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ABSTRACT

To increase understanding of workplace literacy, a study investigated whether data from structured interviews conducted in two previous studies of job literacy and job performance relationships support the process model of literacy proposed by Linda Flower and John Hayes, "A Cognitive Process Theory of Writing." In both studies, this model was adapted for the workplace to determine the extent to which it corresponded to what people talk about when they discuss literacy in their workplace. Subjects in the current study were seven nurses and seven electronic technicians rated as superior performers on the job. Subjects' responses to structured interview questions were subjected to content and contrasting analyses using critical categories derived from the adapted model of literacy. Results indicated that the modified process model of literacy does exist in the workplace. Specifically, findings provided evidence for the existence of (1) the major components of the adapted model, including task environment, schema, and literacy problem solving process; (2) most of the subcomponents and processes/subprocesses of the model; and (3) the subcomponents of conscious goal setting, such as anticipating tasks and evaluating goals. The electronic technician data provided more support for the model than did the nurse data and suggested a higher level of job literacies and more complex uses of literacy for job tasks. Finally, several differences were found between the two groups of subjects for the kinds and uses of literacy in the workplace. These differences suggested that the nature of a worker's job makes a difference in finding evidence for the adapted model. (Six tables of data and 34 references are included as is the modified job literacy problem solving model.) (JD)

INVESTIGATING A PROCESS MODEL OF LITERACY IN THE WORKPLACE

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The purpose of this study was to increase our understanding of workplace literacy by reanalyzing the data from two studies of job literacy. We wished to investigate the process model of literacy proposed by Flower and Hayes. The Flower and Hayes model was adapted for the workplace to determine the extent to which it corresponded to what nurses and electronic technicians talk about when they discuss literacy in their workplace. The adapted model consisted of three major components: task environment (with the general job task/problem situation and portion of the job task completed as subcomponents); scheme (with prior knowledge of the task, text, and audience as a subcomponent); and literacy problem solving process (with planning, translating/doing the task, reviewing/evaluating, and monitoring as subcomponents). The subjects were volunteers, seven nurses and seven electronic technicians, rated as superior performers on the job. The subjects' responses to structured interview questions used in an earlier study were subjected to content and contrasting analyses using critical categories based on the adapted Flower and Hayes model of literacy. The subjects' responses and comments provided indirect indicators of their processes and behaviors. The results of the analyses indicate there is evidence to support most of the components/subcomponents and processes/subprocesses of the adapted model. Worker comments support the existence of the major components of the model and some evidence exists for the subcomponents of conscious goal setting. Little evidence was found for the subcomponents of revising. The electronic technician data provided more support for the model than did the nurse data and suggested higher level of job literacy and more complex uses of literacy for job tasks. Several differences were found for the kinds and uses of literacy in the workplace. Clearly, based on the data, the nature of a worker's job makes a difference in finding evidence for the adapted model. Because of the small sample of subjects, more research is needed in this area.

As the titles of many articles, books, and television shows indicate, literacy is an important topic for research and discussion in a variety of contexts and disciplines. It is clear that although there is a consensus that literacy is an unqualified good, there is little agreement about the nature and functions of literacy. This is especially true for literacy in the workplace. The reasons may be due in part to the comparatively few studies of job literacy and to the lack of appropriate theories and models for the research. The purpose of the present study is to increase our understanding of the nature and functions of workplace literacy by investigating whether data from two studies of job literacy support the process model of literacy proposed by Linda Flowers and John R. Hayes (1981). We adapted this model slightly for the world of work literacy to determine the extent to which it corresponds to what people talk about when they discuss literacy in their workplace.

Recent thinking and writing in the arts, sciences, and technology recognize the existence and significance of different kinds of literacy or literacies (Graff, 1983). These literacies range "from numeracy to graphicacy to various kinds of artistic, visual, aural, and perhaps physical skills of and for reading and expressing communicatively, and meaningfully" (1983, p. 72). We are just now coming to appreciate the notion of differing literacies, the importance and scope of the non-alphabetic, visual literacy for achievements in the plastic arts and technology and probably also in science and medicine.

According to Graff what must be stressed is the extent of the diffusion of the literacy skills of reading and writing and the expanding and changing uses of literacy (p. 75). Literacy skills have been expanding since the Renaissance when crafts increasingly required literate workers because of practical needs and 'new' traditions. Different dynamics appear to be at work with the visual literacy skills as compared to alphabetic skills.

