An Organizational Learning Approach to Information Systems Development

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Abstract

Information generated from communications between users and analysts forms the basis for information systems development and is therefore a major determinant of success. This research investigates the effectiveness of these user/analyst interactions. Tape recordings of user/analyst communications during systems development are used to analyze traditional interaction methods. An alternative "organizational learning" interaction methodology is developed based on the Argyris and Schon organizational learning theory. Finally, this new methodology is used by a group of professionals involved in systems projects and again evaluated based on tape recordings of their user/analyst communications. Results show that traditional user/analyst interactions display primarily error-prone characteristics, and that the new interaction methodology successfully generated more valid information with increased detection of errors.

Keywords: Information systems, systems development, organizational learning, user interface, communication.

ACM Category Numbers: D.2.2, H.1.2, K.4.3, K.6.0, K.6.1

Introduction

The importance of user involvement in information systems (IS) efforts is widely accepted by both researchers and practitioners. Ives and Olsėn [15] describe the perception of the importance of user involvement as "almost axiomatic" in their recent review of the literature that links MIS success with user involvement. Key to this user involvement is the user/analyst interface. This is the point where user knowledge (functional task and problem definition) and analyst knowledge (IS techniques, trade-offs and constraints) must interact effectively in order to implement a system that meets user needs. Here, user objectives, assumptions, strategies, actions, errors, problems, attitudes, etc., should surface so they can be explicitly considered in the system design and implementation processes. Acknowledging this, modern systems development practices and methodologies make increasing use of user/analyst interactions through interviews, work groups, review sessions, etc.

With so many decisions and resources resting on the user/analyst interface it is increasingly important that we fully understand what occurs during user/analyst interactions and how that impacts the resulting systems. A survey of the current information systems literature reveals only rudimentary knowledge in this area, and what information we do have gives cause for concern. Empirical evidence suggests that the quality of interaction is a key factor in determining system outcomes [6, 12, 16, 18] and several works further describe how these interaction and communication processes can be major error sources [1, 7, 22]. A few systems methodologies and proposals have also attempted to address user/analyst interaction processes generally [6, 8, 11, 14, 17]. However, there are, as yet, no operational methods available to help analysts consistently elicit high quality, valid information in their everyday user/analyst communications during all phases of systems development. Given this backdrop, the thrust of this study is twofold. First, to determine the characteristics of actual user/analyst interactions in real IS situations, and to analyze how these interactions inhibit the generation of the quality information needed for systems work. Second, to create an alternative user/analyst interaction process that allows significantly more valid information (problems, assumptions, actions, etc.) to be identified such that it facilitates systems development in a positive direction.

These questions can be fruitfully examined from an organizational behavior perspective using the Argyris and Schon [2, 3] theories of individual action and organizational learning. While there are a number of competing theories that attempt to explain organizational behavior, the Argyris and Schon theory can actually be operationalized in a systems environment and offers a starting point for understanding explicitly how some errors may be built into our information systems.

Their research has shown that the underlying values that govern our thinking and interactions are generally dysfunctional, generating error-prone information, and translating into ineffective personal and organizational action. This normal mode of operation is termed Model 1. They propose a new set of underlying values that, if learned, can facilitate the generation of higher quality information and more effective personal and organizational action (termed Model 2).

This study operationalizes their theory and applies it specifically to the IS environment. The Argyris and Schon theory is first used as a basis for developing a detailed framework for distinguishing Model 1 (error-prone) from Model 2 (error-detecting) user/analyst interactions. Then, an intervention in the form of a course for systems professionals is conducted. At the beginning of the course, these users and analysts collect actual tape recordings and case write-ups of their own user/analyst interactions occurring in their organizations. This data is analyzed in terms of the framework to test the prediction that traditional user/analyst interactions display primarily Model 1 characteristics. The participants then learn and practice an alternative "organizational learning" methodology developed from the Model 2 portion of the framework. At the end of the course, students again collect tape recordings of their actual user/analyst interactions and these are analyzed to determine whether the "organizational learning" methodology produced new interaction patterns and what impact it had on detection and correction of errors.

Theory of Action

The basic building block of the Argyris and Schon theory is the idea that all individuals need to become competent in taking action and simultaneously reflecting on this action to learn from it. They define a "theory of action" as a theory of deliberate human behavior which takes the form: "In situation S, if you want to achieve consequence C, under assumptions $a^1 \ldots a^n$, then do A." They further differentiate between two types of theories of action—theories-in-use (those that actually govern our behavior) and espoused theories (those we state verbally, but may or may not be reflected in our behavior). Theories-in-use can be constructed only from direct observation of the person's behavior. Argyris and Schon see these theories as similar to scientific hypotheses; they may or may not be accurate and must be tested.

Argyris and Schon stress that individual action critical to organizational success must be studied in terms of our actual theories-in-use, instead of espoused theory as is so often done. Specifically, they have conducted extensive studies to determine the governing variables that determine our thinking, the resulting individual actions, and the organizational consequences. These studies have led them to propose that individuals predominantly use an error-prone Model 1 theory.

In Model 1, there are four governing variables (or values) that determine our action: achieving goals; maximizing wins/minimizing losses; minimizing expression of negative feelings; and being rational. These governing variables result in individual action strategies focused on obtaining control over tasks and unilateral protection of oneself. This often causes individuals to act defensively and keep information private in order to control outcomes. In such situations, errors in personal theories-in-use are not easily surfaced, tested and disconfirmed, and overall learning is inhibited.

