer's life often affects his work and his writing often affects his life. Describe as much as you can about the relation between Hemingway's life and his writing. How

did his life influence his writing and how did his writing influence his life?" This task was thought to be at a higher level, i.e. requiring analysis, than the recall measure. Causal inference score was the number of causal inferences contained in the essay, and they ranged from 0 to 8. Inter-rater reliability for scoring was .83 (N = 25).

4. Model-specific measures. In addition to their use for communicating content in a variety of ways, some models of teaching also have process goals, i.e. attempt to facilitate model-specific skills. For example, inductive teaching aims to increase skill in forming concepts while synectics aims to increase skill in metaphorical thinking. Therefore, several model-specific items relevant to these two skills were used for exploratory purposes to note whether synectics teaching produced model-specific effects in metaphorical thinking and whether inductive teaching produced effects on items measuring concept formation.

Specific procedure

The procedure was the same for both groups with order of teaching sessions counterbalanced on the three days.

Day	Information	Teaching	Outcome
1	Hemingway's Life	Inductive teaching	Attitude, Model-specific measures
2	No new information	Synectics	Same
3	No new information	Role playing	Attitude, Recall, Essay

Interaction analysis indices

Results of interaction analysis are summarized by the fifteen indices described earlier which are expressed in proportions. Summarizing interaction analysis results in percentages gives a useful characterization which is comparable between teaching sessions, but does not indicate the absolute number of specific behaviors occurring in that category.

Comparison of Models

Table 1 presents the results of a model-by-model comparison for the two CL groups combined, i.e. based on the two teaching sessions shown in Table 2. For each index, an overall 3 x 2 chi-square was calculated, and where significant, specific comparisons between models were made.

Insert Table 1 about here

Table 1 comparisons provide a general indication of the distinctive features of each of the three models. The indices in Table 1 serve simultaneously to describe the teaching environment of MOTAC I - Grade 7 in objective terms and to provide data for what an exemplary or "ideal" model should look like. This latter point will be elaborated in describing the interaction analysis results of the Grade 9 study. In interpreting the chi-square differences in this and other tables, it should be noted that the indices are related to one another, and the differences viewed accordingly. For example, the greater occurrence of higher student information and less student middle information in inductive teaching are not separate findings.

Table 1

MOTAC I - Grade 7: Interaction analysis indices - Comparison of Models

Index	Inductive Teaching	vs.	Synectics	Inductive Teaching	vs.	Role Playing	Synectics	vs.	Role Playing
1. Total teacher talk	.729		.690	.729		.560 **	.690		.560 **
2. Total structuring	.349		.571 **	.349		.227 **	.571		.227 **
3. Total information	.457		.328 **	.457		.679 **	.328		.679 **
4. Total sanctions	.132		.110	.132		.063 **	.110		.063 **
5. Teacher negotiations	.014		.004	.014		.331 **	.004		.331 **
6. Student negotiations	.024		.000	.024		.634 **	.000		.634 **
7. Teacher middle information	.323		.646 **	.323		.321	.646		.321 **
8. Student middle information	.485		.731 **	.485		.414	.731		.414 **
9. Teacher higher information	.129		.046 **	.129		.271 **	.046		.271 **
10. Student higher information	.090		.038 *	.090		.190 **	.038		.190 **
11. Teacher opinion	.030		.111 **	.030		.145 **	.111		.145
12. Student opinion	.031		.065	.031		.172 **	.065		.172 **
13. Teacher positive sanctions	.159		.362 *	.159		.276 **	.362		.276 **
14. Teacher neutral sanctions	.687		.626	.687		.630	.626		.630
15. Teacher negative sanctions	.006		.000	.000		.000	.000		.000

* = < .05 ** = < .01

(Underlining indicates higher group.)

Comparison of CL groups

Table 2 presents the results of the six teaching sessions by CL group.

Insert Table 2 about here

Results of Table 2 comparisons of teacher behavior can be considered in terms of "student pull" (Klein, 1971). For example, the greater occurrence of teacher use of higher-level information processing for the high CL group in role playing is presumably due to the teacher's susceptibility to student characteristics. That the high CL students themselves make more such statements (.392) in this session supports this notion. Such CL differences in student behavior exemplify model-specific CL characteristics; for example, the higher incidence of student opinion for high CL students in both synectics and role playing.

Outcome Results

Attitude

In expressing their attitude to synectics, the low CL (4.1) was more favorable ($< .05$) than the high CL group (3.4). It should also be noted that the synectics model was less favorably evaluated ($< .05$) by both groups combined (3.8) when compared with inductive teaching (4.3) and role playing (4.4) models.

Recall and causal inferences

The results of these two learning measures can best be shown in a correlational table with CL and CTBS as shown in Table 3.

