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ABSTRACT

This paper focuses on the importance and the significance of the teacher's mastery of an abstract body of knowledge that underlies an educational innovation. Concepts and principles from organizational sociology are applied in order to investigate the relationship between teacher's mastery of this body of knowledge and the process of implementation of the innovation on the one hand, and the relationship between mastery and implementation outcomes on the other. Theoretical propositions of the study are illustrated by a secondary analysis of data gathered by the Program of Complex Instruction at Stanford University's School of Education. A connection is made between the improvement of thinking skills and problem-solving ability utilizing a theoretical model of a program, Finding Out. Implementation of this activity-based bilingual math and science program features a complex instructional approach based on theories and research in the disciplines of cognitive psychology, sociology, and social-psychology. During the academic year 1982/83, Finding Out was implemented in 15 classrooms from 10 schools within three school districts in the San Jose, California, area. Approximately 390 second, third, fourth, and fifth graders participated in the program, which was presented by teachers who had attended a 2-week workshop. The workshop introduced them to the theoretical framework and rationale of Finding Out and gave them the opportunity to practice teaching the program. Data are presented on teachers' scores on Index of Mastery, Index of Non-Routine Behaviors in Finding Out, and Index of Effectiveness, and four case studies are presented to illustrate some of the variables involved. (JB)

CONCEPTUAL UNDERSTANDING AND IMPLEMENTATION:

FACETS OF EDUCATIONAL TECHNOLOGY

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Table of Contents

1.1 Statement of the Problem

This paper focuses on the importance and the significance of the teacher's mastery of an abstract body of knowledge that underlies an educational innovation. Concepts and principles from organizational sociology are applied in order to investigate the relationship between teacher's mastery of this body of knowledge and the process of implementation of the innovation on the one hand, and the relationship between mastery and implementation outcomes on the other. Theoretical propositions of the study are illustrated by a secondary analysis of data gathered by the Program of Complex Instruction at Stanford University, School of Education.

1.1.1 The Teacher - Main Protagonist in the Implementation Process

Although interest in the different aspects of change and the implementation process is as strong as ever before, analysts seem to focus lately more and more on the classroom level and the role of the teacher as change agent. It is at the classroom level that one is likely to observe potential distortions of the innovation's proclaimed goals and/or essential features but it is there too that one can expect and hope for the realization of desired outcomes.

In his book, Michael Fullan (1982) makes the following unequivocal statement: "Educational change depends on what teachers do and think - it's as simple and as complex as that...If educational change is to happen, it will **require** that teachers understand themselves and be understood by others." (p. 107). The importance of the TEACHER as actual implementer of any proposed change, the "street-level bureaucrat" (Weatherly and Lipsky, 1977), the one in direct and immediate contact with the students/clients of the organization (Elmore, 1978, 1980) is evident. Success or failure of the implementation depends ultimately on the teacher's and his/her students' performance in the classroom. This is the reason why educational organizations have invested time, money and effort in the professional development of the institutional staff and why, today, one

can hardly exaggerate the necessity and the significance of staff development.

Recent studies (McLaughlin and Marsh, 1978; Schlechty and Whitford, 1983; Howey and Vaughan, 1983) imply, however, that professional development of the teacher as on individual participant in the educational institution is insufficient; the organizational context of the teacher's reality and the consequences of any actions within this context cannot and should not be disregarded or neglected. Any demand for change in the traditional instructional practices should be accompanied and supported by changes in the organizational environment in which the teacher operates.

1.1.2 The Cognitive Dimension

The teacher's conceptual clarity, understanding and knowledge of the basic principles and features of an innovation were identified in the literature (e.g. Fullan, 1982; Gross, Giacquinta and Bernstein, 1971; Smith and Keith, 1971) as being important determinants of the process of implementation as well as its outcomes. Yet, many proposed educational innovations boast with temerity about being "teacher-proof", thus negating the critical importance of the teacher's mental operations in the process of implementation (Shulman, 1974, p.333).

Berman and McLaughlin (1977) conducted extensive research on the factors and determinants of the implementation and institutionalization of educational innovations. They found that clarity of the proposed innovation was an important predictor of successful implementation and that lack of clarity or "staff uncertainty about what (the teachers) were expected to do generated severe implementation problems and contributed to project demise once federal funding ended" (p.71). The authors' analysis strongly suggested that "teachers can implement innovations better if they clearly understand the project's purposes and precepts" (p.95).