Argyris and Schon then recommend an alternative Model 2 theory-in-use designed to enhance individual and organizational learning. In Model 2, a new set of governing variables (values) are used that facilitate learning: valid information; free and informed choice; and internal commitment. These governing variables result in individual action strategies that are designed to actively test personal theories-in-use, establish joint control of tasks, and protect both self and others in a growth-oriented manner. This decreases defensiveness, leads individuals to intentionally generate information that might disconfirm theories-in-use, and increases overall learning.

It should be noted that Model 1 is not "bad" and Model 2 "good." For example, Model 1 is likely to be more efficient in dealing with routine problems where effective corrective responses are already well-established or under crisis conditions where decisiveness and speed of response are top priorities. However, Argyris and Schon have found that we use Model 1 almost exclusively, and in one study in particular [1] they observed that an MS/OR implementation team acted in Model 1 ways that inhibited effective problem solving. Based on further research [2], Argyris and Schon suggest that a Model 2 approach would be more effective in many of these situations. Examples include cases where there is a recurring problem that Model 1 does not seem to be solving, where there are conditions of dependence on others, or where extensive cooperation is required.

Applied to IS

The first step in applying the theory to IS is to develop a general view of systems development from the perspective of Model 1 and Model 2 (Table 1). A Model 1 scenario predicts an overall error-prone development process, where Model 1 governing variables translate into verbal actions that use or advocate one's own ideas rather than intentionally seek out new information to test the validity of one's own ideas. Such actions are not designed to challenge or disconfirm our ideas, values and norms so that we may engage in significant learning. For example, if an analyst does not value and therefore avoids conflict with users, this might cause the analyst to avoid difficult but important users and implement a system without their involvement and/or delay the project by postponing difficult problems. Both of these behaviors are extremely common and problematic in systems development efforts.

Given this type of thinking and behavior, Argyris and Schon predict a high likelihood of generating poor quality information (i.e., inadequate, uncertain and inaccessible). This poor information then becomes input to system design and implementation and the end result will be an ineffective information system leading to ineffective organizational action. The Model 2 scenario is designed to help eliminate the sources of error inherent in our traditional Model 1 development process. In the systems example above, an analyst would value most the generation of valid information required to build an organizationally successful system. He or she would seek out users with conflicting views and attempt to understand the differences, and explicitly identify and tackle areas where problem resolution could be time consuming and significantly impact the project schedule or design. The primary focus is on generating and testing information so that errors can be detected and corrected before they negatively impact systems processes and products. The resulting systems should more fully support organizations.

Complicating this overall Model 1 development process is the frequent lack of congruence between espoused theory and theory-in-use. If users are specifying requirements based on their espoused theories (e.g., requesting special exception reports so they can correct errors and ensure the integrity of their data), analysts will then build the systems according to these espoused specifications. Later, when the system is installed, it will be used based on the user's actual theory-in-use (e.g., users still don't find time to correct the errors and the data quality remains poor) and the familiar complaint "the system doesn't meet user needs" is likely to be heard. Of course, this lack of congruence can be found on the other side also. Analysts may give users their espoused theory of how they are going to build the system (e.g., describe planning process) and then proceed to build the system based on their actual theory-in-use (e.g., planning is put off in favor of more interesting technical work). This is likely to result in familiar cost and schedule overruns.

The Study

This overall theory of action view of IS development gives rise to the two general hypotheses to be tested in this study. First, that

Table 1. General Framework for Distinguishing Between Model 1 and Model 2 Information Systems Development

Governing Variables	User/Analyst Thinking	User/Analyst Verbal Patterns	Information Generated for IS	Information System
Model 1				
• Define goals and try to achieve them • Maximize winning and minimize losing • Minimize generating or expressing negative feelings • Be rational	• Consider others/environment as origin of problems • Strategies to unilaterally control tasks and environment • Strategies to unilaterally protect self and others	• Loaded inquiry • Advocacy without data or testing • Confront others • Hold theories private	• Inadequate -Bad assumptions -Unresolved differences in views, theories -Incorrect data • Obscure/uncertain -Excessive/sparse -Vague/ambiguous -Not testable • Inaccessible -Unintentionally withheld -Intentionally withheld -Scattered	• Technical/functional errors built in • Supports limited organizational learning (detection and correction of errors required to remain responsive to environmental change) • High cost/benefit ratio • Installation delays
Model 2				
• Valid information • Internal commitment • Free and informed choice	• Consider own role as origin of problems • Strategies to jointly control tasks and environment • Strategies to bilaterally protect self and others • Design situations where people can originate action	• Pure inquiry • Advocacy with data and testing • Make self confrontable/giving others choice to be confrontable • Discuss and test private theories publicly	• Adequate -Valid assumptions -Differing views and theories resolved -Accurate data • Certain -Pruned/enriched -Defined/clear -Tested/validated • Accessible -Surfaced -Discussed -Consolidated	• Technical/functional errors detected and corrected • Fully supports organizational learnings • Low cost/benefit ratio • Installation schedules met

current IS development interactions will display primarily Model 1 error-prone characteristics. Second, that it is possible to create and teach an alternative user/analyst interaction methodology based on Model 2 values that will allow generation of more valid information. In order to develop operational hypotheses and actually create the alternative "organizational learning" interaction methodology, a detailed specification of Model 1 and Model 2 communication must be developed.