Table 2

MOTAC I - Grade 7: Interaction analysis indices - Comparison of CL groups

	Index	Inductive Teaching		Synectics		Role Playing	
		Low CL	vs. High CL	Low CL	vs. High CL	Low CL	vs. High CL
1.	Teacher talk	.752	.706	.731	.650 *	.540	.584
2.	Total structuring	.378	.341	.254	.251	.247	.206
3.	Total information	.447	.469	.519	.626 **	.703	.652
4.	Total sanctions	.120	.146	.147	.075 **	.036	.095
5.	Teacher negotiations	.005	.024	.009	.000	.434	.182 **
6.	Student negotiations	.000	.045	.000	.000	.862	.348 **
7.	Teacher middle information	.279	.374	.615	.674	.404	.226 **
8.	Student middle information	.388	.575 **	.635	.808 **	.603	.158 **
9.	Teacher higher information	.129	.130	.082	.014 *	.135	.432 **
10.	Student higher information	.091	.090	.035	.041	.043	.392 **
11.	Teacher opinion	.029	.033	.057	.159 **	.117	.178
12.	Student opinion	.025	.037	.026	.096 *	.124	.240 **
13.	Teacher positive sanctioning	.174	.280	.431	.235	.333	.250
14.	Teacher neutral sanctioning	.739	.640	.554	.765 *	.619	.636
15.	Teacher negative sanctioning	.014	.000	.000	.000	.000	.000

* =< .05 **= < .01

(Underlining indicates higher group.)

Table 3

MOTAC I, Grade 7: Intercorrelation

	Variable	2	3	4
1.	CL[1]	-.03	-.07	.59 **
2.	CTBS		.56 **	.08
3.	Recall			.08
4.	Causal inferences			

1. All correlations with CL are biserial r's

N = 25 ** = < .01

As will be noted in Table 3, there is a clear and distinctive pattern of relationships: CL to the higher-level measure (causal inferences) and ability (CTBS) to the lower level measure (recall). The mean scores for the two CL groups were identical for recall (14.7), and the causal inference mean score was 5.8 for high CL and 3.5 for the low CL group. This significant (< .01) CL difference might reflect dispositional tendencies present before experiencing teaching sessions, but the results to be presented from the control group in the Grade 9 study make this interpretation unlikely.

Model-specific measures

Differences between CL groups were observed for two model-specific measures. On one inductive teaching measure which required the student to provide labels for already organized groups of statements about

Hemingway, the high CL groups was significantly better ($< .01$) at providing adequate labels. On the synectics measure which reflected a student's selecting remote, or conceptually distant analogies, the high CL scored higher ($< .05$).

MOTAC I - Grade 9

This study was similar to the Grade 7 study in the following: (1) formation of groups (low and high CL), (2) models (inductive teaching and synectics, but not role playing), (3) content material, (4) interaction analysis measures, and (5) outcome measures. It differed in: (1) size of teaching group (6 students instead of 12), (2) number of models experienced (one instead of three), and (3) in the inclusion of two control groups, one which received no model and one which received no model and no information. The study was conducted immediately following the Grade 7 study in May 1973.

Method

Formation of CL groups and design

Students were selected from a pool of approximately 475 Grade 9 students in two Ontario high schools, and assigned to either low or high CL group on the same basis as the Grade 7 study. Forty-eight low CL students (scoring 1.0) and forty-eight high CL students (scoring 1.8 or above), plus a few alternates were assigned to one of four treatments: (1) inductive teaching, (2) synectics, (3) no model control, and (4) no information - no model control. The actual number of students is shown in the following summary:

Condition	Number of students in each group		
	Low CL	High CL	Total
1. Inductive	13	13	26
2. Synectics	13	13	26
3. No-model Control	13	13	26
4. No information - no model control	11	11	22
	50	50	100

The mean CL score for each of the four low CL groups was 1.0. The mean CL score for the high CL - inductive teaching group was 2.0, and for the other three CL groups, 1.9. In addition to varying in CL, the eight groups were formed in order to be equal in ability (SCAT) with an equal number of boys and girls, and an equal number from each of the two schools.

Models of teaching

Although it had been initially planned to use 12 or 13 students in each teaching group, the Grade 7 experience indicated that this number was rather large. Therefore, the four teaching groups above (Low CL - inductive; high CL - inductive; low CL - synectics and high CL - synectics) were each subdivided into two smaller teaching groups of 6 or 7, all from the same school, similar in SCAT score and approximately equal in boys and girls. Bruce Joyce and Marsha Weil each taught one group in each of the

four CL - model combinations. For the most part, the analysis was conducted by combining the two teaching sessions although in some interactions analysis, they were considered separately.

Specific procedure

Following was the procedure for each group:

Group	Information	Teaching	Outcome
1	Hemingway's Life	Inductive	Attitude, Recall, Essay, Model-specific measures
2	Hemingway's Life	Synectics	Same
3	Hemingway's Life	No teaching. Film: "The Killers"	Same
4	None	None	Recall, Model-specific measures

Interaction analysis indices

Comparison of models

Table 4 presents both the comparison of models and the comparison of CL groups within each model. Results are for combined teaching sessions.

Insert Table 4 about here

Table 4

MOTAC I - Grade 9: Interaction analysis indices - Comparison of Models and CL Groups

Index	Inductive Teaching	vs.	Synectics	Inductive Teaching Low CL	Inductive Teaching High CL	Synectics Low CL	Synectics High CL
1. Teacher talk	.707		.617 **	.682	.735 *	.572	.671 **
2. Total structuring	.257		.272	.248	.255	.267	.277
3. Total information	.587		.581	.608	.564	.584	.557
4. Total sanctions	.090		.076	.075	.108 *	.122	.078
5. Teacher negotiations	.010		.064 **	.019	.000	.038	.091 *
6. Student negotiations	.044		.265 **	.067	.000	.217	.364
7. Teacher middle information	.401		.567 **	.380	.424	.543	.589
8. Student middle information	.538		.652 **	.515	.567	.645	.662
9. Teacher higher information	.153		.083 **	.143	.164	.094	.073
10. Student higher information	.086		.120	.088	.085	.144	.086 *
11. Teacher opinion	.058		.106 **	.086	.026 **	.098	.113
12. Student opinion	.017		.060 **	.022	.009	.056	.065
13. Teacher positive sanctioning	.248		.362 *	.343	.174 *	.329	.397
14. Teacher neutral sanctioning	.719		.586 *	.642	.779	.608	.562
15. Teacher negative sanctioning	.000		.000	.000	.000	.000	.000

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

(Underlining indicates higher group.)