In their study, "What Teachers Think about Small-Group Teaching", Sharan, Darom and Hertz-Lazarowitz (1979) investigated teachers' attitudes toward Small-Group Teaching (SGT), a well-researched and

theoretically developed educational innovation. The authors felt that teachers who attempted to implement SGT without acquiring an understanding of the basic principles of this instructional approach were unsuccessful and frustrated, the teachers therefore concluded that SGT was impractical. The researchers hypothesized that "knowledge of the basic principles and characteristics of SGT...would be positively associated with teachers' attitudes" (p.51), which in turn, must be taken into consideration in a discussion of a model of instructional innovation. The researchers found that among the three predictor variables that "made a substantial contribution to the regression equation for each of the three attitudinal scales...teachers' understanding of SGT principles was the most prominent predictor (underline added) of attitudes towards SGT for all scales. Remarcably, understanding of these principles was most effective in predicting attitudes on the teaching efficiency scale...This study indicates that teachers better able to identify the basic principles of SGT are also more likely to feel that this approach is effective for transmitting subject matter." (p. 59).

1.2 Applications of Organizational Theory to Research in Education

Educational researchers have found it useful to apply organizational theory to school settings and thus illuminate and explain problematic issues as well as provide a possible framework for interventions on the level of the organization and the participants in the organization. This paper applies organizational theory in its focus on aspects of the technology in the classroom, a concept that transcends the common usage of technology as meaning machines and/or materials (Cohen, Deal, Meyer and Scott, 1973; Cohen and Bredo, 1975; Intili, 1977). In the first place, educational technology in its broader sense refers to characteristics and features of instructio.. such as the composition of the student body, materials and activities prescribed by the curricula and their degree of uniformity or differentiation. In the second place, educational technology includes techniques of instructional and pedagogical decision making, routine or non-routine. Thirdly, technology includes the existing knowledge of the participants:

understanding of certain cause-effect relations, possession of relevant information, and the intellectual sophistication and specialization required to perform a complex task.

1.2.1 Facets of Technology

In his synthesis of major organizational arguments and research, Scott (1981) enumerates the analytical dimensions of technology described by sociologists who have dealt with this concept.

> Alongside (the) view of technologies varying by stage of processing,..., approaches to technology vary by whether analysts emphasize (1)the nature of the materials on which work is performed; (2) the characteristics of the operations or techniques used to perform the work; or (3) the state of knowledge that underlies the transformation process. (Scott, 1981, p.209)

In this paper, this distinction between materials, operations and knowledge is being applied to the analysis of educational technology.

1.2.1.1 Materials

Materials refer to those objects - "human, symbolic or material" (Perrow, 1970,p.75) upon which work is being performed and which are being transformed from input into output during the production process. Perrow (1967,1970) classifies the raw materials according to their familiarity in the eyes of the performer and according to their variability. In schools, for example, the student body can be considered "raw material" as can the actual curricular activities and materials used by these students. When the student body is heterogeneous as is the case in racially, ethnically, socially and academically mixed settings, the raw material can be defined as highly ambiguous and varied. When the materials and activities used by these students are complex and diverse, unpredictability and variability in the instructional materials (or input) are significantly increased.

1.2.1.2 Operations

The concept of operations refers to features of the work process such as preprocessing of inputs and assessment of outputs, the complexity, i.e. the diversity and the differentiation within the technical workflow, routiness or non-routiness of decision-making,

interdependence of work units (Scott, 1981). A widely used typology of operations, for example, is the distinction between large batch and mass production on the one hand and small batch and unit production on the other.

Applications of this distinction to the classroom have been made, among others, by Cohen and Intili (1981) who based their conceptualization of operations in the classroom on the work done at Stanford University in the Environment for Teaching Program. They said:

> The traditional method of teaching where the class is assigned a task as a whole or sits as a group listening to the teacher talk, is similar to large batch processing in industry. The student completes the standardized task in the prescribed manner and attains the desired outcomes. Instruction of this type shows a low degree of differentiation and a low level of non-routine decision-making. (Cohen and Intili, 1981, p.8)

To continue this metaphor, it is possible to say that when instruction in the classroom is conducted in small groups or individually, it is similar to small batch or unit production. If, in addition, activities and materials are non-standard and tasks are varied and open-ended we can talk about high levels of differentiation in the arrangements for classroom management.

1.2.1.3 Knowledge

Scott says that

> an emphasis on knowledge as compared to materials or operations marks a shift from an objective to a more subjective conception of technology. A conception based on knowledge takes into account the characteristics of the performer as well as those of the work to be performed. For example, materials that are the object of work processes may be objectively variable in their behavior or response to a performer's effort to transform them, but they may also be more or less predictable depending on the knowledge or experience of the performer. (Scott, 1981, p. 211)

Of particular interest here is the work of March and Simon (1958), Perrow (1967,1970), Thompson (1967) and Intili (1977).