Framework for distinguishing between model 1 and model 2

A detailed interaction methodology tailored to IS development was created by synthesizing the information presented by Argyris and Schon and packaging it into six interaction components (causal thinking, strategic thinking, and four verbal interaction components—advocacy, inquiry, confrontability, discussability) that could be studied modularly. For each component, guidelines and examples were given for identifying Model 1 error-prone patterns and redesigning them into Model 2 error-detecting patterns. This work resulted in a comprehensive framework for distinguishing between Model 1 and Model 2 which provided the basis for the intervention, the operating hypotheses, and the coding structures required for data analysis. Each framework component is discussed briefly below, and illustrative examples are given in Tables 2, 3 and 4. The operating hypotheses (H1-H24) derived from this framework are also noted and summarized in Tables 6 and 7.

Causal Thinking (Table 2). In Model 1, problems and situations are most often identified as caused by another person and/or the external environment. There is little identification of how one's own behavior may be problematic or impact the situation in a negative way. This is a powerless position as it requires something or someone outside of oneself to change if a situation is to be corrected. In contrast, Model 2 calls for intentional evaluation of how one's own thoughts and actions impact situations, so that one can generate new, more effective actions. The Argyris and Schon theory applied to IS predicts that current user/analyst causal thinking is predominantly Model 1 (H1).

Strategic Thinking (Table 3). Model 1 strategies identify what must happen in the environment or what one must do unilaterally to ensure that one's own goals are satisfied. Model 2 strategic thinking is very different as it is based on the premise of joint control rather than unilateral control. Attention is focused on what must happen to resolve goal incompatibilities and satisfy other's as well as ones own goals. This results in an emphasis on generating valid information to understand goals and causes so that errors in thinking can be detected and corrected before action is taken. The Argyris and Schon theory applied to IS predicts that current user/analyst strategic thinking is predominantly Model 1 (H2).

Verbal Interaction Patterns (Table 4). Verbal communication reflects our causal thinking and strategies. The Argyris and Schon theory applied to IS predicts that current user/analyst verbal interactions are predominantly Model 1 and result in verbal communication patterns that camouflage and perpetuate errors. In contrast, Model 2 theories of action increase the occurrence of verbal patterns designed to continue addressing a relevant topic (H23) until ideas can be actively confirmed (H21) or disconfirmed (H22) so that errors can be surfaced and corrected before systems installation. These verbal patterns are subdivided into the four components below.

Advocacy. Advocacy (to support publicly, defend a position, idea or action) characterizes most of the verbal action most people produce most of the time (H3). In Model 1, advocacy is used to facilitate unilateral control. The assumption is that others will be more committed to decisions if you give them only the information that supports your position and withhold all other information. The form of Model 1 advocacy is to publicly state a position *without* giving data (something that can be seen, heard, or touched in a straightforward way), or specific examples that can be disconfirmed (H4) and *without* inviting inquiry to test the validity of the position (H5). Paradoxically, these behaviors tend to minimize commitment to decisions made by others and keep errors in thinking from being detected. A Model 2 view states that advocacy is most effec-

Table 2. Distinguishing Between Model 1 and Model 2 Causal Thinking

Model 1 (Error-Prone)		Model 2 (Error-Detecting)	
Characteristics	*Examples*	*Characteristics*	*Examples*
1. Occasionally identifies self as a cause of the problem, but not as an origin of problematic behavior. To the extent self is involved, self's behavior is:		1. Identifies self as a cause of the problem and origin of problematic behavior (thoughts, feelings and actions).	"I designed the software without taking the time to inquire about planned and/or likely changes in the user offices."
a. A logical result of factors outside self's control.	"My specs were bad as the user didn't represent their needs accurately."		
b. Intentionally created for the larger good (not problematic when viewed from a larger perspective).	"I caused user problems by pushing for the documentation we must have if we are to maintain the systems. Someone has to."		
c. Attributed to a larger group that is at fault, of which self is a small part.	"The system our group is responsible for does not accommodate user reporting and tracking."		
2. Does not identify the negative impact of self's problematic behavior (thoughts, feelings and actions).		2. Does identify the negative impact of self's problematic behavior (thoughts, feelings and actions).	"When the change came about, I could not fix the software in time and the users had to work overtime. I have lost some credibility and the users are disgruntled."
3. Identifies other person(s) or the environment as the cause of the problem and origin of the problematic behavior.	"A change in the user's process caused the software to no longer be functional."	3. Identifies other person(s) or the environment's actions that trigger self's problematic behavior (thoughts, feelings and actions).	"I felt under pressure and overworked when I built the system, and when that happens I avoid adding any extra work such as asking users to think about future needs."

Table 3. Distinguishing Between Model 1 and Model 2 Strategic Thinking

Model 1 (Error-Prone)		Model 2 (Error-Detecting)	
Characteristics	*Examples*	*Characteristics*	*Examples*
1. Identifies actions necessary to meet own goals by:	"My goal is to have everyone doing good project planning."	1. Identifies actions necessary to meet ones goals by one's self, giving others as much freedom of choice as possible.	"I need to create a planning process that supports many types of projects and work styles."
a. Others or the environment.	"Project leaders must make time to keep their plans up-to-date."		
b. Self by controlling the situation.	"I have to make them realize planning is important and a job requirement."		
2. Occasionally identifies actions necessary to meet others' goals by others or the environment.		2. Identifies actions necessary to meet others' goals by self.	"I first need to understand their real planning needs and the problems they have with the current planning system."
3. Does not identify goal incompatibilities and necessary areas of cooperation between self and others to resolve goal incompatibilities.		3. Identifies goal incompatibilities and necessary areas of cooperation between self and others to resolve goal incompatibilities.	"I want quality planning and tracking, but the project leaders want to avoid administrative burdens."
4. Does not identify sources of error in behavior (thoughts, feelings and actions) that self needs to surface and generate information about.		4. Does identify sources of error in behavior (thoughts, feelings and actions) that self needs to surface and generate information about:	"I need to test my assumptions (i.e., they only plan when I push), find out what I do that undermines and/or encourages internal commitment to planning, and investigate the dis-

