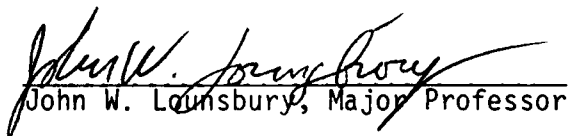
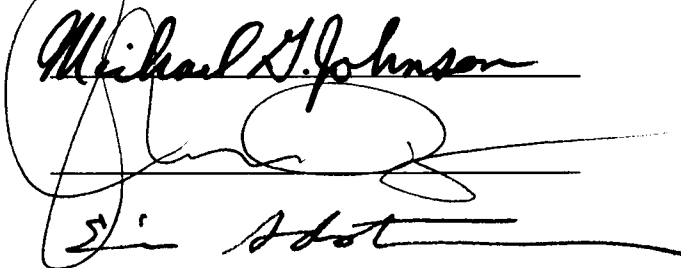
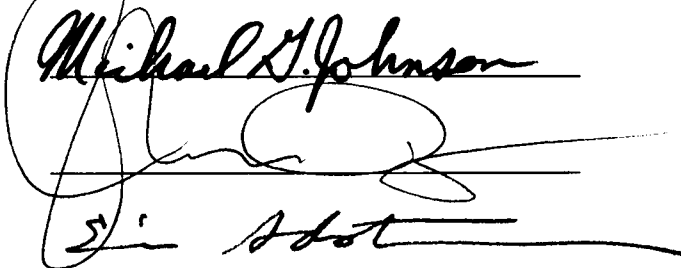


To the Graduate Council:

I am submitting herewith a dissertation written by Sarah Elizabeth Jacob entitled "Expert Teachers' Reasoning About the Problem of Innovation: Microcomputers in Schools." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.


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EXPERT TEACHERS' REASONING ABOUT THE PROBLEM OF
INNOVATION: MICROCOMPUTERS IN SCHOOLS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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Sarah Elizabeth Jacob

March 1986

DEDICATION

To my parents
Phil and Betty Jacob

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ABSTRACT

Previous research about teachers and the problem of innovation in schools has focused on teachers' attitudes, not on their thinking. This study addresses the following questions: (a) Does teachers' thinking about the problems associated with innovation differ from their thinking about other issues related to their jobs? (b) Does the thinking of expert teachers differ from that of a comparable group of non-experts? (c) If experts and others reason differently, are there corresponding differences in their attitudes toward the introduction of an innovation?

The method used was the analysis of verbal accounts to discover rules. Social behavior is guided by propositional rules that define a situation (if conditions) and specify a consequential set of actions (then statements). Teachers' verbal reports could be formulated into if-then propositions such as those used to program rule-based expert systems which have successfully emulated the thinking of professionals in fields other than education. This study, like others of expertise, used peer nomination to identify experts.

The subjects of teachers' "if" and "then" statements were used to categorize their rules. The type of rules teachers used depended upon the problem. Experts defined problems (if statements) either in terms of the "teacher" or "other" factors. Comparison teachers defined all problems in terms of factors other than "teacher."

Experts perceive "teacher" as the major influence in job-related problems of current concern to them. Experts see innovation in schools as someone else's problem not their own.

Measures of attitudes toward computers do not differentiate expert and other teachers. This may be due to the high proportion of computer "users" in the comparison group or the limited time computers have been in schools.

This study indicates that expert teachers can be differentiated from non-experts by the way they define situations. Experts describe the "teacher" as the major determinant of some circumstances but non-experts perceive the "teacher" as affected by, but not determining, any circumstances. Teachers' rules could indicate teachers' sense of efficacy, the only teacher factor significantly related to successful change efforts in schools. The relation between rules and other measures of efficacy is an area for further research.

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I. INTRODUCTION

If thinking determines behavior, models of thinking are needed which adequately lead to replication of behavior as it occurs in various fields. In addition, such models might lead to applications that would improve the problem solving process in these areas. To identify the most effective strategies for solving problems, the thinking of the best problem solvers should be investigated. If the problem solving processes of the best problem solvers can be emulated, it may be possible to teach others to solve problems like the best practitioners in the field, and to use these processes to solve problems similar to the ones these experts solve.

Recently, there has been an increased interest in the nature of expertise, largely as a result of the work of people in the field of Artificial Intelligence (AI) who have been creating expert systems. Expert systems are designed to:

- (a) provide expert-level solutions to complex problems
 - (b) to be understandable
 - (c) to be flexible enough to accomodate new knowledge
- (Buchanan and Shortliffe, 1985, p. 3).

In addition, expert systems handle complex problems but do not emulate complex problem solving processes.

The computer procedures for designing such systems are based on the way people seem to solve problems which is different from the algorithmic processes largely used for numerical processing.

People use "qualitative reasoning techniques that relate items through judgmental rules, or heuristics as well as through theoretical laws and definitions" (p. 3).

It also seems the subject matter makes a difference in the kind of reasoning that an expert uses. Buchanan and Shortliffe (1985) distinguish between fields in which there are laws such as mathematics and physics and those in which there is a body of empirical knowledge and a set of related actions or "independent states and actions" (p. 28).

Production systems, apparently first used by Alan Newell, to model human problem solving in short term memory seem to fit the way in which experts in fields with empirical knowledge bases solve problems. Production systems are computer programs that include a set of rules, a data base, and an interpreter. The rules are composed of a left hand part that is usually formulated as an IF statement and a right hand part that is formulated as a THEN statement. If the left hand part is evaluated as true then the action specified in the rule is carried out. Changes occurring as a result of carrying out the action result in changes in the data base. One rule is not dependent on the other. Solutions to problems require returning to the data base to check another condition in the left hand or IF side (Buchanan, 1984; Coombs, 1984; Alty, 1985; Mansfield, 1985).

For example, if a database includes such facts as students in various classes, then a rule might read something like:

```

IF (Sue in English)
   and (Sue in typing)
THEN not (Sue in art)

```

The THEN statement would result in a change in the database by either an addition of Sue not in art or a deletion of Sue in art and, if this were a scheduling program, would not permit Sue to register for an art course.

Usually, expert systems are based on interviews with experts who provide examples from which programmers develop a data base and a set of rules. Experts do not seem to have meta-reasoning or the ability to describe how they solve problems (Ericsson & Simon, 1980; Pitt, 1983; Argyris, 1980, 1982; Shon, 1983; Coombs, 1984; Alty, 1985; Sammut, 1985). One reason for creating expert systems is to illuminate the knowledge of professionals in the field. Methods for getting at the experts' knowledge have focused on having the expert talk aloud while solving a problem (Ericsson & Simon, 1980; Pitt, 1983; Shon, 1983), having the expert solve a problem in a simulation with actors and talk about the steps right after the experience (Elstein & Schulman), having a person who is a "journeyman" discuss a case and be "cross-examined" during the interview (Kuipers & Kassirer, 1984), and having the experts give examples (Alty, 1985). Recently, some expert systems have been supplemented by procedures in which the expert teaches the machine by providing examples of positive and negative instances and the machine formulates rules and checks them with the expert (Sammut, 1985). Modifications have also been made to some

existing expert systems so that they could be used in teaching students (Sleeman & Brown, 1985; Barr & Feigenbaum, 1982). These modifications were necessitated when it was found that the "knowledge representation structures that were adequate for interactions with an expert were inappropriate for teaching. Underlying principles and structure have to be emphasized to someone who is learning" (Kay, 1985, p. 35).

Differences between experts and novices suggest that experts notice or see more than, and actually differently, than novices (Neisser, 1976). Experts show variation depending on the task and conditions and adults are better than adolescents in problem definition (Pitt, 1982). Schon (1983) suggests that experts know the results of framing problems in certain ways; they can formulate hypotheses and make predictions from them without actually trying out their hypotheses. The novice often cannot: (a) redefine the problem and (b) determine the implications of redefinition so that he or she can decide whether the redefinition will be useful.

Expert Teaching

Some expert systems are being designed to emulate the role of the teacher. Kay (1985) describes five criteria for systems which he says are only demonstrated by "the very best human teachers" (p. 4):

1. Competence in the area being taught
2. Ability to communicate with the student
3. Teaching strategy based on informed educational philosophy
4. Strategy and communication driven by student behavior including a model of inexpert student reasoning processes
5. Ability to use experience to improve their own teaching (p. 33).

However, Kay does not cite any research basis for his list of teacher competencies and he says that current expert systems which include learning use "teaching strategies that are ad-hoc and intuitionistic" (p. 4).

If expert systems are being designed to emulate the behavior of teachers, knowledge of the reasoning of "the very best human teachers" would be valuable. Some studies of teacher reasoning employing methods similar to those used in developing expert systems have been done (Glaser, 1984; Shavelson, 1983; Clark & Yinger, 1979; Tuma & Reif, 1980).

Several of the studies reviewed by Shavelson (1983) and Clark and Yinger (1979) focus on teacher planning and decision making. In general, it seems that teachers do not change their plans once in the classroom setting unless something is going poorly and even then, they fine tune or adjust, not making major changes even if things continue to go poorly. There is conflicting evidence on whether teachers change their predictions about students' performance based on new information. Teachers do not seem to plan on the basis of specified objectives nor does planning follow an "integrated ends-means model" (Clark & Yinger, 1979, p. 235). Rather, the planning process involves the selection of instructional activities which are described as "controlled behavior settings that were shaped and molded by the teacher" (Clark & Yinger, p. 237) and the patterning of routines. "Routines are characterized as methods used to reduce

the complexity and increase the predictability of classroom activities" (Clark & Yinger, p. 237). This selection process is increasingly determined as the academic year progresses and teachers plan for the year, then for the month, week, and day.

For the most part, these studies do not differentiate between expert teachers and others. In a study of types of decisions made by elementary teachers, no difference was found between those teachers categorized as more effective and less effective (Clark & Yinger, p. 249).

Glaser (1984) says that Collins and Stevens identified and described strategies used by expert teachers to select cases that provide students examples that run counter to their theories. In describing the materials used to identify these teaching methods, Glaser uses the term "effective teachers' protocols" (p. 101). It appears that he uses effective and expert synonymously, and no criteria for selection are given.

The process for selecting effective teachers is not described in these studies, but the criteria may be related to a body of "effective teaching" research by Stallings (1979) and others in which selection is based on increases in student achievement. In studies of "effective teaching," emphasis is placed on observed differences in teachers' behaviors, not on whether the teachers perceive themselves to be effective.

"Self-efficacy"

Another type of effectiveness which has recently been the focus of considerable research is "self-efficacy" (Bandura, 1977, 1984). Self-efficacy "is concerned with people's judgments of their capabilities to execute different levels of performance" (Bandura, 1984, p. 232). Ratings of "self-efficacy" are not the same as measures of intellectual achievement but "contributes significantly to performances requiring such skills" (Bandura, p. 249). "Self-efficacy" is not a generalized perception of ability but involves distinguishing those areas or situations in which one expects to be able to perform well from others. People who perceive themselves as efficacious "tend to avoid tasks and situations believed to exceed their capabilities and thus invitations to trouble, but they undertake and perform assuredly activities they judge themselves capable of handling" (Bandura, p. 253).

A sense of efficacy was one of the few teacher measures which distinguished teachers who successfully implemented change in schools (Berman & McGaughlin, 1977). In elaborating this concept, Ashton and Webb (1982) describe teachers' sense of efficacy as:

Specific beliefs about the ability of teachers in general, to motivate different types of students in different types of situations and their own personal ability to motivate students in specific situations (p. 5).

In this study there was a significant relationship between "self-efficacy" and student achievement but no mention was made of

investigating the relationship between teachers' sense of efficacy and teachers classroom behaviors. Gibson and Dembo (1984) did, however, find a relationship between their "teacher-efficacy" scale and classroom behaviors which have been related to student achievement.

Identifying Expert Teachers

Experts are often identified through referral by their colleagues. This method has been used to select physicians and lawyers for research leading to the design of expert systems and is often the practice when one is seeking advice from a professional. However, this method is not common in educational research. Possible reasons for not using collegial referral are the de-emphasis on qualitative differences among teachers that is reflected in the criteria for pay common in school districts (experience, degrees), lack of agreement on what standards to use in evaluating teachers, the difficulty in getting school systems to agree to such differentiation because it might create problems with student placement in classrooms, the relative isolation of classroom teachers from one another, or the fact that teachers do not get their clients through a referral but rather through an assignment process.

In an interview study of a sample of teachers from five towns, Lortie (1975) asked each teacher to describe one "outstanding" teacher who was "working today" (p. 251). The teacher did not need to identify the person nor refer them for some purpose. In describing the "outstanding" teacher working today, the interviewees

emphasized the teacher's relations with students rather than the teacher's ability to instruct. In comparison, teachers were also asked to describe a previous teacher who had been their instructor. In this case importance was attached to both ability in instruction and relations with students. Lortie also says, "A teacher today can be considered outstanding by those who are familiar with his work without being thought to have made a single contribution to knowledge of teaching in general; the ablest people in the occupation are not expected to add to the shared knowledge of the group" (p. 241).

Jackson (1968) interviewed fifty teachers selected by supervisors as "doing an outstanding job in their schools." One or two teachers were chosen from a school which meant that a maximum of ten percent of the teachers in a school would be in the sample which was drawn from schools in the suburban Chicago area. Jackson asked these teachers the following questions about their practice:

How do teachers know when they are doing a good job in the classroom?
What is the relationship of the teacher to authority (specifically changes with experience and feelings about being evaluated)?
What satisfactions in addition to pay are associated with teaching?

Interviews were used rather than observations because it is not possible to find out the reasoning that lies behind action without talking and it is "not only what the practitioner says that is revealing but his way of saying it . . ." (p. 115).

Although Jackson (1968) recommended that teachers selected as "outstanding" by their colleagues be compared with other teachers, no such studies have been done. Such studies are needed to find areas of difference so the influence of these differences on other aspects of teaching can be investigated. In addition, the characteristics which differentiate best teachers can only be defined if differences between these teachers and others are found.

Problems

Harre and Secord (1973) distinguish between formal and "enigmatic episodes." Most social episodes are "enigmatic" and do not have an "explicit set of rules, nor (are they) produced by well-established causal mechanisms" (p. 12). The best way to find out about such episodes, according to the authors, is to collect participant accounts and analyze them to discover the rules people use. These rules are guides to action and also determine our expectations of the behavior of others.

The distinction between formal and enigmatic is similar to the characterization of problems as well-defined (Glaser, 1985; Pitt, 1983) or "ill-defined" (Mitroff, 1983; Glaser, 1985). Well-defined problems have a solution. Although there may be several alternative routes to this solution, there is usually a best or most efficient way to solve the problem. Most research on problem solving has focused on well-defined problems (Ericsson & Simon, 1984; Tuma and Reif, 1980; Pitt, 1983). Analysis of protocols recorded while both

novices and experts worked on solving these problems suggests a means-end heuristic or a comparing of the current state of solution with a goal or subgoal. Another heuristic is to try out a set of possible solutions to see which is the correct one. This fits the diagnostic model according to Glaser (1985).

"Ill-defined" problems are ones for which there are several acceptable alternative solutions, and usually the information is not all available at the beginning of the problem. New information related to the problem is likely to come along or may need to be gathered. This process will affect the current hypothesis. Ill-defined problems are the kinds we usually have in our day-to-day lives. We need to choose a way to get to town or a college, how to get a student to respond to a question, or what to make for supper. Glaser (1985) says that "ill-defined" problems are those in which one or all three of the following is not clearly specified: (a) the initial state; (b) a set of permissible operators (actions to be taken); (c) a goal state.

Although little research has been done in the area of solving "ill-defined" problems, Glaser (1985) cites the work of Voss and states:

There are at least two conclusions we can draw from this research. First, even in dealing with ill-defined problems, solvers use heuristics not unlike those, such as subgoaling, they use in well-defined problems. Second, the very nature of ill-defined problems means that solvers define the problems better for themselves. This suggests that knowledge of the problem domain really makes it easier for a solver to define the problem, such as identifying the constraints (p. 247).

In the research by Voss cited by Glaser (1985) experts differed from students and experts from another domain, primarily in their focus on problem definition which might be similar to the conditional or the IF parts of rules.

In well-defined problems, sequence is usually important (Ericsson & Simon, 1984; Pitt, 1983) but, with "ill-defined" problems, solvers will often change the problem through redefinition or as a result of adding new information. Clark and McCabe (1984) differentiate between computer languages that are imperative and those that are descriptive, the latter is "primarily descriptive definitions of a set of relations. . . ." They go on to say that "we might prefer one set of definitions to another, and we might improve the efficiency of the evaluation by adding extra control conditions to the definition" (p. 2-3). This descriptive language format seems more suited to coding the protocols of solvers of "ill-defined" problems than pseudocode (using English words in program format) for imperative languages since people are more likely to give greater emphasis to definition and to add control conditions, or possible actions, during the course of problem solution than are solvers of well-defined problems.

The Problem of Innovation

Schools, like other institutions, have to respond to change. Introducing change in schools often confronts teachers with problems that may be characterized as "ill-defined." That is, the initial

state or what the innovation is and what is to be changed is often unclear. The possible actions are often unknown because the teacher does not know how to use the innovation or what alternative organizational arrangements can be used or how he or she may be permitted to implement the change. The purposes or goals for making the change are often unclear and may be modified in the course of implementation.