In their classic book, Organizations, March and Simon (1958) describe how rationality and knowledge underlie the two kinds of responses made by members of an organization to stimuli in their environment. When the response is "routinized", it "has been developed and learned at

some previous time as an appropriate response for a stimulus of this class" (p.139). Non-routine responses are problem-solving activities that take into account the participants' previous knowledge as it interacts with practical uses of his knowledge in building a simplified model of the present situation --a model which is "the outcome of psychological and sociological processes, including the (participant's) own activities and the activities of others in his environment..."(p.139). March and Simon go on to qualify these problem-solving activities in the following way:

> Problem-solving activities can generally be identified by the extent to which they involve search: search aimed at discovering alternatives of action or consequences of action. (March and Simon, 1958, p.140)

From the kind of response made, it is possible to make inferences concerning the kind of knowledge that underlies the response. A highly codified, regulated and explicit bank of knowledge is best characterized in March and Simon's terms as a performance program or simply a program, which provides immediate and routine, step-by-step responses to the environmental stimuli. Problem-solving activities, however, reflect reliance upon a broader and more abstract body of knowledge that enables the participant to make non-routine, analytical responses by taking into account different alternatives, immediate outcomes and long-term consequences.

Professional practitioners, and teachers among them, use both kinds of knowledge. They use routine procedures to treat routine tasks but also to identify those situations which cannot be dealt with in routine ways. When routine responses are not adequate, attempts are made to solve problems by applications of a body of knowledge that is complex and abstract. Although it is not situation-specific, this body of knowledge is organized and structured so as to permit systematic application of its concepts and principles.

Following March and Simon, Perrow defines the concept of search as

> exceptional actions undertaken by the individual...They are nonroutine. No programs exist for them...But though nonroutine, one type of search may be logical, systematic and analytical...The second type of search process occurs when the problem is so vague and poorly conceptualized as to make it virtually unanalyzable. In this case, no "formal" search is undertaken, but instead one draws upon the residue of unanalyzed experience or intuition, or relies upon chance and guesswork. (Perrow, 1967, p. 196)

Later on, Perrow (1970) distinguishes between analyzable and unanalyzable search procedures, depending upon the nature and the degree of variability of the stimuli. Analyzable search procedures have their basis in pre-specified instructions, regulations or manuals or in previously acquired knowledge and they characterize two models of organizations: the routine, bureaucratic model and the engineering model. In the latter, the performer can make use of a distinct body of knowledge when analyzing and solving --in routine or non-routine ways -- problems that arise during the work process.

The implementation of the educational innovation which is the subject of the present investigation is an instance of the above described engineering model. The innovation itself has a solid theoretical basis that is supported by educational research; teachers implementing the program received thorough theoretical and practical training and their performance was closely monitored by the developers' staff; adequate performance was maintained and less adequate performance was improved through a sound feedback process that constantly emphasized the linkages between theory and practice. When the necessity arose to respond in routine or non-routine ways to high degrees of variability in the students and differentiation in the task activities, the teachers were able to use analyzable search procedures on an abstract body of pedagogical knowledge.

In her review of Perrow's framework, Intili (1977) points to the critical importance of the existence or non-existence of a distinct body of knowledge "to which the task performer can refer...when analyzing problems related to task performance." (Intili, 1977, pp.17-18). Neither Perrow nor Intili, however, make an analytical distinction between the concept of knowledge and its applications in form of search processes. Following Perrow who defines search processes as actions, Intili has identified search processes with decision making and thus would categorize them under the heading of operations. It is clear, however, that analyzable search procedures do not just pop up in the performer's mind. They are manifestations and applications of abstract knowledge, understanding and intellectual sophistication acquired through formal and informal education as well

as through practical experience. Thus, the theorists claim that the performance of a task consists of an adequate response to stimuli (raw materials) received by the participant. In order to be able to make his response, the performer "searches" his mind for what he knows about the raw material and the techniques or operations to be used.

Thompson (1967) argues that knowledge of relevant cause/effect relationships is present when a technology is put to use. This knowledge dictates performance of those activities which are judged to produce previously specified desired outcomes. Knowledge is a given for Thompson. It is the antecedent for the choice of the raw materials and their treatment in the technology of the organization that leads from the formulation of a goal to its attainment. It is important to note that Thompson emphasizes "the state of man's knowledge" (id. p.18) and thus implies that its measure is an important factor.