These Grade 9 results in the two columns on the left can be compared with the comparable Grade 7 results in the two columns on the left. Comparison indicates that the pattern of specific teacher indices is similar. In both studies synectics was higher on teacher middle-level information and teacher opinion while inductive teaching was higher on teacher higher-level information.

The interaction analysis results from the Grade 7 and Grade 9 studies were used in two recent dissertations, one by Gower (1974) which used these indices to define an exemplary model, and one by McKibbin (1974) who compared these indices with the same teaching sessions coded by the Flanders' system and the Bellack system of interaction analysis.

Comparison of CL groups

The four columns on the right side of Table 4 can be compared with the comparable indices in Grade 7 shown in Table 2. The pattern of "student pull" effects is less consistent from the Grade 7 to Grade 9 than is the consistency of general model indices from the two studies.

Outcome results

Attitude

No differences were found between mean attitude scores of CL or teaching groups. Surprisingly, the most favorable attitude to method was expressed by the low CL - control group who saw a "non-teaching" film (however, this score, 4.3, was not significantly higher than the others.) The most interesting pattern of attitude results came from

considering the correlation of attitude to method with recall and causal inference scores in the three conditions as shown in Table 5.

Table 5

MOTAC I, Grade 9: Correlations between attitude to method and outcome measures in three conditions

		Correlation between attitude to method and:	
In condition:	N	Recall	Causal Inferences
Inductive teaching	26	.00	.37 *
Synectics	26	.50 **	.08
Control	26	-.16	-.19

* = < .05 ** = < .01

Table 5 indicates that favorable attitude to inductive teaching is significantly related to generating inferences which is a process goal of the inductive teaching model. No such pattern is seen in the other two conditions although attitude to synectics was positively related to recall score. This same pattern of correlations was observed for the other attitudinal measure, perceived amount learned.

Recall

Students in the no teaching - no information control condition scored significantly lower (< .01) on recall (10.3) than the other three conditions; however, no other significant differences were noted. Neither CL nor SCAT correlated to a significant degree with recall in any of the three groups.

Causal inferences

Table 6 shows the mean causal inference scores by group.

Table 6

MOTAC I, Grade 9: Mean causal inference scores by model and CL

Condition	Low CL	High CL	Overall
Inductive teaching	3.7	4.4	4.1
Synectics	2.7	4.1	3.4
No teaching control	3.0	3.1	3.1
Overall	3.2	3.9	3.5

Although the effects as indicated by analysis of variance were only at a borderline level of significance, the pattern of causal inference scores is worth noting. That the low CL control score is the same as the high CL control score makes it more likely that the high CL superiority on causal inference in Grade 7 was at least in part a function of the teaching. The relative decrease in low CL - synectics score compared with the high CL score is also of interest; whether this might reflect the low structure of the synectics model or the skills required in that model will require further investigation.

Model-specific measures

Although the model-specific measures were designed to index the effects of specific teaching experience, there were no differences in these measures attributable to teaching condition, i.e. inductive teaching measures were not higher after inductive teaching. However,

the same pattern of CL scores described in Grade 7 was noted on several model-specific measures: high CL students (mean of all 50 in four conditions) were higher on the inductive teaching and synectics measures found earlier. In addition, the high CL group also scored higher on another inductive teaching measure (free grouping, labelling, and justifying) and a general synectics measure ("Imagine you are an apartment building, describe yourself"). These results suggest that within the short-term training period (one-hour), the effects were not sufficient to produce measurable, model-specific results, but that such measures did reflect CL effects.

Discussion of MOTAC I and implications for MOTAC II

No specific evidence was noted in these initial studies for matching as might be indicated by differential effectiveness of a model with either a low or high CL group. The Grade 7 study was not designed to detect differences since learning outcomes were measured only after all three models. In the Grade 9 study the models were not selected for their differing degrees of structure, i.e. both inductive teaching and synectics were classified "moderate" in structure (Joyce and Weil, 1972, p. 305). However, the MOTAC I studies raised specific questions about how the structure of a model is defined. Does structure refer to the degree of teacher-directedness, or to the model's insusceptibility to "student pull" so that a highly structured model would be identical for low and high CL students? A slightly different possibility than degree of teacher-directedness is the degree of precision with which the nature and sequence of teacher moves are specified so that a highly structured model would be more clearly identified, for example, by the pattern of interaction

analysis indices. Or does structure refer to the skill demands required of students in different phases of the model so that a highly structured model would demand less complex skills?