Although daily problems encountered by the practitioner may, in fact, be ill-defined, the professional may perceive these problems as well-defined. That is, he or she may define the initial state and have decided on a certain set of actions to arrive at some satisfactory situation or goal. The complete set of processes used by the practitioner is not likely to be displayed when the situation is familiar, because they will employ frequently used solutions which are likely to be abbreviated versions of the solution heuristics in the problem solver's repertoire (Pitt, 1983).

The introduction of an innovation is likely to present a professional with a novel situation or problem. Schon (1983) and Argyris (1982) suggest that most professionals use the same problem solving strategies for familiar problems, and it is only in novel situations that professionals can reflect on their problem solving processes because they become aware of what they are doing.

A variety of studies have been done investigating the influence of the introduction of an innovation on teachers' attitudes and behaviors (Hall & Loucks, 1981; Hord & Loucks, 1980; Leary, 1983; Newlove & Hall, 1976; Havelock, 1973). There is also some research

about teacher characteristics associated with successful implementation of change in schools (Berman & McGlaughlin, 1977).

If, as Schon (1983) suggested, novel problems lead people to change their usual reasoning process, then studies of how teachers think when they face change ought to show different reasoning strategies than investigations of the kinds of reasoning teachers evidence when they think aloud about familiar problems. No studies have been done about how teachers reason when they face the problem of change in their schools. Therefore, comparisons cannot be made between teachers' thinking about such problems as lesson planning and dealing with students and their thinking about how to introduce innovation in the classroom or school.

The Problem of Microcomputers in Schools

With the recent development of the microcomputer and the rapid decrease in the cost of computing power (Lepper, 1985), schools are now purchasing large numbers of computers (Benderson, 1985). The introduction of this new technology offers the opportunity to study teachers' reactions to the introduction of an innovation in field settings.

The reasons given for school use of computers are varied but include the following: preparing students for jobs which will involve the use of computers; making students aware of the way in which computers are and will be, used in society; increasing the problem solving ability of students by having them learn to program computers;

and individualizing instruction for pupils by using the computer as a teaching machine that can provide immediate feedback and infinite patience.

Most of these reasons are related to the view that society itself is or has moved from an Industrial Age to an Information Age in which services and information are the major source of wealth rather than products (Bell, 1980).

What has actually happened in schools as a result of the introduction of microcomputers? Currently there are about 92 students per computer in schools that have one (Hassett, 1984). The longer schools have computers, the less likely they are to use the computers for drill and practice. More emphasis is being placed on using applications programs like word processors, spreadsheets and data bases in a variety of subject areas (Benderson, 1985). The report of School Uses of Microcomputers indicates that where computers are located in a school affects the ways in which computers are used by students and teachers. If computers are in labs, greater use of the machines is made by both students and teachers than if the computers are in the classroom. Both secondary and elementary students use the computers for programming more when the machines are in labs than when they are in the classroom. Computers in labs have a greater variety of uses than those used primarily in classrooms (Benderson, 1985).

The relation of the computer to the classroom teacher has been discussed in a variety of ways: in terms of a model in which the students are coached by the teacher as they create new models (Kay,

1983); as a replacement for the classroom teacher; as a teacher's aide for the routine instructional tasks, as a secretary for the teacher to help with record keeping (Benderson, 1985; Wagschal, 1984); and as unnecessary to the educational process; and, in fact, a red herring preventing society from dealing with the real problems of education (Weizenbaum, 1984; Benderson, 1985).

In any case, most teachers have had little or no experience with computers, in part because the microcomputer was developed after many teachers were trained. Therefore, major efforts at teacher training are being made and will need to be made if most teachers are to be expected to utilize computers in schools (Sadowski, 1983; Wells & Bitter, 1982). What kind of training is needed, and the amount of time teachers need for training is a subject of debate, and in many cases states and local districts are establishing requirements (Benderson, 1985; Bork, 1982). Experience has shown that training is often not enough if teachers are going to use computers as a tool to teach subject matter. Benderson (1985) says that Roger Kershaw, of the Educational Testing Service's Research Technology Group, "fears that if administrators are unwilling to grant teachers sufficient release time to adapt application programs to their courses, computers in education will go the way of such failed innovations as the teaching machine" (p. 9).

Another reason that teachers give for not using computers is the lack of quality software. It has been suggested that although the complaint may be accurate, teachers may also use this as a reason

for not having computers in schools. Wagschal (1985) in comparing the introduction of computers and television in schools says "the discomfort of school personnel with computers will be equally unlikely to halt the invasion of this new interactive electronic technology into our daily lives." However, software reviewers are skeptical about the quality of the educational software (Hassett, 1984; Benderson, 1985). The process of selection takes considerable time. Most teachers do not know what to look for and, even if they have the time to preview software, it is much more time consuming than scanning a text. Few textbook companies produce software directly related to curriculum, and, if they do, it is often just a mechanical workbook and not an instructional device available in any other form (Brophy & Hannon, 1984). Whether teachers will use unfamiliar approaches is itself questionable.

Shavelson et al. (1984) interviewed teachers nominated as "successful" users of microcomputer in science and mathematics by experts in the field of education. These were: "officials in state government and education; administrators of educational computing organizations; district, school and teacher contacts" (p. 5). These researchers also observed the classrooms of the "successful" users. They found that teachers using microcomputers to teach science and mathematics had four different patterns of use. They distinguish between teachers who orchestrate microcomputer use, employing the machine in a variety of different ways to meet a mixture of cognitive and basic-skills goals; those who use the computer to enrich

the ongoing curriculum; teachers using the computer to supplement specific lessons in a content area; and the drill-and-practice cluster who used the machine to provide basic skills practice almost exclusively. Factors which seemed to influence these patterns included the amount of courseware a teacher was familiar with but not the amount of experience he/she had with computers; the amount of undergraduate coursework in science, mathematics, and social science; and the ability of students in the classroom. Number and location of computers and the grade level did not affect patterns of use. A comparison group of teachers was not interviewed or observed. Therefore, it is not surprising that the teachers in this study all held positive attitudes toward computer use in schools.

In summarizing a report on The Future of Microcomputers in the Classroom, Brophy and Hannon (1984) say:

Many of the claims concerning computer applications in the classroom are unjustified or overblown, and most of the apparently realistic potential applications remain dreams rather than realities for now because of inadequate or inappropriate software, unacceptable costs in time and trouble as well as money, or other practical problems. It seems clear that microcomputers will never replace teachers as the primary instructors in the classroom, but that they do bring capabilities (particularly in word processing and simulation) that could enhance instruction by allowing teachers to do things that are difficult or impossible to do now (p. 28).

However, this same study notes that data collected by the Center for Social Organization of Schools in 1983 showed that only one or two teachers in any school are regular users of computers and these typically teach programming courses.

Except for the Shavelson et al. (1984) study for which finding a sample of "successful" users was difficult, there seem to be no studies which address how teachers think about and plan for the use of microcomputers in schools and his study did not focus on teachers' reasoning about this issue.

The present study was planned to explore differences in the way expert and comparison teachers think about their day-to-day problems and the way they reason about the novel problem of the introduction of microcomputers in schools.

The teachers all taught in a small city school district in Tennessee which had purchased enough microcomputers in 1983 to equip a computer laboratory in each of its schools. Each elementary school had eight to nine computers, each junior high school had ten and the high school lab was expanded to thirteen machines. These computers were purchased on the recommendation of a task force that had been meeting for more than a year. The Computer Task Force was made up of administrative and instructional staff who were interested in computers and who had volunteered to serve. Although there had been programming courses offered to advanced math students since the 1960's at the high school which had an IBM main frame computer, the other schools had no computers or only one or two which had been purchased after 1980.

In the fall of 1984, additional computers for the junior high schools were received from the State of Tennessee which initiated the Computers Skills Next program as a part of the Tennessee Better

Schools program that had been passed by the Tennessee Legislature in the spring of 1984. In addition, each school having any students in grades one through eight received a dual disk drive computer and printer to be used by teachers especially to do the record keeping for the Basic Skills First part of the Tennessee Better Schools program. The school district redistributed the computers that had been in the junior high schools when the ones from the state arrived so that each elementary school had ten computers in its lab and one junior high school had fifteen and the other seventeen. The senior high school had twenty; six of these were intended to form the nucleus of a second computer lab to be operational in 1985-1986 school year when renovation of the high school would be complete.

The Computer Task Force also recommended that the school district make a commitment to teacher training. A variety of workshops was offered during the summer and academic year of 1983-84. The summer workshops were offered by the district at no cost and attendance was voluntary. Teachers who attended were not paid for their time. Some of the workshops were held on school time during the academic year.

In the spring of 1984 the format for inservice was changed in accordance with new state guidelines and the local district designed several ongoing (24 hour) workshops which were planned for one afternoon a month during the 1984-85 school year. Several of these were computer workshops.

The Computer Skills Next program included a requirement for twelve hours of training for all faculty in each junior high school to be completed by December 1984. All junior high teachers who had not had any previous computer training and who hadn't elected to participate in a twenty-four computer workshop were included in computer workshops that covered introduction to microcomputers, word processing, and computer-managed instruction.

Description of the Computer Program

Each school submitted a computer lab schedule to the Computer Task Force and the Assistant Superintendent for Curriculum and Instruction in the fall of 1983. The school schedules reflected the guidelines established by the Task Force that called for providing an hour a week of computer lab time for students in grades four through eight. At the elementary school level, most teachers send groups of children to the computer labs where an aide or parent volunteer supervises although some teachers do direct instruction in the lab with their students.

At the junior high schools, the program has been changed to meet the requirements for the Computer Skills Next program. All students in grades seven and eight are receiving three weeks of time in the computer lab with instruction based on the state developed curriculum. Since many of these students had experience with computers during the 1983-84 school year the curriculum has been revised based on this experience and the skills of the teachers. In one

junior high the math teachers deliver the Computer Skills Next program as part of their math classes, in place of a two week unit previously taught as part of math; teachers from English, math and social studies deliver relevant parts of the computer curriculum in the other junior high school. Additional computer experiences are offered on both schools. In one, a semester course in programming is offered, and in the other a computer segment is offered for low achievers. When not scheduled for these classes, the junior high school computer labs are open to teachers wishing to bring classes to the lab to use software related to their subject.

At the high school all periods are used for computer courses. A Computer Literacy course, programming in BASIC and Pascal, and a software development course are available as electives. A mini-lab is available adjacent to the science department and a second lab is planned which can be used by teachers and students in subjects other than computer science when the school renovation is complete.

Most teachers in the school district, especially those teaching grades one through eight, have participated in six or more hours of computer training and many are expected to provide instruction using computers or about computers for their students. Although the highest budget priority for the elementary schools in 1984 was a computer teacher for the labs, the district did not provide additional personnel, although plans for 1985-86 included additional aide time for the elementary and junior high labs as a part of a school district reorganization plan.

Summary

What is an expert teacher? Neisser says that experts are differentiated from non-experts because of their depth of knowledge, that they actually perceive differently than a novice. Those designing expert systems suggest that experts define situations and what they would do in them by providing examples. The best information according to Alty (1985) comes from experts when you ask them to "give us an example."

Some recent research on effective teachers has utilized Bandura's (1977, 1983, 1984) concept of "self-efficacy." He says that "self-efficacy" involves choosing situations where you can expect to succeed and avoiding those where you think you are unlikely to have control of the circumstances. It is reasonable to think that experts would be "self-efficacious" in their fields.

Argyris (1980, 1982), Shon (1983), Alty (1985), and Simon and Ericsson (1984) have shown that experts often do not have metacognition of what they do and cannot formulate in words what they do. In fact, experts' efficiency and fluidity of behavior may be slowed when people are trying to formulate rules as one sees in the novice, although talking aloud does not seem to interfere with task performance. Through the analysis of expert teachers' accounts of their thinking about the problems associated with the introduction of an innovation in their schools, expert teachers' thinking may be more readily revealed because the situation is novel and they may need to

generate different rules than the ones they use for more familiar problems.

Research Issues

Can teachers' thinking about school-related problems be formulated as IF-THEN propositions like those used in rule-based expert systems?

Does the thinking of expert teachers differ from the thinking of other teachers?

Does teachers' thinking about the problem of innovation (microcomputers in schools) differ from their thinking about other school-related problems.

Do expert teachers' reasons for either using or not using microcomputers differ from those of other teachers?

Are expert teachers more challenged or less threatened by innovation in schools (microcomputers) than other teachers? Or, does the amount of challenge or threat depend on the teacher's Stage of Concern about microcomputers in schools?

II. METHOD

Overview

Two groups of teachers in a small city school district in the southeast were interviewed about their current job related problems and specifically how they were resolving the issue of utilizing microcomputers in schools. One group was a representative sample of teachers chosen as "best" by their peers and the other was a representative comparison group. Since work with expert systems has shown that professional problem solving often takes the form of a series of IF-THEN rules (Alty, 1985), interviews were coded as a set of IF-THEN statements. Rules were classified according to the subject of the IF or THEN segment. Comparisons between the two groups of teachers were made on the types of rules they used for different types of problems. The interviews were also coded using three measures designed to assess teachers' reactions to the introduction of microcomputers in schools: (a) a scale to assess how threatened teachers are by microcomputers in schools; (b) another to determine how challenged they are by microcomputer use; (c) a scale to assess the kinds of concerns teachers have about the innovation of microcomputers in schools. Scores of both groups were compared on these measures.

Participants

All participants were teachers in a small city school district in the southeastern United States. The district had one high school,

two junior high schools, five elementary schools and a special school for pre-primary and some special education classes.

Selection. Ballots were sent to all teachers and administrators in the school district (see Appendix A). Each teacher was asked to select up to five "best" teachers in the district and each administrator was asked to choose up to ten. The ballots were anonymous and a postage paid envelope was included so that ballots could be returned to the local university where they were tabulated by a person not associated with the investigator. A cover letter explaining the procedure accompanied the ballot and the school principals were apprised of the balloting procedure before the requests were sent to the teachers, in case, they received any questions from the teachers. Two hundred and forty-three ballots were sent. A second letter was sent by the tabulator to those not replying (see Appendix A). There were 129 returns from teachers and six returns from administrators making the final percent of return from teachers 56% and from administrators 55%.

The numbers of teachers from each school selected to be in each group was determined on the basis of the proportion of teachers in the district in that school. The distribution of teachers by school is shown below:

High School	27%
Junior High School 1	12%
Junior High School 2	11%
Elementary School 1	12%
Elementary School 2	12%

Elementary School 3	9%
Elementary School 4	8%
Elementary School 5	8%
Elementary School 6	1%

Fifty-four teachers were selected by a colleague not associated with the study, to receive letters requesting that they arrange an interview. Whether a teacher was selected for the expert sample depended on whether they were among the group of teachers getting the largest number of votes in their particular school. A pool of 26 experts was sent the initial letters. Therefore, the top seven vote getters in the high school received interview letters while the top three vote getters in one of the largest elementary schools got letters since that school included 12% of the teachers in the district. The 28 teachers initially selected for the comparison pool were randomly drawn from the teachers in a school making the proportion in the pool equal to the proportion of teachers in that school in the district.

Of the original 26 selected for the expert ("best") pool, 22 returned interview forms (see Appendix A). The number of interview forms returned did not equal the 40 planned. Therefore, an additional pool of potential interviewees was selected. The additional cases were selected to increase the number of comparison group teachers especially from those schools where there were "best" teachers who had agreed to be interviewed but not an equal number of comparison teachers. There were 15 returns from the total of 48 letters sent to teachers selected for the comparison sample.

Interviews could not be arranged with three of the teachers who returned forms because the interviewer was not available during the last three weeks of the school year and, after the schools closed for the year, the teachers were unavailable.

Thirty-five interviews were actually conducted. Of these, five tape recordings failed and so no material was available for transcription. Of these five, three were in the expert ("best") group and two were in the comparison sample.

Expert ("best") teachers. (n=19) Of the 19, five taught in the high school, two in one of the junior high schools, and three in another. Of the nine from the elementary schools, three were from one school, two from each of two others, one from each of another two schools and none from one school.

Comparison teachers. (n=11) The participants in this group include teachers from all levels but not all schools. Three taught in the high school, one in one junior high school and three in the other, and three were in the elementary schools. Two teachers came from one elementary school and one from another.

Procedure

Pilot interviews. These were conducted with three teachers contacted by the investigator. Based on these interviews the first question in the interview was revised (see Appendix B) because it seemed that the question, "What are three or four school related problems that

you have or will be working on or trying to solve during the school year?" caused considerable confusion. Teachers interpreted this as school-wide problems not their own problems or denied having any problems. It seemed that the word "problems" suggested something negative. "Issues" which was used in the revised interview always produced a response. Also the administration question was modified so that teachers could comment on ways administration could hinder as well as help.

A fourth teacher was interviewed. She was able to help with the final rewording of the questions.

Interviews. There were several steps taken to ensure anonymity for teachers. First, teachers who were asked to participate in the study, received a form with the letter requesting their participation (see Appendix A). The teacher designated an interviewer (either the investigator or someone from outside the school system), time, and place for the interview on the form. Then the teacher returned the form to the central office in the school system. A person in the school-system's central office, who had been selected by the Assistant Superintendent, assigned the teacher a number and contacted either the investigator or the alternate interviewer depending on which one the teacher had chosen. The interviewers contacted the teachers and arranged mutually convenient interview times. In all cases the interviews took place at the schools where the teacher taught, although teachers had the option of choosing other sites.