1.2.2 Formulation of the First Hypothesis

Perrow's statement that what is known about the raw materials determines the nature of the search procedures, is the basis for the first hypothesis of this paper. Although he alludes to knowledge of the techniques to be employed, he does not include it in his proposition. I define a body of knowledge as including knowledge of the materials and knowledge of the operations. Thus, Perrow's proposition is further developed and made more specific:

> Given variability in materials and the existence of a body of relevant knowledge that defines analyzable search behaviors, mastery of the body of knowledge will be positively related to non-routine behaviors in the operations of the technology.

1.2.3 Mastery of the Body of Knowledge and the Assessment of Organizational Effectiveness - Formulation of the Second Hypothesis

"To inquire into effectiveness is to ask how well an organization is doing, relative to some set of standards," says Scott (1981, p.318) in opening his discussion on organizational effectiveness. Evidently, the nature of the answers to this question depends on who is asking and why, as well as how the standards and the criteria for evaluation of

the effectiveness were determined. For example, different sets of criteria will be proposed by individuals who have different conceptions and perspectives of organizations. Those who adhere to a rational model of organizations are interested in maximizing productivity and efficiency; natural system analysts emphasize measures of participants' satisfaction and morale as well as survival of the organization itself as indicators of organizational effectiveness; those who adopt the open systems perspective stress the importance of adaptability to environmental demands and flexibility of responses as criteria of effectiveness.

Scott reiterates the importance of the underlying knowledge of the participants in devising tests for the assessment of organizational effectiveness. As he points out, the assessment of certain organizations such as schools and hospitals becomes particularly difficult when certain outcome measures are used because these are so dependent on the state of knowledge. "For example, a patient's medical condition following surgery will reflect not only the quality of care rendered by the surgical staff and the hospital personnel but also the development of medical science with respect to the particular condition treated, as well as the patient's general physical condition and extent of surgical disease at the time of the operation."(Scott, 1981, p.327). Analogously, effectiveness of the teacher's performance should reflect the state of pedagogical knowledge relevant to the instruction of particular skills or content of subject matter to students while taking into account the psychological and sociological background as well as the environmental reality of these students.

I chose to define effectiveness of the educational innovation that I am studying in terms of indicators that take into account the criteria of rational, natural and open system analysts. I am considering productivity (amount of curriculum covered), measures of teachers' satisfaction and their perceptions of the adoption and institutionalization, i.e. the survival of the innovation. Included are also teachers' reports of additional effort and their perceptions of difficulty of implementation. The second hypothesis then is derived directly from Scott's arguments described above:

Given equal access to sources of a relevant body of knowledge, mastery of this body of knowledge will be positively related to effectiveness of the performance.

1.3 Finding Out/Descubrimiento - the Educational Technology

Finding Out/Descubrimiento is an activity based bilingual math and science program whose implementation features a complex instructional approach based upon theories and research in the disciplines of cognitive psychology, sociology and social-psychology. This instructional approach, developed by Drs. E.G. Cohen and E. De Avila from the School of Education at Stanford University, was designed to improve the intellectual, academic and linguistic functioning of children in heterogeneous settings. The emphasis in Finding Out is upon development of thinking skills, cognitive processes and strategies such as conceptual learning and problem solving ability.

1.3.1 Materials

The materials of the instructional technology Finding Out are of two kinds: human --the students, and material --the actual curricular materials used by the students. As mentioned above, the approach assumes differentiation in the student body through developmental, academic, linguistic and/or cultural heterogeneity. Later on, I will show how consequences of this heterogeneity are treated through effective techniques of classroom management.

The curricular materials used by the students are: a) sets of activity cards in English, Spanish and pictographs, arranged around 18 themes (e.g. Measurement, Electricity, Powders and Crystals) that instruct students about the task to be accomplished; b) manipulatives ranging from laboratory tools to everyday household items that students use to observe, to experiment, to estimate and to measure, to infer and to reason about natural phenomena, to discover some of the basic laws of mathematics, physics and chemistry; and c) worksheets in which students practice basic skills (reading, writing and computation) in a meaningful context while recording their answers to questions that ask

about their ideas of why and how certain phenomena occur.

1.3.2 Operations

The theoretical model of Finding Out makes the connection between the improvement of thinking skills and problem-solving ability and increased rates of interaction among students. (De Avila et al 1981; Cohen and De Avila 1983; Stevenson, 1982). In order to increase rates of student-student interaction, the classroom is restructured into learning centers of more than one and less than six students and teachers are asked to delegate authority to the groups.(Cohen and Intili, 1981). Through the introduction of new cooperative norms into the classroom, students are encouraged to use each other as resources while accomplishing the tasks. Students deal with the uncertainty of the task by discussing, requesting and offering assistance and, in general, solving problems together.(Navarette, forthcoming). Although completion of the worksheets is the individual's responsibility, the group as a whole cannot move on to the next center unless all members have completed the task.(Cohen and De Avila, 1983).

