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Strategy-Based Technical Instruction: Development and Evaluation

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for

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This research note discusses scripted peer cooperation, an economical and effective technique for improving the acquisition of technical knowledge and skills. Experiences with scripted cooperation have also been shown to facilitate transfer to individual learning situations and to unscripted groups. At a more specific level, the research behind this note has identified parameters relevant to the assignment of participants to dyads based on pre-measured characteristics, to the selection of scripts dependant on target tasks and the outcomes desired, and to the use of node-link knowledge maps as communications props.

In addition, we have used our detailed analyses of cooperative interactions to develop models of task-oriented group processing. This research program has thus provided a basis for the development of an information processing model of cooperative learning, and our detailed analysis of this approach has been a first step in providing a conceptual framework for this powerful educational technique. (KR)

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Overview of the Final Report

This three-year project (plus a nine-month extension) has resulted in the publication of 20 articles in professional journals and books, and in the presentation of 58 papers at international, national, and regional conventions. We have received hundreds of requests for our papers and our training and evaluation materials from academic and technical organizations around the world. In addition, many of the organizations have reported that they have successfully implemented versions of our materials and approaches in their own settings.

Based on our interactions with leaders in cognitive and educational psychology it is clear that we have also made substantial contributions to the development of instructional theories. A bibliography of our project-related articles and presentations is provided in Appendix A of this report.

The remainder of this report provides a synthesis of our theoretical and empirical efforts as they relate to the improvement of technical training environments. Details of our work can be accessed through the list of references or the bibliography presented in Appendix A.

Scripts and Strategies for Technical Training Environments

Introduction

The ideal technical training environment will produce an individual who is able to effectively:

- perform technical tasks, both individually and in cooperation with co-workers;
- acquire new technical information "on the job";
- communicate with others in the task environment;
- monitor, diagnose, and correct problems associated with critical tasks;
- maintain positive motivation and concentration during task performance.

The construction of such training environments is not a simple task. Lauren Resnick, in her Presidential address to the Annual Meeting of AERA (1987) criticized current approaches to technical education because of their over-reliance on traditional, academic approaches to instruction. These approaches ignore some of the important differences between technical and academic instruction and learning. In particular, academic and technical settings differ substantially in the instructional goals involved and the types of information communicated.

Technical Training Goals

The individual in a technical training scenario is expected to achieve a wide variety of goals. These goals can include the following:

- acquiring detailed knowledge of the structure and functions of a complex piece of equipment;

- translation of technical instructions into a skilled performance;
- retention of skills over time;
- communication of technical information to a variety of audiences;
- acquisition of new procedures without external guidance;
- effective performance in a team setting.

Types of Information Communicated in a Technical Training Environment

The information to be learned in a technical training environment comes from a variety of sources, classroom lectures, training manuals, examination of, and practice with the equipment, and interaction with other trainees. This is in contrast to most academic situations where lectures and textbooks are the primary sources of information.

In addition to differential modes of communication of information, a primary difference in the two kinds of learning settings is in the type of written presentations employed. The information presented in technical manuals is based on the results of detailed behavioral and functional task analyses of jobs to be performed. Included in such texts are structural and functional descriptions of technical systems for operating, maintaining, and trouble-shooting these systems (Duffy, Curran, & Sass, 1983). Technical text, therefore, emphasizes concrete objects and operations. The procedures described are often algorithmic and the text is densely written with little redundancy (Schenck, 1977). All of the information contained in the instructions is usually necessary for the successful completion of the target task. On the other hand, academic text typically contains a lower percentage of critical ideas supported by redundant explanations, examples, and other types of elaborations. As a result of the differences in text types, the kinds of learning activities which are effective with academic text processing may not be effective in learning from technical text. An example of such a learning activity is summarization which, although effective with academic text (Spurlin, Dansereau, Larson, & Brooks, 1984; Yager, Johnson, & Johnson, 1985), may be relatively ineffective in learning from technical text because of the inherent lack of redundancy in such text.

Technical text also differs from academic texts by its dependence on visual representations (Stone & Crandall, 1982). These representations can take the form of pictures, charts, or diagrams. While academic texts use illustrations, the illustrations are not usually an integral part of the information presented and are often redundant with the verbal text. The inclusion of critical pictorial representations in technical text poses problems for trainees. Many learners do not use graphic/visual information effectively (Dwyer, 1978; Martinez-Boyd, 1988). Furthermore, low ability learners appear to experience particular difficulty with using visual processing strategies (Thorndyke & Stasz, 1980). In some cases, the presentation of related pictorial information can actually interfere with text processing performance (Schenck, 1977). A newcomer to technical learning thus faces two difficulties with respect to learning activities. First, those activities which have previously been effective for the learner may not work with technical text. Secondly, the special nature of technical text (e.g., the lack of redundancy in the text, the inclusion of pictures) may require the use of learning activities with which the new technical learner has little experience.

Technical education also differs from other kinds of education in the contexts in which it occurs. Academic education is primarily individualistic. Technical training often occurs in small groups. Group instruction is often necessitated by the expense involved in the provision of the appropriate equipment for training purposes. The target training procedures may also require the coordinated efforts of a number of individuals.

The individual in a technical training situation is thus faced with difficulties in managing the various information inputs from text, pictures, the equipment itself, other learners and actual practice. This multiplicity of information sources places an enormous burden on the learners' resource management capabilities.

Primary sources of information for an individual in a technical training setting are the training manuals or other technical documentation. The difficulties encountered by the individual are further exacerbated if the information in these manuals is presented poorly. The problems posed by poorly presented technical information are pervasive (Smillie, 1985) and are encountered in a wide variety of settings, including the military, vocational education, and in the home (Stone &

Crandall, 1982). Unfortunately, there has been relatively little controlled research designed to identify important principles guiding the design of technical documentation (Stone & Crandall, 1982). In a later portion of this paper, we will describe some of our preliminary work on this issue.

In summary, the problems involved in designing appropriate technical training environments are primarily related to difficulties posed by the diversity of instructional goals and methods. More specifically, there are major difficulties in the presentation and processing of technical text, and in the performance of concrete tasks in a social context. These are problems which are not usually encountered in most academic environments.

The focus of this particular research program has been to identify effective and efficient learner-based methods for processing technical material as currently presented. The remainder of the paper, therefore, will primarily deal with issues related to the identification of such methods. In the latter part of the paper, we will introduce some ideas and preliminary data on some ways to improve the presentation of technical text.

A Framework for the Design and Delivery of Technical Training

One of the major problems with the design of technical training environments has been the lack of an overall conceptual framework within which to couch the goals of technical training and evaluate the outcomes from such training. There has also been an absence of a systematic delivery system for accomplishing the goals in such environments. Dansereau (1986) developed a model of cognitive task performance which appears to provide an appropriate conceptual structure for the design, implementation, and evaluation of technical training environments. This framework, to be described below, is termed the CAMS model. Dansereau (1979, 1985, 1987a, 1988) and his colleagues have also developed and fine-tuned a methodology for the delivery of instruction in training environments. This delivery system (to be described in succeeding paragraphs) is called "scripted cooperation".

CAMS model. In this model, levels of performance are viewed as depending on the complex interaction of cognitive/motor (C), affective (A), metacognitive (M), and social (S) activities of the learner. Within this framework, cognitive/motor activities include comprehension, recall, and skilled performance. Affective activities include motivation, anxiety, and concentration. Metacognitive activities include comprehension and performance monitoring, error detection and correction. Social activities involve awareness of and effective communication with co-workers, apprentices, and supervisors.

Outcomes from training can also be classified in terms of CAMS. Two primary kinds of outcomes can result from training. The first category of outcomes are cognitive, affective, metacognitive and social outcomes which are dependent on the specific content of the training. Such outcomes could include memory of the task, positive affect about the task and the instructional setting, ability to detect errors in the task performance, and the ability to coordinate one's activities with those of others who share the task. These might be viewed as task specific skills which result from training. A second category of outcomes include those CAMS which are not dependent on the specific content of training. These latter outcomes can include such skills as increased knowledge of general principles which might be applied to subsequent tasks, general motivation to learn and strategies for coping with frustration, strategies for error detection and correction, and a willingness to learn with and from others. These task-independent skills are necessary for positive transfer to other learning and performance environments.

Scripted cooperation. The primary instructional delivery system for technical training used by Dansereau and his colleagues has involved the use of scripted cooperation among peers. "Scripting", as used here, involves the specification of roles played by cooperating participants during a training episode. The use of "script" is analogous to that of a theater script. The designated roles are characterized by the performance of specific processing activities designed to facilitate the acquisition of technical information or performance of a target task. These activities embedded within the script, are specific strategies which serve as subcomponents of the script. See Figure 1 for an example of the prototypical script.

Insert Figure 1 about here

Scripting Principles

There are a number of major principles underlying the script. The incorporation of these principles in text-processing strategies, either alone or in combination with others, have been shown to facilitate learning. These principles are (1) the use of multiple passes through the material (Dansereau, 1985; Robinson, 1946), (2) active processing by the learner (O'Donnell, et al., 1986; Spurlin et al., 1984), (3) the use of metacognitive activity (Baker & Brown, 1980; Brown & Palincsar, 1982) and (4) the use of elaboration (Reder, 1980; Reder, Charney, & Morgan, 1986; Weinstein, Underwood, Wicker, & Cubberly, 1979).

Multiple passes involves going over the target material more than once, each time at a different level of processing. An example of this is the SQ3R method (Robinson, 1946). In the script described previously (see Figure 1), the use of multiple passes is accomplished by requiring the student to stop intermittently and engage in certain re-processing activities at specified breakpoints.

The second principle involved in the script is that of active processing. Students who are passive with respect to learning have been shown to do poorly when compared to those who are active (O'Donnell et al., 1986; Ross & DiVesta, 1976; Spurlin et al., 1984). For example, in comparing students who were asked to detect errors in oral summaries with students who were not given such instructions, Spurlin et al., (1984) found that being instructed to listen actively (i.e., detect errors) resulted in better recall of the factual content. In the prototypical script for technical training, the activity of the learner is promoted by requiring the student to put away material, reiterate information, give feedback, alternate roles, and elaborate on the reiterated information.

A third principle, which is related to the notion of an active learner, is that of metacognition. Metacognitive skills refer to a learner's ability to assess his or her own state of knowledge or comprehension relative to the goal of the task and to adjust his or her activities in order to meet that goal. Learners have typically been shown to be weak in their metacognitive skills (Brown, 1978). Metacognitive activity in the prototypical script is stimulated by the alternation of roles, forcing the learner to experience another perspective. Interaction with a partner also provides the learner with the opportunity for observing and imitating another person's metacognitive activity. Finally, having to reiterate information to another person may serve the function of a "triggering event" which can result in a heightened awareness by the learner of his or her metacognitive processes (Baker & Brown, 1984).

The fourth principle is that of elaboration. Elaboration involves linking new concepts to prior knowledge and personalizing new information. Examples of effective elaborative techniques include making analogies, forming mental images, or using visual or verbal associations (Mayer, 1980; Reder, 1980; Weinstein et al., 1979; O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, & Young, 1985).

Collectively, these four principles operate to facilitate the active processing and accurate encoding of information, appropriate rehearsal of the information, and commitment of the information to long-term memory. The use of scripts which embody these principles have been shown to be successful in promoting retention of information (Larson et al., 1984), positive affect towards the learning environment (O'Donnell, Dansereau, Hall, & Rocklin, 1987), and transfer to other settings (Dansereau, 1987b; McDonald, Larson, Dansereau, & Spurlin, 1985).