Each interview included four questions:

1. What issues related to your job are you currently trying to resolve or figure out?
2. When you think about microcomputers, what are your concerns? How would you resolve these?
3. How can administration help or hinder you in implementing your suggestions?
4. Describe an inservice about microcomputers that you would design for yourself.

Most interviews took between thirty and forty-five minutes although some ran as long as an hour to an hour and fifteen minutes. All interviews were tape recorded with the permission of the interviewee. The interview tapes were numbered and each recorded tape was transcribed and identified by number. The investigator did not know which interview numbers were associated with which of the groups until data analysis was complete.

Scales. The pilot interviews were used to identify indicators of microcomputers being either a threat or a challenge to teachers and tentative six point scales were developed using phrases from the pilot interviews (see Appendix C). The responses to the second question and follow-up probes were used to identify themes like those expressed in the tentative scales. Table 1 shows the Challenge and Threat scores assigned by two coders to 14 interviews. The coders had the same mean for scores assigned in each of the scales ($M = 2.7$

TABLE 1
Comparison of Coders' Scores for Scales Measuring
Challenge, Threat and Stage of Concern

Subject	Challenge		Threat		Stage of Concern	
	Coder No.		Coder No.		Coder No.	
	1	2	1	2	1	2
100	4	4	2	2	3	3
101	4	4	0	0	3	3
104	3	3	2	2	4	3
105	4	1	0	2	5	4
107	3	3	2	2	2	2
108	3	4	1	0	1	0
109 ^a	-	-	-	-	5	4
113	4	4	1	1	2	2
116	2	2	3	3	2	2
117	1	1	3	1	3	3
119	2	2	0	1	4	4
120	3	4	0	0	4	4
121	0	0	1	1	2	0
144	1	3	0	2	1	1
147	4	3	2	0	3	5
Sums	38	38	17	17	44	40
Means	2.7	2.7	1.2	1.2	3	2.7
Inter-rater	Challenge		Threat		Concern	
Reliability	r = .88		r = .83		r = .81	

Note: ^aThis case was not transcribed when inter-rater reliability was established for Challenge and Threat scales.

for the Challenge scale and $M = 1.2$ for the Threat scale). The Pearson product-moment correlation between the scores indicates reliability between the coders on these two scales ($r = .88$ for Challenge, $r = .83$ for Threat).

A Manual For Assessing Open-ended Statements of Concern About An Innovation (Newlove & Hall, 1976) was used to identify statements in response to Question 2 that could be given a Stage of Concern code. Since the directions in the Manual discourage averaging coded statements and encourage the coder to assign a stage scale rank on the basis of the preponderance of statements of a certain rank, differences among raters might be expected. The scores assigned by the coders were similar with the first coder having a mean assigned score of 3 and the second a mean of 2.7. The correlation between scores indicates agreement between the coders ($r = .81$).

Coding. Recent work has suggested that experts usually do not use algorithms but use heuristics (rules of thumb) instead. These hunches are based on incomplete data that are dependent on the problem. Expert reasoning about "ill-defined" problems often seems to take the form of a set of IF-THEN rules (Alty, 1985; Clark & McCabe, 1984). A microcomputer language which uses such rules is micro-PROLOG.

Two classes of words are used in micro-PROLOG, arguments and relations. Arguments are nouns and their corresponding pronouns; relations are verbs, adjectives, and adverbs as well as prepositions which are often hyphenated such as appropriate-for. These are combined to form facts such as

software appropriate-for students
 software expensive
 teachers give students students software

IF-THEN formulations seemed especially suitable as a way of coding teachers' reasoning since the problems they raise have many possible solutions (ill defined). In addition the problems themselves may be reformulated in the process of trying to reach a solution.

Natural divisions in the interviews were used as the coding segments or units. A natural division occurred when the interviewer asked another question after the teacher stopped talking or summarized what he/she had been saying. Often these summary sentences began with words like so, therefore, or were repeats of previous content. Frequently, they were followed by a pause. Such markers have been used in protocol analysis reported by Simon (1984) and Pitt (1983).

To determine whether it was possible to formulate teachers' reasoning in the interviews as IF-THEN rules, twenty segments from twenty interviews were coded independently by the investigator and another graduate student who is an experienced public school teacher. All the interview segments were able to be coded as IF-THEN rules by both.

For example both coders wrote:

IF (teacher teaches new-course)
 THEN (teacher develops curriculum)

for the following segment:

Currently, I'm teaching ninth grade algebra this year out of a textbook. I taught it one other time since I've been here, but that was out of another text. So, I've had to develop that curriculum this year. Ah, the computer work, I'm having to work on developing that curriculum or supplementing that curriculum I've--I'm giving them. I'm given a basic curriculum, but then I've got to embellish it and develop it to suit my taste. So, I'm having to work up these curriculums each year. It's just not a duplication of the year before.

The format of the rules was similar to those used for micro-PROLOG but the relation words were not always hyphenated when they occurred with prepositions and sometimes more than one relation word was used in a clause. For example, parent ask student about report, includes the relations "ask" and "about" in the same clause with an argument or noun between. When a word was used by a coder in formulating a rule, the word was recorded as either an object or relation (see Appendix E). If the coder thought that a teacher's rule could not be correctly formulated using the words in the list available at the time, new words were added. All words in the list were words actually used by one or more teachers and are not the coder's words although coders used words previously used by other teachers in formulating rules for later interviews.

The coders agreed on the wording of eighteen of the twenty segment. Based on the high level of agreement between the coders both with regard to the possibility of formulating segments of teachers' interviews as IF-THEN rules and on the actual wording of the rules the balance of the interview data was coded as sets of rules in an IF-THEN format.

III. RESULTS

Overview

"Best" or expert teachers were compared with a sample of other teachers (called the comparison group) on a variety of measures. The "best" group included most of those teachers who had been selected while the comparison group did not represent a majority of the random sample selected for comparison.

However, there were differences between the groups in the way they thought about school related problems. Teachers' reasoning, which could be reliably formulated as rules similar to those used in rule-based expert systems, was dependent on the problem. Differences in rules were evident in what words teachers had as subjects in the clauses of their rules rather than in the words describing "relations" between "objects." The subjects of expert teachers' contingency (IF) and outcome (THEN) clauses changed when the problem was different, while the subjects of the comparison group's contingency clauses were the same across situations. For the comparison group, only the subjects of outcome (THEN) clauses changed when problems differed.

Expert teachers used conditional statements with "Teacher" as subject, for issues they raised and inservice education. The experts' IF statements for the computer issue and for the administration question did not have "Teacher" or "Student" as the major subject.

Experts' subjects for this problem were mainly in the "Other" category. Comparison teachers' IF statements also had most subjects in the "Other" category for the computer problem. These teachers' THEN clauses, however, often had "Teacher" in the subject position.

Although expert teachers' thinking about the microcomputer situation differed from their reasoning about issues they raise, and from the thinking of comparison teachers, there were no differences in the groups' attitudes toward microcomputers. However, the comparison group had a much greater proportion of computer using teachers and there were differences between "users" and "non-users" on the challenge measure.

Participation

Teachers selected as "best" by their peers are more willing to be interviewed than their comparable colleagues. On the first mailing, 85% of the "best" teachers returned a form arranging for an interview. A second mailing was necessary to get 15 teachers for the comparison group or 31% of the total of 48 comparison teachers sent interview letters. The return rate of 85% for "best" teachers was significantly higher than 31% return rate of the comparison group $\chi^2(1, n = 74) = 19.21, p < .001$.

The Language Used in Teachers' Rules

Each clause in a teacher's rule included both object words and relation words (see Appendix E). Relation words either describe properties characteristic of individuals such as "experienced" or "frustrated," or they may relate one individual to another such as "teaches" or "father-of." Certain relations involve three objects such as, "the teacher gave the student the book." The individuals or objects of these relation words are called "arguments" in mathematics or logic (Clark & McCabe, 1984).

Table 2 lists some of the relation words used by teachers in the IF and THEN clauses of their rules for Question 1 (What are some issues related to your job that you are currently trying to resolve or figure out?) and Question 2 (When you think about microcomputers what are your concerns? How would you try to resolve these?). The words are listed on the left and the type and subject of the clause by question form the headers of the columns. As can be seen, only a few words accounted for the largest number of relation words used by teachers. Frequently, the same word was used in different kinds of clauses. The word "has" or "have" was often used especially in specifying conditions (IF clauses). In fact, it was the most frequently used relation word in conditional statements in four of the IF categories and was the second most frequent relation word in the two remaining categories. Teachers were specifying something the subject must have before an action could or could not be taken.

TABLE 2
Relation Words Used in Teachers Rules for Questions
1 and 2 in IF and THEN Clauses

Relation Words	Question 1						Question 2					
	IF Clauses			THEN Clauses			IF Clauses			THEN Clauses		
	T	S	O	T	S	O	T	S	O	T	S	O
has/have	18	15	8	11	2	-	24	9	23	5	2	3
use	4	-	-	4	-	-	9	13	-	38	16	11
used-for	-	-	-	-	-	-	-	-	7	-	-	5
gets	3	-	-	-	-	2	3	-	-	6	3	-
want	8	-	-	9	-	-	3	-	-	8	-	-
need	-	4	-	-	-	-	-	2	-	-	-	10
buy	-	-	-	-	-	-	4	-	3	3	-	2
learn-to-use	-	-	-	-	-	-	3	-	-	3	-	-
plan	13	-	-	13	-	-	-	-	-	6	-	-
secure-with	-	-	-	-	-	-	9	-	-	-	-	-
experienced-with	-	-	-	-	-	-	4	-	-	-	-	-
prepared	-	-	-	-	-	-	-	-	-	4	2	-
believes	-	-	-	-	-	-	4	-	-	-	-	-
frustrated	-	-	-	8	-	-	-	-	-	4	-	-
teach	13	-	-	4	-	-	4	-	8	-	-	-
learn	-	-	-	-	2	-	-	-	-	-	5	-
helps	-	-	5	-	-	-	-	-	3	-	4	-
know	-	-	-	-	-	-	-	3	-	3	2	4
makes	-	-	-	-	-	-	3	-	4	-	2	5
in	5	-	8	-	9	-	3	3	17	-	2	-
choose	-	-	-	-	-	-	5	-	-	-	2	-
improve	-	-	-	-	-	3	-	-	-	-	2	-
do	-	-	-	4	-	-	-	3	-	-	3	-
available	-	-	-	-	-	-	-	-	18	-	-	4
appropriate-for	-	-	-	-	-	-	-	-	6	-	-	3
changes	-	-	11	9	-	4	-	-	3	-	-	3
is	-	-	-	-	-	-	-	-	5	-	-	3
required-to	3	-	-	-	-	-	3	-	-	-	-	-
design	-	-	-	5	-	-	3	-	-	-	-	-
includes	-	-	-	3	-	2	-	-	3	-	-	-
No. of words mentioned	8	2	4	10	3	4	15	6	12	10	12	11
Total mentions in column	67	19	32	70	13	11	84	33	100	80	45	53
No. mentions in category	170	76	104	203	41	58	126	64	183	155	74	134
% mentions in col. of cat. mentions	39	25	31	34	31	18	67	52	55	52	61	40

Note: T=Teacher; S=Student; O=Other

The action words used most frequently in teachers THEN clauses were quite different in Question 2 from those used in Question 1. Clearly, the action most commonly mentioned was "use" in Question 2. This often was a reference to using or not using computers. In Question 1, the most commonly mentioned actions were "planning" followed closely by "having" or "changing" when "Teacher" was the subject of the THEN clause. Although there were only a few action words referring to "Student" or "Other" (both categories combined had less than half the number of action words there were in the THEN clauses with the "Teacher" as subject), "in" was most frequently mentioned when "Student" was the subject of the clause and "change" when "Other" was the subject of the THEN clause. Teachers frequently spoke of students either in terms of a group they were "in" or a subject the student was "in." It is interesting to note, that the word "change" was used in the IF condition only in Question 1 while it was used in THEN statements in both questions but, "change" was only used in clauses in which "Teacher" was the subject in Question 1.

Teachers' Rules for Issues in the Questions

To find out if there were differences in the ways teachers reason about issues which they bring up and those presented by the interviewer, the rules teachers generated in response to Question 1 (What are some issues related to your job that you are currently trying to resolve or figure out), were compared with those they used in response to Question 2 (When you think about microcomputers in schools,

what are your concerns? How would you try to resolve these?), Question 3 (How can administration help or hinder you in implementing your suggestions?) and Question 4 (Design an inservice program about computers for yourself).

Before comparisons could be made the rules were categorized. The subjects of the IF part and the THEN part of the rule were used as the basis for categorization. For example, a rule was included in the IF teacher THEN teacher (T-T) category if the subject of the conditional or IF part of the rule was "Teacher" and the subject of the action or THEN part of the rule was also "Teacher." All of the rules could be classified in one of the following nine categories:

IF teacher THEN teacher	(T-T)
IF student THEN teacher	(S-T)
IF other THEN teacher	(O-T)
IF teacher THEN student	(T-S)
IF student THEN student	(S-S)
IF other THEN student	(O-S)
IF teacher THEN other	(T-O)
IF student THEN other	(S-O)
IF other THEN other	(O-O)

Table 3 shows the number of rules used by teachers in each group by category. Each rule was classified on the basis of the subjects in the IF and THEN parts of a rule. When a rule had several clauses in a part, the part was classified on the basis of the subject used in a majority of the clauses.

The following rule was classified as an IF Teacher THEN Teacher rule since the subject of most of the IF clauses and THEN clauses was "Teacher."

TABLE 3

Distribution of Rules by "Best" and Comparison Teachers in Response to Interview Questions 1, 2, 3, and 4

Rule	Question 1			Question 2			Question 3			Question 4		
	Best		Comparison	Best		Comparison	Best		Comparison	Best		Comparison
	n	%		n	%		n	%		n	%	
T-T	57	(43)	27 (36)	29	(20)	23 (28)	5	(20)	4 (12)	22	(64)	14 (33)
S-T	21	(16)	13 (17)	10	(7)	5 (6)	-	-	-	-	-	2 (5)
O-T	21	(16)	9 (12)	28	(20)	12 (15)	7	(28)	5 (15)	6	(18)	8 (19)
T-S	8	(6)	0 -	6	(4)	3 (4)	-	-	1 (3)	-	-	-
S-S	9	(7)	6 (8)	12	(9)	4 (5)	2	(8)	-	-	-	1 (2)
O-S	2	(2)	6 (8)	11	(8)	8 (10)	-	-	3 (9)	-	-	1 (2)
T-O	3	(2)	6 (8)	10	(7)	2 (2)	3	(12)	6 (18)	3	(9)	13 (32)
S-O	1	(1)	2 (3)	3	(2)	6 (7)	-	-	1 (3)	-	-	1 (2)
O-O	8	(6)	6 (8)	32	(23)	19 (23)	8	(32)	13 (39)	3	(9)	3 (7)
Total	130	99	75 100	141	100	82 101	25	100	33 100	34	100	43 100
Mean no. of rules	6.8		6.8	7.4		7.5	1.3		3	1.8		3.9

```

IF (teacher choose computer-time)
  and (computer in classroom)
  and (teacher know-about available software)
THEN (teacher use computer)

```

The first row of the first two columns in Table 3 shows that 43% of the "best" teachers' rules and 36% of the comparison teachers' rules were in the IF Teacher THEN Teacher (T-T) category when teachers were generating rules about issues which they raised themselves in Question 1. Teachers in both groups most frequently formulated rules in which "Teacher" was the subject of the IF part of the rule and the THEN part of the rule when they were free to select their own issues and to describe how they went about resolving these.

An expert described the current teaching situation in the following terms:

My teaching some has altered just a little bit in that I'm teaching (subject 1) and (subject 2) both, and so, that has given me a little more to prepare for. That has impacted.

This segment was expressed in the following rule:

```

IF (teacher teaches more subjects)
THEN (teacher has more preparation)

```

A comparison group teacher describes the teaching situation in these terms:

I really don't think much about it any more. My problems that I have had in the past have been discipline problems. I don't . . . I've done this so long that I'm pretty certain as to what I need to get done.

This description was formulated in the rule:

```
IF (teacher experienced)
THEN not (teacher have problems)
```

Although a large segment of both "best" and comparison group teachers also formulated IF Teacher THEN Teacher (T-T) rules about computer use in schools (20% of "best" teacher rules and 28% of comparison teacher rules), there were many rules of the IF Other THEN Teacher (O-T) type (20% "best" teacher and 15% comparison group) and of the IF Other THEN Other (O-O) type (23% of the rules of both groups fall in this category for the computer question).

For example, two junior high school teachers saw the use of computers with their students differently. The expert teacher said:

And, another is I think I've got to realize that my program may not be the best taught on the computer. That it may not be the best way for it to be presented. And, that instead of trying to feel like I've got to become computer-wise, and it would involve lots of computer activities in my classroom, that I need to worry about getting some quality things involved. And, if I can't do that then not feel so much pressure which I have felt in the past, I must admit to get with these little boxes. You know, get in there and push those buttons so that little screen can talk to these kids and not feel so guilty about that. Maybe I'm coming to that I think, but there is some good work to be done on them.