Graff argues that nonverbal thinking, a central mechanism in engineering design, involves perceptions the tools of the artist, not the scientist. He believes, too, that an understanding of traditional alphabetic literacy can only be achieved with an appreciation and understanding of the oral, aural, and visual literacies. Today's high technology world also illustrates an integration of non-verbal oral and aural literacies (Ong, 1982) with alphabetic literacy in addition to expanding, changing uses of literacy.

The situation in the world of schooling provides a contrast. Major differences between school and workplace literacies have been noted by Mikulecky (1983, 1984, 1985). In school, students typically read books to find facts to answer low-level teacher or textbook questions and write phrases to fill in blanks, copy, or make notes individually. A perfectly correct complete product is emphasized, not the process or a partial product. Students work on one task at a time for lengthy periods of class time or as homework in order to learn from texts the core knowledge of a domain. Literacy skills are not used or used infrequently to evaluate and assess, communicate with others, or to accomplish tasks.

In the workplace, however, workers must have and use more literacies. Discussing and asking questions of co-workers is an important means of acquiring information. Workers ask questions twice as often as students (Mikulecky, 1982). Workplace reading/writing emphasizes communication of

ideas, and analysis and problem solving; shifts between one literacy and another is typical. More diversity exists in the workplace for literacy--the range of materials and tasks is broad. In sum, the dynamics for school literacy and workplace literacy differ, which helps explain why school literacy skills do not easily transfer to the workplace.

The problem of the transferability of literacy skills is illustrated in recent research (Sticht, 1981). Sticht reports that military recruits given traditional basic skills training make gains while in class, but tend to revert and lose their skills within eight weeks. In contrast, job related literacy and computational training does not suffer this reversion. U. S. Army retention studies have indicated that "personnel retained 80% of their end-of-course gain in job literacy training [but] only 40% of their end-of-course gain in general reading" (1981, p. 40). Earlier, Sticht had concluded that "the present results show that reading is not altogether a generic skill assessable by any test of reading ability" (1980, p. 303). People learn what they are taught; and for many learners, transfer is limited.

It is likely that comparatively high levels of literacy(ies) skills will be required in the workplace in the future with workers expected to become generalists. Industrial workers now perform a wider range of duties as robots and software take over many of the specialized skilled jobs (Sticht & Mikulecky, 1984). This means then that there will be expanded and changing uses of literacy as workers encounter new and more problems to solve. Decisions about literacy learning and training must therefore be based on research grounded in theories of problem solving as well as organizational communication and literacy theories.

A General Model of Problem Solving

Greeno (1978) has synthesized the theoretical literature on problem solving. Problem solving requires both knowledge and "how to" skills for applying the knowledge. Cognitive tasks, i.e., problems, involve psychological processes. Understanding the processes requires specifying relatively detailed models of how the processes occur. The models ideally specify the nature of the component processes or steps and the way in which subprocesses or sub-steps are organized into a complete procedure for doing a task, that is, solving a problem. Problem solvers set goals and subgoals and select from available actions in the process of solving the problem. They recognize and analyze patterns, return to the higher goal for which the subgoal is intended, and anticipate actions that would lead to new problems. Process, skill, and flexibility appear to be paramount.

As Simon (1980) notes, the enormous change in the knowledge that can take place in a person's professional lifetime makes it difficult to predict specific future needs for knowledge or skill in the workplace and makes general problem solving skills essential for transfer of training. However, current work in the cognitive psychology of problem solving (Larkin, Heller, and Greene; 1980) emphasizes the need for domain-specific problem solving skills that include both procedural and subject matter knowledge as well as general problem-solving skills. It has been found that while both experts and novices break problems into subparts and set subgoals to deal with difficulties, the experts understand and emphasize the whole problem situation with its constraints better than novices who use more preceived approaches. Their findings also show the importance of continually reconceptualizing a problem throughout solution and the impact of knowledge of concepts and principles as well as procedures on solutions.

A Process Model of Communication Based on Problem Solving

In order to better understand, describe, and explain how job literacy is an enabling factor for solving work place tasks, it is necessary to investigate a process model that is built on theories of both problem solving and literacy. Such a model would include components and sub-processes for oral, aural, and visual literacies, reading and writing literacies, social interaction, and problem solving, and it would be non-linear and recursive. We have adopted a model that is adapted from the model developed by Flower and Hayes (1981) to explain writing in order to incorporate many of these components.

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Figure 1 about here

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The Flower and Hayes' model, "A Cognitive Process Theory of Writing," was itself adapted from a problem solving model. In the Flower and Hayes' model, writing is conceived of as a goal-directed thinking process. The goals driving the writing/thinking process are comprised of both higher level goals and lower level subgoals. These goals are further divided into two types: process procedural goals that are essentially discourse instructions and content/message goals which are essentially the things the writer wants to say or mean.