While the activities or strategies embodied in the script described can be utilized by individuals, the script has been found to be most effective when deployed by cooperating dyads.

<u>The Use of Cooperating Dyads</u>

Cooperative learning is different from peer-tutoring approaches which require that one of the participants be an expert with respect to the target content. Cooperative learning has been extensively investigated (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Slavin, 1983a) and been shown to result in improved achievement outcomes (e.g., Dansereau, 1985; Johnson, Johnson, & Skon, 1979; Slavin, 1983a; 1983b); and racial attitudes (Sharan, 1980; Warring, Johnson, Maruyama, & Johnson, 1985; Ziegler, 1981). Furthermore, cooperative learning has the potential to prepare participants in technical training environments for subsequent "group" and "team" activities (Smith, Johnson, & Johnson, 1981).

In the work of Dansereau et al., dyads were selected as the unit of analysis because larger groups may promote the formation of coalitions, thus encouraging competition rather than cooperation (Peterson, & Janicki, 1979). The use of larger groups may also serve to overload the participants in terms of the number of differing information inputs available, and encourage passivity or social loafing (Latane, Williams, & Harkins, 1979; O'Donnell et al., 1986). Finally, cooperating groups of more than two people increase the difficulties involved with delineating the operative processes within the group (Dansereau, 1985).

In using the prototypical script, each partner plays certain roles and performs specified activities. The use of variants of this script have repeatedly led to improved acquisition of technical knowledge and positive transfer of skills to the learning of new tasks. In the evaluations of scripted activities conducted to date, there has been no attempt to manipulate extrinsic motivation. This is in contrast to most other cooperative learning approaches which do not prescribe activities but rather simply instruct the participants to help each other learn under the anticipation of some form of group reward. Although these unscripted approaches appear to directly improve task performance, they have not been shown to enhance transfer to other tasks and they have limited utility in settings where there is little or no ability to provide effective rewards.

Applications to Technical Training

The prototypical script, derived from extensive research on text-processing with a variety of texts (Dansereau et al., 1979; Dansereau, 1985; 1988) was then modified, where necessary, to the specific demands of a variety of technical information processing tasks. These adaptations to the prototypical script were guided by the theoretical perspectives of J. R. Anderson (1982; 1983; 1985).

Three stages of skill acquisition have been identified by Anderson: (1) the declarative stage in which the learner acquires an initial characterization of the target skill; (2) the knowledge compilation stage in which the learner eliminates errors from the procedure; and (3) the proceduralization stage in which the procedure is appropriately applied in an automated manner. The research to be described has focused primarily on the declarative stage of skill acquisition. The declarative stage most closely intersects with academic text processing, involving as it does a text processing component and a task performance component. Focusing on this stage has allowed for the examination of a variety of text processing problems with varying kinds of technical text and their relationship to performance. It has also allowed for the specific examination of difficulties experienced in translating text into a procedural enactment. Understanding the declarative stage of acquisition is extremely important because differences in learner outcomes occurring at this initial stage are likely to reverberate throughout the later stages of skill acquisition. In this regard, research in other domains has provided some tentative indications that the pattern of differences found after initial exposure to materials is maintained despite re-exposure to the same material (Sindelar, Monda, & O'Shea, 1988).

Overview of Tasks Used in the Research Program on the Application of Scripted Cooperation to Technical Training

Nineteen separate experiments were conducted as part of this research program. Experiments were conducted on two central types of tasks: acquisition tasks and production tasks. The examination of acquisition tasks centered on processing of three primary types of technical text. The first of these can be described as "structural" text. An example of such text is that describing the structure of a piece of medical equipment (e.g., an MA1- Respirator). This particular kind of text is heavily supported by the use of illustration. The second kind of technical text may be termed "functional" text. The goal of this text is to describe the functions of a piece of equipment, in contrast to "structural" text which merely describes the location and structure of each piece of equipment. The third kind of technical text used was "procedural" text which described how to do something (e.g., set up intravenous therapy equipment and administer an intravenous infusion).

The second group of tasks which were examined consisted of production tasks. The production tasks studied included the writing of technical instructions and the performance of medical procedures.

<u>A Typical Experiment</u>

The typical experiment consisted of two experimental sessions. During the first session, participants completed a series of individual difference measures. They were then given brief script instructions and then proceeded to use the scripts with the target tasks. During the second session, which typically occurred after a five day interval, participants completed tests over the materials/procedures learned. Post-experimental questionnaires were also administered.

<u>Methods of Assessment</u>

The methods used to assess the data emerging from the experimental program reflected the various components of the CAMS model, that is, cognitive/motor, affective, metacognitive, and social outcomes. Cognitive/motor outcomes were assessed using recall measures or performance measures. Metacognitive, affective, and social outcomes were assessed using a variety of methods which included traditional Likert scale questionnaires, transfer to new tasks with a different social context, ratings of partners, and the use of subjective graphing. Subjective graphing is a post-task measure that requires the participant to graph their affective and metacognitive states during learning or performance episode (See Figure 2 for example). Details of this approach are provided in Dees, Dansereau, & O'Donnell, 1988 (see Appendix B); Hall, Dansereau, & O'Donnell, 1988 (see Appendix C); and O'Donnell, Dansereau, et al. (1987).

<u>Summary of Results</u>

Two main issues serve as the organizing framework for summarizing the results of this program of research: (1) Is the instructional approach adopted, supported by the resulting experimentation? and (2) Are manipulations of the prototypical script, designed to meet the specific demands of varying technical tasks, both appropriate and successful?

<u>Validation of Approaches</u>

Three principles emerge from our research program which serve to validate the general approaches adopted for the design of technical training outlined in this paper. These are as follows:

- technical information processing can be differentiated from academic information processing.
- cooperative learning of technical material is more effective than individual efforts.
- the use of a script results in better outcomes than when no script is used.

<u>Differentiation of technical information from academic information processing.</u> Two sources of evidence can be drawn

upon which effectively serve to differentiate between academic and technical information processing. Firstly, the kinds of activities on strategies which are effective with descriptive prose are not effective with the learning of procedural information (Hythecker, et al., 1985; Hythecker et al., 1986; O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, & Young, 1985). Acquisition of information from structural/functional technical text is more similar to the acquisition of academic text than to acquisition of procedural information from text. Furthermore, activities such as frequent summarization which has been shown to be effective with expository text (Spurlin, Dansereau, O'Donnell, & Brooks, 1988), are not particularly effective with procedural text (O'Donnell, Rocklin, et al., 1987).

A second source of evidence supporting the distinction between technical and academic information processing comes from the examination of the individual differences which predict achievement in the two domains. Vocabulary level was shown not to be as important for performance of a medical procedure as for recall of the information (O'Donnell, Dansereau, & Rocklin, 1988). In addition, individual differences which successfully predicted recall of structural/functional information did not predict recall of procedural information (Hall, Rocklin, et al., 1988; Skaggs et al., 1987).

The direct application of academic text processing strategies to the domain of technical text processing, even though incorporated in the same general script, is not very effective. The nature of the elaborations included as part of the general script must be adapted to fit the varying goals of the text. Examples of how effective tailoring of elaborations to better fit the demands of technical text described earlier include the use of <u>static</u> imagery (emphasizing location, orientation of equipment parts) for the acquisition of structural information (Larson et al., 1986); the use of <u>dynamic</u> imagery (emphasizing the interdependence of movements of equipment parts) with functional information (Lambiotte et al., 1986); and the use of simulated movement (emphasizing the actions <u>upon</u> the equipment) with procedural information (Hythecker et al., 1986).

<u>Cooperative learning in technical training is more effective than individual efforts.</u> While cooperative learning has consistently been shown to be effective with academic style tasks (e.g., text-processing, mathematics, social studies (see Johnson et al, 1981; Slavin, 1983b). The present research program provides evidence that cooperative learning is also effective in technical training. In general, the results indicate that cooperating dyads outperform individuals on both acquisition and production tasks.

Cooperating dyads have been shown to perform better than individuals in the recall of structural and functional information (Larson, et al., 1986; Lambiotte, et al., 1986). Dyads also recall more procedural information than individuals

(O'Donnell, Dansereau, Hythecker, et al., 1988; O'Donnell, Dansereau, Hall, et al., 1988). In production tasks, cooperating dyads write more communicative technical instructions than individuals (O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, 1985).

Cooperating dyads also perform better than individuals on the immediate and delayed performance of a procedure (O'Donnell, Dansereau, Hall et al., 1988). Furthermore, the initial benefits which accrue as a result of a cooperative training experience have been shown to persist over 3-week (O'Donnell, Dansereau, Lambiotte, et al., 1988) and 6-week intervals (O'Donnell, Dansereau, Hall, et al., 1988).

While, in general, dyads outperform individuals, this is not invariably the case and positive results associated with the use of cooperative dyads cannot simply be attributed to some kind of placebo effect. In one experiment, cooperating dyads did not perform better than individuals in the recall of functional information (Lambiotte et al., 1986). Participants who studied two procedures and were then asked to work cooperatively with another participant to compare and contrast or review the procedures together, recalled less than those individuals who engaged in the post-study activities individually (Young et al., 1987). Cooperation among peers does not necessarily work effectively in all situations or for all tasks. The successful use of cooperative learning, especially within the context of technical learning, seems to require careful scripting of the activities of the participants.

Advantages of externally provided scripts over participant generated scripts. The provision of experimenter provided scripts and strategies has generally been found to be more effective than scripts generated by either individual participants or cooperating participants. Clear advantages for the externally provided script over participant scripts were found, for example, in the free recall of equipment diagrams (Larson et al., 1986). This finding was supported by subsequent research in which participants in groups using experimenter-provided strategies recalled more of the equipment diagrams than those in unscripted groups (Lambiotte et al., 1986).

The advantages of the external scripts are also observable in research using procedural text. In one experiment (Hythecker et al., 1986) in which there was no observable benefit associated with cooperative learning, the use of an externally imposed script was still associated with improved performance compared to those participants who were required to generate their own scripts.

The provision of scripts also promotes positive affect towards the task at hand (Lambiotte et al., 1986). In addition, the experience of working cooperatively with an externally imposed script also appears to prepare participants to work more positively in a subsequent unscripted group setting (O'Donnell, Dansereau, et al., 1987).

In the same way that the benefits of cooperative learning are dependent on appropriate scripting, the actual success of the scripts depends on the selection of strategies to include as part of the script. In some instances, participants who generate specific processing strategies perform as well (Lambiotte et al., 1986), or better (O'Donnell et al., in press) than groups using specific strategy components as part of the general script employed. The selection of these sub-strategies for maximizing the effectiveness of the scripts is obviously important. The next part of the paper will address aspects of that selection process.

Inside the Script

Questions which are often asked about research on script manipulations relate to whether or not those scripts are actually used, what impact they have on the processing of the participants, and whether or not this processing has an effect on the outcomes from the training.