However, as predicted by sociological theories of interaction in small groups (Berger, Cohen and Zelditch, 1972) and as demonstrated in numerous empirical studies (for a summary see Cohen, 1980), the interaction among students is not balanced; high status students take and are given more opportunities to talk, to interact, to make decisions and to have them accepted by the group as a whole, than do low status students. Among students, high status is usually assigned to students who exhibit better than average academic performance and who are often chosen as friends by their peers and thus are considered as having social influence and power. In order to counteract the inequity of this situation and increase access to interaction for low status students, some opportunities for non-routine operations by the teachers are built into the approach. The first is the multiple-ability treatment (Cohen,1982) by which the teacher explains to her/his students that there are multiple abilities needed for the performance of each task and reinforces some of these abilities in low status students thus raising their expectations for competence. An additional means to equalizing rates of interaction among the students

is the assignment of group roles on rotating basis to all the students in the group. The authority and legitimacy associated with the roles of group facilitator (responsible for the smooth functioning of the group), reporter or checker enables the young incumbents of these roles to act and interact regardless of their status in the classroom.

As mentioned above, delegation of authority to students by the teacher is a major feature of this approach. However, in general, it is difficult for teachers to delegate authority. When six learning centers are in action, after the initial orientation and before the final wrap-up, the teacher is no longer the focal element in the classroom. Moving from cente to center, facilitating the interaction only when absolutely necessary and without interfering in the students' discovery process, asking questions, stimulating and extending the child's thinking, providing specific feedback, (Dornbusch and Scott,1975) reinforcing cooperative behaviors and role performance, assigning competence to low status students, the teacher becomes a supportive catalyst of the learning process rather than an unconditionally available and easily accessible source of expected answers. Unlike the initial orientation and the final wrap-up, the above behaviors are non-routine teacher behaviors defined as such since their implementation depends upon the teacher's judgment and decision-making in a particular situation.

From the description of the operations up to this point, it is evident that the implementation of this approach is neither simple nor easy. Management of the simultaneous operation of six swarming learning centers at all times in addition to the maintenance of an unusual social and normative environment is a heavy burden upon the teacher. Team teaching and additional organizational support become an absolute necessity in this complex situation.(Cohen and Intili, 1982, Mata, forthcoming). Coordination of team meetings and feedback sessions (Dornbusch and Scott,1975) to the teacher are all part of the approach.

All the above teacher behaviors are non-routine because no specific program (as defined by March and Simon) can be provided to the teachers that would direct them to which behavior, if any, to engage in at any

particular time of the activity. On the contrary, teachers will have to search their mind and make a decision as to which behavior to use given a particular situation during Finding Out. For example, after observing the operations of the students at a particular learning center, the teacher might decide to extend learning by providing additional examples, she or he might decide to reinforce cooperative behaviors or to comment on the functioning of the roles. The teacher might decide to address the group as a whole or to provide feedback to an individual. Finally, the teacher might decide to move on to the next learning center without saying anything at all.

1.3.3 Knowledge

The following concepts and principles are the theoretical basis for Finding Out:

A. Goal of Finding Out/Descubrimiento

- The educational objective of Finding Out is the improvement of academic, cognitive and linguistic functioning of students in mixed settings.

B. Concepts and principles from cognitive psychology

- Intellectual development occurs through generalizations from experience in problem-solving situations.
- Learning is facilitated by motoric involvement.
- Contextual embedding is adding meaning.
- Learning-set formation involves exposing students to multiple experiences of the same concept or alternatively providing students with different ways of approaching a problem.

C. Concepts and principles derived from sociology and social-psychology

- Delegation of authority by the teachers increases lateral relations among students (student-student interactions) which in turn are positively related to learning outcomes.

- Increase of lateral relations is supported by the introduction of new (cooperative) norms to the setting.

- In task-oriented groups, status problems interfere with balanced interaction among students.

    1. Multiple ability treatment is an intervention designed to equalize status.

    2. The assignment of roles to members of a group provides authority and legitimacy to the incumbents and thus modifies status arrangements among students in a task oriented group.

- The complexity of the technology is directly associated with complexity of the organizational structure as well as "professional" complexity of the performer.

    1. Interdependence among team members is directly related to program implementation.

    2. Reflective Decision Making in team meetings is directly associated with program implementation.

- Soundly-based feedback to students is directly related to learning outcomes, investment of effort by students and satisfaction from the program.