Each of the fourteen MOTAC I teaching sessions was the first exposure of students to that specific model. Although perhaps it should have been obvious, it seemed quite noteworthy to us that the initial session of any model which meets the criterion of objective specification required for a model of teaching will necessarily be fairly high in structure (defined in terms of teacher-centeredness.) From this viewpoint, one would not expect CL-model differences to appear until students experienced several sessions with the model. Some hint of CL differences occurring after a longer exposure to a model is seen in the pattern of causal inference scores in MOTAC I. Following this lead we considered the effect of number of sessions by disregarding the nature of the model. Scores of Grade 7 students were considered only in terms of three sessions; scores for Grade 9 inductive teaching and synectics in Table 6 were combined for the one-session group; and the control group scores in Table 6 were considered no sessions. Results are summarized in Table 7.

Table 7

MOTAC I: Mean causal inference scores re-aggregated by number of teaching sessions

Number of sessions	Low CL	High CL	Total	CL Difference
3	3.5	5.8	4.7	+ 2.3
1	3.2	4.2	3.7	+ 1.0
0	3.0	3.1	3.1	+ 0.1

Results of Table 7 are the most important outcome findings of MOTAC I in their displaying not only orderly CL group increases, but differences between CL groups as a function of number of teaching sessions. These results were important to consider in designing MOTAC II.

In addition to number of teaching sessions, results of MOTAC I were also considered in terms of several other questions related to designing MOTAC II: (1) what model, (2) how flexible should the model be to "student pull", (3) how many students in a teaching group, and (4) what outcomes to measure and how to measure them? Inductive teaching seemed to provide the most promising results in MOTAC I (Tables 5 and 6), and it also seemed most relevant to CL in terms of skill demands. If several sessions were used, the teacher could allow the model to become more susceptible to student responsibility in later sessions.

Comparing our impressions with the size of the group in the Grade 7 study (12-13) with those of the Grade 9 study (6-7), it seemed that a number midway between, eight, should be optimal. In considering outcomes, the attitude, recall, and essay measures seemed to be worth retaining, but the results from the model-specific measures were not encouraging. As discussed, part of the difficulty may have been with the short, one-session (for each model) intervention. Process measures such as skill in concept formation skills or metaphorical thinking are unlikely to be affected by a one-hour experience. Therefore, it seemed more reasonable to attempt to obtain such information from students' response during, rather than after, exposure to the model. The specific nature of these "imbedded" measures will be described in the next section.

IV. MOTAC II[3]

MOTAC II was similar to MOTAC I in (1) its use of low and high CL groups, (2) its use of Hemingway content materials (with slight variation), (3) its use of inductive teaching (although in elaborated form), (4) in the general system of interaction analysis, and (5) in some outcome measures (attitude, recall, essay). It differed from MOTAC I in (1) the number of students/teaching group, 8, (2) its elaboration of the inductive teaching model, (3) its use of three long sessions, the final one without the teacher, and (4) interaction analysis coding which identified each specific student (so that individual student measures of degree of participation and information level were available), and (5) the addition of an outcome measure, impressions.

Apart from the longer period of intervention, the most important feature of MOTAC II was its explicit objective to train the students to use the model themselves. Thus, although there were three 90-minute "teaching" sessions, the final session in which the teacher was not present was considered in itself an outcome measure.

The emphasis in MOTAC II, therefore, was on an articulation of the inductive teaching model so that it was not only longer (90 minute sessions), but could be repeated so that the basic intervention was 180 minutes, or three times longer than MOTAC I. It was hoped that this

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3. We appreciate the assistance of several colleagues in conducting MOTAC II: Peter Adams, Dhun Berhamji, William Fehlberg, Thomas Moore, Geoff Peruniak, and Mary Rosser. Roma Reid's contribution to MOTAC II was so great that she should have been included as a co-author, but the authorship was set in August prior to this study. Her work on interaction analysis coding was indeed much appreciated.

extended intervention would provide a more comprehensive framework within which to analyze the teacher-student interactions as well as attitudinal and learning outcomes for low and high CL students. The study was conducted during a three week period in November and December 1973.

Method

Formation of CL groups

Two groups of eight low CL students and two groups of high CL students were selected from approximately 225 students in the same school from which the MOTAC I - Grade 7 students had been selected the previous school year. Formation of the groups was the same as before: the mean CL scores for each of the two low CL groups was 1.0 and for the two high CL groups, 2.0. Each of the four groups contained four boys and four girls, and each was similar in ability (CTBS). The groups were originally formed on the basis of 1972 CTBS scores, but the CTBS was administered again to the 32 students the week after completion of MOTAC II. Mean CTBS for the low CL group was 8.1 and for the high group, 8.2. There were no absences during the eight days of experimentation.

Content materials

The first portion of information was very similar to MOTAC I: chronology, mini-bank, and three stories. The design required a comparable portion of information on Hemingway's writing. A 19-page booklet of information on Hemingway's work was prepared consisting of portions of the Paris Review interview by George Plimpton with Hemingway about his writing, and excerpts from his writing.

Model of teaching

The inductive teaching model was elaborated by reiterating the

enumeration-grouping-labeling sequence at a higher level using the labels as stimuli. The model was also amplified in terms of required learner skill, involvement options, hypothesized model-relevant outcomes, and content outcome boosted. These various aspects are summarized in "Scripting a Model" (Joyce, Weil, McKibbin & Gower, 1973) as shown in Table 8.

Insert Table 8 about here

The first session (A) on Hemingway's life was approximately 90 minutes and the second session (B) on Hemingway's work was also about 90 minutes. At the third session (C) the students were instructed to use the model to try to understand the relation between his life and work. Because the aim of the first two sessions was to teach the students to use the model on their own, the teacher attempted to encourage the students' to become more responsible in the B phase through negotiating, talking less, etc. The involvement options listed in Table 8 were borrowed from Greta Morine of the Far West Laboratory, especially her notion of "responsive options", and served to operationalize the increased student responsibility and decreased teacher control in Phase B.