This segment was coded in the following IF Other THEN Teacher rule:

```
IF not (computer best-way for subject)
THEN (teacher use some quality software)
```

The comparison group junior high teacher said:

I think . . . I've used in class . . . I've taken classes to the computer lab. I've found them very useful but I have very limited time to prepare materials and I've found the best materials are the ones that I make up myself. I haven't purchased anything um, that I've really felt was worth the money. I've purchased about three things, and I haven't really felt like we've gotten out money's worth from them.

The IF Teacher THEN Other rule for this segment was:

IF (teacher uses computers)
 and (teacher prepares computer materials)
THEN (computers useful)

The comparison teacher viewed the use of computers as contingent on whether the teacher made materials appropriate for student use while the expert teacher saw the subject matter as determining whether the teacher decided to use computers.

Expert and comparison group teachers used different kinds of rules when the questions changed. In order to compare rules, rules were grouped to have sufficient numbers in the categories. First, the rules were grouped according to the subject of the IF part of the rule and compared. Next, the same rules were summed by the THEN part for comparison. Table 4 shows the differences in the categories of rules used in the four different interview questions. Teachers in both groups had more rules with "Teacher" as the subject of the IF part of the rule for issues they raised in Question 1 than in their rules for any of the other three questions. "Teacher" was the

TABLE 4

Differences in the Type of Rules by Question for Comparison
and "Best" Teachers

Questions	Rules Grouped		Rules Grouped	
	Best χ^2	Comparison χ^2	Best χ^2	Comparison χ^2
Q1 with Q2	20.8**	6.9*	25.9**	5.9
Q1 with Q3	13.5**	15.2**	6.3*	17.0**
Q1 with Q4	10.3**	6.4*	6.8*	7.9*
Q2 with Q3	.9	3.8	2.8	7.5*
Q2 with Q4	18.6**	9.4**	15.0**	4.5
Q3 with Q4	10.2**	7.4*	8.0*	7.1*

Note: T-T (IF Teacher THEN Teacher); T-S (IF Teacher THEN Student);
T-O (IF Teacher THEN Other); S-T (IF Student THEN Teacher);
S-S (IF Student THEN Student); S-O (IF Student THEN Other);
O-T (IF Other THEN Teacher); O-S (IF Other THEN Student);
O-O (IF Other THEN Other)

Q1 (What issues related to your job are you currently trying to
resolve or figure out?); Q2 (What are your concerns about com-
puters . . .); Q3 (How can administration help or hinder you?);
Q4 (Design an inservice about computers for yourself).

*p < .05

**p < .01

subject in 52% of expert teachers rules when they were grouped by the subject of the IF part of the rule while "Teacher" was the subject in 32% of the rules for Questions 2 and 3 when they were categorized in the same way. Like the experts, comparison teacher rules had more subjects classified as "Other" for the problems addressed in Questions 2 and 3. Forty-seven percent of comparison teachers' rules had "Other" subjects in the IF part for Question 2 and 64% of Question 3 rules were of this type. Part of the difference in the distribution of rules used in the questions is attributable to the use of "Student" as subject. In Questions 3 and 4 "Student" was rarely mentioned in the rules. These questions were about how administration could help the teacher and teacher inservice. Therefore, the low incidence of rules having the student as subject in either part of the rule, was to be expected.

The "best" teachers used significantly more rules in which "Teacher" was the major factor in the situation when they talked about current issues of importance to them (Question 1) than when they talked about resolving their concerns about microcomputers (Question 2) $\chi^2(2, n = 271) = 20.81 \text{ } p < .001$. The frequencies of rules fitting the different categories also changed for the comparison teachers $\chi^2(2, n = 157) = 6.9 \text{ } p < .05$. Half of the difference is due to a decrease in the number of rules in the "Student" categories, 28% in Question 1 to 18% in Question 2, rather than a decrease in rules in the "Teacher" category. The category showing an increase was Other, increasing from 28% to 47%.

When teachers' rules for Question 3 (How can administration help or hinder you?) are compared with their rules for Question 4 (Design an inservice for yourself about microcomputers), the rules of both "best" and comparison teachers depend on the question or the problem the teacher is addressing $\chi^2 (1, n = 59) = 10.2 \text{ } p < .01$ for "best" and $\chi^2 (1, n = 76) = 7.4 \text{ } p < .01$ for comparison. For Question 3, both groups have the largest proportion of rules in the categories beginning with IF Other segments, 60% for "best" and 64% of comparison teachers' rules.

One "best" teacher said that administrators could help most by:

Find a hundred thousand dollars. I think money is the big factor, particularly when you're talking about bringing people on board. People cost money. I think they are limited with their money. They are limited by . . . this is one program of many. So, it cannot receive all the attention, the time and money. I've found the administration very supportive. I would like to see more staffing and possibly a better facility and more monies to do things with, but, I don't think that's an administrative problem. I think that he's limited . . . it's not what he wants to do; it's that he's limited. So, I don't see the problem in working with him, it's that he's limited just as we are.

The IF Other THEN Other rule coded for this response was:

```
IF not (enough money)
  and (administration supportive)
THEN not (school-system adds-to faculty)
  and not (school-system get better facility)
```

A comparison teacher in the same school responded:

Um . . . I think the main thing would be providing us time and maybe sometimes letting us be the judge as to how we can best use our time. Because we all have different needs.

Sometimes, some of us need to be down there without any other instruction from anybody . . . I would just like to sit at the computer and make some materials. Or sometimes, if I don't get these papers graded that are stacked a foot high, I'll never be able to plan another thing. You know, and my needs vary from time to time based on, you know, what units I'm on; and it may not jibe with what forms have to be filled out by the system, you know or what inservice we have to do here and there. So, maybe allowing us more time to judge for ourselves what work we can best do to improve our teaching or plans or whatever.

This rule also was coded as an IF Other THEN Other rule:

IF (administration permitted teachers)
 and (each teacher decides what-to-do to-improve
 teaching)
 THEN (administration helps teachers)

Question 4 rules most frequently started with an IF Teacher part. "Best" teacher rules were in this category 74% of the time while 63% of the comparison teacher rules were in this category.

"Best" teachers are more likely to think of the teacher responding or acting in the situations in which they see the teacher as the relevant condition since they use more rules with "Teacher" as the subject when rules are grouped by the THEN section of the rule for Question 1 than they do in Question 2, $\chi^2 (2, n = 271) = 25.88 p < .001$. Teachers in the comparison group do not differentiate actors in the two different questions. There is not a significant difference in comparison teachers' rules for Questions 1 and 2 when the subjects of the THEN parts are the basis for grouping the rules $\chi^2 (2, n = 157) = 5.87 p > .05$.

Differences Between IF and THEN Clauses

Rules frequently had several clauses in an IF or THEN part. The tabulation of clauses by subject of the clause is more sensitive to the variety of factors mentioned by teachers and to the number of actions teachers mentioned taking or not taking in response to those factors. However, the number of clauses are more influenced by the judgment of the coder because the coder decided whether to use a separate clause for something in the teacher's statement while a rule represents a natural segment of the interview. When rules were grouped, however, a rule part was categorized on the basis of the majority of subjects in clauses, tabulation by subject of clause maintains the integrity of the actual subjects used. In the following there are 6 clauses in the IF part and 2 clauses in the THEN part of the rule.

```

IF not (public-opinion-of-teachers good)
    and (teachers work after school with students)
    and (teachers required-to-do Basic-skills)
    and (teachers work together)
    and (teachers organize more)
    and (teachers keep records)
THEN (teachers do job better)
    and (teachers find ways to tell public)
  
```

Clauses were tabulated by the subject of the clause, again Teacher, Student, or Other. Table 5 shows the distribution of IF and THEN clauses in the rules by the subject of the clause for Questions 1 and 2. Table 6 is the distribution of clauses for Questions 3 and 4 while Table 7 displays the chi-square values for comparisons between all questions.

TABLE 5

Distribution of Subjects of IF and THEN Clauses by "Best"
and Comparison Groups for Questions 1 and 2

IF Clauses	Question 1				Question 2			
	Best		Comparison		Best		Comparison	
	n	%	n	%	n	%	n	%
IF-T	114	(52)	56	(44)	85	(33)	52	(38)
IF-S	14	(19)	25	(20)	40	(16)	22	(16)
IF-O	63	(29)	45	(36)	131	(51)	64	(46)
Total	191	(100)	126	(100)	256	(99)	138	(100)
Mean	11.5		11.5		13.5		12.5	
THEN Clauses								
THEN-T	150	(70)	82	(67)	97	(38)	65	(49)
THEN-S	30	(14)	16	(13)	63	(25)	23	(17)
THEN-O	34	(16)	25	(20)	95	(37)	44	(33)
Total	214	(100)	123	(100)	255	(100)	132	(99)
Mean	11.3		11.2		13.4		12	

Note: n = number of clauses

TABLE 6
Distribution of IF and THEN Clauses by Group for
Questions 3 and 4

IF Clauses	Question 3				Question 4			
	Best		Comparison		Best		Comparison	
	n	%	n	%	n	%	n	%
IF-T	16	(32)	25	(41)	51	(71)	24	(51)
IF-S	3	(6)	2	(3)	1	(1)	1	(2)
IF-O	31	(62)	34	(56)	20	(28)	22	(47)
Total	50	(100)	61	(100)	72	(100)	47	(100)
Mean IF	2.6		5.5		3.8		4.3	
THEN Clauses								
THEN-T	24	(50)	17	(34)	60	(52)	36	(58)
THEN-S	5	(10)	7	(14)	3	(3)	2	(3)
THEN-O	19	(40)	26	(52)	52	(45)	24	(39)
Total	48	(100)	50	(100)	115	(100)	62	(100)
Mean	2.5		4.5		6.1		5.6	

Note: n = number of clauses

TABLE 7

Differences in Types of Clauses Used in Questions 1, 2,
3, and 4 by Teacher Group

Questions	Best		Comparison	
	χ^2	n ^a	χ^2	n ^a
IF Clauses				
Q1 with Q2	31.12**	447	1.27	264
Q1 with Q3	12.29**	241	.21	187
Q1 with Q4	2.75	263	.53	173
Q2 with Q3	.03	306	.09	181
Q2 with Q4	10.99**	328	.71	167
Q3 with Q4	13.04**	122	1.1	108
THEN Clauses				
Q1 with Q2	47.96**	469	7.92*	255
Q1 with Q3	7.15*	262	11.11**	184
Q1 with Q4	10.4**	329	1.29	185
Q2 with Q3	2.38	303	3.37	182
Q2 with Q4	6.47*	370	1.3	194
Q3 with Q4	.05	163	6.5*	112

Note: χ^2 has 1 df in all cases (categories of clauses were Teacher (T) and Student + Other (S + O)).

^aNumbers are the number of clauses used in each comparison.

*p < .05

**p < .01

Tables 5, 6, and 7 show that the subjects of "best" teachers' IF clauses changed when the problem changed. "Teacher" was the main subject in 52% of the expert teachers' IF clauses for issues they raised themselves (Q1). "Teacher" was also the most important subject in 71% of "best" teachers IF clauses for Question 4, the question about designing inservice. "Other" and "Student" combined accounted for the 67% of the subjects in experts' IF clauses for the administration issue (Q3), and for 66% of IF clause subjects for microcomputer concerns (Q2). Experts differentiated between the conditions for issues they raised themselves (Q1) and concerns about microcomputers (Q2), $\chi^2 (1, n = 447) = 31.12$ $p < .001$. There were also significant differences in conditions mentioned in Q1 and those in the administrative situation (Q3) $\chi^2 (1, n = 12.29)$ $p < .01$. However, the subjects for the administrative question (Q3) and the microcomputer situation were the same (Q2) $\chi^2 (1, n = 306) = .03$ $p > .10$. There were also significant differences between the subjects "best" teachers used in IF clauses for the inservice question (Q4) and those in Question 2, $\chi^2 (1, n = 328) = 10.99$ $p < .01$, and those in Question 3, $\chi^2 (1, n = 122) = 13.04$ $p < .01$. "Best" teachers, however, had "Teacher" as the subject of conditional clauses in both the inservice situation and for their own problems $\chi^2 (1, n = 263) = 2.75$ $p > .10$.

On the other hand, the subjects of comparison teachers' conditional statements did not change when the problem changed. There were no significant differences between the questions when the subjects of IF clauses were compared across questions.

The major differences between questions for comparison teachers were found in the subjects of their THEN clauses. "Teacher" was the subject of 67% of comparison teachers' consequential statements for the problems they raised (Q1), and in 58% of the THEN clauses about inservice (Q4). In the microcomputer situation, comparison teachers' THEN clause subjects were split evenly between "Teacher" and the combined "Student" and "Other" categories. Only in the administration question, did comparison teachers have subjects mainly in the combined "Other" and "Student" category (68%). There were significant differences between the subjects of comparison teachers' consequential statement for Questions 1 and 2, $\chi^2 (1, n = 255) = 7.92 \ p < .01$; Questions 1 and 3, $\chi^2 (1, n = 184) = 11.11 \ p < .01$; and Questions 3 and 4, $\chi^2 (1, n = 112) = 6.5 \ p < .05$.

The subjects of "best" teachers THEN clauses also depended on the question. "Teacher" was the subject of 70% of experts' consequence statements for Question 1 and fifty-two percent for Question 4. "Student" and "Other" accounted for 62% of the subjects in Question 2 and 66% in Question 4. There were significant differences between the THEN clauses of expert teachers for Question 1 and:

Question 2, $\chi^2 (1, n = 469) = 47.96 \ p < .001$;

Question 3, $\chi^2 (1, n = 262) = 7.15 \ p < .01$; and

Question 4, $\chi^2 (1, n = 329) = 10.4 \ p < .01$.

Expert teachers' subjects in THEN clauses for Questions 2 and 4 were also significantly different $\chi^2 (1, n = 370) = 6.47 \ p < .05$.

A comparison of the amount of variability between questions for each group was done using the difference between questions in the percent of clauses in the "Teacher" and "Other" categories. Table 8 shows the amount of difference in the percent of clauses in the category by group. The mean difference in the percent of clauses in the "IF Teacher" category for "best" teachers was 23 points while the mean difference for the comparison teachers in this category was 7 points. There was a significant difference between the groups in the variance in percent of subjects in the IF "Teacher" category, $F(5, 5) = 12.12$ $p < .01$. "Best" teachers also varied more than comparison group teachers in the percent of clauses in the "Other" category when the questions changed, $F(5, 5) = 5.2$ $p < .05$. However, mean percentage when change in category use was compared for THEN clauses, there was no significant difference between the comparison and "best" teacher groups.

Microcomputer Use

Teachers' thinking. Teachers selected as "best" by their peers reformulated rules more than teachers in the comparison group when the subject changed from issues teachers identified (Q1), to that of computers in schools (Q2), raised by the interviewer. There were 14 teachers who had 50% or more of their rules in the IF Teacher THEN Teacher category in Question 1. Ten of these were "best" teachers and four were in the comparison group. None of these 10 "best" teachers used a majority of IF Teacher THEN Teacher (T-T) rules in response to

TABLE 8
Difference in the Percent of Clauses in a Category for Question by "Best"
and Comparison Group

Absolute Percent Difference								
Questions	Clause Type							
	IF Teacher		IF Other		THEN Teacher		THEN Other	
	B	C	B	C	B	C	B	C
Q1 - Q2	19	6	22	10	32	18	21	13
Q1 - Q3	20	3	33	20	20	33	24	32
Q1 - Q4	19	7	1	9	18	9	27	19
Q2 - Q3	1	3	11	10	12	15	3	19
Q2 - Q4	38	13	33	1	14	9	8	6
Q3 - Q4	39	10	34	9	2	24	5	13
Mean difference	23	7	22	10	16	18	15	17
F (5, 5)	F=12.1*		F=5.2*		F=1.1		F=1.4	

Note: B = Best; C = Comparison

*p < .05.

Question 2. Four members of this group of 10 "best" teachers used a majority of IF Other THEN Teacher (O-T) and another four used a majority of IF Other THEN Other (O-O) rules.

A "best" teacher who used an IF Other THEN Teacher (O-T) used the following:

```
IF (schedule is problem)
THEN (teacher plans time)
      and (teacher works-with groups)
```

While the following IF Other THEN Other (O-O) rule was used by a "best" teacher in talking about computers:

```
IF not (other-teachers interested-in computers)
THEN not (other-teachers believe computers valuable for students)
      and not (students benefit-from computers)
```

The most important category of rules for two of the four comparison teachers who had a majority of rules in the IF Teacher THEN Teacher (T-T) category in Question 1 was (T-T) in Question 2. An example is:

```
IF not (teacher secure-with computers)
      and (teacher teaching wordprocessing)
      or (teacher teaching-with computers)
THEN not (teacher enjoy teaching).
```

"Best" teachers who had a majority of subjects in the "Teacher" category of their IF clauses for Question 1 were likely to have a majority of subjects in the "Other" category when they discussed

conditions relating to microcomputer use in Question 2 $r(17) = .54$ $p < .05$. For the comparison group, there was a negative relation between the "Teacher" category in Question 1 and the subjects in the "Other" category in IF clauses for Question 2. Although the relation is strong $r(9) = -.59$, it is not significant.

An example of some of a "best" teacher's IF statements in Question 1 and the same teacher's conditional or IF statements for Question 2 will demonstrate the nature of the relevant conditions that might be mentioned.