- Soundly-based feedback to teachers is directly associated with their conceptual understanding and knowledge of the concepts and principles underlying the program; with investment of effort by teachers; with satisfaction from the program and with the probability of its future institutionalization.

1.4 The Setting and the Sample

During the academic year 1982/83, Finding Out was implemented in fifteen classrooms from ten schools within three school districts in the San Jose, CA area. In the fifteen classrooms, approximately 390 second, third, fourth and fifth graders participated in Finding Out. Students were largely of Hispanic descent but Anglos, Asians and Blacks

were also represented. Parental background was from working to low middle class.

In August 1982, the San Jose Bilingual Consortium recruited and invited 19 teachers to participate in a two-week (seven hours a day) workshop. During the first week of the workshop, the teachers were introduced to the theoretical framework and rationale of Finding Out. During the second part of the workshop, they had the opportunity to practice teaching Finding Out to a group of 30 children. While teams of teachers experienced instruction by using this novel approach, they were observed, videotaped and then given specific feedback on their performance. During the fall, assistants/aides received a one-day workshop on Finding Out. In January 1983, a day-long follow-up workshop was provided to the Finding Out teachers and their assistants and its agenda emphasized the reinforcement of complex and non-routine teacher behaviors required by the program, for example, providing specific feedback, and stimulating and extending thinking.

As part of its instructional program, the Finding Out project also provided three formative feedback meetings with all the participating teachers. In these meetings, soundly based feedback was given to the teachers based upon weekly observations performed in their classrooms. These feedback meetings were seen by the Finding Out project staff as a teaching and learning device of the theoretical foundations of the program as well as opportunities for problem-solving with the teachers.

The 18 teachers who implemented Finding Out (one teacher was transferred from the district) had various organizational arrangements in their classrooms. Table 1 is a summary of the staff arrangements in the Finding Out classrooms.

Table 1

Features of Staff Arrangements in FD/D Classrooms 1982/83

SCHOOL ID	CLASSROOM ID	TEACHER ID *	GRADE	TEAMING ARRANGEMENTS
01	01**	01*** 19	3	Teacher 01 was an ESL specialist whose team member/assistant was a resource teacher, teacher 19 was a regular classroom teacer.
02	02	03 17***	4	The ESL specialist (17) brought her students to the 02 teacher's FD/D classes.
	03	03 17***	2	The ESL specialist brought her students to the 03 teacher's FD/D classes.
03	04	04	3/4	Teacher teamed with bilingual aide.
04	05	05 16	3	Teacher 05 teamed with bilingual aide. Teacher 16 was a resource teacher.
05	06	06	3	Teacher teamed with bilingual aide.
	07	07	1/2	Teacher teamed with bilingual aide. There were also student teachers in this classroom.
06	08	08	3	Teacher teamed with bilingual aide and later with student teacher.
	09	09	2	Teacher 09's team member was the teacher from the LD classroom. This team was supported by a resource teacher.
07	10	10	2	Teacher teamed with bilingual aide.
	11	11	3	Teacher teamed with bilingual aide.
08	12	12	2	Teacher teamed with bilingual aide.
09	13	13	2	Teacher teamed with bilingual aide.
	14	14	4	Teacher did not have an assistant.
10	15**	15***	4/5	Teacher teamed with aide.

* All these teachers participated in the summer training
** These classrooms are Language Development Centers
*** ESL specialist

Sixteen teachers who were actively and directly involved in the implementation of the program are the population for this study. Among the sixteen teachers, fifteen were female and one teacher was male. They had varying numbers of years of teaching experience, in grades K-6. Seven teachers were fluent English-Spanish bilingual, four had some Spanish proficiency, one had some Japanese proficiency and four were monolinguals (two of them ESL teachers). Before the beginning of the summer workshop, ten teachers reported having had previous experience using multiple learning centers in the classroom. However, most of the teachers used ability groupings in math, reading and about half of them had used ability groupings in science and social studies.

1.5 Sources of the Data and Operationalization of the Indicators

Data for the analysis of teachers' mastery of the underlying body of knowledge of Finding Out were obtained from interviews with the teachers and questionnaires administered to them prior to the interview. The questionnaires and the interviews were evaluated, coded and scored.[1] An Index of Teacher's Mastery of Finding Out was constructed by including all the items from which conceptual understanding and knowledge of teachers could be inferred. The questionnaire also included items about teachers' satisfaction from the program, their perception of program institutionalization and of the difficulty of its implementation as well as a report about the extra amount of effort invested in it. Teachers had also given to the project information about the amount of curriculum (number of units) covered. An Index of Effectiveness was constructed on the basis of these items. In the construction of this index, the measure of productivity on the teacher level (number of units completed) was entered twice. This was done for theoretical reasons: evaluations of research data performed by the project have shown that productivity of the teacher was a strong predictor of productivity on the level of the students (number of worksheets completed), an additional indicator of effectiveness.