In a subsequent refinement of this model (1984), Flower and Hayes argue for the importance and reality of multiple working representations of meaning in the writing process. They believe that 1) writers at work represent their current meaning to themselves in a variety of symbolic ways ranging from imagery to metaphors and schemas, to abstract conceptual propositions, to prose and 2) if the end product is to be expository prose, these alternative

modes can be placed along an informal scale from non-verbal imagery to text. An important aspect of their model refinement is abstract networks of knowledge which include schema, concept, and metaphor construction. The notion of schema as a richly connected network of information that is abstract, generic, constructed over time and extracted from experience has been discussed by many scholars (e.g., Anderson, 1977; Anderson and Pearson, 1984; Crismore, 1982a, 1982b; Fiske and Linville, 1980). As Flower and Hayes (1984) point out, although there is no consensus on the operational definition of a schema and it seems quite vague, and although some have noted limitations in schema theory (Spiro and Myers, 1984), schemas are quite useful as thinking tools and may have much in common with a visual analogy or a generalized prototype in initial representation of the concepts people use in the planning component of the literary process model. The prepackaged abstract knowledge structures seem to be essential for all aspects of the problem solving processes used for writing and reading such as task, topics, audience, and strategies.

Our adapted model consists of three major components: task environment, schema, and the literacy problem solving process. The task environment component has two sub components, the general job task or problem situation with literacy activities often embedded within other activities and portion of the job task or written product developed so far. The schema component involves the workers' prototypical prior knowledge for the task, text, and audience. The prior knowledge consists of content/structural knowledge and process/ procedural knowledge (knowing <u>that</u> and knowing <u>how</u>). The literacy problem solving process component has four sub processes: planning (generating ideas, organizing ideas, and goal setting), translating (doing the task, putting ideas on paper), reviewing (evaluating/revising either collectively or

individually) and monitoring (metacognitive awareness and use of strategies to monitor and self-check other strategies) (Brown, 1980). Both individual and group process can be part of the literacy problem solving process (Mitchell, 1982), and it can incorporate oral, aural, and visual non-verbal modes (Mikulecky, 1982, 1985; Graff, 1983; Flower and Hayes, 1984).

In the remainder of the paper a portion of the data from two job literacy studies will be reanalyzed in an attempt to investigate the modified literacy model developed by Flower and Hayes.

The relationships between literacy and job performance were studied for nurses by Mikulecky and Winchester (1983) and for electronic technicians by Mikulecky and Ehlinger (1985a). The studies involved the observing, interviewing, testing, and rating of job performance of 27 nurses and 29 electronic technicians. Based on the job ratings, seven nurses and seven technicians were categorized as superior or expert in job performance. The findings indicated few differences in general literacy demands and tested literacy abilities displayed by the superior performance nurses and electronic technicians and those not rated as superior in performance. In both studies the time spent reading and CLOZE test scores were not good indicators of measured job performance. Data gathered from structured interviews and metacognitive tasks, however, suggests that superior job performing nurses and electronic technicians had a clearer understanding of the uses of literacy on the job and employed more effective processes for using literacy to enhance job performance by solving job problems such as communicating. Cognitive and metacognitive skills (e.g., identifying key concepts, summarizing key ideas, elaborating on key ideas with relevant details, and self-monitoring and cross checking) and interpersonal, communicating skills correlated significantly with job performance. Both metacognitive awareness and use of literacy

strategies tended to distinguish superior performing nurses and electronics technicians from others.

If the modified Flower and Hayes model is a workable model, we would expect to see support for it in the job behaviors of superior performing workers. In order to investigate this hypothesis, the structured interview data for the 7 superior nurses and 7 superior electronic technicians from the nurse and electronic technician studies were reanalyzed. It was reasoned that the workers rated as top job performers would more likely display the characteristics and processes that comprise the modified model of literacy. The data also lend themselves to investigating the possibility that differences exist between superior rated nurses and electronic technicians in their uses of job literacy for solving problems and in their ability to articulate their literacy processes. The research question then was: Is there evidence that the modified Flower and Hayes model corresponds to what superior rated workers talk about when asked about literacy in a structured interview?

METHOD

This study involved reanalyzing the data from structured interviews used in two previous studies of job literacy and job performance relationships.