Question 1:

IF (teacher uses student questions)
and (teacher gives speech to other-teachers)
IF (teacher encourages new ideas)

Question 2:

IF (renovation-of-school complete)
and (enough equipment available in classroom)
IF not (commercial-software available)

Reasons for microcomputer use. "Best" teachers' reasons for using or not using computers were predicted to be different than the reasons of the comparison group. Table 9 lists the reasons teachers gave for using or not using microcomputers. Sixty-eight percent, 13, of the "best" teachers and 45%, five, of the comparison group teachers had one or more clauses in the THEN parts of their Question 2 rules which indicated that the teacher would or would not use computers. The IF clauses of these rules were then examined to determine the reasons for either using or not using.

TABLE 9
Reasons Teachers Give for Either Using or
Not Using Microcomputers

Reasons	Best (n = 13)		Comparison (n = 5)	
	n	%	n	%
Students	6	(46)	2	(40)
Computer Available	8	(62)	3	(60)
Software	5	(38)	5	(100)
Training	6	(46)	4	(80)
Time	4	(30)	4	(80)
Other	7	(54)	4	(80)

Some of the reasons were:

- Students want to use computers
- Computers in classroom
- Software quality is not good
- Teacher not have training
- Teacher not have time
- Other teacher in department uses

"Best" teachers explained their use or non-use of computers more on the basis of computer availability while comparison teachers were significantly more likely to explain their use or non-use on the basis of software quality, time, and training or lack thereof $\chi^2 (5, n = 18) = 28.76 \ p < .01$.

Proportion of computer users in the groups. There was a greater percentage of teachers who could be classified as computer "users" in the comparison group, 73%, than in the "best" teacher group, 32%. "Non-users" constituted 68% of the "best" teachers and 27% of the comparison group. Those comparison teachers who agreed to participate in the study were significantly more likely to be computer "users" than were the "best" teachers $\chi^2 (1, n = 20) = 7.03 \ p < .05$.

Those teachers classified as users in this study are those who work directly with students in the lab or in their own classroom or those who have or are using computers for their own work. Teachers who are classified as non-users are those who have not taught students in their classrooms or in the labs using the computer and/or do not use the computer for school work, even though they may have learned

how to use computers. The following comment exemplifies those made by a teacher classified as a computer user:

So, sometimes I could take the whole group at once to the lab and sometimes, if I choose I can send half and half.

A comparable remark, reflective of those in the non-user category was:

My personal experience is zilch.

Attitudes toward microcomputers. The distribution of teachers' scores on three measures of attitudes toward the use of microcomputers in schools is shown in Table 10. The measures were based on responses to Question 2 of the interview, "What are your concerns about microcomputers in schools? How would you resolve these?"

"Best" teachers were no more likely than their comparison group colleagues to perceive the introduction of microcomputers as an opportunity or challenge for either their students or themselves. A one-way analysis of variance indicated no difference between the groups on the measure of Challenge $F(1, 28) = 3.51$ $p < .05$.

Expert teachers were expected to be more likely to perceive the introduction of computers in schools as an opportunity or challenge. One possible explanation for the lack of a significant difference was that the comparison group included a much larger proportion of computer users than the "best" group. The mean challenge score of computer using teachers was 3.3 while that of "non-users" was 2.2.

TABLE 10

Scores of "Best" and Comparison Teachers on Measures of Reactions to the
Introduction of Microcomputers

	Frequency of Scores													
	Best Teachers (n = 19)						Comparison Teachers (n = 11)							
	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Scales ^a	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Challenge ^b	2	4	4	4	4	1	-	0	2	0	2	6	1	-
Threat ^b	8	2	4	4	1	0	-	5	1	4	1	0	0	-
Stage of Concern ^c	0	1	6	8	2	2	0	0	2	2	2	4	1	0

Note: Mean Challenge M = 2.4 comparison m = 3.4

Mean Threat M = 1.2 comparison M = 1.1

Mean Stage of Concern M = 2.9 comparison M = 3.0

^a0 is low, 6 is high

^bSee Appendix C for descriptions

^cSee Appendix D for descriptions

The difference between means is significant, $t(14) = 2.2$ $p < .05$.

Using computers seems to be related to whether computers are seen as challenging.

Stage of Concern (see Appendix D) scores indicate the issues teachers consider important at different times during the course of adopting an innovation. The longer a teacher has been involved with using an innovation, the more he or she is likely to be concerned about how the innovation will affect students and how to get other teachers to use the innovation. However, many teachers never get concerned about these issues because they never resolve the problems related to managing the use of the innovation in an instructional setting. Based on the percentage of teachers in both groups who were classified as computer "users" (32% of "best" and 73% of comparison), the comparison group teachers might have been expected to evidence a higher mean score on the measure of Stage of Concern about microcomputers. The mean score for "best" was 2.9 while 3.0 was the mean for the comparison teachers. Both groups seemed to be primarily concerned with issues related to management of computers in the instructional setting. The one-way analysis of variance was not significant for Stage of Concern differences between the groups $F(1, 28) = .06$.

However, there were some small differences in Stages of Concern when teachers were grouped as "users" or "non-users." "Users" mean score of 3.3 was higher than the non-user mean of 2.7. "Best" teachers

who were "users" had a slightly higher mean concern score (3.5) than comparison group "users" but, were almost one stage ahead of their "non-using" "best" teacher colleagues whose average score was 2.8. Although these differences were not significant, computer use may have some influence on Stage of Concerns as suggested by previous research on innovation adoption.

Summary

A group of expert teachers who were nominated by their peers and administrators as the "best" teachers in the school system and a randomly selected sample of their colleagues who had not been nominated, were asked to participate in this study of "teachers' problem solving." The percentage of experts participating was 84, while 31% of the comparison sample agreed to participate.

Before comparing the thinking of the groups with regard to several school-related issues, the teachers' interview protocols were coded. The teachers' thinking about issues related to their jobs, microcomputers in schools, the effect of administrative action, and designing their own inservice about computers, could be reliably formulated as rules similar to those used in rule-based expert systems. Teachers' rules were categorized on the basis of the subjects used in their IF and THEN clauses because the "relation" words used by teachers were not specific.

Expert or "best" teachers' rules were different than those used by the comparison group. Experts were more likely than comparison

teachers to view themselves as the subject of both the conditional (IF) and the consequence (THEN) clauses of their rules when the issues were ones they raised themselves or involved designing an inservice program for themselves. When the problems were related to administrator action or microcomputers, experts did not use "Teacher" as subject in a majority of their conditional statements. Experts' rules for issues they raised themselves were much like those for the inservice problem. The contingencies in the microcomputer problem and the administrator situation were viewed as similar by the experts, although the subject affected was different for the two situations.

Comparison teachers, on the other hand, did not have the "Teacher" as the major subject in any of their conditional statements for any of the problems. The subjects of their THEN clauses were the same for issues they raised and the inservice question. No difference in the subjects of these consequential clauses was found for the microcomputer and administrative questions.

Although "best" teachers' thinking about the microcomputer situation, and their reasons for using or not using these machines, differs from that of the comparison group, the groups do not differ in their attitudes towards computers. The proportion of computer "users" is significantly higher in the comparison group. When teachers are classified as "users" or "non-users," the "users" are significantly more challenged by computers than are the "non-users."

IV. DISCUSSION

Expertise

The results of this research support the view that experts perceive situations differently than non-experts (Neisser, 1976; Pitt, 1983). The way in which an expert views a situation may be expressed in his or her rules for that situation (Harre & Secord, 1973; Buchanan & Shortliffe, 1984). The most consistent difference between "best" teachers and the comparison group was that there were changes in the subjects of "best" teachers' conditional statements while there were no changes in the subjects of comparison teachers' IF clauses for different problems. This gross measure, the percentage of subjects in the initial position of conditional statements which fall in the "Teacher" or "Other" category, indicated differences between teachers in the way they define problems. In the research of Voss on "ill-defined" problems, cited by Glaser (1985), the major difference between experts and novices was that experts focused on problem definition. Pitt (1983) and Schon (1983) also found that novices and experts from other fields had most difficulty in initial problem definition. Expert teachers define some problems as "teacher" problems; that is, the teacher is able to formulate the problem statement or conditions in terms of the teacher. Then there are problems which the expert teachers view as situations where someone or something outside themselves is the major factor in the initial circumstances. Teachers in the comparison group, on the other hand, almost

never defined a problem in which the teacher was the major factor. The subjects in the initial position of their IF statements were usually in the "other" category. The expert teachers were likely to define issues they raised themselves and the problem of teacher inservice in terms of the "teacher" while they viewed the problems associated with microcomputers and administration in terms of factors outside themselves. The comparison teachers mainly formulated all problems in terms of someone or something "other" than the teacher. When expert and non-expert teachers talk about the same problems, experts may, depending on the problem, state the situation differently than their non-expert colleagues. For example, an expert teacher talks about making the class interesting the following way:

Well, one concern of course, is to cover the content that I should be teaching, then how do I teach it . . . different ways that I can present the material so that it will be motivating, be attractive for the student to learn. And then just the logistics of doing that, the cut and paste, the typing, that kind of thing; that eats up a lot of my extra time.

The problem is defined in terms of the "teacher" in the IF segment of this rule:

```
IF (teacher cover content)
  and (teacher use different-approaches)
THEN (teacher makes materials)
  and (teacher uses time)
```

A teacher from the comparison group described a very similar problem in somewhat different terms:

Just to keep the class from being boring, where you come in and do the same thing every day, I've dropped from . . . for example, we've been doing budgeting and stretching the dollar. And so, for example, today we had an auction, you know, what are things worth to you, how do you decide what those things are worth. We've bartered, where you trade different things, I've played "The Price is Right," guessing what prices and how far your money will go. I set them up in an apartment one day and gave them all their expenses, and then gave them all life's little tragedies, like car tags and radiator's blow up, and flat tires and fillings that fall out. Just that sort of day-to-day experiences that will make it more realistic, and that's where they're learning. Of course, that's what I like about my subject, it is applicable to life, you know, it's not something you learn in theory and then go out and apply it. It's just concepts you learn and apply right then. So, that sort of thing.

This teacher's problem formulation focuses on the class:

IF (class is boring)
THEN (teacher uses activities)

Relationship of Thinking to "Efficacy"

Expert teachers' rules show they believe they can determine the conditions in situations which are of concern to them and when they are asked to design learning experiences for themselves. However, the conditional statements in expert teachers' rules suggest that these teachers do not believe they have control over the conditions when the problems involve computers or administration. Comparison teachers, on the other hand, do not seem to see themselves as influencing the outcome of any problems raised in the interview questions, including those issues which these teachers said they were working to resolve.

Bandura (1983) says that a person who can control the occurrence of stimuli believes he or she is effective and has "self-efficacy." Teachers who see themselves as in control of the conditions influencing the outcome of a problem are likely to be "self-efficacious." When teachers see themselves as reacting to situations they perceive as being in the control of something or someone other than themselves, it is likely that they feel ineffective. If, on the other hand, they see themselves as neither controlling the situation nor being the major responders, "self-efficacy" may not be an issue, thus, they may be considered neutral or "uninvolved" in such circumstances.

In a study of "teacher-efficacy," Gibson and Dembo (1984) found that teachers' "self-efficacy" was reflected in items that tapped teachers' sense of their own ability to bring about student change. This "self-efficacy" component and a measure of teachers' beliefs about whether students can be taught were combined in a "teacher-self-efficacy" scale. A relationship was found between teachers scoring high on "teacher-efficacy" and some teaching behaviors identified as important in student achievement. The authors suggested further investigations of teachers' "self-efficacy" including determining how general this perception is across situations.

Expert teachers in this study seem to see themselves as "self-efficacious" in classroom situations and in circumstances where they are the learners and can choose how they will learn. On the basis of what they mention as determinants of the conditions, expert teachers do not have "self-efficacy" in situations involving computers in schools or administrators.

For example, the relation of a "best" teacher to students is described in the following protocol excerpt:

Another thing that's with me because I teach the same children year after year, and I've known them since kindergarten, seeing that they very much need help and to accept the need maybe they don't. Maybe it's motor skills, I see all of that from having seen them since they were in kindergarten. That's a real one for me because I think any teacher in this school . . . the classroom teacher that has them, the guidance counselor can name you those same children, you know. And to me it's important enough that I want to be able to do something about it, or at least make a stab. . . .

This section was summarized in the following rule:

IF (teacher teaches students for years)
THEN (teacher sees some students need help)
and (teacher wants-to-help)

A "best" teacher expresses concern about the effect of computers on teaching in the following:

In my area. I wonder sometimes about the pressure to use them in a subject matter where they may not be too useful. It is . . . everybody is coming up with ideas and ways to use them, and I find members of my own department who want to do the same thing. And, I wonder if we might do something worse or might not do something as good as what we are doing if we are pressured into using them. And I don't mean somebody sitting on high, "You must use a computer." I just mean by colleagues all using them for this and that and the other. I feel like well, you're getting behind the times if you don't find a way to use it, you know.

This teacher's words are coded in the rule:

IF not (computers useful in subject)
 and (pressure from other-teachers in department to use
 computers)
 THEN not (courses same)
 and not (courses good)

Many teachers may feel ineffective in most situations. Comparison teachers who were selected as representative of the teaching population not considered "best" do not mention themselves as the major determinant of the conditions in any of the problems either they or the investigator raised in these interviews. In addition, comparison teachers' rules have the "teacher" as the object affected by, or reacting to, the conditions in the computer, inservice situations and in areas the teacher sees as issues for him or her. "Efficacy" theory would suggest that people who must react to situations which are not in their control will believe they are ineffective in those situations. Only in circumstances where administrators are acting, are comparison group teachers "uninvolved." In this situation factors other than the teacher are the subjects of both the conditional and consequential sections of comparison teachers' rules.

A comparison teacher expresses pressure when student needs are the problem in the following segment:

I feel it has put more pressure on us . . . as teachers. As I said, no one has told us that, but you feel it, you know. It's just a feeling there. I don't take it personally whether the students pass or not, but yet there's that . . . still that pressure there to cover all the basic skills necessary to pass it. And as I said, it's a tremendous amount of drill with the low-functioning students . . . over and over.

This segment was formulated as the following rule:

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IF (students required-to-take state test)
THEN (teacher pressured to-cover material)
      and (teacher includes more practice)
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Administrative requests affect the quality of the information the administrator gets but not the teacher's behavior in this section of a comparison teacher's account.

But I think this administration does a pretty good job of requesting input. I'm not so sure that all of us are that good at actually giving the input. And, I think it's because of the time again. You know, we're handed a piece of paper that says, "Would you list your choices for this and hand it back tomorrow," you know. Or even if they say hand it back in a couple of days, you know if the music teacher doesn't show up or if I don't have my Wednesday afternoons and once I go home, you know, filling out a paper is the last thing on my mind. I've got one kid in (sport) and another kid in (sport), attend a concert, you know, attend a PTA meeting. I still don't have time to fill out the paper so, if we're going to be handed a paper and we want your opinion on this, let's do it at a staff meeting where we all have to be there and have time for it.

The rule for this segment was:

```
IF (administration asks teachers)
   and not (plan time for teachers to answer)
THEN not (administrators get good information)
```

Expert teachers' rules depend on the problem. Some problems are viewed as different and others as similar. When experts change their rules they frequently change both the subject of their contingency clause and the subject of their consequence clause. Sometimes they change only the contingency part and occasionally the consequences

are seen as different than those in another problem even when the subject of the conditional statement is the same. When "teacher" is the subject of the conditional statements in a rule, the "teacher" usually is the main actor in the consequence. This type rule characterizes expert teachers' rules for the issues they raise and insert into their programs. We could describe these problems as ones the teacher "owns." These are likely to be those situations in which the teacher has "self-efficacy." Rules in which "other" factors are the subject of the conditional and consequential clauses of the rules suggest that the teacher does not "own" the problem and feels responsible for neither the conditions nor the outcomes. Rules in which "other" factors are the subjects in the IF statements and "teacher" is the subject of the outcome statements which are used by expert teachers in response to the administration question, probably indicate situations where the teacher cannot control the stimuli but are affected by them. People do not believe they are "self-efficacious" in this type of situation, according to Bandura (1983). Comparison teachers often used rules of this type.

Expert Teachers

The expert teachers selected for this study were nominated by their peers. A reliable basis for selecting experts has been to ask their peers to nominate outstanding practitioners in their field. This study adds to previous research based on expert teachers' accounts (Jackson, 1968; Shavelson, 1983; Putnam & Duffy, 1984),

by comparing expert teachers with a group of their colleagues selected at random from teachers in the same school system. The expert teachers in this study (i.e., those selected as "best" by other teachers and administrators in their district) were more willing to participate in the research than were teachers chosen for the comparison sample. Johnson (1985), in a conversation with the investigator, said other investigators have found experts more willing to take part in research than were their colleagues.

Participants were not asked why they agreed to participate and each participant was told at the beginning of the interview that the interviewer did not know which persons were in which group.

There are several possible explanations for the differences in participation. One, comparison group teachers who did participate believed they were in the "best" teacher group while those who chose not to participate did not think they would be selected as a "best" teacher by their peers. The investigator has heard people in the district mention some of the teachers who turned out to be in the comparison sample as being outstanding teachers. These teachers probably do think they were in the "best" group and, in fact, might have been selected if a different process were used. At least one teacher who was contacted and did not participate spoke to the investigator saying she knew she would not have been selected for the "best" group because she was new to the school system. Consequently, she decided not to participate. This may be just one example of several in which a teacher did not believe he or she was in the "best"

group and therefore decided not to give up the time to be interviewed just to be in the comparison group.