Interaction analysis

The same basic coding manual was used with an identification of each student who made a comment. This permitted calculation of two individual scores for each student: (1) total number of comments and (2) an information index, calculated by weighting each information comment

Table 8

Scripting a Model - Concept Learning

Task	Required Learner Skill	Involvement Options	Hypothesized Model-relevant Outcome	Content Outcome Boosted
1. Concept Attainment exercise	Discriminate attributes; Infer principle; Analyze strategy	Reception-Selection Sharing Strategies (Move) Student Leadership	Concept-attribute Concept of classification	Integration
2. Enumerate data	Recall; Select by criterion e.g. heterogencity triviality abstract-concreteness	Individual - Group (Number) Student Leadership	Enumerate data by criterion	Recall
3. Select data	Develop criteria; Apply criteria	Group (Number)	Apply criteria	Recall
4. Group data: Initial pass (Includes Label)	Generate Groups	Individual - Group - Class (Number)	Group basis of common attributes	Integration
5. Share - classify - justify - predict labels	Identify common elements of grouped data; Generate multidimensional possibilities	Student - talk	Identify principles of classification Concept of classification	Integration
6. Regroup - label data of some group members	Regroup - relabel data	Student - talk	Concept of classification	Integration
7. Multidimensional grouping	Generate multidimensional possibilities	Number	Multiple classification	Integration

: 8 (Continued)

Task	Required Learner Skill	Involvement Options	Hypothesized Model-relevant Outcome	Content Outcome Boosted
8. Share, classify, justify	Identify principles of multidimensional grouping	Student-talk	Concept of multiple class	Integration
9. What is a label? (Share labels)	Analyze labels	Student-talk Leadership	Nature of Label	Integration
10. Alternative Labels (Generate and share)	Generate labels which refer to common attributes Compare labels against criteria of appropriateness	Student-talk	Criteria for adequacy of labels	Integration
11. Group labels	Generate concepts of concepts	Student-talk Number Leadership	Group Abstractions	Integration
12. Share Groups	Analyze concepts of concepts	Student-talk Number Leadership	Criterion for grouping abstractions	Integration
13. Label grouped labels and share	Generate labels	Student-talk Number Leadership	Ability to use labels for grouped labels	Integration
14. Characterization Task (Newspaper Story)	Use labels to operate on data	Student-talk Number Leadership	Application of labels in descriptive tasks	Integration

by a score of 1 (low), 2 (middle), or 3 (high), and dividing by total information comments. Otherwise, the same interaction analysis indices were calculated for each of the two teaching sessions (A and B), for each of the four groups, and for combined low and high CL groups. Inter-coder reliability was .85.

One other individual measure was obtained from the teaching session: number of concepts a student formed as indicated by the number of groups in the grouping phase. Each student kept his cards in retrievable form so it was relatively easy to obtain this "imbedded" measure. An attempt was also made to obtain an indication of the inferential level or complexity of labels, but this was not productive since almost all labels were non-inferential, e.g. his family, his travels.

Outcome measures

1. Attitude measures. These were the same as before, and were administered after each of the three phases.

2. Recall. Two comparable 17-item objective tests on Hemingway's life were used, one after Phase A teaching and one after Phase B.

3. Essay (Causal inference). The same form as for MOTAC I was used for two of the four groups so these data were available for only 16 students (8 high and 8 low).

4. Descriptions. Students were first asked to describe Hemingway's life as follows:

> "Imagine that you are describing Ernest Hemingway to someone who knows nothing about him. How would you describe Hemingway as a person? Write as many descriptions of the sort of person he was - use either single words or phrases to describe what he was like."

Students' free response to this question were coded on a five-point scale for conceptual complexity which ranged from 1 (either all good or all bad) to 3 (both positive and negative features acknowledged; descriptions at an inferential level) to 5 (presenting superordinate concepts to account for his positive and negative qualities). This score will be referred to as the complexity index.

On a second sheet students were asked to write on the following:

> "Now imagine you are describing Hemingway's writing to someone who knew nothing about it. What was his writing like? Write as many descriptions of his writing as you can think of. Use either single words or phrases to describe what his writing was like."

Responses to this question varied primarily in terms of whether reference was made to his writing style, e.g. simple, straightforward, or to content, e.g. adventurous, violent. Therefore, the reference to style measure was the frequency of such descriptions. For the first two groups, these two questions, along with "essay" question to relate his life and work were administered in individual interviews after Phase A and Phase B. The repeated use of the "essay" question in an interview format produced very little variability in response so this data could not be used; however the description data were quite comparable to the written form. As a result, essay (causal inference) data were available for all 32 students.

Specific procedure

Each of the four groups was brought from the school to the OISE

studio for two consecutive days for the following procedure (approximate number of minutes in parentheses):

Phase	Information	Teaching	Outcomes
A	Hemingway's Life (60)	Inductive teaching on his life (90)	Attitude, Recall Descriptions (30)
B	Hemingway's Work (45)	Inductive teaching on his work (90)	Attitude, Recall Descriptions (30)
C	No new information	Independent inductive teaching on the relation between life and work (90)	Attitude, Essay (50)

Also, for two groups a short Phase D was included for exploratory purposes: information was given on Banbury, England followed by an independent inductive teaching session. No outcome measures were obtained.