The Use of Scripts

There is strong evidence indicating that participants do in fact use the experimenter-provided scripts during the target learning episode. This evidence comes from the analysis of videotapes (O'Donnell et al., in press; O'Donnell, Dansereau, Rocklin, et al., 1988), audiotapes (Skaggs, et al., 1987) and self-report of the participants (O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, & Young, 1985). Participants are also able to provide accurate summaries of the script prior to actual training with target materials (O'Donnell, 1986). When participants were allowed to return to the use of their own study skills and were later asked to describe their study methods (O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, & Young, 1985), participants reported that they had incorporated elements of the experimenter-provided scripts into their study methods.

<u>Impact on Processing: Manipulations of CAMS processes</u>

In the various tasks employed in this research program, we have used a general instructional script (see Figure 1), tailored to the demands of technical training, using Anderson's model of skill acquisition as a guiding framework. While the adaptations made to the general script appear to constitute minor variations (e.g., static vs. dynamic imagery), the manipulation of the strategies involved in these adaptations (or component activities of the script), result in the activation of CAMS processes which differ in kind and in strength. Such results provide support for Dansereau's ideas (1986) that the goals of the task, the individual characteristics of the cooperating members, the nature of the task at hand, and the script used by the participants will dictate what CAMS processes will be emphasized during a learning situation and with what effect.

<u>CAMS Processes</u>

<u>Cognitive/motor processes.</u> One set of experiments (O'Donnell et al., in press; O'Donnell, Dansereau, Hall, et al., 1988; O'Donnell, Dansereau, Hythecker, et al., 1988) was conducted to explore the translation of text into a procedural

enactment, using a medical procedure as the target task. Experimenter manipulations were designed to differentially emphasize the translation of text into a declarative representation or to emphasize the translation of the declarative representation into an actual performance. The former was achieved by including a "planning" component in the general script, in which the participant would first describe what he/she intended to do prior to the actual performance. The latter emphasis was accomplished by allowing the participants to refer to their instructions and/or their partners at any point in the training performance. Results from these experiments indicated that the manipulations resulted in the experimental groups spending markedly different amounts of time on different cognitive/motor activities (i.e., preparation, feedback, performance, reading, etc.). These differences in distribution of effort also appeared to lead to differential performance on the target task.

In another set of experiments concerned with the processing of structural/functional information (Lambiotte et al., 1987; in press), variations in the component activities used by the participants as part of a more general script, also resulted in participants reporting differential amounts of time and effort spent on various processing activities.

Affective processes. Scripting manipulations have also impacted on the affective climate of the cooperative learning episodes (see Appendices B and C for details). Scripts which have incorporated strategy components which promote interaction with, or dependence on the partner, result in learning situations which are characterized by more positive affect than those scripts which tend to limit interaction (O'Donnell et al., in press).

The direction and strength of the affect experienced by cooperating participants has also been shown to be influenced by the scripts employed (Dees et al., 1988). Participants who used a script which included strategies for intermittent planning and performance showed an increase in liking for the target material over the time course of the learning episode whereas those participants who did not include a planning activity in the general script demonstrated a decrease in liking for the material over time.

Metacognitive processes. Script manipulations appear to influence the metacognitive activities of the participants. A number of aspects of the scripts may contribute to the facilitation of metacognitive activity. Having a partner available may be a critical component. The availability of a co-worker has previously been shown to improve workers' use of technical instructions/manuals on the job (Kern, 1985). The presence of a co-worker appeared to enhance general metacognitive activity and recognition of when additional information was needed. The improved use of additional information sources (e.g., co-workers, manuals) resulted in improved performance (as evidenced by fewer errors) of the target tasks (Kern, 1985).

Another important component of the script in the facilitation of metacognitive activity may be the alternation of roles (performer/recaller or observer/listener). For example, participants who maintained a fixed role as either listener or recaller in using the prototypical script actually recalled more information, but less accurately, than those participants who alternated between roles (O'Donnell, Rocklin, et al., 1987).

A third important component in the stimulation of metacognitive activity is the activity level of the listener/observer (Spurlin et al., 1984). Participants who were instructed to listen to summaries with the goal of detecting errors, recalled more information than listeners who did not receive these instructions.

Social processes. The degree of interaction and amount of verbalization by cooperating partners has also been shown to be influenced by the scripting manipulations (e.g. O'Donnell, 1986; O'Donnell, Dansereau, Hythecker, et al., 1988). Scripts which include a strategy for referring to notes or to the partner, promote more interaction between the partners than a script which does not include such a strategy component.

Summary

The manipulations of the script, characterized by the incorporation of various strategy subcomponents, produce differences in the cognitive, affective, metacognitive, and social activities of the cooperating participants. Furthermore, these CAMS differences appear to impact on subsequent recall and performance.

Manipulations of CAMS Outcomes

In addition to differences in the CAMS processes which are activated by scripting manipulations, differences in CAMS outcomes (both content-independent and dependent) achieved by participants as a result of training can also be accounted for by manipulations of the script-strategy combinations utilized by the participants. Content-dependent CAMS outcomes are those outcomes which directly relate to the specific learning episode under investigation. Content-independent CAMS outcomes are outcomes which are not tied directly to the specific content of the particular learning environment or task, relating more to transferable skills than to acquired task-specific skills.

Content-dependent CAMS

Cognitive/motor outcomes. The cognitive/motor outcomes which we have examined include the analysis of free recall, cued recall, and performance (both immediate and delayed).

Recall. Recall measures have included both the recall of text and of visual accompaniments to text. They have also included short delay and long delay measures. Short delay recall is usually assessed after a 5 day interval. The recall of different kinds of information is facilitated by adapting the kinds of elaborations engaged in by the participants to the specific goals of the task. For example, the use of imagery is a form of elaboration that is very successful (Hythecker, et al., 1985). Specifying the kind of imagery to engage in is especially helpful with different kinds of technical information which rely heavily on illustration. Instructing participants to engage in static imagery facilitates the acquisition of structural information (Larson et al., 1986), whereas instructing participants to use dynamic imagery facilitates the acquisition of functional information (Lambiotte et al., 1986). Tailoring the elaborations employed by the participants when studying procedural text can also be effectively scripted by the inclusion of simulated movements (Hythecker et al., 1986). The facilitative effects of the use of elaborations which are specific to the goal of a particular task are consistent with previous research on the effects of precise elaboration (Stein & Bransford, 1979).

Manipulations of script-strategy combinations have been shown to result in differential patterns of recall of information about the equipment and actions necessary to perform a medical procedure (O'Donnell, Dansereau, Hall, et al., 1988). Participants who used a scripted approach to learning both equipment and actions recalled more of the equipment information than those who used a similar scripted approach with only the "action" information. Identical patterns of recall were also found after a 6-week interval.

Performance. The kinds of strategies which promote immediate performance of a procedure are not necessarily those which promote good retention of the procedure. For example, the performance of those participants having access to the instructions or partner during the first procedural enactment of a procedure results in an initial performance which far exceeded that of those participants who do not (O'Donnell, et al., in press). However, after a delay of 5 days, the initial advantage of the participants who had access to instructions/partners disappeared and in fact, their performance fell below those of participants who were not given unlimited prompting. The combined use of a "planning" strategy and a "prompting" strategy seems to promote the mental effort necessary to retain the procedure in addition to producing good performance on the first procedural enactment.

Affective outcomes. Affective outcomes are also influenced by scripting differences. Participants satisfaction with their partners, their liking for the materials, etc., have been affected by the combinations of scripts and strategies which they used (Larson, et al., 1986; O'Donnell, 1986).

Metacognitive outcomes. Differences in metacognitive outcomes can also be achieved. As previously demonstrated in the current research program, the use of experimenter-provided scripts enhances the metacognitive activity of the cooperating partners.

The use of an experimenter-provided script results in participants making more accurate assessment of their performance on a learning task (O'Donnell, Dansereau, et al., 1987) than assessments of performance made by participants who generated their own scripts. While the between-group differences in the above analysis are not significant, they do provide, however, some promising indicators that the ability of trainees to detect/correct errors and evaluate their own performance can be trained using relatively simple procedures.

Errors. The script manipulations also impact on the number and kind of errors made by participants. Findings from the current research program support those of Kern (1985) in that, those who were allowed access to their instructions or partners during training made fewer errors of omission and more errors of commission during training than those participants who did not access their instructions/partners (O'Donnell et al., in press). Using available prompts during training seems to facilitate a more complete performance in terms of the number of actions included, despite some lack of accuracy in doing so.

According to Kern's analysis, the availability of a co-worker "prompts" recognition of when information is needed. Support for this analysis comes from the results of one experiment conducted as part of the current research program which compared the performance of a group of participants who were specifically directed to learn about the equipment necessary to perform a medical procedure and a group of participants who were simply informed that they could refer to documents describing the equipment if necessary (O'Donnell, Dansereau, Hall, et al., 1988). It was anticipated that the performers would be likely to need to have declarative knowledge of the equipment in order to make correct choices of equipment.

Participants who specifically learned about the equipment did not make significantly more correct choices when performing than those who did not learn this information specifically. It appears that participants were able to refer to the instructional materials for the appropriate information.

The current research program also extends the work of Kern (1985) by examining the kinds of errors made during training and the delayed performance of the an initially well-performed procedure. While the prompted group completed more of the procedure during training, they did so with some degree of inaccuracy. The initial advantage of a more complete training performance was not maintained over a five day delay period (O'Donnell et al., in press). The "prompted" group (i.e., those who had access to materials/partners during training) made more errors of commission during training than the group who planned first and then performed. The mere performance of most of the necessary actions was not enough to maintain those actions in memory over a five day interval. Perhaps the heightened metacognitive activity during the training episode was task-specific, illustrating the need for both content-dependent and independent goals in training approaches. In contrast, the participants who used a script which incorporated a "planning" sub-strategy made less errors of commission during training. The inclusion of a sub-strategy which focused on declarative knowledge of the procedure and which allowed for more opportunity to detect errors appeared to improve the accuracy of the initial performance. In a subsequent experiment which combined the advantages of prompting and planning resulted in a good initial performance and retention of the performance.

The presence of a partner seems to be an important component in improving metacognitive outcomes. Another important aspect of the script which serves to enhance accuracy of performance is the alternation of roles played by the cooperating partners (O'Donnell, Rocklin, et al., 1987). The effect of alternation of roles in this particular experiment was not on total amount of information recalled, but on the accuracy with which the information was recalled.

Content-independent CAMS. Scripted dyadic learning has been shown to result in transfer to individual learning of expository prose (McDonald et al., 1985) and technical text (Lambiotte et al., 1987; in press; Larson et al.,1986). Potential explanations for these effects include the possibility that being exposed to the CAMS activities of another person within the context of learning somewhat novel information may provide the trainee with ideas about alternative approaches to processing the information. The adaptation of the experimenter scripts into the existing learning repertoire of the learner/trainee may also stimulate transfer to other information processing activities (O'Donnell, Dansereau, Rocklin, Lambiotte, Hythecker, Larson, & Young, 1985). Variations in the strategy components of a script (teaching role vs. learning role) have also been shown to promote the transfer of skills to new situations (Lambiotte et al., in press).

There is evidence that social skills, in addition to cognitive skills, can also be transferred from an initial cooperative learning experience. Participants who used an experimenter provided script when engaging in an initial cooperative task later reported liking a second partner more than those participants whose initial experience did not involve the use of a script (O'Donnell, Dansereau, et al., 1987).

Processes and Outcomes

The script manipulations successfully impact on the nature of the processing engaged in by cooperating dyads. The actual time spent on various parts of the learning task are influenced by the nature of the script/strategy combinations used (O'Donnell et al., in press). Those who spent more time in preparing to perform an actual medical procedure recalled more of the information about the task after a delay than those who spent less time on preparation. Conversely, those who spend more time on performance during training, actually performed best after a delay.