continued

Model 1 (Error-Prone)		Model 2 (Error-Detecting)	
Characteristics	*Examples*	*Characteristics*	*Examples*
		a. Untested assumptions. b. Information withheld by self or others that would be useful to solving the problems. c. Discrepancies between espoused theory and theory-in-use. d. Inconsistencies in views, goals or other information. e. Information gaps.	crepancy between what we say (planning is critical) and what we do (consistently put it off)."

Table 4. Distinguishing Between Model 1 and Model 2 Verbal Interaction Patterns

Model 1 (Error-Prone)		Model 2 (Error-Detecting)	
Characteristics	*Examples*	*Characteristics*	*Examples*
1. Advocacy—without directly observable data or inquiry	"It's critical that the Controller support the project, and I think she does."	1. Advocacy—with both directly observable data and inquiry	"It's critical that the Controller support the project and I think she does. She has assigned a full time person and set up monthly status meetings. What do you think?"
2. Inquiry—loaded	"What's wrong with the report? The grand total is off?"	2. Inquiry—open ended	"What's wrong with the report?"

continued

Table 4. Distinguishing Between Model 1 and Model 2 Verbal Interaction Patterns **continued**

Model 1 (Error-Prone)		Model 2 (Error-Detecting)	
Characteristics	*Examples*	*Characteristics*	*Examples*
Inquiry—inferential	"How stable is your department?"	Inquiry—grounded in data.	"Terminals cost $200 to relocate. How often does your department move?"
		Inquiry—testing	"I understood you to say the data elements are deleted. Is that right?"
3. Confrontability—confront others about their actions	"You didn't resolve the errors on the edit list this week as you were supposed to."	3. Confrontability—make self confrontable	"I tend to get overly nervous near deadlines, and may be too concerned about the unresolved errors. Could you tell me what's involved in correcting them, and what problems you're having?"
Confrontability—make demands of others	"You have to show me your procedure today."	Confrontability—express preferences giving others choices	"My design is due this week and it would be best if you would show me your precedure today. If not, I'm sure we can work something out."
4. Discussability—relevant thoughts held private	Thinks: We can't afford another installation delay. Says: "We can use the system without documentation—it's not very important	4. Discussability—relevant thoughts discussed publicly	Thinks: We can't afford another installation delay. Says: "I'm concerned documentation will cause another delay we can't afford. The schedule is already very tight without including documentation."

tive when there is confrontation and learning and all relevant information is shared publicly. In Model 2, advocacy is backed up by directly observable data (H14) or at least a specific example (H13) that can be disconfirmed, as well as inquiry designed to test the advocacy (H12). This makes the advocacy publicly disconfirmable and results in a much higher likelihood that an error in thinking will be detected and corrected.

Inquiry. Inquiry (to seek knowledge, examine or investigate) is an attempt to encourage the generation of valid information. In Model 1, the governing variables inhibit the extent and spirit of inquiry. A strategy of unilateral control implies that inquiry be presented in such a way that the answers are implied in the question so that they are more likely to agree with the predetermined answers in the mind of the inquirer (H6). Further, where error-detecting inquiry is used, it will be used to gather information, rather than actually test existing information for errors (H7). In Model 2, the use of inquiry is intentionally increased (H15) and the focus is on clear open inquiry to discover the meanings attributed to actions, inferences, assumptions and evaluations (H16), rather than to reinforce ideas already established (H17). Also, with more questions asked by users and analysts practicing Model 2, others should be encouraged to provide more data and specific examples in response to such inquiry (H24).

Confrontability. The manner of presentation used in challenging ideas has a significant impact on the resulting information generated. Confrontation is key to detecting errors in our theories, assumptions, ideas, proposals, etc. In Model 1, this is done by confronting another person's actions, ideas or feelings (H8). Confronting others by challenging the validity of their positions tends to elicit a defensive response and keep important information from being volunteered. One way of generating more valid information (although much more difficult) is to make oneself confrontable instead (H18). This requires that one identify his or her own personal responsibility in the situation and discuss this publicly in order to create a less threatening environment for other people's responses. Requesting information or action from another person can also be done in either a confronting or nonconfronting manner. A Model 1 approach makes demands of others (H9), whereas in a Model 2 approach, one expresses preferences and ensures others the opportunity to suggest alternatives and make choices (H19).

Discussability. This refers to identifying and publicly discussing those thoughts that are most relevant to solving a problem. A steady flow of thoughts, feelings, theories, assumptions, etc., exist in one's head and manifest in one's actions both directly and indirectly. In Model 1, the unilateral control strategy causes many such thoughts to be kept private (H10), especially those of an interpersonal nature (H11). Errors in these private thoughts cannot be easily detected and corrected. In Model 2, a conscious effort is made to identify such thoughts, feelings, assumptions, theories, etc. and state them publicly so they can be challenged by others. An increase in interpersonal topics should also follow (H20). This allows theories to be frequently added, updated, or deleted, and facilitates creative, lasting solutions to problems.