Subjects

The subjects of this study were seven nurses and seven electronic technicians rated as superior performers on the job. All were volunteers. Of the seven nurses, all of whom were employed at a large metropolitan hospital, two were student nurses (SPN's), two were licensed practical nurses (LPN's), and three were registered nurses (RN's). Of the seven electronic technicians, one was a trainee in a technical school and one was an experienced worker while five were supervisors at a naval base or electronics plant.

Structured Interview

The structured interview was developed in the earlier studies to allow observers to verify observations made during the 8-hour observation period and to add supplementary anecdotal information from the point of view of the subjects. The interview consisted of seven open-ended questions dealing with literacy demands and strategies, and a few questions dealing with general demographic information. The demand and strategy questions asked about the more complex literacy aspects of the job and about methods of using literacy to be more efficient. These open-ended questions were designed to elicit the subjects' level of metacognitive awareness and use of metacognitive strategies and their ability to articulate these job literacy processes. Two raters read the responses to the structured interview questions and reached agreement about relevance to the modified model.

Data Analysis

The subjects' responses to the interview questions were subjected to a content analysis. Critical categories based on the components of the adapted version of the Flower and Hayes' model were devised for the analysis. Contrastive analysis was used to examine the content of the nurses' and engineers' responses to the open-ended questions. Because a process model is non-linear, recursive, and dynamic, it is difficult to separate out the discrete component parts. Some comments seemed to fit more than one component or subprocess. This is to be expected since workplace problems are often complex, involving multiple documents and multiple-attempted solutions. It must be kept in mind that the subject's comments analyzed for this study were not responses to a set of structured questions concerning job literacy problem solving processes per se. Rather, the responses and comments were given to a

different set of research questions asked in an earlier job literacy study and, thus, are only indirect indicators of the subjects' processes and behaviors.

RESULTS

Results will be discussed by way of presenting data related to the various components of the job literacy problem solving model. Next, the similarities and differences between occupations will be highlighted.

Task Environment: The General Problem Situation

As Table 1 indicates, the general job problem for nurses was to gain a clear understanding or to help others gain a clear understanding of the patient in order to help the patient recover and return home. For the electronic technicians, the general problem was to insure a quality product.

Schema and Prior Knowledge

It was difficult to directly determine from worker comments the role that schema or background knowledge played in solutions of job problems. The few comments that could be seen indicative of schema reflected background knowledge about both problems and procedures. For example, one nurse commented that she must transpose routine information into more complex writing when developing a care plan--she was aware of a procedure. An electronics technician was able to borrow from his background experiences working with television in order to deal with a set of specifications. The findings shown on Table 2 indicate that the electronic technicians referred to schema (or lack of schema) slightly more often than did the nurses.

Task

The nurse mentioned earlier commented that she had to transpose her knowledge (schema) for routine patient care into a written care plan and found this a complex task. An electronic technician indicated that his schema for working on TV's allowed him to understand what the authors of specs were talking about (perhaps filling in gaps). Another mentioned having to build prior knowledge schema by studying drawings and schematics when he encountered a new circuit board, thus illustrating the use of visual literacy for accomplishing a task. The drawing was compared to the schematic for matching and then the board was compared to the schematic in a process of pattern recognition. Yet another electronic technician explained how his schema for a machine and his schema for the author of an unclear job procedure interacted. After the description of the process was read and a comprehension problem encountered, he thought of the person writing the procedures, realizing the author probably hadn't actually performed the task. Because the electronic technician knew how the machine was supposed to work, he could check the writing, check his own knowledge and determine how the written procedures should have been written to accomplish the task. The schema for technical writers who had not performed the task was used in conjunction with the technicians machine schema to effect a solution to the problem task.

The Planning Component

Worker comments partially supported the first component of the Literacy Problem Solving process (i.e., planning subdivided into the subprocesses of generating ideas, organizing ideas, and goal setting). -The findings for planning are shown in Table 3.

Generating Ideas. There were no explicit statements by either nurses or electronic technicians about generating ideas with the exception of one nurse who mentioned writing notes to herself for reports.

Organizing Ideas. The analysis found abundant evidence that organizing ideas is an important aspect of planning for job tasks for both nurses and electronic technicians. Nurses organized general and specific ideas by color coding them, and embedded lists of things to do in their notes for themselves and for doctors. Several electronic technicians developed their own logs or file systems as methods to organize their ideas. Module stages, completed work, and documentary information (for parts, manufacturers, and vendor ideas) were organized and put on file cards for future reference.