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1. Inter-scorer reliability for the interviews was 0.9.

Bilingual observers made weekly visits to Finding Out classrooms and observed patterns of classroom arrangements and student activity (e.g. number of students talking and manipulating, number of learning centers in use) as well as teacher behaviors.[2] For ten minutes each time, the observers recorded the frequency of non-routine teacher behaviors such as giving specific feedback, talking about multiple abilities, talking about child's thinking, talking about roles, etc. Twice during the period of observation, the observers also recorded a "snapshot" of the classroom from which percentages of students seen talking and manipulating together at the learning centers was calculated. This measure was used as indicator of teacher's delegation of authority.

Fourteen teachers and their classrooms were observed 10 times and one teacher and her classroom was observed 8 times during the implementation of Finding Out. One ESL teacher team-taught with two other Finding Out teachers in their respective classrooms. This teacher was observed 10 times in classroom #2 and eight times in classroom #3. She is assigned #16 when in classroom #2 and #17 when in classroom #3. An Index of Non-Routine Behaviors in Finding Out was constructed from these data.

Additional sources of information about teachers' organizational context were obtained from audiotapes of the feedback meetings of the teachers with the Finding Out project staff, and from documentation about implementation collected by the staff.

1.6 Results

Results of analyses reported in this paper are illustrative of the application of a theoretical framework from organizational sociology to the investigation of educational technology (for additional and more detailed results see Lotan, forthcoming).

Table 2 shows the distribution of teacher on the three indices used in the study.

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2. Inter-observer reliability was 0.91 for the Whole Classroom Observation Instrument and 0.91 for the Teacher Observation Instrument.

Table 2

Teachers' Scores on Index of Mastery, Index of Non-Routine Behaviors in Finding Out and Index of Effectiveness

Teacher ID #	Teacher's Score on		
	Index of Mastery	Index of Non-Routine Behaviors in FO/D	Index of Effectiveness
1	13.08	20.36	8.0
2	4.75	14.00	6.83
3	5.42	17.48	5.83
4	9.58	14.04	6.83
5	13.50	17.97	6.93
6	10.58	17.58	6.17
7	11.67	21.48	4.0
8	11.83	20.77	4.0
9	9.42	23.39	4.67
10	4.92	20.91	6.0
11	8.17	21.56	5.17
12	5.83	24.18	6.50
13	11.83	18.27	7.67
14	8.00	13.13	8.67
15	9.75	23.00	missing
16	3.92	15.39	6.83
17	3.92	16.58	5.83

Teachers' scores on the Index of Mastery vary from 3.92 (Teacher #17) to 13.5 (Teacher #5), with a mean of 8.60 and a standard deviation of 3.28. The mean of the Index of Non-Routine Behaviors is 18.83, standard deviation is 3.47 and values range from 14.0 to 24.18. On the Index of Effectiveness, teachers' scores range from 4.0 to 8.0, the mean is 6.25 and standard deviation is 1.33.

In order to test the hypothesized relationship between these variables, Spearman's coefficient of rank order correlation was calculated. Table 3 shows the results of this operation.

Table 3

Spearman's Rank Order Correlation Matrix of Indices of

1) Mastery, 2) Non-Routine Behaviors and 3) Effectiveness

Index of	1	2	3
1 Mastery	1.0		
2 Non-Routine Behaviors	0.303	1.0	
3 Effectiveness	0.111	-0.530*	1.0

*$p<0.05$

The coefficients of correlation between the Index of Mastery and the two other indices are not statistically significant. A significant negative relationship was found between the Index of Non-Routine Behaviors and the Index of Effectiveness. Although this relationship is not directly relevant to the hypotheses of this paper, it will be used to illuminate certain problematic aspects in the interpretation of the results.

Since the sample of cases in this study is relatively small, it is useful to consider some specific teachers and their rank relative to other teachers on the various indices. For example, Table 2 shows the following: Teacher #1 is high on all three indices; Teacher #7 is high on the Index of Mastery, quite high on the Index of Non-Routine Behaviors but low on the Index of Effectiveness; Teachers #8 and #9 are quite high on the Index of Mastery but low on the Index of Effectiveness.