Research setting and design

Since learning Model 2 in an IS context was expected to be extremely difficult [2], a research strategy was needed that would maximize chances of subjects internalizing Model 2 skills and values. First, an action research approach was used so that an intervention could be initially designed, but actively improved during the experiment to take advantage of instructor and/or student insights. Second, the traditional teaching method used by Argyris and Schon (highly unstructured and lengthy) had to be modified to fit within the typical systems learning environment (highly structured, explicit, and not extended over a long period of time). The intervention took the form of a two part course, Creating an Effective User/Analyst Interface [19], offered to professionals involved in real systems projects. The full course lasted 6 months, each part meeting 2 hours weekly for a period of 3 months. The class sessions were therefore structured to include: lectures from the course text [2]; discussion of the framework for distinguishing between Model 1 and Model 2; role modeling of Model 2 interactions by the instructors; student practice of the Model 2 basic skill components defined in the framework; analysis of Model 1 and Model 2 behavior found in the user/analyst interactions taped by students on their jobs; and discussion of student observations during their Model 2 practice in actual work situations.

Course materials [19] are extensive and available from the author upon request. The instructors were the author and Don Rossmoore, a professional consultant in the Argyris and Schon action theory. One class given at UCLA began with 30 professionals from 12 different organizations, and 9 participants continued through part 2. Another class, given onsite at Hughes Aircraft, began with 18 professionals and ended after part 1 due to problems within the organization not attributable to the study.

The specific research design was pre-experimental (one group pre-test, post-test). At the beginning of the course, each participant tape recorded one of their own user/analyst sessions in their own organization (first pre-test measure). This provided first order data about traditional user/analyst communications so that actual, rather than espoused, behavior could be studied.

Several 5-minute segments from each tape were transcribed, based on a modified random selection scheme. In addition to random selection, segments were selected where the students felt they had been especially effective in their interactions as well as where they felt they had been especially ineffective. This was done so that the Argyris and Schon prediction—that people use Model 1 even when they think they are being effective—could later be tested. Students also prepared a written case study about another user/analyst interaction where they described their thinking (causes of problems, goal and strategies) as well as reconstructed the dialog that occurred during the interaction (second pre-test measure). This case format has previously been used by Argyris and Schon [4] and is based on research on patterns of thought in the philosophy [21] and psychology [24] disciplines.

At the end of the course participants again collected a direct sample of their behavior—another tape recording of their user/analyst interactions in their own organization (post-test measure). Randomly selected five-minute tape segments were also transcribed from these final tapes. A final written case study was not used as a post-test measure as students used cases as aids to learn Model 2 throughout the course and a testing bias might have been introduced.

Given the pre-experimental design, two issues related to validity were carefully considered. First, can the threats of maturation, history, multiple treatment interferences and/or the Hawthorne effect invalidate the results? Previous work by Argyris and Schon [4] gives overwhelming evidence that these potential threats are minimal for the Model 2 intervention process. Indeed, they have educated people about Model 2 and had them actually try to design Model 2 behaviors, and still people continue to automatically produce Model 1 actions until they actually practice Model 2 skills for a period of time. In addition, if pre-test results of users and analysts who have years of experience do not show Model 2 behavior, then it seems very unlikely that an event or normal individual growth will cause Model 2 behavior to naturally emerge over this 6 month intervention. Since these threats have not proven significant in past research, this study can use the one group, pre-test, post-test design and take advantage of its strengths. Specifically, the pre-test and post-test on the same group allows comparisons of performance by the same group, as well as controlling for selection and differential mortality.

The second issue concerns generalizability. With respect to the first general hypothesis—that current systems development occurs within an environment demonstrated by Model 1—there seems to be no strong reason that findings cannot be generalized across systems analysts, systems applications and organizations (see Table 5 for profile of respondents). However, one cannot similarly generalize about the process and product of Model 2 training. Due to a high mortality rate,

Table 5. Participant Profile

Variable	Value	Initial (n = 48)	Final (n = 9)
Number of Organizations		9	6
Sex	Female	25	6
	Male	23	3
Ethnicity	Caucasian	42	7
	Other	6	2
Age	20–29	14	3
	30–39	19	4
	50 and over	15	2
Education	Less than Bachelor	10	2
	Bachelor	24	2
	Advanced Degree	14	5
User/Analyst Role	Users	8	3
	Analysts	40	6
Position	Supervisor/Manager	18	4
	Non-Supervisorial	27	4
	Consultant	3	1
Years of User/Analyst Interactions	Mean	7.8	4.5
	Std. Dev.	6.5	5.3

the final sample size was very small—only nine students were measured after the intervention. It is likely that a strong selection process determined which students finished. Specifically, those who finished were highly motivated to improve their verbal interactions, and had higher educational levels. In addition, other factors such as psychological types, cognitive styles, human information processing abilities, etc., not measured in this study might also account for mortality and/or the facility to learn Model 2 skills.