The errors made during training when performing a medical procedure were also influenced by the scripts used. Differences in the nature of errors made as a result of the scripting manipulations later impacted on delayed performance of the task.

In other experiments, participants' perceptions of their own efforts were influenced by the script manipulations (Lambiotte et al., in press; Lambiotte et al., 1987). These differences in perceived effort and time expenditure were also related to outcomes.

Summary

The script manipulations were successful in controlling the activation of cognitive/motor, affective, metacognitive, and social processes. Differences in outcomes which tapped these same dimensions (both content-dependent and content-independent) were also found as a result of the script/strategy combinations and differential activation of CAMS processes during training.

Selecting Strategy Components for Scripts: General Principles

The basic principles guiding the selection of strategies for inclusion in the prototypical script are derived from an analogy drawn between the kinds of tasks examined as part of this research program and the development of other skills, such as reading.

Analogy to other skills. The processes involved in the deployment of the prototypical script (see Figure 1) are similar to those involved in the development of other skills. For example, language is first acquired by reception (parental chatter, etc.), initial practice (babbling, or 1- to 2-word sentence), feedback, and finally, the internalization of thought. This last phase might be considered the automatization of language.

The same procedure is followed for the acquisition of reading skills. First, someone reads aloud to the child, the child learns to associate written words with meaning, learns to read aloud to himself or herself, eventually subvocalizes when he/she reads, and finally, reads silently to himself or herself.

The analogy drawn between these skills and the skills used when deploying the script described in this paper is a rather rough, imprecise analogy. It does, however, allow us to identify a number of important principles. These principles relate to the availability of a model, initial practice, feedback, and the internalization or automatization of a specific skill. There is a fading from a very public exercise of the skill (initial practice) to a more private exercise of the skill (automated performance. The following paragraphs will describe how these same principles can be found, embedded in the general script and component strategies.

Modeling. The scripts provide the opportunity to observe another engaging in cognitive activity. Because thinking is such a private activity, it is very difficult to observe. The problem of making cognitive activity visible can be solved by the inclusion of such strategies as overt verbalization or summarization of text contents, performance of actions described in the text, etc.

Initial practice. While serving as a model of cognitive, affective, and metacognitive activity to the observing partner, the "modeling" partner is also experiencing an initial practicing of his/her understanding, communication capability, and/or performance capability. This source of information is invaluable. People have traditionally been found to be relatively weak at metacognitive activity (Brown, 1978). The actual utilization of reading skill may have become automated to the point where the reader is not aware of his/her own lack of comprehension (Baker & Brown, 1984). The initial practice provides a "triggering event" which prompts the exercise of metacognitive skill and the affective skills which are likely to be necessary as a result of discovering that a text was not understood or the actions described were not correctly performed.

Feedback: The development of skills requires feedback on the initial practice. The inclusion of the provision of feedback as a strategy component of the general script provides the partner who is engaging in an initial practice with an important element in the development of cognitive skill.

Automation: Finally, the development of automation only comes with extensive practice. However, a good beginning in the development of specific skills can be ensured by the provision of appropriate scripting.

Selecting Script Components: Specific Principles

The specific selection of script components is guided by the CAMS framework in general, and two specific considerations: (1) the goal of the task; and (2) individual differences which are germane to that specific task.

Goals of the Task

It is evident that the goal of the task is of critical importance in selecting the strategy components to embed in a general script. The direct application of strategies which are effective with expository prose are not necessarily effective in the domain of technical text-processing.

Selecting strategy components or modifying strategies is best guided by a clear characterization of the target materials and tasks. For example, if the task is to learn the overall and sub-functions of a piece of equipment, the trainee will most likely need to learn what each part of the equipment does and how it affects other parts of the equipment. In this case, the use of dynamic imagery as a script sub-strategy will allow the trainee to view the equipment as an interacting set of components.

The conceptualization of training processes and outcomes within the framework of the CAMS model points to the complexity of possible outcomes from a training scenario. The general script, with appropriate modifications, can successfully promote the simultaneous attainment of a number of different goals. In cases where this is not possible, selections of strategies will depend on whether or not the goal of the task is one of immediate successful performance without any concern about the social-affective climate within which the task is performed, or whether the goal is one of inculcating positive attitudes necessary for continuous work, or any number of other possible goals.

<u>How script variations are made</u>. Variations in the strategies actually incorporated into the prototypical script for specific tasks generally revolve around variations in the task.

<u>Examples of strategy variations as a result of task/text</u>

<u>demands.</u> Charney and Reder (1987) identified three components of skill learning which provide an informative framework for the analysis of tasks. The first of these components involves learning novel concepts and functionality of novel procedures/objects. We have previously described variations in strategies (e.g., the use of static or dynamic imagery) which resulted in differential recall of declarative knowledge of the structure and function of equipment. Details of this particular research can be found in Larson et al., (1986) and Lambiotte et al. (1986).

The second component of skill learning identified by Charney and Reder (1987) is that of learning to execute procedures. Adaptations to the general script in Figure 1 for the purpose of learning to execute procedures involved successive approximation of actual practice, beginning with mental imagery of the execution of the procedure (Hythecker, et al., 1986), the use of simulated movement (Hythecker, et al., 1986), and finally, the actual enactment of the procedure itself (O'Donnell, Dansereau, Hythecker, et al., 1988; in press; O'Donnell, Dansereau, Hall, et al., 1988). Strategies which constituted actual practice were more effective than those which did not. In addition, those strategies which more closely simulated actual practice (e.g., the use of simulated movement) were more effective than those which simply involved a mental rehearsal of the procedure, a strategy previously shown to facilitate performance of skills (McKay, 1981). Strategies which combined some of the potential benefits of mental rehearsal (reflectivity, Meichenbaum & Goodman, 1971; error detection; Baker & Brown, 1984) with those of actual practice appeared to provide the optimal script.

The third component of skill learning according to Charney and Reder (1987) involves learning when to use the correct procedure. This particular aspect of skill learning seems to require both declarative and procedural knowledge of a specific procedure. It appears that the declarative knowledge must be available in order to make correct choices about which procedure to use and when. One experiment in this particular research program was conducted with the specific purpose of preliminarily delineating the conditions in which it is necessary for a trainee to learn about a procedure declaratively prior to having the opportunity to acquire procedural knowledge about the task from actually practicing the procedure (O'Donnell, Dansereau, Hall, et al., 1988). For the particular procedure under investigation, it appeared that the acquisition of declarative and procedural knowledge can occur simultaneously, provided that the strategy components which separately foster the acquisition of these two kinds of knowledge (planning and prompting activities) are incorporated in the general script.

Individual Differences

Individual differences have traditionally impacted on academic learning (Hall, 1988; Hall, Rocklin, et al., 1988; Slavin, 1987). Examples of individual differences which have been shown to have relevance for such learning include vocabulary level (Larson et al., 1984) and cognitive style (Larson, Dansereau, Goetz, & Young, 1985). These measures have proven to be consistently related to performance on academic tasks. However, there is some indication that the kinds of predictors used in academic settings (e.g., basic skills scores, aptitude tests, etc.) do not accurately predict job performance well (Stedman & Kaestle, 1987). Wagner and Sternberg (1987) differentiated between practical and academic intelligence and has addressed the issue of the importance of cognitive style as a mediator of intelligent behavior. Other possible mediators of performance in a technical training environment include personality variables, preferences for certain kinds of tasks, co-workers, and subjective reactions to features of the learning environment (e.g., the other trainees, the learning tasks, etc.).

The role of academic predictors in the prediction of technical training outcomes. The academic predictors which we have examined include vocabulary level as measured by the Delta Reading Vocabulary Test (Deignan, 1973). Scores on this measure have been shown to be moderately correlated with SAT scores (Dansereau, 1978). A second measure which has been associated with successful academic achievement is the construct of field-dependence/independence (Larson et al., 1985). The Group Embedded Figures Test (Oltman, Witkin, & Raskin, 1971) has been used to assess this construct.

In general, vocabulary level is not as strongly related to outcomes from a technical training task as is usually found with more academic tasks (Hall, 1988). Vocabulary was a better predictor of recall of descriptive than procedural text (Hall, 1988). Individual differences in vocabulary are also more important for recall tasks than for performance tasks (O'Donnell, Dansereau, & Rocklin, 1988).

Field-dependence/independence does not appear to be strongly related to general outcomes; the effects of individual differences on this dimension on outcomes seem to depend on the particular script-strategy combination being used by cooperating dyads. In one experiment (O'Donnell et al., in press), strategy manipulations were ineffective in creating differences in recall, irrespective of the participant's degree of field-dependence. This was not true, however, for the performance measures. Participants who were field-dependent performed best in those groups which involved a strategy component allowing them access to their instructions or partners. The reverse was true for field-independent students who performed best when they trained in groups with strategy components which required greater dependence on personal (versus externalized) memory. In a second experiment in which all participants had access to partners and/or instructions during training, the interaction of field-dependence/independence with script was not found. The addition of "prompting" as a strategy component may have served to alleviate problems for field-dependent participants.

The impact of individual differences on dimensions which typically denote success/failure on academic tasks appears to depend on the target task and the particular script-strategy combinations.

Individual differences and material type. Interactions of individual differences with the recall of different types of material have been found (Hall, Rocklin, et al., 1988). Induction ability (Ekstrom, French, & Harman, 1976) significantly predicted recall of structural/functional information by dyads. This is possibly due to the fact that learning this kind of information require organization skills and the successful dyadic learner must be able to integrate more pieces of information from more sources than the individual learner of the same material.

The recall of procedural information typically is more difficult to predict than that of structural/functional or descriptive information. In one experiment (Skaggs, et al., 1987), higher scores on a measure of "deep processing" (the ability to critically evaluate and compare and contrast information) facilitated the recall of procedural information.

Social orientation. Participants who score high on a measure of social orientation perform better when they study in dyads than those who show lower social orientation (Hall, Rocklin, et al., 1988).

Summary

Individual differences appear to have an important impact on performance with technical training materials, depending on the nature of the task, the scripts/strategies used, and the mode of assessment.

Overview Summary

A prototypical script was identified which provides the learner in a technical training environment with an efficient and effective method for acquiring technical information and performing concrete procedures. Important sub-strategies of this prototypical script include the use of multiple iterations through the target material/task, active processing of information, elaboration of the material, and the use of feedback. Although the script can be used individually, the optimal use of the script involves cooperation among pairs of learners, who alternating between the roles of recaller/performer and that of listener/observer.

The use of the CAMS framework of cognitive/motor task performance provides a useful method of encapsulating the variety of processes involved in learning in a technical environment and also is a useful framework for summarizing the outcomes from such training. The activation of cognitive/motor, affective, metacognitive, and social processes and outcomes can be controlled by manipulations of the prototypical script.

While the prototypical script is generally effective, adaptations must be made to accommodate the characteristics of specific kinds of technical information (e.g., structural) or tasks (e.g., immediate or delayed performance). The use of the CAMS framework guides the selection of task- or material-specific adaptations. These adaptations generally involve relatively minor changes, usually at the sub-strategy level. Individual differences must also be considered in the adaptation of the general script. Specific examples of such adaptations can be found in Appendix D.