A second possibility is that comparison teachers who agreed to participate may have thought the interview would be about computers because the investigator was the part-time computer coordinator in the school district at the time. Teachers selected for the comparison group may have decided to participate because they were interested in computing. The fact that a large proportion of the comparison sample could be classified as computer "users" lends credence to this possibility. These teachers probably consider themselves successful computer "users," perhaps even leaders in computer use in the district and would, therefore, want to participate.

Third, non-computer using teachers in the comparison sample may have thought the interview would be about computers and, if they were not interested in computers, they may have decided not to participate. A fourth reason may have been related to teacher groups in specific schools. A few schools were not represented at all in the comparison sample. Perhaps, some schools have groups of teachers that either participate or do not participate in a project.

Although the comparison group in this study may not be representative of all of the non-"best" teachers in this school district, differences were evident between the two groups. It is likely that this comparison group is more like the expert group than the initial random sample that was drawn for comparison. Most experts volunteered to be interviewed as did these comparison teachers. Second, several

teachers in this group have a reputation, in the district, for being excellent teachers. The differences between the groups would probably have been greater if the comparison group had been larger and more representative of the sample.

Based on the characteristic participation pattern of experts described by Johnson (1985) in his conversation with the investigator, the process for selecting experts in this study must have been quite accurate as almost all of the original sample agreed to be interviewed.

Implications for Use of Computer in Schools

The finding that the average Stage of Concern score was the same for both the groups of teachers supports their research on the process of innovation adoption which has shown that all teachers go through the same sequence of attitude change each time they adopt a new innovation (Newlove & Hall, 1976; Hall & Loucks, 1981). First, teachers want more information about the innovation, later they worry about managing the change in their classrooms, and much later, often never, they are concerned about involving other teachers in using the innovation (see Appendix E). Teachers in this study were most concerned about how to utilize computers in their subject areas and how to plan for student use of computers. These are the management concerns typical of teachers who have only been using an innovation for a short time. Most teachers in this school system probably had not had the time to reach the higher Stages of Concern about computers

because the school system had purchased computers for most of the schools only one year previous to the study and teacher training had been offered for just a little more than a year. Also, many of the teachers in the expert group were not computer users and Stage of Concern is related to use or implementation of an innovation.

Whether teachers perceive computers as a challenge or opportunity seems to be more related to whether a teacher is a computer "user" than to their teaching expertise. Again, if more teachers become computer "users," differences between expert and other teachers may be found in their attitudes toward computers. The comparison group in this study had a significantly higher number of computer using teachers than did the expert group which may mean that it is not a truly representative group of comparison teachers in the district. Had the group included more "non-users," differences might have been found between experts and their colleagues with regard to perceived opportunity offered by computers in schools.

Expert teachers do, however, differ from comparison teachers in their reasons for either using or not using computers. Of those teachers whose rules included conditions which determined whether they would or would not use computers, experts gave reasons having to do with the availability of computers while the comparison group more often specified software, training and time in their conditions. Having the computer in the classroom was often a condition for use in "best" elementary teachers' rules. For example:

IF (teacher has computer in classroom)
THEN (teacher use computer)

It is possible, that having the computer in the classroom is seen by the teachers as a means for gaining control of the conditions for use of computers. Thus, the teacher would be more able to be effective than in the present circumstance which is often seen by "best" teachers as one where they cannot control the situation and therefore, the outcomes are not their responsibility. On the basis of expert teachers' rules for the computer situation, most do not believe they are in control of the contingencies; therefore, many do not take action in this area.

Comparison teachers' rules which most often include software, training, and time in their conditions for use, imply action on the part of the teacher with regard to these conditions. For example, all of the comparison teachers had rules which included a reference to software quality in one or more conditional statements. Teachers in this group saw the lack of quality software resulting in their having to develop software themselves, or having to spend precious time previewing, or in their not being able to use computers. Expert teachers were more likely to see lack of software as a problem to be solved by others such as companies producing better materials or having students write programs based on teachers' ideas.

There is some evidence that locating computers in laboratories in schools where the number of computers is small, results in more

students using computers for longer periods of time especially for programming assignments (Benderson, 1985). The implication of the present study is that computers ought to be made available where the teacher is if expert teachers are to find the most fitting uses for computers in schools. If machines are placed in the classrooms or departments of expert teachers, it is likely that these teachers will formulate rules for the use of computers which put the teacher in control of the circumstances for computer use. If schools want to develop instructional models for computer use based on the reasoning of their expert teachers, it would probably be wise for the schools to make computers easily available to these teachers.

Limitations

The size of the sample in this study, thirty teachers, is limited, but it is large when compared with many studies of expert reasoning which have often used only one or two subjects.

All the teachers interviewed for this study taught in the same school district. Although selecting the sample from one district was intended to limit the number of factors influencing the thinking of teachers (especially with regard to microcomputers), generalization to other school districts with different organizational patterns, financing and microcomputing facilities may be inadvisable.

The teachers in this study were not observed or reinterviewed to determine whether their behavior was related to the rules they seem to use. Especially with regard to uses of microcomputers in

schools, changes in reasoning which may be related to length and type of use, need to be investigated over time.

Further Research

Additional studies need to be done utilizing the technique of coding interview segments about current problems as rules similar to those used in logic programming. Programming a computer simulation of expert teachers' reasoning about a prototypical situation on the basis of rules coded from protocols of their responses, seems to be a logical next step in examining the usefulness of conceptualizing teachers' reasoning as a rule-making process.

More studies need to explore the usefulness of differentiating experts' problem definitions from those of non-experts on the basis of the "objects" they use in the initial position of IF clauses in their rules.

This study provides some evidence that reasoning about a problem depends on the situation and it is suggested that reasoning is related to teachers' sense of "self-efficacy" in specific situations. Differences between experts and comparison teachers were related to the rules both used for different situations. As suggested by Gibson and Dembo (1984), further investigations are needed to identify more situations in which teachers feel effective. More importantly, the situational factors that contribute to expert teachers' feelings of "self-efficacy" need to be distinguished from those which lead the experts to feel ineffective or "uninvolved."

Conclusions

This study has demonstrated the feasibility of discovering rules in teachers' accounts of their own thinking as suggested by Harre and Secord (1973).

Social behavior is to be explained through the collection and analysis of participants' accounts. Through this channel, we hope to be able to discover what leads people to follow the particular social ways they do. In this way we hope to discover the rules, plans, conventions, images and so on that people use to guide their behavior (p. 151).

In addition, simply categorizing the main subjects of the conditional clauses in teachers' rules was sufficient to differentiate "best" or expert teachers from teachers in the comparison group. Experts define situations in these conditional statements either in terms of the "teacher" or some factor or factors outside the "teacher." Comparison teachers, on the other hand, do not use "teacher" as the major factor when they are defining the conditions for the problems addressed in this study, even those issues they mentioned as ones they were currently trying to resolve.

For example, a "best" teacher describes behaviors that affect students in the following segment:

Well, one of the things that I think about that I probably spend more time thinking on and can never come up with anything is how to motivate children who just are not motivated at all. There are children who I'm very well aware in just dealing with them that they are bright, that they have much that they are not using any of their abilities or using

very little. And, they don't seem to find ways to motivate. Now, I won't have many of those in the (number) grade, because (number) graders still will do many things because they still like to please teachers or adults. So, sometimes, just with that . . . but, then there are some children who are just completely turned off; not many but a few from school. I try to think of ways to reach them.

The rule formulated for this concern was:

IF (teacher motivate students)
THEN (students use abilities)

The same teacher in thinking about how administration could help said:

I'm one of those people who don't always try to second guess administrators. I'm not in the position that I have to do that. And, I feel that administrators both like at the central office and at the building level are much more aware of the overall picture; so, I don't feel like . . . I'm just the classroom teacher over here in the (number) grade and what I might really want and certainly feel like I can go to my principal and ask him, and if I present my request in a way and back them up with my reasons if I thought it out, I've always found that he's very cooperative about helping me work out details. And at the same time, he understands an overall picture of how the things and how my request is going to fit in. And so, even though I would go and make a request, I have never gone and made a request that I was not given careful consideration, and either helped in that way or given a very careful explanation of why it did not work in the overall picture. So, I don't tend to second-guess administrators, and I don't.

The rule shows the teacher accepting the decision:

IF (administrator has overall-picture)
and (teacher make request)
and (teacher has reasons)
THEN (teacher accepts administrator-decision)

The comparison group, as a whole, did not see themselves as the major influence in any problem situations but often saw themselves as the persons affected by situational factors.

One comparison group teacher felt the classroom program had to be changed.

There has been a change in the state exam and we've had a high rate of student failures over the last (number) years. And right now I have a brand new schedule that is different from any (similar subject) teacher in the state. And, I have my students one hour a day for theory. And, we're strictly going through that book . . . you know, I'm covering that book more thoroughly than I was before because the way it was twenty percent of their practice is supposed to be theory and eighty percent skills. And, I'm now in the process of giving them a little bit more than twenty percent theory.

The effect of the situation is coded in this rule:

```
IF (many students fail state-test)
THEN (teacher changes schedule)
      and (teacher includes more theory)
```

The distinction between problems experts cast in terms of the "teacher" and those in which "other" factors are the major subject would support the view that some people attribute the causes of behavior to internal factors, "internal locus of control," while others see their behavior as dependent on outside factors, "external locus of control" (Phares, 1975). Although comparison group teachers' rules do indicate an external locus of control for most of the situations they describe, expert teachers' rules indicate that the situation affects attribution. When the issue is one the expert teacher

is struggling with or when it involves designing an inservice program, the expert teacher sees the "teacher" as the most relevant influence in determining subsequent behavior, even the behavior of others. On the other hand, when the question is use of microcomputers or working with administrators, expert teachers attribute the cause of behavior to factors "other" than themselves.

Teachers' sense of "self-efficacy" is evidenced in the pattern of subjects used in the conditional, or IF clauses, and consequential, or THEN clauses, of their rules. When teachers' rules have "teacher" as the major subject in both the IF clauses and the THEN clauses, teachers are likely to be describing problems which they "own" or situations in which they are "self-efficacious" (Bandura, 1977, 1983, 1984). When the major subjects of the conditional clauses are factors "other" than the teacher and "teacher" is the subject of a majority of the consequent clauses, teachers are probably describing situations in which they are affected by circumstances which are not in their control. These are the situations in which the teacher probably believes he or she is ineffective. Finally, the teacher may describe a situation which is formulated in a rule in which factors outside the teacher are the major subjects of both the conditional and consequential parts of the rule. Such rules probably are typical for problems for which the teacher does not take responsibility, which he or she does not "own."

When asked to consider the problem of innovation as exemplified by the introduction of microcomputers in schools, expert teachers'

rules show that these teachers cannot yet define this problem in terms which allow them to be in control of the conditions nor, however, do they see themselves as being primarily affected by this new innovation; it is not their problem. Although a large percentage of the comparison teachers did, in fact, use computers with their students or for their own work, they also did not see themselves as the major influence in determining the outcomes of computer use in school. This is not surprising, because these teachers do not distinguish problems on the basis of who or what influences the contingencies in problems.

This study has shown that it is possible to identify rules that teachers use in resolving job related problems. Further, the evidence is that the rules depend on the situation. The situation affects the way in which expert teachers define their "enigmatic" or "ill-defined" problems. The subjects of expert teachers' conditional statements can be used as indicators of whether the problem is able to be viewed as a one in which the "teacher" determines the circumstances or whether control of the situation is attributed to factors beyond the teacher's control. Comparison teachers did not define any problems in terms which would suggest that they determined the conditions, although their rules for some problems indicated that they saw themselves as affected by circumstances in some situations and not in others.

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APPENDIXES

APPENDIX A
LETTERS TO TEACHERS, BALLOTS,
AND INTERVIEW FORMS

February 18, 1985

Dear Teacher,

Will you please help with a dissertation research project to find out if schools are taking advantage of the thinking of their "best" teachers. To find answers to this question, interviews will be conducted with teachers selected by their Oak Ridge colleagues as "best" as well as a comparison group. The interviews will be analyzed to identify the processes teachers use to solve problems. By doing this we may be able to learn ways to solve problems more effectively. The school administration has considered this dissertation proposal carefully and has given permission for the study to be conducted. As a first step, each teacher can help by identifying those teachers he/she knows personally who she/he considers to be outstanding ("best"). Some teachers will then be asked to give 30 to 45 minutes of their time for an interview. I will do the analysis of the interview transcripts as a part of my dissertation research. All teachers will receive a summary of the research findings including any suggestions for how they might be applied.

Please assist by doing the following:

1. Fill out the attached sheet naming up to five of your colleagues you consider to be outstanding or "best" teachers.
2. Return the sheet in the attached, postage paid envelope to the University of Tennessee where it will be tallied by someone who does not know any Oak Ridge staff and then destroyed.

Those selected for the interviews will be contacted in mid to late March.

Your anonymity will be protected by:

1. Having your choices of "best" teachers tallied at UT by someone who does not know you or any Oak Ridge staff. The selection sheets will then be destroyed.
2. Having reminders sent directly to you from UT if your selection sheet is delayed so no one in Oak Ridge will know that you have been recontacted, including me.
3. Having the samples of teachers chosen according to a set of guidelines so the interviewers will not know whether the teacher being interviewed is in the group of

"best" teachers or in the comparison group. The names of those in each group will not be available during the analysis of the interviews either.

4. Giving teachers who are selected to be interviewed a choice of having me or someone outside the school system do the interview and having the choices of interviewer made on a special form which will be returned to Mrs. Eleanor Chandler. She will make up the lists of teachers for each interviewer, keeping your choice confidential.*

5. Keeping all information in the interviews confidential. No names will be used in any reports.

Thank you for your help,

*A research study of this nature is optional for staff.

February 20, 1985

Dear Building Principal, Assistant Principal and Assistant
Superintendent for Curriculum and Instruction,

As a first step in my dissertation research project about teachers' problem solving processes, I am requesting both teachers and supervisors to identify those teachers they consider to be the "best" in Oak Ridge. Those teachers selected as "best" as well as a comparison group will be interviewed in mid to late March.

Will you please assist by:

1. Filling out the attached sheet naming up to ten teachers you consider to be the "best" teachers in Oak Ridge.
2. Return the sheet in the attached, postage paid envelope to the University of Tennessee where it will be tallied by someone who does not know any Oak Ridge staff.

Your anonymity will be protected by:

1. Having your choices of "best" teachers tallied at UT by someone who does not know you or any Oak Ridge staff. The selection sheets will then be destroyed.
2. Having reminders sent directly to you from UT if your selection sheet is delayed so no one in Oak Ridge will know that you have been recontacted, including me.
3. Keeping all information in the interviews confidential. No names will be used in any reports.*

Thank you for your help,

Sally Vogel

*A research study of this nature is optional for staff.

Please PRINT below the names of up to five Oak Ridge teachers who you consider to be the "best" teachers you know. Then return this sheet in the attached, postage paid envelope to the University of Tennessee.

1. _____
2. _____
3. _____
4. _____
5. _____

February 26, 1985

Department of Psychology
Austin Peay Building
University of Tennessee
Knoxville, TN 37996-0900

Dear Teacher:

If you have not yet had a chance to send in your choices for up to five "best" teachers in Oak Ridge, would you please take a few minutes now to fill in the enclosed selection sheet? Would you please return your choices in the postage paid envelope you received with the original choice sheet or mail it to the above address?

The larger the return the better the selection process will be as more teachers are likely to be included in the group chosen as "best."

The number in the lower corner of your sheet is to help me keep track of the number of returns by school. I am destroying all choice sheets after I tally them and the lists of returns will be discarded when the tallying is complete.

Thank you for returning your selections promptly.

Beverly Davenport
Secretary

March 27, 1985

Dear Teacher,

You have been chosen for a sample of teachers to be interviewed for Sally Vogel's dissertation research on teacher's thinking about job related issues.

The enclosed form is provided so that you will have the opportunity to choose who will interview you. If you would like Sally to conduct the interview, select Option I. Due to her work schedule, she is available for interviews on Mondays and Fridays. However, she may be able to arrange another time if you are not able to arrange a time on Monday or Friday.

If you would like someone from outside the school system to interview you, Marcia Keith a former teacher and principal who is currently a graduate student at the University of Tennessee can conduct interviews on Tuesday and Friday afternoons. If you want Marcia to interview you, please check Option II and indicate the dates and times you can be available.

If you will not participate in an interview, check Option III.

You may arrange interviews during planning periods, after school, or possibly on Saturdays.

Eleanor Chandler has offered to help with this project. She will receive your choices and keep them in strictest confidence. She will also arrange an interview schedule for Marcia based on your selections of dates and times. Should you select Sally as your interviewer, she will contact you to arrange a time based on your reply.

Please return the enclosed interview selection form in the enclosed envelope to Eleanor Chandler at the School Administration Building by Wednesday, April 10.

Thank you.

John Lounsbury

Name _____

Please put a check on the line next to the option you choose.