Each of the four groups went through at least the three phases during the two days. For designation purposes they will be referred to by the order in which they came: Groups 1 and 4 were low CL and Groups 2 and 3 were high in CL.

Interaction analysis indices

Comparison of CL groups in Phase A

Table 9 summarizes indices separately for the four teaching groups and for CL groups combined.

Insert Table 9 about here

Table 9

MOTAC II - Interaction analysis indices - Comparison of CL groups: Phase A

	Index	Low CL Group 1	vs.	High CL Group 2		Low CL Group 4	vs.	High CL Group 3		Total Low CL (1 + 4)	vs.	Total High CL (2 + 3)	
1.	Total teacher talk	.803		.793		.724		.747		.761		.769	
2.	Total structuring	.312		.316		.310		.309		.311		.312	
3.	Total information	.438		.381		.374		.428		.404		.405	
4.	Total sanctions	.131		.154		.119		.092		.125		.123	
5.	Teacher negotiations	.156		.128		.128		.246	**	.142		.188	
6.	Student negotiations	.143		.000		.000		.200		.062		.048	
7.	Teacher middle information	.429		.279	**	.359		.327		.402		.305	
8.	Student middle information	.367		.395		.353		.289		.360		.338	
9.	Teacher higher information	.178		.505	**	.123		.382	**	.156		.438	**
10.	Student higher information	.227		.363	*	.219		.421	**	.223		.394	**
11.	Teacher opinion	.127		.122		.044		.109	*	.120		.082	
12.	Student opinion	.049		.031		.007		.011		.028		.018	
13.	Teacher positive sanctions	.291		.232		.298		.164		.295		.205	
14.	Teacher neutral sanctions	.645		.732		.688		.800		.666		.759	
15.	Teacher negative sanctions	.000		.000		.000		.000		.000		.000	

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

(Underlining indicates higher group.)

The most striking and consistent finding is the higher incidence of both teacher higher-level information processing and student higher-level information processing in the high CL teaching groups. Whether this was due to "student pull", "teacher pull", or their interaction is impossible to determine though it seems most likely that the results reflect a dyadic interaction of teacher adaptation to "student pull".

Comparison of CL groups in Phase B

Table 10 summarizes the interaction analysis indices for Phase B which was intended to be more student responsible and less teacher controlled than Phase A.

Insert Table 10 about here

First, the observed high CL superiority in Phase A on higher-level information processing by both teacher and student is not in evidence. The Phase B topic, Hemingway's work, was generally more difficult than his life in Phase A which may account for the general decrease in higher-level processing by students.

When Table 10 is compared with Table 9, one notes a general increase for both CL groups in teacher negotiation which verifies the intended shift to student responsibility. Table 10 also indicates that this occurrence of teacher negotiation was greater for high CL than low CL groups.

Table 10

MOTAC II - Interaction analysis indices - Comparison of CL groups: Phase B

Index	Low CL Group 1	vs.	High CL Group 2		Low CL Group 4	vs.	High CL Group 3		Total Low CL (1 + 4)	vs.	Total High CL (2 + 3)	
1. Total teacher talk	.779		.666	**	.653		.768	**	.722		.728	
2. Total structuring	.243		.338	**	.308		.276		.273		.301	
3. Total information	.419		.424		.365		.404	*	.394		.412	
4. Total sanctions	.141		.107		.145		.132		.143		.122	
5. Teacher negotiations	.180		.319	**	.292		.314		.233		.316	*
6. Student negotiations	.333		.228		.210		.407		.245		.306	
7. Teacher middle information	.365		.328		.316		.385		.351		.368	
8. Student middle information	.317		.228		.309		.384		.313		.307	
9. Teacher higher information	.270		.314		.166		.248		.240		.268	
10. Student higher information	.309		.346		.244		.254		.275		.299	
11. Teacher opinion	.140		.140		.066		.119		.116		.125	
12. Student opinion	.038		.007		.019		.048		.028		.029	
13. Teacher positive sanctions	.321		.239		.305		.322		.314		.294	
14. Teacher neutral sanctions	.643		.674		.666		.644		.654		.654	
15. Teacher negative sanctions	.000		.021		.000		.000		.000		.000	

* = < .05 ** = < .01

(Underlining indicates higher group.)

Outcome measures

Attitude

Table 11 shows the mean scores on attitude to method for the two groups after each phase.

Table 11

MOTAC II: Mean attitude to method scores by CL group

Group	N	Phase A	Phase B	Phase C (Independent)
Low CL	16	4.38	4.44	4.44
High CL	16	4.32	4.44	4.88

Because the distributions were highly skewed, Phase C scores were compared by a median split and using the Fisher exact test (Finney, Latscha, Bennett, and Hsu, 1963). The high CL scores (15 rated C at 5) were significantly higher ($< .02$) than the low CL group (9 rated C at 5). Therefore, the CL differences occurred, as would be expected, when students were given a chance for greater self-responsibility. This finding was further pursued by considering the reasons given by the students for their rating. Responses were scored in the three categories: internal (emphasis on freedom, opportunity to learn by oneself, etc.), external (emphasis on specific absence of teacher, difficulty with method, etc.) and neutral/indeterminate. Inter-rater reliability was 86%. When internal responses were compared with others, the high CL group used significantly more internal responses (Fisher exact test $< .05$) than did the low CL group.