The prototypical script which has been developed, and the guidelines identified for task/goal specific adaptations of that script, address many of the problems in technical education which were identified by Resnick (1987). The script involves an intersection of typical academic approaches to instruction (e.g., the use of text processing strategies) with the specific features of the technical training environment. These features included the social context of learning in such environments and the differing demands of technical text processing.

In the beginning of this paper, we noted that the learner in a technical training environment is faced with difficulties posed by the presentation of technical information and the unavailability of appropriate learning methods. The difficulties experienced by the learner will be ameliorated by the use of the scripts described here. The remaining problem is to identify methods for improving the quality of presentation of technical information.

Improving the Presentation of Technical Information

Three major categories of criticisms have been levelled against the general presentation quality of technical manuals and supporting documentation. Firstly, the reading level of the texts have, in many instances, exceeded the reading comprehension skills of the intended users (Kern, 1985). Secondly, in many instances, decisions about the content to be included in these manuals appear to have been made with little understanding of the intended users' needs or the situations in which the materials will be used (Kern, 1985). Thirdly, the presentation of technical information relies heavily on the use of illustrations. Unfortunately, there is substantial evidence that suggests that learners experience a great deal of difficulty processing this type of information (Dwyer, 1978) and even greater difficulty integrating it with text (Pinker, 1985). There has been little research which has examined how individuals process visual information of the kind found in technical training or user manuals. In addition, little research has addressed the problem of how individuals use and integrate combinations of visuals and text (Pinker, 1985; Stone & Crandall, 1982).

Knowledge Maps

One technique for presenting technical information which has the potential to ameliorate some of the previously identified problems is the use of multiple-relationship knowledge maps (Dansereau, O'Donnell, & Lambiotte, 1988). Multiple-relationship knowledge maps are two-dimensional spatial/verbal representations of information. These types of displays convey information by presenting concepts or ideas and their interrelationships in the form of node-link networks (see Figure 3 for an example). One important advantage of knowledge maps over more conventional displays, such as flow charts and hierarchies, is that maps have the capacity to represent a variety of relationships and structures in a single display.

Insert Figure 3 about here

While such maps have not previously been examined in the context of technical training, there is some evidence which suggests their potential value in that domain. Map development appears to assist the instructor in understanding the nuances of a knowledge domain and helps in the identification of portions of the domain that may pose learning difficulties (Camperell & Smith, 1982; Hawk & McLeod, 1983). Knowledge maps produced by experts inform learners about the interrelationships of ideas and the logical connections between higher-order and lower-order concepts (Armbruster & Anderson, 1984).

Potential of Knowledge Maps to Reduce the Reading Difficulty of Technical Text

The use of knowledge maps in the presentation of technical text has the potential to reduce the reading difficulty of the texts. One of the primary contributors to "reading difficulty" is the syntactic complexity of the writing. In knowledge maps, the basic unit of information is the "node-link-node" proposition, which is comparable to a simple, active, declarative sentence (see Figure 3). Syntactic complexity is therefore kept to a minimum in the development of these maps.

In addition to a possible reduction in syntactic complexity, the spatial skills of the user can be engaged in the acquisition of information from knowledge maps. The information processing burden of the learner with low verbal skills may thus be potentially alleviated. The use of a summary set of relationships (links between nodes; see Figure 4) to connect ideas also reduces the amount of verbiage in the presentation of the information.

Insert Figure 4 about here

<u>Potential of Knowledge Maps to Improve the Usability of Technical Text</u>

One major problem with the use of technical information is that the intended users of such information (e.g., technicians) do not use the training/user manuals (Kern, 1985; Wright, Creighton, & Threlfall, 1982). Reasons given for failure to use such information included complaints about the content of the manuals, difficulties experienced in locating the appropriate information in the manuals, and complaints that the manual was too cumbersome to use when performing the task.

Evidence from the current research program has demonstrated the importance of "prompting" or reference to the instructions/partner in achieving optimal outcomes from a training episode (e.g., Dansereau, 1987a; O'Donnell et al., in press; O'Donnell, Dansereau, Hythecker, et al., 1988). Kern (1985) has also demonstrated that reference to the instructions when performing a task is associated with superior performance on the task. The use of knowledge maps has the potential to enhance the accessibility (and consequent usability) of technical information because the macrostructure of the information presented in the form of a knowledge map is readily available to the reader/user and the relationships between different pieces of information are clearly delineated.

A second problem related to the use of technical manuals is the varying needs of the users. We have shown that the use of different sub-strategies when processing technical text serves to highlight different kinds of information (Lambiotte, et al., 1986). The use of knowledge maps also has the potential to highlight different kinds of information by the spatial arrangement of the information. In addition, since knowledge maps allow multiple processing routes through the information, different users (e.g., maintenance vs. trouble-shooting personnel) can tailor their processing to fit their needs and preferences.

Potential of Knowledge Maps to Delineate the Relationship of Visual and Verbal Information

One of the difficulties students have with pictorial information is relating it to the relevant textual information. Knowledge maps allow the linking of pictorial information directly into the knowledge structure (see Figure 3). This direct linkage should assist the reader in interpreting and integrating the illustrations.

Preliminary Data on the Use of Knowledge Maps

A number of findings from pilot work conducted on the presentation of technical information via knowledge maps have provided some tentative support for the potential value of these maps in a technical training context (O'Donnell, Dansereau, Lambiotte, et al., 1988; O'Donnell, Dansereau, & Pitre, 1988; Hall, Dansereau, Lambiotte, et al., 1988). Delayed recall data and performance data indicated that learning a medical procedure from maps can lead to relatively effective long-term memory of the information, and under some conditions can result in good performance of the target procedure. Exposure to knowledge maps as a learning tool results in subsequent improvement in both map and text processing. Participants reported that they learned more about their study skills when they used maps.

Both structured and open-ended questionnaire data collected during these preliminary experiments support the efficacy of maps as instructional devices. Participants were generally positive about the use of maps. The generation of positive affect towards the material may be of real importance in a technical training environment as Kern (1985) has noted that many workers exhibited negative attitudes to the technical materials they were required to use.

The efficacy of knowledge maps appears to depend on the nature of the domain of information presented and they seem to be most suited to the presentation of procedural information. The preliminary work conducted to date also indicates that the learners' spatial scanning abilities may have an important impact on their acquisition of information from knowledge maps.

General Summary

The problems involved in designing appropriate technical training environments are primarily related to difficulties posed by a diversity of instructional goals and methods inherent in such environments. Specifically, there are major problems associated with the presentation and processing of technical text and the utilization of such texts to perform concrete procedures in a social context.

The focus of this research program has been on the identification of successful learner-based scripts for the processing of technical text and the performance of concrete procedures. Given the wide variety of materials utilized in a job setting (Mikulecky, 1982), the development of flexible learner-based approaches to technical training appears to have important and immediate applicability.

The development of technical learning scripts involved the adaptation of successful text-processing scripts to the demands of technical information processing. The prototypical script involved the use of cooperating dyads and the controlled activation of cognitive/motor, affective, metacognitive, and social processes (CAMS). Adaptation of the prototypical script to specific task demands (e.g., different material types, different desired outcomes) were guided by Dansereau's (1986) CAMS framework for task performance and Anderson's (1982) skill acquisition theory. The adaptations made to the typical script involved manipulations of sub-strategies of the script.

The results of the research program demonstrated that the scripting of the CAMS activities of learners is successful; cooperative learning is more effective with technical information tasks than individual efforts; and manipulations of the prototypical script to accommodate specific task demands led to enhanced performance.

The latter part of the research program provided a preliminary examination of the use of knowledge maps as a means of improving the presentation/usability of technical text. Results of preliminary experimentation indicate that the use of knowledge maps has the potential to facilitate the communication of procedural information.

Combining scripted cooperation among peers and the use of knowledge maps may produce even further benefits by easing the difficulties experienced by learners with the presentation of information and by facilitating the use of such presentations for the purpose of performing target tasks.

References

Anderson, J. R. (1982). Acquisition of cognitive skills. Psychological Review, 89, 369-406.

Anderson, J. R. (1983). The architecture of cognition. Cambridge, Mass: Harvard University Press.

Anderson, J. R. (1985). Cognitive psychology and its implications. New York: W. H. Freeman & Co.

Armbruster, B. B. & Anderson, T. H. (1984). Mapping: Representing informative text diagrammatically. In C. D. Holley & D. F. Dansereau (Eds.), Spatial learning strategies, (pp.189-209). Orlando, FL: Academic Press.

Baker, L. & Brown, A. L. (1980). Metacognitive skills and reading. (Technical Report No. 188). Urbana: University of Illinois, Center for the Study of Reading.

Baker, L. & Brown, A. L. (1984). Metacognitive skills and reading. In P. D. Pearson (Ed.), Handbook of reading research (pp. 353-394). New York: Longman.

Brown, A. L. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), Advances in Instructional Psychology. Hillsdale, N.J. Lawrence Erlbaum.

Brown, A. L. & Palinscar, A. S. (1982). Inducing strategic learning from texts by means of informed self-control training. (Technical Report No. 262). Urbana: University of Illinois, Center for the Study of Reading.

Camperell, K. & Smith, L. L. (1982, Oct). Improving comprehension through the use of networking. Paper presented at the Southeastern Regional Conference of the International Reading Association, Philadelphia, PA.

Charney, D. H., & Reder, L. M. (1987). Initial skill learning: An analysis of how elaborations facilitate the three components. In P. Morris (Ed.), Modelling cognition (pp. 135-165).

Dansereau, D. F. (1978). The development of a learning strategies curriculum. In H. F. O'Neil (Ed.), Learning Strategies (pp. 1-29). New York: Academic Press.

Dansereau, D. F. (1985). Learning strategy research. In J. W. Segal, S. F. Chipman, & R. Glaser (Eds.), Thinking and learning skills, Vol. 1.: Relating instruction to research (pp. 209-239). Hillsdale, NJ: Lawrence Erlbaum Associates.

Dansereau, D. F. (1986, April). Development of a cooperative learning technology. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Dansereau, D. F. (1987a). Technical learning strategies. Engineering Education, 77(5), 280-284.

Dansereau, D. F. (1987b). Transfer from cooperative to individual studying. Journal of Reading, 30(7), 614-619.

Dansereau, D. F. (1988). Cooperative learning strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), Learning and study strategies: Issues in assessment, instruction, and evaluation (pp. 103-120). San Diego: Academic Press.

Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Diekhoff, G. M., & Evans, S. H. (1979). Development and evaluation of an effective learning strategy program. Journal of Educational Psychology, 71(1), 64-73.

Deignan, G. M. (1973). The Delta Reading Vocabulary Test. Air Force Human Resources Laboratory, Lowry Air Force Base, Co.

Dees, S., Dansereau, D. F., & O'Donnell, A. M. (1988, April). An analysis of affective responses to a cooperative learning task. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Tulsa, OK.

Duffy, T. M., Curran, T. E., & Sass, D. (1983). Document design for technical job tasks: An evaluation. Human Factors, 25, 143-160.

Dwyer, F. M. (1978). Strategies for improving visual learning. State College, PA: Learning Services.

Ekstrom, R. B., French, J. W., & Harman, H. H. (1976). Manual for Kit of Factor-Referenced Cognitive Tests. Princeton, NJ: Educational Testing Service.