Goal Setting. Few workers directly reported setting goals to accomplish tasks. Worker comments do, however, contain a good deal of inferential evidence that the nurses and electronic technicians accomplish job tasks by breaking down the tasks into sub-steps as is seen in a nurse's response. The nurse reads the doctor's orders to learn what the patient has, reads the lab work report, and if she finds the patient has something seriously wrong, then relates that information to the patient and elaborates by explaining about the disease (e.g., malignancies). The electronic technicians first review data, then analyze and summarize it, and send a written report to vendors and funding sources. The multi-step task situation is reported much more often by the electronic technicians than by the nurses.

Goal setting involves the sub goals of 1) Exploring and researching a literacy task, 2) Interpreting and predicting task components and audience needs, and 3) Defining purposes for each literacy task.

Exploring/Research:

Both nurses and electronic technicians reported exploring and researching a task by using reading and face-to-face communication. The nurses reported reading what other nurses and doctors in their own hospital situation have written about the patients; these included observation notes, the cardex, charts, medical sheets, and doctor's orders. The electronic technicians reported reading procedure guides for conducting tests, sample tables of test results, schematics representing electronics circuit boards, and specs. (specifications). Nurses asked other nurses or doctors for clarification when interpretive problems arose and electronic technicians asked engineers for explanations of unfamiliar schematics. In each occupation some workers assessed themselves as lacking in knowledge or having comprehension problems and therefore went to an expert for help. Only the data from the nurses showed writing by the worker being used to explore and research the task.

Anticipating/Predicting:

There were fewer worker comments to support workers anticipating or predicting what was needed to do a task than for exploring or researching a task. One nurse mentioned having to write for the next shift the following day which implies anticipating the kinds of information about patients that would be needed by other nurses and the head nurse. One electronic technician noted that at times he was given previews of tasks by phone and written specifications for the next day. He compared information that he heard on the phone with the written specs and then thought about the reasons for the task comparing this information to what he typically did for that test. These behaviors suggest that he distinguishes between features of the task situation in order to anticipate and predict appropriate action for accomplishing the

task. Listening, reading and metacognitive skills are used to anticipate the task demand.

Defining Purposes:

Data from both nurses and electronic technicians indicate that workers do define purposes for tasks. For the nurses the purposes included documenting, communicating, updating knowledge about patients' mental outlooks and reactions, and medication changes. The electronic technicians define purposes that also include documenting, updating knowledge about the care of new parts, changes in production and test procedures, and writing reports.

The Translating Component

Table 4 demonstrates that this aspect of the literacy problem solving process was duly reported by all nurses and electronic technicians. Many of the tasks that subjects reported they were doing have already been discussed earlier for other findings. Additional translating reported by nurses include:

- o writing descriptions of drainage or suction by using familiar analogies
- o deciphering doctor's orders
- o reading and then following procedures
- o observing patients for accurate "readings" of patients

In addition to what has already been noted about what electronic technicians report as tasks, these tasks were also reported:

- o recording test data on forms
- o writing research or special circumstances reports
- o breaking down yield reports into outputs
- o stating reasons for a rejected part
- o explaining a proposed course of action to correct a problem

o adding other necessary information to reports as needed.

The Reviewing Component. Few workers' comments supported the reviewing component of the literacy. As can be seen from Table 5, a single nurse reported reviewing a doctor's orders and procedures.

Evaluating Goals/Mechanics. One nurse reported that she read and reviewed the doctor's orders and the procedures, but no one reported evaluating goals, revising what had been read or written on either lower mechanical levels or higher levels. An electronics student commented that he referred back to his textbook when he did not understand what he was to be measuring. Another reported that he evaluated the schematic when a part failed. One also noted that he studied and reviewed engineers' comments on his schematics to help him remember measurements when he analyzed the boards or showed someone else how to analyze them. No evidence was found for the revising process or a collective evaluating process.

The Monitoring Component

According to the model, monitoring interacts with the planning, translating and reviewing components and is a continuous process. Table 6 shows that most of the nurses seemed to find decoding and deciphering doctors' handwriting a problem in following written orders. One nurse reported metacognitive monitoring activities such as thinking about the topic of the doctor's order as an aid in interpretation and deciphering. If that failed, nurses called the doctor and asked for clarification or found someone familiar with the case to help. Self-monitoring was evident when a nurse reported thinking about what she was going to do and why she was going to do it when new procedures seemed complicated. Electronic technicians reported similar strategies. When an experiment didn't work and the reason was not obvious,

one technician retraced his steps to see what he was supposed to be doing. If that failed, he asked a colleague.

Similarities For Nurses and Electronic Technicians

Many commonalities relevant for the literacy process model were revealed from the analysis of the structured interviews of the nurses and electronic technicians. The following list summarized these similarities.