OPTION I

I am willing to be interviewed by Sally Vogel. The times when I could arrange an interview are:

Monday Date: _____ Time: _____
Friday Date: _____ Time: _____
Other Date: _____ Day: _____ Time: _____
Place: My Classroom _____ Other (please specify): _____

OPTION II

I would like to be interviewed by Marcia Keith. The times when I could be available on Tuesday and Friday afternoons are:

Tuesday: Date(s): _____ Time: _____
Friday: Date(s): _____ Time: _____

I cannot arrange an interview on Tuesday or Friday afternoon but could arrange an interview on a Saturday.

Saturday: Date: _____ Time: _____

If you cannot arrange an interview at any of these times please call Eleanor Chandler to tell her when you can. If possible she will try to find a time when Marcia could interview you.

OPTION III

I do not wish to participate in an interview

Please RETURN this form to Eleanor Chandler by Wednesday, April 13, 1985 in the enclosed envelope.

APPENDIX B
PILOT INTERVIEW

Interview Schedule (Draft)

Thank you for taking your valuable time for this interview. Your comments will be kept confidential and no names will be used in the report.

This study is an investigation of how educators solve school related problems.

1. What are three or four school related problems that you have or will be working on or trying to solve during the school year? (If integrating computers into the instructional program, etc. is not mentioned ask: Will having your students work with microcomputers present any problems for you this year? Why or why not?)
2. When you think about microcomputers what are your concerns?
3. How are you presently using microcomputers, if you are? If not currently using, ask, How will you be using computers with students? How will you be using the microcomputer to do your own work?
4. If currently using, What obstacles or problems do you find in trying to use (implement the curriculum, etc.) microcomputers with your students? for your own work? What difficulties do you foresee when you use microcomputers with your students? (Ask the second part of this question if the teacher is not currently using computers with his/her students).
5. What steps are you going to take to overcome these obstacles or resolve these difficulties? (If no mention is made of the principal, school administration, etc., Ask) Will you need to get help from the administration to carry out these plans or take these steps? Are there steps you have not suggested because you feel you would not get support from your principal, other teachers, or other administrators? (If yes, Ask) What would you do if you were sure of getting support for your plans?

APPENDIX C
CHALLENGE AND THREAT SCALES

Challenge Scale

Challenging, advantageous

The coder should consider any of the respondent's comments about microcomputers in determining which of the following categories to assign to the respondent's verbal report of how he/she views the introduction of microcomputers in schools. However, the coder is most likely to find the respondent's first comments about the introduction of microcomputers to be those that are most useful in making a judgment about which category to assign. Usually, these comments occur in answer to the question "What are your concerns about microcomputers in schools?" But, the respondent may express a point-of-view about microcomputers in schools in answer to the first question or the one about difficulties in using them with students. Assign the highest number in the scale if there is a doubt about which category to use. The following six categories are used ranging from 0 for not a challenge, opportunity or puzzle to 5 best change in recent history in education.

0 Not an Opportunity -- no evidence in the interview that microcomputers in schools are an advantage, change for positive, or of interest (use only if neutral not if negative)

1. A different way of presenting subject matter:
2. Students interested so teacher involved: "My students . . . interested in using them, so I have been involved with them in working with programs that will better enable them . . ."
3. Computer can help me do my work better: I can save time using computer, use it for grading, can organize my materials, etc.
4. Computer offers opportunity: "I guess I think in terms of what the computer can do for me. And I don't really think of it as a problem. I guess, because I always think of change as being necessary to keep from being stagnated." "I have absolutely no concerns in my subject area, because I see them as being a real breakthrough for mathematics."

5. Computer offers exceptional opportunity: "I don't know that we've had any other type of mechanism that has given us the same reinforcement, the same pleasure, and the same quiet way of helping students work."

Threat Scale

Threat, Burden

The coder should consider any of the respondent's comments about microcomputers in determining which of the following categories to assign to the respondent's verbal report of how he/she views the introduction of the microcomputers in schools. However, the coder is most likely to find the respondent's first comments about the introduction of microcomputers to be those that are most helpful in making a judgment about which category to assign. Usually, these comments are found in answer to the question, "What are your concerns about microcomputers in schools?" But, they may also appear in response to the first question or later in the interview when teachers respond to "What difficulties or obstacles do you find (or do you expect) in using microcomputers" Assign the highest number in the scale if there is a doubt about which category to use. The following six categories are to be used ranging from 0 for not a threat or burden to 5, required to use, mandated.

- 0 Not a Threat or Burden -- There is no evidence in the interview that microcomputers in schools are viewed as an additional requirement or burden that is being placed on teachers.
- 1 Have to have because students will need them -- Teacher makes comments such as "Well, I think that we can't turn our backs on them." "We're going to have them in schools, they are a part of our everyday life." "I don't know how I'm going to, but I must." "We need to and we're going to start next year."
- 2 Not enough time -- Teacher makes comments about finding time to prepare, get trained or district not making time available.
- 3 Not interested, other things more important -- Teacher says things like, "I'm not really a computer person," "I don't like computers," "Need to spend more time on basics," "Passing fad."

4 Won't replace teachers -- "Computers can't take the place of one-to-one contact," "District should spend the money on more aides, waste of student time, the real work gets done in the coassroom."

5 Forced to use -- district requirement, state mandate.

APPENDIX D
STAGES OF CONCERN

STAGES OF CONCERN ABOUT THE INNOVATION

- 0 AWARENESS: Little concern about or involvement with the innovation is indicated.
- 1 INFORMATIONAL: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.
- 2 PERSONAL: Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision-making and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
- 3 MANAGEMENT: Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
- 4 CONSEQUENCE: Attention focuses on impact of the innovation in students in his/her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.
- 5 COLLABORATION: The focus is on coordination and cooperation with others regarding use of the innovation.
- 6 REFOCUSING: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

APPENDIX E
WORDS USED IN RULES

WORDS USED IN RULES

SPECIFYING REFERENTS

Listed below are categories of objects and relational terms used by interviewees. For each labelled section, try to write one or more relational statements expressing the idea of the section. These should take the form (object verb object) for "binary" relations like teacher needs time or (object verb) for "unary" relations such as properties of objects or individuals like "teacher prepared" or (verb object object object) for ideas like "teacher gives students assignments. The purpose is to be able to formulate rules that teachers use in shorthand form. Add to the category lists as you go along if something is mentioned that is not listed.

OBJECTS

abilities	Activities (games)
aide	aggravations
answers (solutions)	anything
appendix	Apple-computers
assignments	area
BASIC	basics
Basic-Skills	beginning
behavior	
behavior-modification-methods	benefits
best-way	Board-members
Career-Ladder	catalog
central office (superintendent, asst. supt., etc.)	
changes	choices
class	Classroom
commercial-software	companies
computer-assisted-instruction	computer-games
computer-help	computer-lab
computer-location	computer-management
computer-operation	computer-program
computerized-text	Computers
committee	communication
communication-channels	concerns
consequences	
constraints	content
continuity	copy
corrections	court
Curriculum (course, program)	
database	day
decision	department

department-chair (head)
development
discipline
disruption
education
entry-in-catalog
essay
evaluator
example
experience
experts
facilities
field-trip
gadgets
grade
grammar
graphs
grouping
guidance
home-computer
idea
information
Interest
invisible-objects
job
knowing (knowledge)
leader
lesson
levels
list
local-evaluation
loss
machine-scorable-tests
mistakes
Money (funds, budget)
morale
Motivation, involvement
new-course
new-way
next-time
notes
objective
other-events
others (someone-else)
other-teachers
overall-picture
papers
parts
patron

details
different-approach
displeasure
drill
enough
equipment
evaluation
evaluation-objective
excuse
experiments

faculty
format
goals
grading
frant
graphics
guest-speakers
help
homework
impact-of-computers
inservice
inventory

keyboard
lab exercises
learning
letters
license
location

low-students
manual
Materials (books)

more
moving
new-grade
next-level
next-week
novel
other-agencies

other-subject
outside classroom

parents
part-time-job
people (person)

perfectionist	plan
portfolio	practice
pressures	
principal (local administrator)	priority
problem	problem-solving
program	project
Public	public-opinion-of-teachers
quality	quantity
questions	
reading	reasons
Recognition	records
release-time	remedial-work (remediation)
renovation-of-school	reports
request	Requirements
research-projects	resources (not money)
respect	results
retrieval	review
Rules (regulations)	same-way
Schedule	School (specific school)
School System	science-teachers
scientific-equipment	self
simulation	single parents
situation	
skills	Software
solution	something
stage	State
state-evaluation	statistics
standards	store
structure	students
student-decline	student-programmer
subject	success
suggestion-box	task
team-of-teachers (team-teaching)	teacher
teaching	teacher-requests
tests	text
Tennessee instructional models	
TIMS	theory
Time (weekend, planning, at-home, summer)	
tools	topic
touch-screens	types
typist (typing)	untruths
unions	university
uses	value
varied-review	variety
versions	vocabulary
way	
what-to-do	whole-class
work	word-processing

workshop
years (many, 18)

writing

RELATIONS

access
adds-to
afford
apply
approves
ask
attend
at
believes
benefits
best
between
bought (buys)
call (contact)
catching-up
choose
communicates
competent
come-to (visit)
considers
control
copy
cost
create
criticize
damage
dedicated-to
design
different
discouraged-by
disruptive
each
effective (effectively)
encourage
evaluates
every-week
expects
expensive
expresses
face
fair
fast
feel

accept
affected
after
appreciative
appropriate-for (best-for)
assess
available
before
belongs
beneficial-to
better
bored

cannot
change
clever (don't-miss-a-trick)
compares
complete
concentrated
content
coordinates
correct
cover
creative
current
decide
demonstrates
develop
difficult
displays
does
early
emphasize
enjoy
every
examine
experienced
explains
extra
fail
fascinate
faster-than
find (found)

finish
 flexible
 frequently
 frightened (afraid-of)
 frustrated
 gets
 get-back-to
 Gives
 gives-up
 grades
 gripe
 hands-on
 has (sees)
 heterogeneous
 impacted-by
 improve
 includes
 independently
 inservice
 in-use
 is (be)
 join
 keep
 know
 Knows-less-than
 lacks
 lags
 learn-to-make
 less
 limited-to
 little
 lose
 machine-scorable
 make-up
 many
 memorize
 miss
 monthly
 most
 moves
 need
 new-to
 observes
 on
 open
 overload
 permit
 philosophical
 play-with

first
 focus-on
 friendly
 from
 functional
 get-along
 gifted

 good
 grant
 grouped
 handicapped
 helps
 high
 important
 in
 increase
 individualize
 introductory (introduce)
 involved-with

 just-do
 know-about
 know-how-to
 know-which

 learn
 learn-to-use
 like
 listen-to
 longer
 lowered
 makes
 manage
 meet
 misbehaves
 monitors
 more
 motivate
 must
 new
 number (e.g. 8, 18)
 old
 only
 organize
 participate
 personal
 plans
 poor

prepared
pressured
prevent
prove
put (bring, added)
questions
read (reread)
regularly
relieved
remedial
repeat
require
resolve
same
schedules
see
sends
share
slowly
some
standardize
stimulate
supportive
survey
takes
teaches
thinks
together
trained
tries-to
turn-on
understand
used-for
useful
valuable

voice-operated
wait-until
waste
with
work-on
worries
writes
wrong

present

preview
provide
put-on

recognize
rejects
remain (stay)
remember
replace
required-to-do
review
save
secure-with
self-directive
several
simple (easy-to-use)
socialization
spread-out
stay
study
surprise

talk-to
tells (talks, says)
to

tries
turn-off
uncertain
uninvolved

uses
vocational

visible
wants
whole
work

worth
written-by

APPENDIX F

A "BEST" TEACHER PROTOCOL AND RULES

APPENDIX F

INTERVIEW 117

QUESTION 1 - WHAT ISSUES RELATED TO YOUR JOB ARE YOU CURRENTLY TRYING TO RESOLVE OR FIGURE OUT?

- Q. What I'd like to ask you is whether you can tell me some . . . when you go home at night or on weekends or when you have time to think about your job, what kind of current kinds of issues or concerns are you dealing with or thinking about?
- A. I think the main issue is just getting a positive idea of education to the public. We have so much trouble educating our parents to all the good things, I feel, that are going on in education. I think they have confidence in the school, but I don't think they don't realize a lot of the extra things that we do and a lot of the good things that come from working after hours to help their child have a better opportunity in school. And, I think if we can learn to make more noise about that I think we'd be better off, because we are . . . we have to toot our own horn if we get the support of the public. But, we are working hard, and I think it's important that the public realizes that especially in light of all the new things that are going on in education. And, they are getting the benefits of the hard work. I've seen more this year of teachers trying to work together and trying to be as organized and do the job as efficiently as possible in light of basic skills, and all the things we've been told we have to do and organize and keep very accurate records continually on different subjects. I think we're doing a better job, and I think the public is aware of the efforts through parent meetings and things, but the more we can assure them that we are and are conscientious about the curriculum that we offer to the children the better off we're going to be, because they're the ones that are going to spread the word for us.

RULE

If not (public-opinion-of teachers good)
 and (teachers work after school with students)
 and (teachers required-to-do Basic-skills)
 and (teachers work together)
 and (teachers organize more)
 and (teachers keep records)
THEN (teachers do job better)
 and (teachers find ways to tell public)

Q. Can you tell me how you might . . . what kinds of things you're thinking about how that might be done?

A. Well, as I mentioned I think through parent meetings that we are accustomed to here in our system, having the parent meeting in the fall, I think is the time to get started on the right foot--explain the curriculum to them, explain exactly what we plan to do for the year. We do have a plan written for the year on each subject which we have to do and the overall view of it. I think as soon as we assure them that we're going to follow that and tell them of any of the extra things that we're going to do. For instance, the school newspaper, the Tremont camping trip, all of the extra things that are really . . . that their child will benefit from that they may not have that opportunity just everywhere. But, we're conscientious about planning and prepare the children for it. All these skills build throughout the year particularly in English to build to the point of writing the school newspaper. We work very hard or I do all year in the English classes just to get to that point. It gives them something to look forward to. I think, getting the message to the parents is very, very important--doing that with the parent meetings, I think you ought to have them. From my own experience as a parent, that's not always been the case for my daughter. I have not always known at the beginning or had parent meetings. I think that it's important that that take place, because parents just want to be assured that they're going to cover the curriculum, their child's going to have the benefit of all the extra things that are available on that grade level. And, I suppose through things like the school newspaper--we have a golden opportunity there. The children write about things that have gone on in the school, then the parents come back to me and say they have read that. They are aware of what is going on in the school. So, it's a good way to get some positive publicity about what the children have done from their point of view--field trips that they take that are educational that they have an opportunity through messages home, letters, formal letters home have to be signed. They find out about what's going on and more aware of some of the good things that the children do and naturally just communicating with them through PTA, through homework that goes home signed. Conference time, conference time is real important of course we have two days set aside too for conferences. I think that's real important because whether it's a problem or whether it's just to pat them on the back and tell them some positive things their child is doing--every parent's interested, and sometimes the ones that have the least problems are the most interested in what's going on, and it's just a good time to do some good public relations, and an opportunity to explain how well their child's doing and

what they can look forward to in the future. Any time you have a form to tell parents whether it's a formal meeting or conference time, I think it's important.

RULE

IF (teacher plans curriculum for year)
 and (teachers plan extra activities)
 THEN (teachers communicate with parents)
 and (public-opinion-of-teachers improves)

- Q. You also mention that you thought the teachers were working together better or more, both better and more I gather, or at least I got that feeling.
- A. Maybe it's because I know of so many--well, in our building there's four of us that are working toward the Career Ladder. So, there's more interaction, I mean we will meet and discuss things that we're thinking about and that's important. It's not--you know, we're not just sitting around sympathizing with each other, we're getting in there and helping and seeing how can we make this work and what can we do to help each other and share. It, surprisingly, it is--there's been a lot of sharing of ideas, too. And some people--and even I was a little skeptical about the fact that it might make you be more closed about what you want to share for fear that someone else might grab that idea, but that's not what I found to be true. It may be otherwise with other people. Everybody's unique. I have my own unique style of teaching so does everyone else. The things, the big overall ideas are what we talk about. We work together on so many ideas to start with--the discipline, overall school discipline policy. And, a lot of things are big ideas, how we handle the reading curriculum, how we handle the math curriculum, all of that's something that we work together with anyway. So, it has been fun to interact and discuss how we're going to prepare this or each individual style and each way the teacher wants to prepare the portfolio.

RULE

IF (teacher in Career-ladder)
 and (other-teachers-in-school in Career-ladder)
 THEN (teachers share ideas)

- Q. Can you tell me a little more about what you people have done together?

- A. Well, just informally we've shared portfolios. We go and say, "Have you finished section 1, section 2?" You know, like that then we say, "Well, how did you do that?" We've met after school, informally, and shared how we've written up the instructional lesson plan. "Does that make sense to you?" this sort of thing. "You read it; does it communicate to you what we want it to?" And, it's been interesting reading other units and so forth. Particularly in that area--the instructional area--we've shared more with how we approach that. Also, in evaluation we've talked a little bit together, a few of us informally that are involved in how the math curriculum--you know, "explain it" and the reading, you know, "is it clear, do you understand, have I covered everything, have I missed anything that we do?" you know, pre-test, post-test, retesting, "Have I missed anything?" And, that sort of exchange of ideas to make sure. It just makes you review it. It's not that we don't do that already, it's that we're putting it down in black and white. It gives us a chance to really review it. Once you see it in black and white you have a chance to say, "Well, I need to be more conscientious about doing more of this or that, you know, and make sure I have all my reteaching done immediately, and that sort of thing. It's just a good way to make yourself take a look at the way you're evaluating. It was for me. I'm just speaking for myself. Particularly the evaluation idea. I've-- I think I've gained from that part of it. And, being sure in the lesson plan that I have covered everything. For instance, in the evaluation I think sometimes I automatically assume some things, and it's good for me to have to spell it out in script form to make sure that I don't assume that I actually do it. So, for that reason it has helped, and it has made us more organized.