Hall, R. H. (1988, April). Individual differences and the procedural learner. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Hall, R. H., Dansereau, D. F., & O'Donnell, A. M. (1988). Subjective graphing of metacognitive, affective, and social processing: A preliminary examination within the context of cooperative learning. Manuscript submitted for publication.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Hawk, P. P., & McLeod, N. P. (1983). Graphic organizer: An effective teaching method. Middle School Journal.

Hythecker, V. I., Dansereau, D. F., O'Donnell, A. M., Larson, C. O., Lambiotte, J. G., Rocklin, T. R., & Young, M. D. (1985, April). The development and evaluation of a strategy for procedure learning. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Austin, TX.

Hythecker, V. I., Dansereau, D. F., Rocklin, T. R., O'Donnell, A. M., Young, M. D., & Lambiotte, J. G. (1986, April). The development and evaluation of a modified procedure learning strategy. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Fort Worth, TX

Johnson, D. W., Johnson, R. T., & Skon, L. (1979). Student achievement on different types of task under cooperative, competitive, and individualistic conditions. Contemporary Educational Psychology, 79(4), 99-106.

Johnson, D. W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin, 89(1), 47-62.

Kern, R. P. (1985). Modeling users and their use of technical manuals. In T. M. Duffy & R. Waller, (Eds.), Designing usable texts (pp. 341-375). Orlando, FL.: Academic Press.

Lambiotte, J. G., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., & Rocklin, T. R. (1986, April). Technical learning strategies: Acquisition of structural and functional information. Paper presented at the Annual Meeting of the Southwestern Psychological Association.

Lambiotte, J. G., Dansereau, D. F., O'Donnell, A. M., Young, M. D., Skaggs, L. P., Hall, R. H., & Rocklin, T. R. (1987). Manipulating cooperative scripts for teaching and learning. Journal of Educational Psychology, 79, 424-430.

Lambiotte, J. G., Dansereau, D. F., O'Donnell, A. M., Young, M. D., Skaggs, L. P., & Hall, R. H. (in press). Effects of cooperative script manipulation and transfer. Cognition and Instruction, 5(2), xxx.

Larson, C. O., Dansereau, D. F., Goetz, E. T., & Young, M. D. (1985, Februrary). _Cognitive style and cooperative learning: Transfer of effects._ Paper presented at the Annual Meeting of the Southwest Educational Research Association, Austin, TX.

Larson, C. O., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., Lambiotte, J. G., & Rocklin, T. R. (1986). Technical training: An application of a strategy for learning structural and functional information. _Contemporary Educational Psychology_, _11_, 217-228.

Larson, C. O., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., & Rocklin, T. R. (1984). Verbal ability and cooperative learning: Transfer of effects. _Journal of Reading Behavior_, _16(4)_, 289-295.

Latane, B., Williams, K., & Harkin, S. (1979). Many hands make light the work: Causes and consequences of social loafing. _Journal of Personality and Social Psychology_, _10(4)_, 342-348.

Martinez-Boyd, D. (1988, April). _The planning performance trade-off in use of textual and illustrated procedural instructions._ Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Mayer, R. E. (1980). Elaboration techniques that increase the meaningfulness of technical text: An experimental test of the learning strategy hypothesis. _Journal of Educational Psychology_, _72_, 770-784.

McDonald, B. A., Larson, C. O., Dansereau, D. F., & Brooks, L. W. (1985). Cooperative learning: Impact on acquisition of knowledge and skills. _Contemporary Educational Psychology, 10(4)_, 369-377.

McKay, D. G. (1981). The problem of rehearsal or mental practice. _Journal of Motor Behavior_, _13(4)_, 274-285.

Meichenbaum, D. H., & Goodman, J. (1971). Training impulsive children to talk to themselves: A means of developing self-control. _Journal of Abnormal Psychology_, _77(2)_, 115-126.

Meyer, B. J. F. (1975). _The organization of prose and its effects on memory_. Amsterdam: North-Holland Publishing Co.

Mikulecky, L. (1982). Job literacy: The relationship between school preparation and workplace actuality. _Reading Research Quarterly_, _17(3)_, 400-419.

O'Donnell, A. M. (1986). _Cooperative procedural learning: The effects of prompting and planning activities_. Doctoral dissertation, Texas Christian University, Fort Worth, TX.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., & Rocklin, T. R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. _Journal of Educational Psychology_, _79_, 431-437.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Skaggs, L. P., Hythecker, V. I., Peel, J. L., & Rewey, K. L. (1988, April). Learning concrete procedures: The effects of processing strategies and cooperative learning. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Hall, R. H., Skaggs, L. P., Lambiotte, J. G., & Young, M. D. (1988). Cooperative procedural learning: The effects of prompting and pre- vs. distributed planning activities. Journal of Educational Psychology, 80(2), 161-171.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Larson, C. O., Rocklin, T. R., Lambiotte, J. G., & Young, M. D. (1986). Effects of monitoring on cooperative learning. Journal of Experimental Education, 54(3), 169-173.

O'Donnell, A. M., Dansereau, D. F., Lambiotte, J. G., Hall, R. H., Skaggs, L. P., Rewey, K. L., & Peel, J. L. (1988, August). Concept mapping: Impact on text recall and performance. Paper presented at the Annual Meeting of the American Psychological Association, Atlanta, GA.

O'Donnell, A. M., Dansereau, D. F., & Pitre, U. (1988, April). The effects of exposure to knowledge maps. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Tulsa, OK.

O'Donnell, A. M., Dansereau, D. F., & Rocklin, T. R. (1988). Individual differences in the cooperative learning of concrete procedures. Manuscript submitted for publication.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., & Larson, C. O. (1985). Cooperative writing: Direct effects and transfer. Written Communication, 2(3), 307-315.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., Larson, C. O., & Young, M. D. (1985). Effects of elaboration frequency on cooperative learning. Journal of Educational Psychology, 77, 572-580.

O'Donnell, A. M., Rocklin, T. R., Dansereau, D. F., Hythecker, V. I., Young, M. D., & Lambiotte, J. G. (1987). Amount and accuracy of information recalled by cooperative dyads: The effects of summary type and alternation of roles. Contemporary Educational Psychology, 12, 386-394.

Oltman, P. K., Raskin, E., & Witkin, H. A. (1971). Group embedded figures test. Palo Alto, CA: Consulting Psychologists Press.

Peterson, P., & Janicki, T. (1979). Individual characteristics and children's learning in large-group and small-group approaches. (Technical Report No. 496). Madison: Wisconsin Research and Development Center for Individualized Schooling.

Pinker, S. (1985). Visual cognition: An introduction. In S. Pinker, (Ed.). Visual cognition, (pp. 1-63). Cambridge, MA: MIT Press.

Reder, L. M. (1980). The role of elaboration in the comprehension and retention of prose: A critical review. Review of Educational Research, 50(1), 5-53.

Reder, L. M., Charney, D. H., & Morgan, K. I. (1986). The role of elaboration in learning a skill from an instructional text. Memory and cognition, 14(1), 64-78.

Resnick, L. B. (1987). Learning in school and out. Educational Researcher, 16(9), 13-20.

Robinson, F. P. (1946). Effective study. New York: Harper.

Ross, S. M., & DiVesta, F. J. (1976). Oral summary as a review strategy enhancing recall of textual material. Journal of Educational Psychology, 68, 689-695.

Schenck, E. M. (1977). The technical writer-readability formulas and the non-technical reader. Journal of Technical Writing and Communication, 7, 303-307.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. Review of Educational Research, 50(2), 241-271.

Sindelar, P. T., Monda, L. E., & O'Shea, L. (1988, April). The effects of repeated readings on instructional and mastery level readers. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Skaggs, L. P., Rocklin, T. R., Dansereau, D. F., O'Donnell, A. M., Lambiotte, J. G., Young, M. D., & Hall, R. H. (1987, April). Dyadic learning: Individual differences, interaction, and performance. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, D. C.

Slavin, R. E. (1978). Student teams and achievement divisions. Journal of Research and Development in Education, 12, 39-49.

Slavin, R. E. (1983a). Cooperative learning. New York: Longman, Inc.

Slavin, R. E. (1983b). When does cooperative learning increase student achievement? Psychological Bulletin, 94(3), 429-445.

Slavin, R. E. (1987). Ability grouping and student achievement in elementary schools: A best-evidence synthesis. Review of Educational Research, 57(3), 293-345.

Smillie, R. J. (1985). Design strategies for job performance aids. In T. M. Duffy & R. Waller (Eds.), Designing usable texts, (pp. 213-243). Orlando, FL.: Academic Press.

Smith, K. A., Johnson, D. W., & Johnson, R. T. (1981). The use of cooperative learning groups in engineering education. In L. P. Grayson & J. M. Biedenbach (Eds.), Proceedings: 10th Annual Frontiers in Education Conference, (pp. 29-32). Washington, D. C.: American Society for Engineering Education.

Spurlin, J. E., Dansereau, D. F., Larson, C. O., & Brook, L. W. (1984). Cooperative learning strategies in processing descriptive text: effects of role and activity level of the learner. Cognition and Instruction, 1(4), 451-463.

Spurlin, J. E., Dansereau, D. F., O'Donnell, A. M., & Brooks, L. W. (1988). Text processing: Effects of summarization frequency on text recall. Journal of Experimental Education, 56(4), 199-202.

Stedman, L. C. & Kaestle, C. F. (1987). Literacy and reading performance in the United States, from 1880 to the present. Reading Research Quarterly, 22, 8-46.

Stein, B. S., & Bransford, J. D. (1979). Constraints on effective elaboration: Effects of precision and subject generation. Journal of Verbal Learning and Verbal Behavior, 18, 769-777.

Sticht, T. (1985). Understanding readers and their use of texts. In T. M. Duffy & R. Waller (Eds.), Designing usable texts, (pp. 315-339). Orlando, FL.: Academic Press.

Stone, D. E., & Crandall, T. L. (1982). Relationships of illustrations and text in reading technical material. In Advances in reading/language research, Vol. 1 (pp. 283-307).

Thorndyke, P. W., & Stasz, C. (1980). Individual differences in procedures for knowledge acquisition from maps. Cognitive Psychology, 12, 137-175.

Wagner, R. K., & Sternberg, R. J. (1985). Practical intelligence in real world pursuits: The role of tacit knowledge. Journal of Personality and Social Psychology, 49(2), 436-458.

Warring, D., Johnson, D. W., Maruyama, G., & Johnson, R. (1985). Impact of different types of cooperative learning on cross-ethnic and cross-sex relationships. Journal of Educational Psychology, 77(1), 53-59.

Weinstein, C. E., Underwood, V. L., Wicker, F. W., & Cubberly, W. E. (1979). Cognitive learning strategies: Verbal and imaginal elaboration. In H. F. O'Neill, & C. D. Speilberger (Eds.), Cognitive and affective learning strategies (pp. 45-75). New York: Academic Press.

Wright, P., Creighton, P., & Threlfall, S. M. (1982). Some factors influencing when instructions will be read. Ergonomics, 25(3), 225-237.

Yager, S., Johnson, D. W., & Johnson, R. T. (1985). Oral discussion, group-to-individual transfer and achievement in cooperative learning groups. Journal of Educational Psychology, 77(1), 60-66.