Analysis

A coding scheme for content analysis was developed to distinguish between Model 1 and Model 2 communication so that the tape transcripts and case write-ups could be analyzed. Initial coding schemes were developed (i.e., loaded inquiry was coded L, inferential inquiry I, etc.) and then subjected to an evolutionary process to ensure they were exhaustive, mutually exclusive, and that instructions were adequate to ensure interrater agreement. Cohen's K [9] was selected as the appropriate statistic to check interrater agreement as it handles nominally scaled data and gives a measure of agreement after chance agreement has been removed from consideration. The researcher and two independent raters then coded the data. The guideline of 80% agreement was met in most instances. An agreement of slightly less than 80% was allowed for very low frequency behavior. In these cases, the chance agreement is very high and a single disagreement between raters can bring Cohen's K to less than 80%. The coding schemes were also used to construct the dependent variables so that the operating hypotheses (Tables 6, 7) could be tested.

Results & Discussion

Traditional interaction process

The results of testing hypotheses about traditional user/analyst interactions are presented in Table 6. While Argyris and Schon report

Table 6. The Traditional Interaction Process

Operating Hypothesis	Case Scenarios (n = 48)*			Tape Transcripts (n = 9)		
	Mean	Std Dev	Confidence Interval	Mean	Std Dev	Confidence Interval
Traditional interactions display primarily:						
H1: Model 1 causal thinking patterns.	90.2	21.1	84.9–95.6		Not applicable	
H2: Model 1 strategic thinking patterns.	88.4	17.8	83.7–93.1		Not applicable	
H3: Advocacy rather than inquiry patterns.	66.6	26.6	60.2–73.0	76.0	16.3	71.5–80.5
H4: Model 1 advocacy patterns not including specifics or data.	81.4	28.7	74.4–88.4	81.2	12.9	77.7–84.7
H5: Model 1 advocacy patterns not including specifics, data or inquiry	98.8	5.4	97.5–100.0	96.7	4.7	95.4–98.0
H6: Model 1 inquiry patterns (loaded and inferential inquiry).	49.8	35.4	39.7–59.9	74.2	23.2	67.6–80.8
H7: Model 2 error-detecting inquiry patterns that generate new information (open ended, grounded inquiry) rather than disconfirm existing information (testing inquiry).	98.2	9.4	95.2–100.0	89.1	19.7	82.2–96.0
H8: Model 1 confrontability patterns about negative impacts (confronting others about their actions).	–	–	–	–	–	–
H9: Model 1 confrontability patterns about requests (make demands of others).	100.0	0.0	100.0–100.0	94.1	24.3	83.8–100.0
H10: Model 1 discussability patterns (relevant thoughts held private).	87.2	25.1	80.8–93.6		Not applicable	
H11: Topics discussed that are not interpersonal (not about communication, human interaction process or human factors).	95.3	16.1	91.4–99.2	95.4	17.4	90.6–100.0

* Figures are given in percentages and the confidence intervals are based on the T distribution with p = .05

Table 7. The Organizational Learning Interaction Process

Operating Hypothesis	Ties	−Ranks/ Mean	+Ranks/ Mean	Z	Sign Level (1 Tail)
Organizational learning interactions are significantly greater than traditional interactions in:					
H12: Percentage of Model 2 advocacy patterns (includes both data and inquiry).	3	2/2.00	4/4.25	−1.36	.086
H13: Percentage of advocacy patterns with specifics.	1	2/3.00	6/5.00	−1.68	.047*
H14: Percentage of advocacy patterns with data.	0	1/4.00	8/5.13	−2.19	.014*
H15: Percentage of inquiry patterns.	0	1/4.00	8/5.13	−2.19	.014*
H16: Percentage of Model 2 inquiry patterns (open ended, grounded in data, and testing inquiry).	0	1/1.00	8/5.50	−2.55	.006*
H17: Percentage of Model 2 inquiry patterns for testing (testing inquiry).	1	0/0.00	8/4.50	−2.52	.006*
H18: Percentage of Model 2 confrontability patterns about negative impact (make self confrontable).	7	0/0.00	2/1.50	−1.34	.090
H19: Percentage of Model 2 confrontability patterns about requests (express preferences, giving choice).	8	0/0.00	1/1.00	−1.00	.156
H20: Percentage of interpersonal topics discussed.	6	1/3.00	2/1.50	0.0	1.000
H21: Percentage of active confirmation patterns (confirming another person's advocacy giving data/specifics as proof).	2	3/2.00	4/5.50	−1.35	.088
H22: Percentage of active disconfirmation patterns (disconfirming another person's advocacy giving data/specifics as proof).	1	2/3.00	6/5.00	−1.68	.047*
H23: Percentage of patterns directly continuing the topic just previously discussed.	0	2/2.50	2/2.50	−2.07	.019*

continued

Table 7. The Organizational Learning Interaction Process continued

Operating Hypothesis	Ties	− Ranks/ Mean	+ Ranks/ Mean	Z	Sign Level (1 Tail)
H24: Percentage of advocacy patterns with specifics or data displayed by persons not trained in the organizational learning method.	0	1/2.00	8/5.38	− 2.42	.008*

(n = 9 matching initial and final tape transcripts)
* significant at p = .05 or less.

that organizational behavior is overwhelmingly Model 1, there are no constants proposed for testing this theory specifically (i.e., "90% of all thinking and verbal patterns are Model 1"). Thus, to gain an overall sense of the extent of Model 1 patterns, a confidence interval was constructed around the sample mean for each of the hypotheses. Overall, the figures show solid support for the existence of an error-prone Model 1 systems development environment. While this is evident from a review of the table, the following points are of special note.