Individual measures

Table 12 summarizes the characteristics of the major individual measures.

Insert Table 12 about here

All of the inter-rater reliability coefficients appeared quite adequate. Since most of the measures were administered both after Phase A and after Phase B, it was possible to correlate the two measures for an estimate of stability or test-retest reliability. For the reference to style measure, the stability coefficient is a contingency coefficient; for the others, product moment coefficients. The information index seemed quite unstable, and this is probably due to factors discussed in relation to the decrease in higher level student information processing which occurred because of the increased difficulty of the Phase B topic (Hemingway's work). Otherwise, most measures seemed fairly stable.

Table 13 presents mean scores by CL group.

Insert Table 13 about here

We have already observed that the greater difficulty of the Phase B task decreased the information index generally, and therefore probably accounts in part for the lack of high CL superiority on the information index in Phase B. In keeping with the increased difficulty, number of concepts decreased for both groups although the high CL students were

Table 11

MOTAC II: Mean attitude to method scores for CL groups in three phases

Group	N	Phase A	Phase B	Phase C (Independent)
Low CL	16	4.38	4.44	4.44
High CL	16	4.32	4.44	4.88

Table 12

MOTAC II: Characteristics of individual measures

Measure	Source of Measure	Range of Scores	Inter-rater Reliability	Stability (r_{AB})
Total comments	Interaction analysis	4 - 72	.85	.80 **
Information index	Interaction analysis	1 - 3	.85	.17
Number of concepts	Teaching session	1 - 12	--	.54 **
Complexity index	Descriptions	1 - 5	.91	.54 **
Reference to style	Descriptions	0 - 4	.97	.79 **
Causal inferences	Essay	1 - 10	.95	--
Recall	Recall	0 - 100%	--	.34 *

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

Table 13

MOTAC II: Mean scores by CL group for each phase

Measure	Phase A (Hemingway's Life) Low CL	Phase A (Hemingway's Life) High CL	Phase B (Hemingway's Work) Low CL	Phase B (Hemingway's Work) High CL
Information index	1.7	2.1 *	1.9	1.9
Number of concepts	5.44	7.00	3.69	5.82 *
Complexity index	2.50	2.75	1.75	2.82 *
Recall	72%	73%	65%	68%
Reference to style	0.2	1.6 **	0.3	1.3 *
N	16	16	16	16

Fisher exact test: * =<.05

** =<.01

Underlined group is significantly greater

significantly higher. The complexity index was based on his life in both cases so was unaffected by the greater difficulty.

How much of the higher complexity index of the high CL students may have come directly from the teaching session is an important question.

One way to approach this question indirectly is to consider correlations between measures in the teaching session and outcome measures. Table 14 presents intercorrelations among Phase A measures as well as their relation to CL and CTBS scores.

Insert Table 14 about here

The biserial correlations to CL are an alternative mode of analysis for data already analyzed in Table 13. As in MOTAC I, Grade 7, CTBS is significantly related to recall, but to no other measure.

Table 15 presents the same measures for Phase B.

Insert Table 15 about here

Results of Table 15 are very similar to those of Table 14 with the additional significant relation between a measure in the teaching session (number of concepts) and an outcome measure (complexity index). CL does not relate to number of comments in either table because number of comments are relative to the number of comments made by the other

Table 14

MOTAC II: Intercorrelations among Phase A measures
(Hemingway's Life)

		1	2	3	4	5	6
1.	CL[1]						
2.	CTBS						
3.	Comments	-.15	.04				
4.	Information index	.51 **	.08	.33 *			
5.	Number of concepts	.38 *	-.06	-.18	.03		
6.	Complexity index	.10	.12	.32	.18	-.02	
7.	Recall	.08	.46 **	.06	-.01	-.06	.13

1 = Biserial r's
* = < .05
** = < .01

Table 15

MOTAC II: Intercorrelations among Phase B measures

(Hemingway's Work)

		1	2	3	4	5	6
1.	CL[1]						
2.	CTBS						
3.	Comments	-.05	-.09				
4.	Information index	.01	.16	.10			
5.	Number of concepts	.57 **	.09	-.08	-.18		
6.	Complexity index	.51 **	.06	.35 *	.09	.27	
7.	Recall	.01	.58 **	.09	-.09	.24	.24

1 = Biserial r's

* = < .05

** = < .01

Table 16

MOTAC I & II:Mean causal inference scores re-aggregated by number of hours

Number of hours	Total N	Low CL	High CL	Total	CL Difference
4	16	2.4	6.8	4.6	+ 4.4
3	25	3.5	5.8	4.7	+ 2.3
1	52	3.2	4.2	3.7	+ 1.0
0	26	3.0	3.1	3.1	+ 0.1

seven students, all of whom were the same in CL. A design in which teaching groups were heterogeneous in CL would be required to test this relation.

Causal inferences. The mean high CL score (6.8) was significantly higher ($< .001$) than the mean low CL score (2.4). These mean scores can be added to Table 7 (since they represent the equivalent of about four sessions, or 240 minutes) in order to extend the relation between duration of teaching and causal inference score as shown in Table 16.