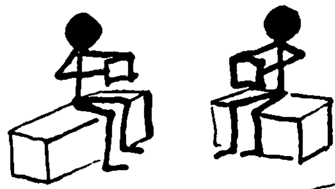
Young, M. D., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., Skaggs, L. P., Hall, R. H., & Rocklin, T. R. (1987, April). Effects of cooperative compare/contrast and review strategies on the acquisition of technical information. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, D.C.

Ziegler, S. (1981). The effectiveness of cooperative learning teams for increasing cross-ethnic friendship: Additional evidence. Human Organization, 40, 264-268.

List of Figures

Figure 1. PROTOTYPICAL SCRIPT

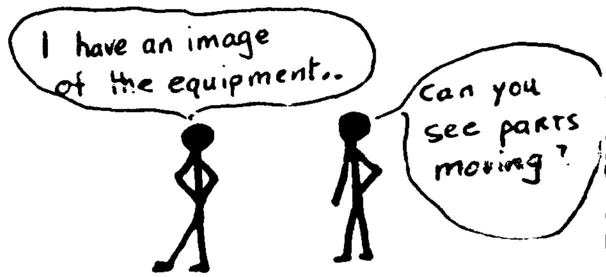
Both partners read the first section of the text.



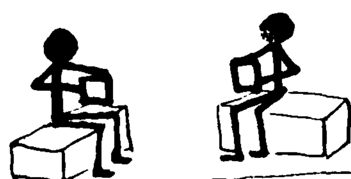
Partner A reiterates the information without looking at the text.

Partner B provides feedback, without looking at the text.

Both partners elaborate on the information.



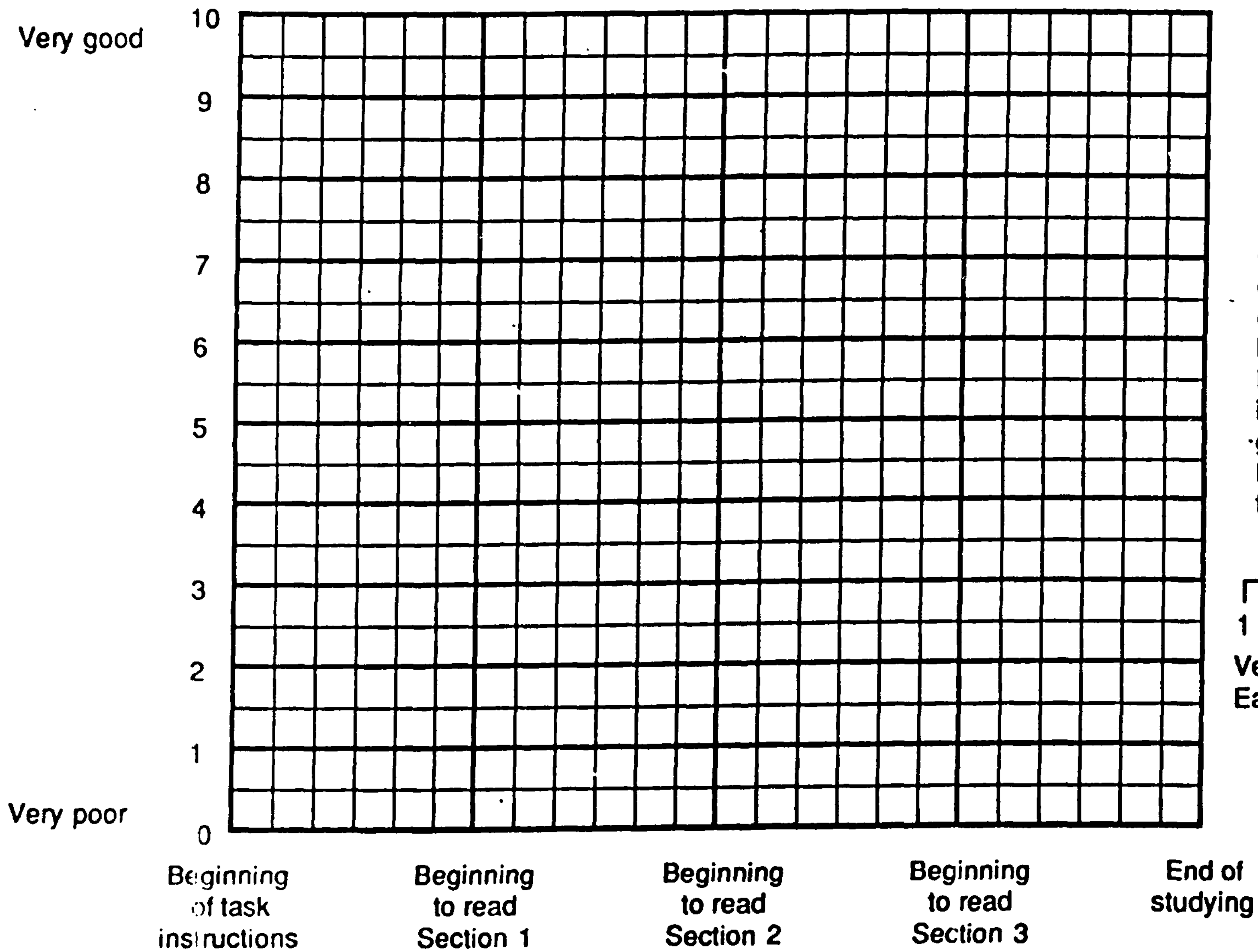
Both partners read the second section of the text.



Partners A and B switch roles for the second section.

A and B continue in this manner until they have completed the passage.

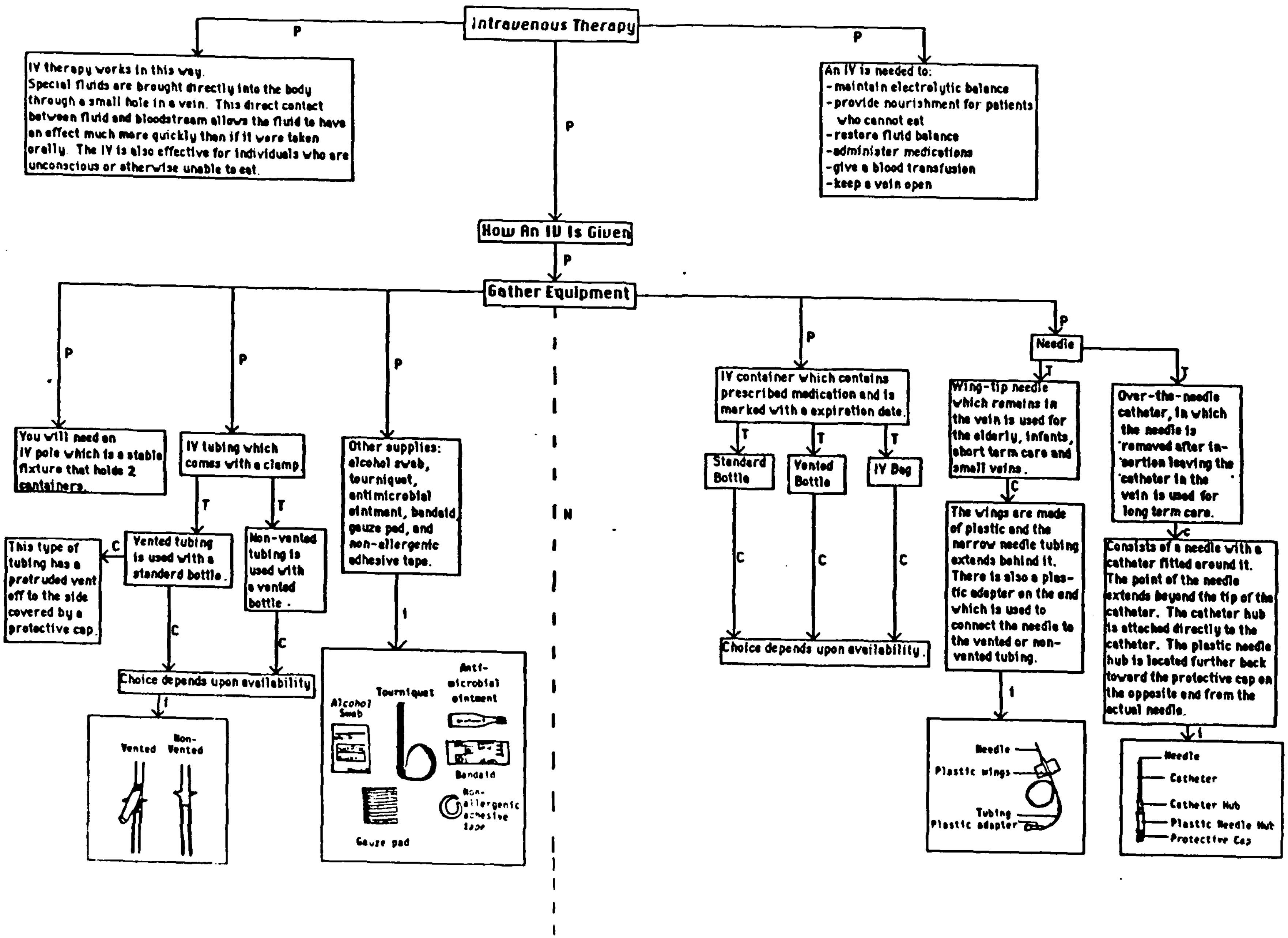
How good was your concentration while studying?