1. Metacognitive Behaviors. They both indicated knowing when they knew, what they knew, what they needed to know, and the usefulness of intervention strategies such as active monitoring and self-checking. These superior job performers had shifted from just doing tasks to knowing and articulating about the tasks. They exhibited planful behaviors as they integrated, orchestrated, and structured and organized information.
2. Reading Behaviors. Both nurses and electronic technicians had to read on a literal level in order to precisely and accurately follow written procedures whether they were a doctor's order or a set of procedures for conducting a test on products. Both read in order to update their knowledge about possible changes in their task environments or tasks. They looked for modifications and new trends and patterns as they read to compare old and new information they read and interpreted material that had been transformed from one communicative sign system to another such as symbols, code words, abbreviations. This kind of reading requires a great deal of metalinguistic and metacommunicative awareness and inferential reasoning. Both had to elaborate from a rich store of schemata as they read summarized information, filling in gaps and

supplying their own supportive details and particular instances for the key ideas.

3. Writing Behaviors. Superior performing nurses and electronic technicians documented what they observed in order to preserve an accurate record for the future. The documentation required careful, close observing, describing and recording of appropriate, selected details to be effective as future evidence or learning tools. But they also wrote summaries of information on forms. This means then that they needed the ability to select both important general ideas and important details and then express them clearly in written form for others to understand. Much of their writing was constrained by set forms, giving it a formulaic quality. Both nurses and electronic technicians understood the writing conventions for their task environment. Both wrote as individuals rather than as members of a group.

4. Interpersonal Behaviors. Social interaction skills were used by both nurses and electronic technicians as they solved their job tasks. They used question-asking skills to research topics and gather supplementary information and clarify. They used explaining skills to inform and instruct patients or co-workers and learned themselves from listening to others in their task environment. The social and interpersonal dimension seemed to be important not only for conveying and learning ideas but also for establishing and maintaining appropriate social role-relationships among co-workers. There was no evidence that either nurses or electronic technicians shared what they read or wrote in discussion groups. Both seemed to have easy access to other

co-workers for social interactions that were oral and aural literacy events used to accomplish tasks.

Differences Between Nurses and Electronic Technicians

Although the nurses and electronic technicians were quite similar in most of their behaviors pertinent to the literacy process model, there appeared to be some differences.

1. Reading Behaviors. The text that the nurses read seemed more situation-specific and context dependent. Nurses typically read materials written by other nurses doing similar tasks or by doctors in the hospital where they worked. The electronic technicians, however, read letters written by vendors, and manufactures, or manuals written by technician writers. There appeared to be a difference in the distance between the authors and readers of the written texts and the range of written text types. The nurses read materials that were typically handwritten so they often had to decode and decipher illegible texts. The electronic technicians, however, seemingly read more printed or typed texts and had interpretation problems with procedure manuals written by others who had not done similar tasks and which, therefore, were at times unclear and difficult to understand. Nurses read more verbal charts and cardexes while the electronic technicians read more non-verbal, representations of schematics, drawings, and blueprints.
2. Writing Behaviors. The nurses appeared to have fewer opportunities for composing letters and reports. The electronic

supervisors not only recorded information, but also analyzed causes and effects, diagnosed, explained, gave rationales and justifications, and proposed recommendations and solutions. The RN nurses seemed more constrained in their writing tasks and seemed to have fewer opportunities to go beyond the personal note taking and recording type of writing tasks to actual composing tasks. The nurses wrote sensory, descriptive texts in contrast to the electronic technicians who wrote reports of experimental tests with interpretation of results and implications and recommendations for the future. The level of cognitive demand and complexity for writing appeared to be higher for the electronic technicians than for the nurses. The nurses wrote daily while the electronic technicians did not.

Interview Response Style.

In the structured interview both nurses and electronic technicians were asked about how reading and writing related to job performance. The nurses answered more evaluatively and subjectively than did the electronic technicians, explaining to what extent and in what ways reading and writing were important for performing their job. For example, the nurses commented, "Reading is important." "It (reading/writing) is an important factor." Reading is 50% of the job. Writing is 45%." The nurses seem oriented to other people (patients, other nurses, doctors) in their answers and self-reference (I) was infrequent. The electronic technicians, however, used self-reference extensively and answered in terms of that they read or wrote, for example, "I complete daily summary sheets." "I read to know what to do for new parts." The electronic technicians used self-referencing pronouns five times more than did the nurses. The nurses focused on third person

pronouns and others while the electronic technicians focused on self and products/objectives.