Table 16

MOTAC I & II: Mean causal inference scores re-aggregated by number of hours

Number of hours	Total N	Low CL	High CL	Total	CL Difference
4	16	2.4	6.8	4.6	+ 4.4
3	25	3.5	5.8	4.7	+ 2.3
1	52	3.2	4.2	3.7	+ 1.0
0	26	3.0	3.1	3.1	+ 0.1

High CL scores, and especially high CL superiority, continued to increase as low CL score decreased. The MOTAC II relation between CL and causal inferences, expressed in terms of biserial r was .81. Causal inference was also significantly related to total information index ($r = .51$, $< .05$), but as before, unrelated to CTBS ($r = .11$).

Independent phase

At the conclusion of Phase B, the teacher told the group that their task in the next teaching session (C) was to use the inductive teaching strategy to understand the relation between Hemingway's life and his work. The teacher told them that he would not be present for this phase, but that they would have available the enumerated information from Phase A (Life) and Phase B (Work) so that the enumeration phase would consist of eliminating unnecessary items. At this point the teacher asked each group how they wished to work, with a leader or without.

Our discussion of MOTAC II up to now has largely ignored the specific characteristics of each of the four groups, considering the two low CL groups together and the two high CL groups together. However, in the independent phase, and the plans preceding it, each of the four groups displayed the idiosyncratic features which will be briefly noted. From a design standpoint, the replication feature of MOTAC II was very valuable because, as will be described, it provided a broader basis for establishing distinctive features of low and high CL groups while also emphasizing the specifically distinctive characteristics of each of the four groups.

Leadership question

When asked if they wanted a leader in Phase C, both low CL groups were unanimous in favoring a leader, as would be expected. Both groups decided to use a formal procedure to elect the leader. Group 1 selected a rather quiet boy, while Group 4 selected a very dominant girl. The

reaction of the two high CL groups was equally consistent and theoretically expected: neither group wanted a leader, e.g. "No, we'll do it on our own."

Group behavior in independent phase

The best way to communicate how Group 1 (low CL) reacted is to mention initially that none of the research staff thought they would be capable of carrying out the task on their own. Group 1 had been very dependent and passive in both Phase A and Phase B so that we held serious reservations about their capability to deal with this difficult problem. We were wrong; we seriously underestimated how well these fairly dependent students could learn on their own. We share our mistaken prediction because if teachers and researchers are to take seriously the idea of student self-responsibility in learning, they must entertain the possibility that it can occur, and moreover that the teacher's presence is not essential.

Why were we wrong? First as just indicated, we overestimated the need for a teacher's presence for any students. Second, Group 1 coped with the task by creating the structure and support they required. They began by carefully listing each of the specific tasks (cf. Table 8). The leader became a teacher following a lesson plan who led the group through a step-by-step application of the model. If he experienced difficulty, one of the group occasionally assisted him in his directive role. Their emphasis was almost entirely on the teaching strategy as a method to be completed with almost no attention to its problem solving purpose, i.e. how well it helped to understand the relation between Hemingway's life and work.

By contrast, Group 2 (high CL) was entirely concerned with the problem of relating Hemingway's life and work. They discussed the functional necessity of certain steps in the model and eliminated those steps which they felt were not required. During their discussions, one girl emerged as the facilitator of the group's feelings and views though she was not a leader directing the accomplishment of tasks. While the "output" of Group 1 was their successfully accomplishing a step-by-step application of the model, the "output" of Group 2 was their shared understanding of the relation between his life and work (and this, of course, affected the results in Table 16).

The reaction of the other two groups was similar in its reflecting CL differences. In Group 4 (low CL) the leader was much more forceful than the Group 1 leader, and she directed the group by taking the role of a highly directive teacher. Group 4 followed the sequence closely, but was guided more by the strong leader than by the list of steps. Group 3 (high CL) was less concerned with the specific steps than Group 4, but was also considerably less effective than the other high CL group primarily because of two or three students who deprecated other students and disrupted the group process. Group 3 serves as a valuable reminder that high CL students are not universally superior in every way, and that there are student characteristics other than CL. Group 3 was not always effective because some students exemplified another characteristic of some high CL students at this age, a difficulty in listening to the other person and understanding his view. In the process of learning self-responsibility, some high CL students may be excessively concerned with themselves and

their own views, thus "tuning out" the ideas of others.

It was impossible to apply the same system of interaction analysis completely to coding Phase C, partly because of the difficulty in defining who was "teacher" and partly because several students often spoke at the same time. We are continuing efforts to analyze these sessions with some variation of the interaction analysis system. Some fragmentary analysis was possible, and showed interesting patterns. For example, Group 2 (high CL) displayed significantly more ($< .05$) positive sanctions to one another than did Group 1 (low CL). Finally, it is of interest to re-consider the results of attitude to Phase C shown in Table 11 in relation to the foregoing observations.

V. Conclusions

This first MOTAC series has been valuable for the questions it has raised, for the surprises it has provided, and for its reminding us of some common-sense notions easily forgotten in designing research. Students can learn to teach themselves, and the question is how to facilitate the acquisition of such self-responsible skill. Educational intervention of short duration such as one hour is unproductive both for student learning and research understanding.

The teaching-learning process is enormously complex, but the present series shows promise of gaining some understanding of this dyadic interchange and its effects. While many of our initial theoretical ideas require revision in light of these results, the general assumption underlying the MOTAC series has been strengthened: that a comprehensive

understanding of the teaching-learning process can be approached through the systematic combination of models of teaching, student accessibility characteristics, and informational systems in designs permitting a maximum diversity of outcome measures. This assumption, guided by the present results, will serve to design future MOTAC studies.

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