Both cases and tapes showed that advocacy was not often combined with specifics or data (H4). Of all communications intended to advocate ideas, explain processes, answer questions, etc., only about one-fifth made any mention of a specific example or included data. This is compounded by the fact that a typical discourse (one person speaking without interruption) intended for advocacy included several advocacy statements. This sparseness of specifics and data raises interesting questions. Since a great deal of detailed information (data and specifics) is purportedly required to construct systems, where is this data coming from? Is it being generated in user/analyst sessions, but at a very slow and inefficient rate? Are systems builders obtaining their data primarily through other vehicles? Or are systems being built without as much explicit specification of data as we generally think?

The overall focus on advocacy without inquiry is thematic in current interaction data. In describing strategies the most common approach was advocating an explicit course of action designed to bring about a specified outcome (H2). This is in contrast to the Model 2 strategy of identifying error sources in one's own understanding and proposing action to generate valid information before a solution is specified. Only one-fourth of user/analyst discourses contain any inquiry (H3), and about half of this inquiry is error-prone Model 1 (H6). These results imply that systems analysts are likely to be building many of their untested ideas, assumptions and understandings into their work. Likewise, users are probably not ensuring that systems folk are accurately understanding their needs and faithfully representing them in finished systems.

Interesting differences are apparent between participants' reports of their behavior (case write-ups) and their actual behavior (tape transcripts). Actual behavior from tapes showed a significantly higher percentage of advocacy patterns (H3) than case write-ups ($p = .04$). Tapes also showed a higher percentage of error-prone Model 1 inquiry (H6) than cases ($p = .001$). Note that the standard deviations are smaller for the tapes than for the cases, indicating more consistent behavior in actual tapes than in reported case dialogues. The differences between cases and tapes may be due to the fact that systems professionals are trained as to the importance of good inquiry. This is likely to be better reflected when mentally reconstructing a dialog for a case write-up, than when actually communicating with users or analysts. If so, this gives additional credence to the systems implications of the Argyris and Schon theory. Namely, analysts and users are espousing different behaviors than they are actually performing and these discrepancies are likely to be built into their information systems and remain undetected until systems are actually used.

The analysis of cases implies that many thoughts potentially relevant to effective solutions were not surfaced and/or discussed (H10). This, combined with the fact that interpersonal issues (topics about communication, human interaction processes, and human factors) are not frequently discussed (H11), has major implications for the overall quality of systems solutions. If interpersonal, political and social issues are critical to successful systems, as the literature increasingly suggests, then keeping information about these issues hidden may be a major contributing factor to ineffective systems.

Hypotheses about the organizational learning interaction process

The results of testing hypotheses about the new organizational learning user/analyst interaction methodology are presented in Table 7. Interaction patterns from the initial and final tapes are compared for each of the nine participants who completed the course. The Wilcoxin matched pairs test was chosen as a conservative nonparametric statistic since the assumptions necessary for the T-test were questionable for this data. The first set of hypotheses (H12 thru H20) test the success of the intervention (i.e., were students able to demonstrate their new Model 2 based skills). The second set of hypotheses (H21 to H24) test the impact of the organizational learning interaction process on the user/analyst session as whole. While students' final data was generally improved over their initial data, the following specific comments are of interest.

Students showed improvement in all areas related to inquiry. The percentage of inquiry (H15), of error-detecting Model 2 inquiry (H16) and of inquiry for testing (H17) all showed significant increases (null hypotheses rejected at $p = .01$). Such results may indicate that the inquiry component of Model 2 is one of the easier to learn and/or that systems professionals are more keyed to inquiry and internalize this skill more quickly than other skills. In any case, it is extremely encouraging, as the spirit of inquiry (found so lacking in traditional interactions) is well recognized, both theoretically and practically, as a key to effective systems development.

It appears that students also learned to produce more directly observable data and specific examples in their interactions (H13, H14 significant at $p = .047$, $.014$) but were unable to consistently put this data together with advocacy and inquiry (as a package) to create a significantly increased number of full Model 2 advocacy patterns (H12 not significant). It may be that the learning process had reached the point where students were gaining competence with the individual components (specifics, data and inquiry), but had not yet mastered combining these components on the spot in their user/analyst sessions. Measures would have to be taken after further practice to determine if this was the case. As with inquiry, an increase in the use of data and specifics is most encouraging as these are also recognized as cornerstones of good systems work.

Neither confrontability patterns nor the frequency of interpersonal topics discussed were significantly different in the final data. With regard to confrontability patterns about negative impacts, a complicating factor was the extremely low frequency of the behavior as measured in the tapes. This makes it difficult to measure whether or not any new confrontability behavior was actually learned. For this reason, nothing could be concluded from these results.

Hypotheses used to test changes in how users and analysts make requests and how often they surface interpersonal issues were also not supported. Argyris and Schon report that learning is more difficult and time consuming for skills which require more personal change. These findings may bear this out, since new advocacy/data and inquiry patterns were demonstrated, while confrontability and discussability patterns (requiring change of a more personal nature) remained unchanged. Again, further research would be necessary to determine if and when measurable learning occurs for these patterns.

The occurrence of active confirmations of another person's advocacy (using data or specifics as proof) did not significantly change (H21), while the occurrence of active disconfirmation of advocacy did significantly increase (H22). The most important of these in terms of detecting systems errors is the process of disconfirmation since this is where the Argyris and Schon organizational learning theory is focused. While the measures of disconfirmation used in this research are only indicators of overall error-detection (5 minute tape segments are not adequate for determining larger errors), the significant increase implies that the Model 2 based interaction process may well increase error detection and correction of a larger scope. The results of the organizational learning interactions also show an overall increase in the continuity of topics discussed (H23). Users and analysts are more likely to uncover errors when they continue to pursue discussion of a topic until it is fully understood, rather than frequently starting new topics without resolving the previous topic.