SUMMARY OF THE RESULTS

The major conclusion drawn from analysis of the structured interview data is that the modified Flower and Hayes process model of literacy does seem to exist in the workplace. Worker comments support major components of the model: Task Environment, Schema, and Literacy Problem Solving Process. Some evidence exists for the sub-components of conscious goal setting such as anticipating task, generalizing ideas, evaluating goals, and self-monitoring. Little evidence was found, however, to support the subcomponent of revising. The electronic technician data provided more support for the model than did the nurse data and suggested a higher level of job literacies and more complex uses of literacy for job tasks. Several differences between superior rated nurses and electronic technicians were found for the kinds and uses of literacy in the workplace.

DISCUSSION

Although worker reports provide evidence to support most of the components/subcomponents and processes/subprocesses of the modified model, there is a need for further research to investigate those areas supported by only sparse evidence. The small sample of subjects and the limitation of inferring subject processes from general comments make strong conclusions unwarranted at this time.

It does seem clear that the nature of a worker's job makes a difference in finding evidence for the adapted model. The opportunities for using differing components of the model in solving problems varies according to the job. Superior performing nurses did not have job descriptions and respon-

sibilities that allowed them to engage in predicting and/or diagnosing very often. They were not to risk subjectivity and speculation when recording information about patients. In a similar fashion, nurses' evaluation of data was usually discouraged since it is not, for example, part of the LPN job description. Electronic technicians conversely, were expected to diagnose and predict causes for equipment failure. They hypothesized to produce best case solutions and were expected to analyze problems and evaluate schematics and lay-outs as well as the work of other technicians. A single occupation is therefore not likely to reflect all components of the model unless the occupation embraces a diversity of literacy problems to be solved.

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Table 1
Schema: Prior Knowledge of Task, Procedures, Authors, Audience*

Sub Components of Prior Knowledge/Schema	Subject Comments
	I. Nurses
Procedure	- [When] writing a care plan, routine information is in my head, and I must transpose it into writing.
	II. Electronic Technicians
Task	- Our experience working on TV's allows us to know what they [authors of specs] are talking about.
Analyzing Authors	- When I encounter a new board I'm not familiar with, then I have to really study drawing and schematics. Then [I have to] see how they match then look at the board to follow what the schematic shows. - I read the process of how the job is to be done. It's hard [because] people doing the writing haven't always done the work. [But] terms aren't difficult [and the] steps aren't hard because I know how the machine is supposed to work. [I] read the description, think of the person writing, check for what I see [in the writing] and then tell [myself] how to fix [the written procedures].

*Although electronic technicians referred to or background knowledge of schema more often than nurses, neither directly reported much about their prior knowledge.

Table 2

Planning*

Subprocesses	Subject Comments
	I. Nurses
Generating Ideas	- I write notes to myself, especially in the report.
Organizing Ideas	- When writing I use red ink for pertinent [specific] information and black ink for general information. I try to be as organized as possible. - I use different colors for different information. - I sometimes write notes containing a list of things to do. - I try to do things as systematically as I can so that I can pick up where I left off when [I am] interrupted. - I make notes to the doctor on things to be ordered and done.
Sub Steps	- I read doctor's orders, lab work, find serious things wrong, report to the patient and explain malignancies.
	II. Electronic Technicians
Organizing Ideas	- I have developed my own log system to keep track of modules through various stages of testing and also of work completed for future reference. If a vendor, engineer, etc. wants to know what stage the testing of a batch of mods is in, or what has been completed, I have this information for each reference. - I developed a file system in which the documentation [basic ID and other information] information is recorded on separate file cards (5 x 7) for each part and filed according to the company which manufactures the part. I coordinated the data on a 5 x 7 card and file according to vendor - [this] saves a lot of time pawing through a filing cabinet.

Table 2 (continued)

Planning*

Subprocesses	Subject Comments
	I. Nurses
Exploring/Researching	- I read what others write . . . in order to have a clear understanding of the patient. - [I] write observations for others [in order to have a clear understanding of the patient] - the only way to find out information about the patient is to read the cardex, chart, medical sheet, etc. - Shifts can read about patient types and how the patient has tolerated care and medication. - I also read reference books and specific information about patients. - With reading the doctor's orders, I would ask someone who is used to that doctor's handwriting or [else] call the doctor.
Anticipating/Predicting	- Writing for the next person (is 45% of the job) - the next shift, next days nurse, or head nurse.
Defining Purposes	- Everything you do must be documented - Writing is the major way of communicating to nurses on other shifts. - This [writing observations] helps doctors because they do refer back to nurse's notes. - [Reading] what's going on concerning the patient, i.e., whether [the patient] will lie or [I have orders] to push him. - It [reading or writing] is an important factor as helping them [patients] to get home quicker. When charting a view of the patient [any new outlook] must be noted and different medication changes for the patients day to day [must be noted].
	II. Electronics Technicians
Exploring/Researching	- When I'm not familiar with a schematic . . . Ted and I have to go to an engineer who will explain.