RULE

IF (teachers meet)
 and (teachers share ideas)
 THEN (teacher improves)

For sure, you have to save everything, and instead of just throwing it away, I've started saving samples of things children have done. But, then that's got a negative too, because I'm trying to save samples that the children have done. I will try to send them home and then get them back. So, they don't always get to keep everything now, because I need a copy of it myself. Or, sometimes I'll try to copy it if it's easy to do. If you can use the copy machine. So, it works both ways. I feel like I have to save more, and I can let them have it for a while, and then I have to get it back.

- Q. You have saved all student work or just a sample?
- A. No, just a sampling of things. You can take one skill, for instance, and show pre-test, post-test and if they don't do well in post-test get a retesting on it. Get a workbook sample, get a magazine sample of the testing.
- Q. This has to be for one student, but it doesn't have to be for all your students?
- A. Yeah, you don't have to have it for all. One of the things that I don't always save is if you have someone in to the group to speak to the group, then to have proof that they've been in the room and that they have spoken to your group, you should have some kind of formal evaluation. Well, I do that; I have a rating scale 1-5 on the scale and what the topic was and the reaction to it. Well, many times I let them keep that. I don't take it back up after I've just looked at it and given it back to them. Because it's just for my own information, you know, how they perceived it and whether they picked it up the main idea or not. Now, I keep it.
- Q. I see.
- A. So . . . run out of storage space.
- Q. I was wondering about that.
- A. There are three boxes back there.

RULE

IF (teacher in Career-ladder)
 and (teacher has-to-save materials)
 THEN (teacher organizes better)

QUESTION 2 - WHAT ARE YOUR CONCERNS ABOUT COMPUTERS IN SCHOOLS?

- Q. Well, you've talked about some changes that have occurred in the school system and in the state this year by mentioning the Career Ladder and the Basic Skills Management System. One of the changes that I have been affected by or involved with is the bringing of computers in the school, and I wonder what you felt--what current concerns you might have about having them in schools.
- A. O.K., I'm not really a computer person, personally. I've had to learn and go through the process as many of the other teachers have. I am not as comfortable using the computers as some teachers are. My--I think we're fortunate here in that we have a person

who, you know, who mans the computer room, and I meet with her. We plan out exactly what I want the students to do while they're in the computer room. For instance, we're working on Basic Skills now, so I have a plan for math and for reading things that they're going to do. Each lesson she gives me feed back. She gives me a form back on exactly how they scored on each thing that I've asked her to do. So, I can monitor it. I am responsible for what they do and I am also aware of the evaluation process and how well they did on that particular skill. So, I'm aware of what's going on. I do not enjoy being there with them all that time; so, I keep--she--I set up the curriculum, and she takes care of that end of it--the computer room. And, I keep the rest of the class.

RULE

IF not (teacher secure-with computers)
 and (aide in computer-lab)
 THEN (teacher meets with aide)
 and (teacher plans computer-activities)
 and (aide gives report to teacher)

The negative things about it is the scheduling; it's really hard on us having the children go in the computer room--I have split class. I have some left and some that go. So, it makes you more aware of managing your time. I take part of the group and do some spelling and some real work with them while the others are gone. But, it is a little bit disruptive that they go twice a week--well, that means the entire group--half go one day and half the next. But, there are two periods of time there that it disrupts. But, I've worked around it and worked spelling drill into it which some of them need more help with exercises and things like that. So, you can look at it on the plus side also.

RULE

IF (schedule is problem)
 THEN (teacher plans time)
 and (teacher works-with groups)

But, until you had a computer for everyone it would be hard; you have to work out something because you're going to have to schedule it around some subject area.

RULE

IF (computer for each student)
 THEN not (schedule is problem)

Q. What do you think about having them in schools?

A. Well, I think that we can't turn our backs on them at all. They're here; they're part of our everyday. We're going to have to have them in schools. I do think by having them in elementary school is really going to help. When they get to junior high, they're going to have more skills than they realize. I think they're going to find that out in the near future. Because we've had computers two years, successfully, where every child goes through some kind of program here in the elementary school, fourth grade on up. By the time we send them to junior high they really have a great deal of computer skills. You'd be surprised, you know. There's a lot you have to reteach a little bit in the beginning. But, they have more advanced skills, and so that part would probably lend itself to the junior high doing even more sophisticated work with computers. And, I think we in elementary school tend to use it more in terms of curriculum or in ideas like, you know, more drill in math for the computer, and that sort of thing. In junior high, they could--I'm not sure I speak for what is really and truly going on, but they can do more work with teaching them how to program or do other things that are more advanced with the computer. They've got a general knowledge of it. I think it has a place in schools is what I'm saying, and I think to me personally in elementary school I see it as curriculum support.

RULE

IF (computer in elementary-school)
 THEN (computers support curriculum)
 and (students have computer-skills)
 and (students learn-to-write computer-programs next level)

Q. Different people feel differently about having them in schools?

A. I'm sure. I've heard a lot of negative, too. Because of--it's hard to replace that one on one instruction and eye contact and all that.

Q. One of the things that you mentioned as difficulty about having them is a question of what you do with the children that don't go, how you schedule it. Are there other difficulties that you foresee in--that you have seen, that come up, that you are

seeing, or that you foresee happening in terms of in their use in schools?

- A. Well, it's hard to say. As you know in our situation right now, I'm thinking in terms of the future, the sixth grade is fixing to move out of the elementary school and into the junior high. Now, I don't know how that's going to--we have not solved the problem of how we are going to use computers next year yet.

Q. Oh, good. Here's a good issue for you to talk about.

- A. I don't know the answer to that yet.

Q. I don't want you to--the thing is I'm not really interested in issues; I'm interested in you thinking aloud about some things that might come up next year.

- A. Alright, there we're going to have to deal with more people using the computers. We're going to have to find the time when computers are available, number one. But, still when Cedar Hill closes we're going to gain a few computers; so, it should work out a little better I hope as far as having a few more computers available. But, they do have computer classes that are set up in eighth grade seventh and eighth grade both at Jefferson as far as I know where computers are in use at a certain period of time definitely. And, we have to work around that which, you know, if everybody will work together on scheduling . . . (?) But, for instance, in our situation we have two teachers who are really interested in working with the computer, really enjoy it and would love to be a part of it. Part of our thinking has been we can rotate some of our classes around that. For instance, maybe in my teaching social studies--while I'm teaching social studies another group can be doing something with the computers, and we can still have feedback. If they're a part of our math group and if we want some extra support with certain things in math we can tell them what we want to do, but they can work in the computer room while we're teaching social studies or science and rotate it around maybe three classes where the student would have an opportunity to go. I don't know because some people see it as such an integral part of the classroom that they would like to just have easy access to it, you know, any time. I don't see that that would be possible with the numbers we're talking about of students. I think we're going to have to work together on it and have a time set up that students can use it. And probably, as a regular class as we have now, you know. I really don't know. It depends on the number of computers we have and how we can work our schedule. But, we do--there's one thing we definitely would like to solve. I don't know how we're going to go about

doing it, but we would love for that not to be a pull-out program where we have a fragmented part going to the computer room; some staying in. This seems to be an opportunity to clear that up by having it as a regular, as the junior high does presently, as a regular class. Maybe we can work it where it can be. Almost as a regular class and rotate that with social studies/science--something where we won't have the pull-out that we do now at the present time. Because that's really difficult for a teacher to deal with--a pull-out program. We have so many in the elementary school now. We have TACL going out; we have resource going out; we have some going to, let me think, music, band, strings; all of this, you know, constantly. And computer right now is a pull-out program which is another negative from the classroom teacher's standpoint, unless she's directly involved in the computer room--he or she.

RULE

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IF (grade in new-school)
    and (more computers available)
    and (computer-lab-time available)
    and (other-teachers want-to-teach computers)
THEN (teachers rotate classes)
    and (computers are regular class)
    and not (part-of-class stay in classroom)
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Q. Do you see any options about that? Let's talk about the elementary school set-up. Do you see any way of solving that problem?

A. To keep it from being pull-out?

Q. Yeah.

A. Not unless there were enough computers that they were in the classroom. You know, if I had computers over here where the study carrels are then I could send some students right after, for drill work, right after a skill class. That's the way I would like to use them as support for particular skills especially in light of trying to get them ready for Basic Skills test and any different way of presenting the material is helpful as long as you can present it in a different manner. So, to me using the computer that way is nice because students get tired of the material presented one way all the time. So, any time you can vary it, and they can benefit from it, it's important--drill work, particularly multiplication. I have a low math group that really needs it. So, if it were in the classroom, it would certainly be a lot easier. But, that's just not possible. Then again, you've got to worry about proper storage of material,

you know, the computer and all that. We're not air conditioned or anything around here so it's kind of hard for us to have a--you know, the available space. The room where they are stored now is air conditioned. And, you know, the disks and all that.

- Q. But, from your point of view as a teacher, it would be better if you could have them in your room?
- A. Yes, I think so. Because that would keep it from being--that's the only way right now to keep it from being a pull-out program in the elementary school.

RULE

IF (computers in classroom)
 and (students bored with subject)
 and (room appropriate-for computers)
 THEN (teacher use computers for drill)

Now, in the junior high setting, you may be able to work it around--rotate somewhat around--but there again, we're still carrying the same program to the junior high schools so it's going to require a lot of thinking and management, you know, as to how we can best--and we have given that a lot of thought. We haven't come up with the answer yet, but it's certainly something where we see an opportunity now to do something about it through working together. There has to be a way to make it more efficient use of our time without having it, you know, fragmented.

RULE

IF (grade in new-school)
 and (curriculum same)
 and (teachers work together)
 THEN (teacher change program)
 and (schedule better)

- Q. Let me cue into something you said. You said, "Right now which is something we could do . . ." I'm kind of making a leap of faith, and I probably shouldn't do this. Do you think that there is sort of critical moments when you can make changes?
- A. Yes, I think so. Because sometimes you're just locked-in to a situation, but when you are in the process as we are now of a major change taking the sixth grade out of the elementary school, certainly. You know, let's make it the best program

we can while we have the opportunity. Once we get there and if we carry the things we've been dissatisfied with and put them right back into the same setting we're not getting anywhere. But when we have an opportunity to change it then we need to take advantage of it.

RULE

IF not (teachers like something)
and (school-system changes)
THEN (change for better)

QUESTION 3 - HOW COULD ADMINISTRATION HELP OR HINDER YOU IN IMPLEMENTING YOUR SUGGESTIONS?

- Q. O.K. I thought that's what . . . I'm trying to keep my attention on the time, too. Are there ways that you think that the administration could help or hinder you in this process?
- A. Oh, there are numerous ways the administration could help. They--the administration ultimately sets the schedule, if you want to know the truth, on the special classes in our system--the band, the strings, all the pull-out programs, the times we have music, art. The sheet is handed to me that this is the way you're going to--you know, you may schedule your classes, your academic classes around the time--you have art at a certain time, because they have to look at the total school and best use the art teacher, the music teacher, all of that sort of thing. But administration has the opportunity to help schedule it to where it will benefit the classroom teacher, definitely. And I think, most of them are very aware of the problems we have and work as closely as they can getting feedback from teachers trying to see how it can be best used. I don't think there's an administrator that isn't aware of all the pull-out programs we have in elementary school and definitely wants to make the best situation possible. But, it's just, you know, wise use of personnel; you can't always do it.

RULE

IF (administration help)
THEN (plan schedule beneficial-to classroom-teacher)

- Q. Are there any other ways that they could help? Or that they do hinder?

- A. Well, hinder . . . I don't know if . . . being aware to me is the most important thing. Now, what they do with it after you tell them. I mean, they'll listen. The administrators tend to listen. In fact, on a system-wide committee I served on years ago this same problem was presented to Dr. (Name) on pull-out programs in the elementary school, particularly. It wasn't computers at that point, but it was the band and strings program. We hashed that out and never did find a solution that fit everyone. Except the administration did back the fact that they could not touch the skills area of math and language arts. They could take them out of social studies or English or something else, but not the "sacred skill" time. We got that much accomplished. Because up until that time, we didn't have--you know that could be touched also. But, parents became upset some of the ways that--some of the things their children were missing because of the pull-out program although it's a bonus and it's an optional thing, many children wanted--I mean, many parents wanted to provide their children with that opportunity. And, they knew that it was at a sacrifice to something that was going on in the classroom. But still, parents began to talk in PTA meetings and said, "Can't we have it a different way?" And, I think administration began to listen to some of the pressures from teachers and from parents that please if you're going to, you know, if we are going to have this wonderful opportunity for our children at times that do not interfere with the basic skill areas, the reading and math in particular. So, they have worked in light of that. But, there again you share your music teacher--goes from school to school. And you have to block times in each school. And, computers--back to them--are a little bit--we don't have a computer aide all the time. So, we have to work around that particular schedule also. But, administrators can help block in the times that they're in the building or the times that they're available. And sometimes it's a sacrifice to some grade levels. For instance, one time we had to have our skills in the afternoon--our reading and our math in the afternoon to accommodate some of the children being able to go to resource at that time, because of the total school scheduling problem. That was very difficult for me because all the research says the best time to teach skills is in the morning--memory retention everything, particularly math recall, and they're tired in the afternoon. It's very difficult to teach the strong skills that are so important for retention, everything to be successful with basic skills test. Now, that sort of thing I didn't like to have to do. I personally did not like that sacrifice, but I went along with it for two years. And then we decided to talk with the principal and say that we've given our time; let us change this for a while to be fair about it. Because we shared resource teachers with another school, and lots of different things that . . .

RULE

IF (administration plans schedule)
 and not (classroom-teachers like schedule)
 and (teachers pressure administration)
 and (parents pressure administration)
 THEN (administration listens)
 and (administration changes schedule)

But, you know, ultimately you want what's best for the students. You've got to find a way to work all of this--all these problems of scheduling--around what's best for the children. But there are ways system-wide committee where all teachers represented from every grade level meet with Dr. (Name) and discuss these problems. And, he tries to work because he gets back to the principals and makes them even more aware it is a system-wide problem, and we want to work on scheduling it. And, I think that's a real important thing to not sympathize and say, "Oh, you poor teacher I'm so sorry you have to put up with that." Don't do that. Talk about it. Go to the right people. Discuss it. Ask your peers. Ask the administrators to listen, you know, is there anything. You know, you don't have to be forceful; you just say, "This is a problem and we need to talk about it. We need to try to plan maybe in the future if not now we can do something to make the situation better for the student."

RULE

IF not (schedule best-for students)
 THEN (teacher tell school-system-committee)
 or (teacher tell central-office administrator)
 and (central-office-administrator talk-to principal)

QUESTION 4 - DESCRIBE AN INSERVICE PROGRAM ABOUT COMPUTERS THAT YOU WOULD DESIGN FOR YOURSELF.

- Q. I'm going to ask you to think about your current--the kinds of concerns you presently have about computers and about scheduling and about all that kind of thing. What kind of inservice program would you design for yourself about computers, if you were going to design one?
- A. Well, I've already been to a couple of workshops on just learning the terminology and how to basically use the computer. And some that reviewed some of the materials. For me as an elementary school teacher, I would like to go to some workshops that just really went through a wealth of material that I don't have time

to do in the classroom that I could preview and I could try to find what I thought was best to plug into some of my curriculum area. I don't have the desire to go very deep into computers. It's just not what I enjoy doing. But, I would love to find some strong materials that I could use and plug into the curriculum. You know, particularly I like to work with writing, and I like to work with . . . (Turn tape over) and that's what I'd like to do is find some things I could get excited about and maybe that would make my interest be even greater in using computers if I could really pick out some things that I thought were worthwhile to the children. There are; I'm not saying there aren't. I just meant, you know, some different things. The time--you just don't have the time; that's one of the biggest problems--finding the time to sit down during the day with a limited number of computers and try to go through materials--every time I have a short break or something it's spent with routine things just trying to clear the desk. Get some of the papers stacked to take home that night to grade just get them in the right order, so I can pick them up when I need to go and plan ahead what I'm going to do tomorrow and the time flies--you don't have time the computers are either in use or you just don't have time to go and sit and go through whatever's available. Many times you have to rely on the judgement of someone who says, "Hey, this is good and you need to look at it and that sort of thing."

RULE

IF (teacher knows computer-operation)
 THEN (teacher wants time)
 and (teacher wants computer available)
 and (teacher preview software appropriate-for curriculum)
 and (teacher develop interest in computers)

Q. I really appreciate your taking the time . . .

VITA

Sarah Elizabeth Jacob was born in Philadelphia, Pennsylvania on August 19, 1936. She attended elementary schools in Media and Swarthmore. Later she went to Westtown School. In September, 1952, she entered Shimer College as a Ford Foundation Fellow. She graduated with a Bachelor of Arts in June, 1955.

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