The value of the organizational learning approach is vastly increased if it can positively impact the behavior of not only those who have been trained in the method, but of others who have not been trained in Model 2. Thus, the verbal patterns of other users and analysts who were not enrolled in the experimental course, but participated in a user/analyst session with someone who was enrolled, were analyzed. In fact, those who were not trained also showed a significant increase in use of specifics and data (H24 significant at $p=.008$). This is important as the error-prone nature of interactions diminishes with increased use of specifics and data—the more people generating data in a session, the better. These untrained people did not, however, show significant increases in use of inquiry, error-detecting inquiry, confrontability or discussability patterns.

Qualitative results

In addition to the quantitative analysis used to test hypotheses, a substantial effort was put into a qualitative analysis. The course sessions were rich in data about experiences students had while evaluating their user/analyst interactions and experimenting with the new interaction methodology.

As students began to practice Model 2, they were grateful for the tools and found them quite useful in systems work. When practicing, students often experienced surprising results and saw definite learning on their own part. They also expressed frustration at the strength of their old Model 1 patterns and the difficulty in achieving proficiency with Model 2. In this regard, students developed a number of techniques and recommendations based on their Model 2 practice. Two of these recommendations are presented here to give a general idea of qualitative findings. They are presented in a format consistent with the spirit of this research. Specifically, each technique is presented in a Model 2 format—*advocated* and coupled with real examples *(data)*. Future research will be required to provide the *inquiry* to confirm or disconfirm the advocacy.

Technique #1. It is much easier to use Model 2 interactions, especially inquiry, when one knows very little about a topic and consciously realizes this lack of knowledge. As soon as we begin to gain knowledge about a topic, we build a mental framework and develop a point of view. Our emphasis then turns toward advocating what we already know and inquiring only to "fill in" our framework. Inquiry designed to truly challenge our current knowledge base diminishes considerably. Major learning can occur if one makes a conscious effort at inquiry in areas where knowledge or opinions have already been formed.

Model 1 Interaction	Model 2 Redesign
A: "I've done some research and have developed a prototype model and now need some input from you. What numbers should I use to predict the June expenditures?"	A: "I've done some research and have developed a prototype model. However, a lot of my own ideas and assumptions are built in and it's likely they may not be what we want. How can we look at what I've done so we can identify any errors?"

Technique 2. Students reported that when faced with a problem, their first inclination is to propose or advocate a solution based on whatever information they have. This often results in poor and suboptimal solutions and inhibits identification of more relevant problems that should be addressed. Thus, when a problem surfaces the first mode of operation can more effectively be inquiry into the problem and intentionally holding off on proposing a solution. This means considering one's primary job to be generation of valid information, and not problem solving. This allows (1) increased potential for identifying related problems and perhaps a solution that is wider in scope, (2) a less pressured feeling, since the interim step of generating information takes the immediate pressure off having to find a solution, and (3) a greater likelihood that others will generate their own solutions in the process.

Model 1 Interaction	Model 2 Redesign
A: "When Chuck isn't there we contact Connie, but she can't answer the questions because she hasn't been brought up to speed. It's got to be frustrating for her as well."	A: Same.
B: "Well, what we need to institute immediately is a written sequence of operations that have to be done, what's to be expected from this operation and what to do in the event you don't get what you expect—put it in black and white."	B: "Can you tell me the questions you asked that Connie couldn't answer so I can get a better idea of what's going on?

Conclusions

This research was born of the idea that significant errors may be built into information systems during user/analyst interactions. The Argyris and Schon research implies that the current systems development process is immersed in Model 1 behavior—verbal communications are error-prone and inhibit learning. The data collected from users and systems professionals fully confirms these implications, and indicates that a major error source in systems work is attributable to ineffectual personal interactions between users and analysts. The Argyris and Schon theory also predicts that a new interaction behavior based on Model 2 could be developed which will positively impact user/analyst sessions. Both the quantitative and qualitative data gathered throughout the course support these predictions for the professionals studied here.

It is increasingly important that both researchers and practitioners actively and directly address the systems communication and interaction processes. If these processes are major error sources, then they are also potential areas for major improvement in systems efforts. It would be extremely beneficial to find a way to systematically and cost-effectively improve the interaction process and to eliminate errors once they have been introduced through user/analyst interactions, but before they are actually built into systems. This requires a comprehensive understanding of the characteristics of errors introduced during user/analyst interactions, as well as the process by which such errors are introduced (this research is a start).

For those who are committed to improving the effectiveness of user/analyst interactions as they occur, it must be recognized that this is a difficult road to travel. Major changes in both thinking and behavior are required, making it highly unlikely that there will be any quick and easy results. Practitioners cannot look to a 1 week seminar to teach their staff to be effective error detectors and communicators. Likewise, this is not a problem that can be solved by a short-term research plan.

Establishing a systematic link between error-detection during user/analyst interactions and a formal development methodology may be a key to greatly improving systems efforts. Until a methodology can be created that facilitates generation of valid information at the user/analyst communication stage and then provides a vehicle for that valid information to be systematically translated into the system design and construction, current IS development methodologies, no matter how elegant, will faithfully weave communication errors into their documents, designs and systems. Practitioners should be aware that the marketplace of existing systems development methodologies will not address a major error source existing at the level of the user/analyst interface.

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