Table 2 (continued)

	Planning*
	- I do lots of cross-referencing: tables in front of test procedures giving test results, procedure guides for conducting tests, and schematics to see functions of components.
Anticipating/Predicting	- We sometimes get a preview of what's coming sometimes. I call downstairs [and am] told what is wanted done. Then [they] give us spec for the next morning. [After reading the specs] I compare them to what was said, think about why, compare [the spec] to what I usually do in the test.
Defining Purposes	- I complete daily summary sheets and call in totals daily. - I read to know what to do for new parts [for information about care and handling] and for changes in the production [which happens a lot on the new products lines].

* Workers comments support the planning component.

Both nurses and electronics technicians report using subprocesses (organizing ideas; exploring/researching; anticipating/predicting; defining purposes) for analyzing the general problem situation related to their particular task environment.

Table 4

Translating*

Process	Subject Comments
	I. Nurses
Doing the Task Doing (Reading) Doing (Writing)	- Writing the description of drainage or suction and trying to find correct words that tell others exactly how it smells, looked, etc. is hard. When I write a description I try to describe it [by comparing it] to something that others can identify with (size, color, consistency, amount, etc.] - The nurse must take what has been designated [in writing] and do it exactly (do not read [anything] into it). Follow procedures. - [When] deciphering a doctor's orders/ progress notes, I try to read it word for word. Then I guess at what it might be. I also bring someone in who can read it. I call the doctor if all else fails.
	II. Electronic Technicians
Doing the Task Doing (Reading) Doing (Writing)	- I read test procedures and electronic mil. spec sheets. I record test data on forms. - [For] reports, I review data, analyze and summarize, and send to vendors and funding source. - I read documents from and correspond with vendors. I also occasionally write a research or special circumstances report. - I am given daily yield reports [to read, which] break down outputs, tests, and rejects. - I do correspondence: first, I fill out documentation control sheets (identification such as part, number, etc.) If the part is being rejected, [I] state the reason [and] include the failure rate. If [it is] applicable, [I] also include in the correspondence the assembly drawing, schematics, wire board drawings, and test results as required by the situation. I explain a proposed course of action to correct the problem, it [it is] known. I add any other necessary corrections, turn

Table 4 (continued)

Translating*	
	it in for approval, (if this is required) or give it directly to word processing. - I test [in order to] diagnose likely points where problems may be occurring. - [I do] report writing when a module has failed. I must clarify what tests failed, the nature of the malfunction and given a proposed course of future action.

* Workers frequently mentioned the subprocesses (doing the task: Reading or Writing) for the translating component.

Table 5

Reviewing*

Subprocesses	Subject Comments
Evaluating goals/Mechanics	I. Nurses
	- then I read and reviewed the doctor's orders and the procedures
	II. Electronic Engineers
Evaluating goals/Mechanics	- Usually we go over [the task] in class first. I read the beginning first, set up, refer back when I don't understand what I am supposed to be measuring. I evaluate the schematic when a part fails.
	- I [make note of] engineers comments on my schematics so that when I analyze the boards or show someone else how to analyze, we'll remember measurements at some points along.

* There are few worker comments directly related to reviewing components. Both nurses and electronic technicians reported evaluating goals. No specific mentions were made of the revising sub-goal.

Table 6

Monitoring*

Sub processes	Subjects Comments
Self-checking Self-questioning	I. Nurses - I find it hard to decipher and follow doctor's orders. If I think about what he is writing about, it helps. If they are still unclear, I call him to clarify the orders or find someone familiar with the case. - I find reading unfamiliar procedures [to be] complicated. I usually think about what I am going to do and why I am going to do it.
Self-checking Self-questioning	II. Electronic Technicians - When doing an experiment that doesn't work, and I can't figure out why, then I go back to the beginning to see what I'm supposed to be doing [and] then ask Larry.

* Not all workers reported the monitoring component, but there is evidence that workers do engage in metacognitive higher level monitoring activities.

JOB LITERACY PROBLEM SOLVING MODEL

(Based on Flower & Hayes, 1981)