1.7 Discussion

The data do not support the hypothesis proposed in this paper. Although Spearman's r for the relationship between mastery and non-routine behaviors, between knowledge and operations, is in the predicted direction, it did not achieve statistical significance. There is no empirical evidence for a significant relationship between knowledge and effectiveness, as measured by the Index of Mastery and the Index of Effectiveness, respectively. There is, however, a significant negative relationship between "quality" and "quantity" of instruction. This suggests that other factors, not included in the model of this paper, influence teachers' performances in the classroom. A brief consideration of selected cases may point to the identity of these additional variables.

1.7.1 Case of Teacher #1

Teacher #1 was an ESL teacher in the Language Development Center (LDC) at her school. She had a self-contained classroom, in which the furniture was permanently set up into learning centers. She taught Finding Out to a regular third class at her school. The students and their regular classroom teacher came to the LDC four days a week for 45 minutes. On the fifth day of the week, the teacher prepared next week's unit by putting the activity materials together and reviewing science books relevant to the topic of the next unit. The Finding Out teaching team at the school included, in addition to Teacher #1, the credentialed assistant (the regular classroom teacher) who had received the assistants' training at Stanford and the resource teacher at the school who had participated in the two-week summer workshop at Stanford. The team held regular and impromptu team meetings and used the meeting techniques proposed by the program. The principal of the school was well informed and very supportive of the program and made serious efforts to adopt it on a school-wide basis. This teacher then, had strong organizational support during the implementation of the program. She had broad and thorough knowledge of the underlying

concepts and principles of Finding Out, she implemented prescribed behaviors and she showed effectiveness in the outcomes.

1.7.2 Case of Teacher #7

Teacher #7 was a bilingual classroom teacher who taught a combination first and second grade. She had decided to implement Finding Out only with her second graders and during the time she worked with them, the aide or the student teacher worked with the first graders. Analyses of the data performed by the project suggested that grade level as an important predictor of productivity.(Cohen and De Avila,1983). Second grade students need more time (usually twice as much) as third or fourth graders to finish a curricular unit. Grade level then, should be an important control variable when measuring productivity on the teacher and on the student level.

Teacher #7 did not find herself in a team situation as defined by the program. She and the other team-member (a third grade Finding Out teacher at her school) found it difficult to coordinate team meetings although they had made plans to do so. Although the principal seemed interested in and supportive of Finding Out, he did not give the teachers special release time to prepare materials or to meet for regular team meetings. Teacher #7 showed a good understanding of the underlying body of knowledge of Finding Out and good performance in the classroom --as prescribed by the program. She did not, however, achieve a high level of effectiveness, probably due to the organizational constraints within which she operated.

1.7.3 Case of Teachers #8 and #9

Like Teacher #7, Teacher #9 taught a bilingual second grade in which students functioned well below grade level. In addition to the second graders in her classroom and in order to benefit from the presence of another adult in the room, a special education teacher and twelve learning disabled students were brought in during implementation of Finding Out. There were about forty students at ten simultaneous learning centers in the classroom. After a delayed start due to difficult problems of logistics and a lengthy cooperative training of

the students, this teacher finished three units of the curriculum during the academic year.

Teacher #8 was from the same school. He taught a bilingual third grade in an open pod. His colleagues complained that Finding Out was "too noisy" and disturbed their classes. Teacher #8 had to change locations for Finding Out four times during the year, at one point teaching it in the school cafeteria. During the academic year, he worked with three different student teachers/aides who acted as his assistants in Finding Out and who had received no special training. Although, Teacher #8 and her team member invited him to join them during their planning and preparation meetings, Teacher #9 preferred to continue working in isolation although he expressed regrets about this fact. Like Teacher #9, this teacher also finished three units.He showed, however, a thorough understanding of Finding Out.

In summary, grade level, physical location and arrangements of the classroom, organizational support or conversely organizational constraints seem to be important factors that affect program implementation and outcomes. An alternative model that takes into account the organizational context within which the teacher operates needs to be formulated and tested.

1.8 Conclusion

In the past decade, teachers' thought processes have proven to be an important and fruitful topic for educational research. (see Clark and Peterson, in press). Much insight and understanding has been acquired regarding the mental lives of teachers and the implications for teacher education have been pointed out. The paradigm used in this line of research is generally derived from cognitive psychology and the ultimate goal is "to construct a portrayal of the cognitive psychology of teaching..."(id.)

In this paper, the cognitive dimension and its relationship to behavioral variables in the teaching process are examined with the use of principles and concepts from organizational sociology. The use of

novel and alternative theoretical frameworks has several analytical benefits: it points to new concepts and it illuminates previously obscure relationships among them, thus opening avenues for creative research in the future and, in general, adding to the body of knowledge about the problems and the questions under study.

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