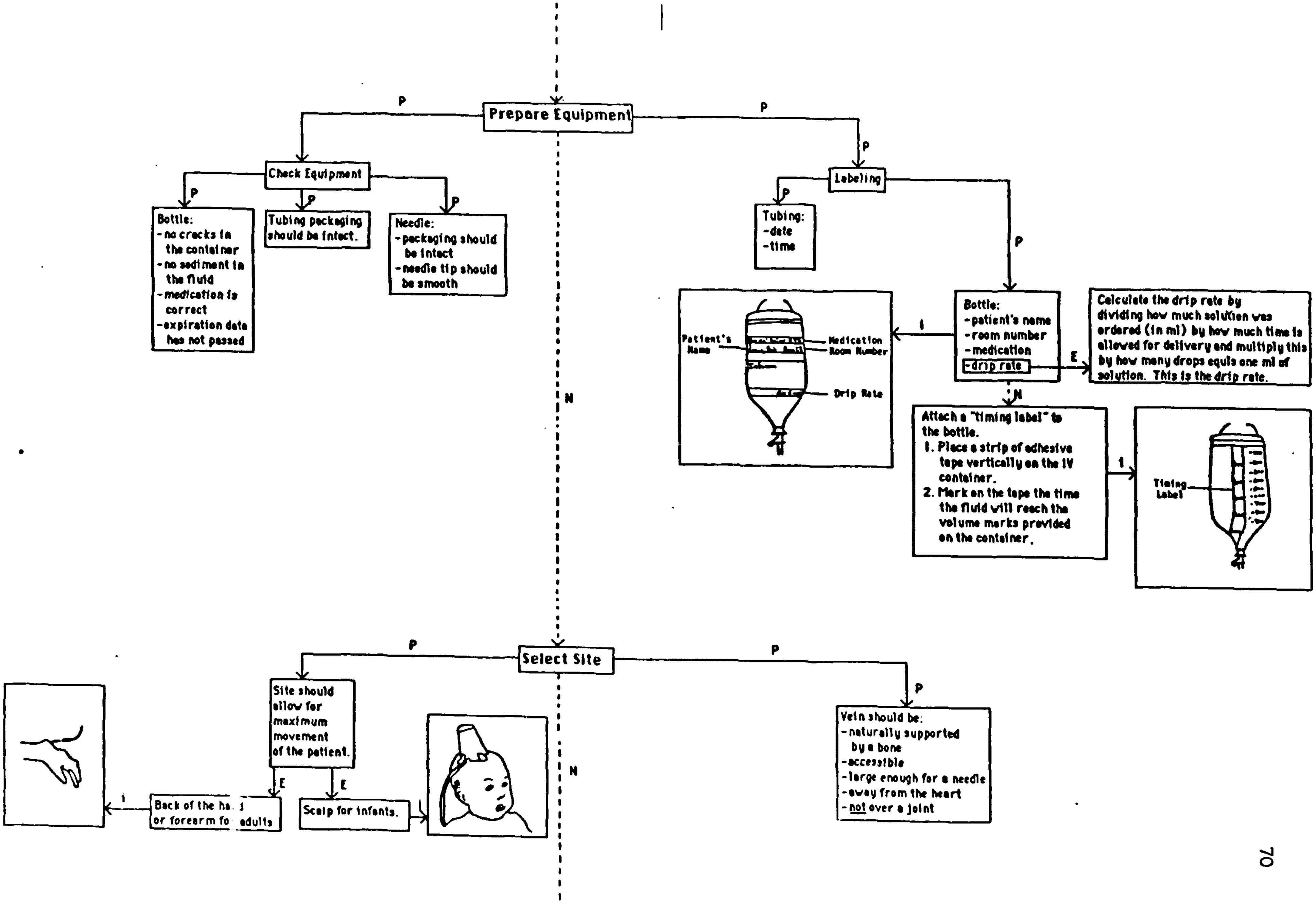


After filling in the graph, please circle a number on the the scale below to indicate how easy or hard it was to use the graph to describe how you were feeling.

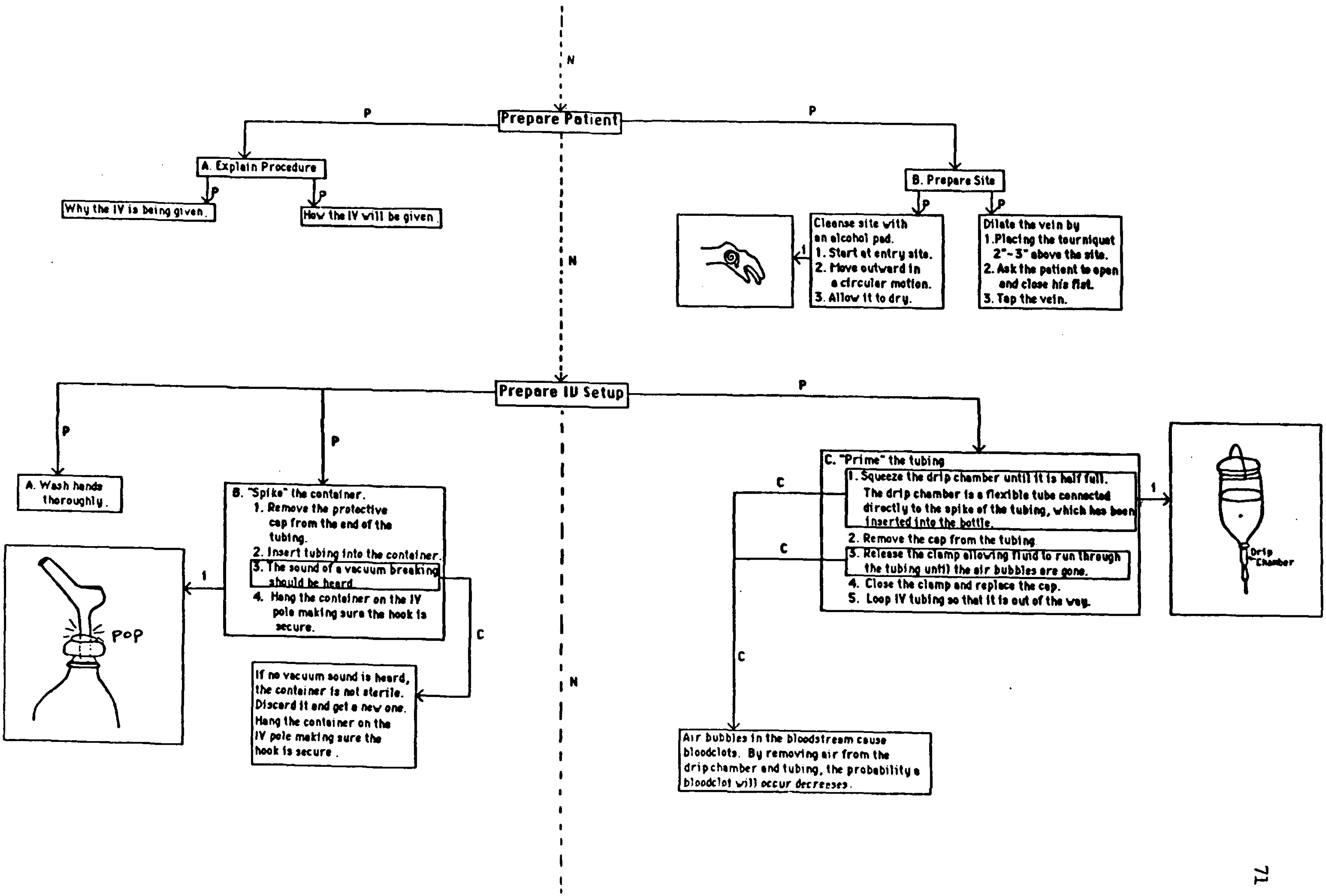
1 2 3 4 5 6 7

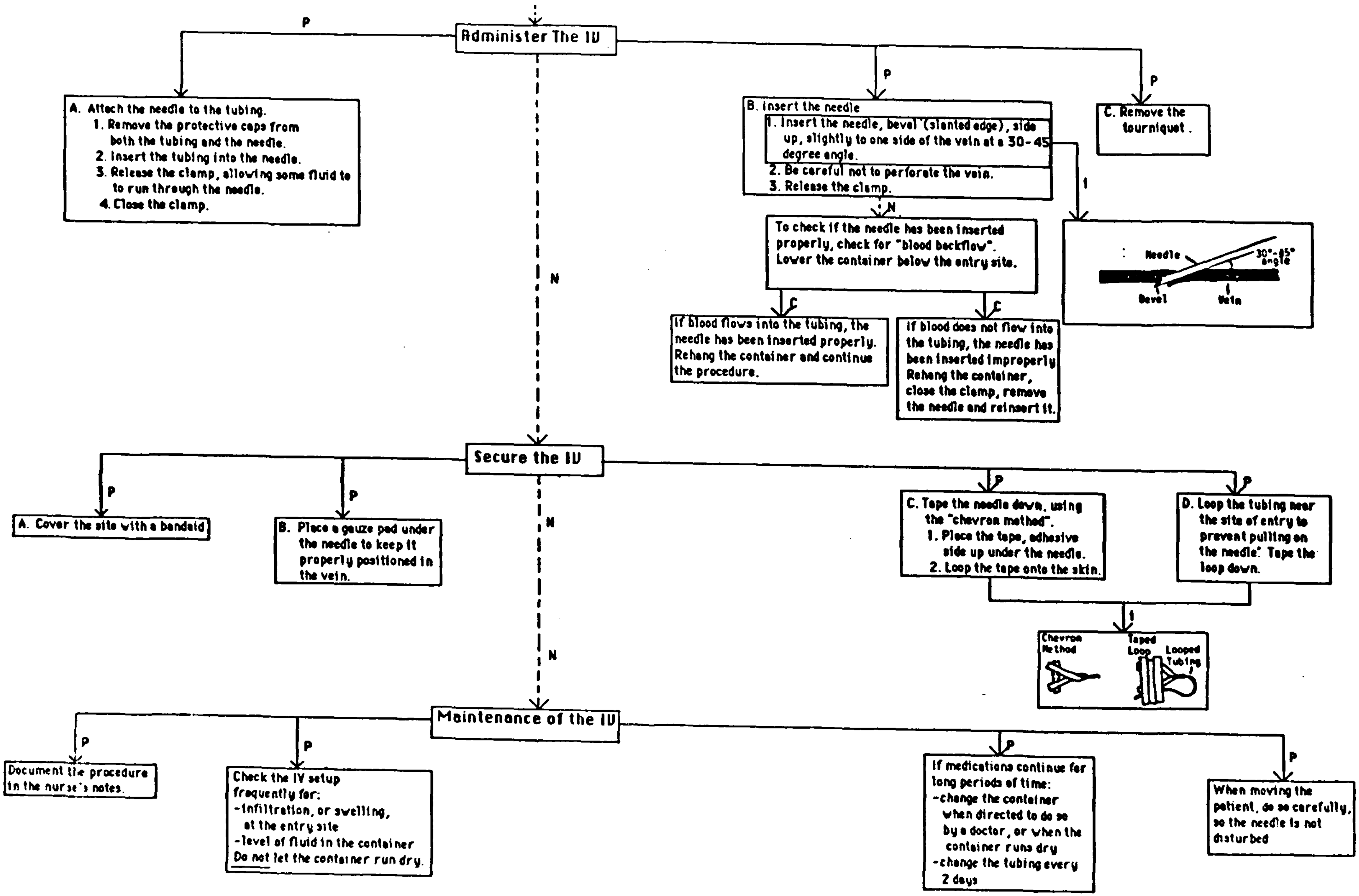
Very Easy — Very Difficult


Intravenous Therapy
P
IV therapy works in this way.
Special fluids are brought directly into the body through a small hole in a vein. This direct contact between fluid and bloodstream allows the fluid to have an effect much more quickly than if it were taken orally. The IV is also effective for individuals who are unconscious or otherwise unable to eat.
An IV is needed to:
-maintain electrolytic balance
-provide nourishment for patients who cannot eat
-restore fluid balance
-administer medications
-give a blood transfusion
-keep a vein open
How An IV Is Given
Gather Equipment
N
You will need an IV pole which is a stable fixture that holds 2 containers.
IV tubing which comes with a clamp.
T
Vented tubing is used with a standard bottle.
Non-vented tubing is used with a vented bottle.
C
This type of tubing has a protruded vent off to the side covered by a protective cap.
Choice depends upon availability.
I
Vented
Non-Vented
Other supplies: alcohol swab, tourniquet, antimicrobial ointment, bandaid, gauze pad, and non-allergenic adhesive tape.
Alcohol Swab
Tourniquet
Anti-microbial ointment
Bandaid
Gauze pad
Non-allergenic adhesive tape
IV container which contains prescribed medication and is marked with a expiration date.
Standard Bottle
Vented Bottle
IV Bag
Choice depends upon availability.
Needle
Wing-tip needle which remains in the vein is used for the elderly, infants, short term care and small veins.
The wings are made of plastic and the narrow needle tubing extends behind it. There is also a plastic adapter on the end which is used to connect the needle to the vented or non-vented tubing.
Needle
Plastic wings
Tubing
Plastic adapter
Over-the-needle catheter, in which the needle is removed after insertion leaving the catheter in the vein is used for long term care.
Consists of a needle with a catheter fitted around it. The point of the needle extends beyond the tip of the catheter. The catheter hub is attached directly to the catheter. The plastic needle hub is located further back toward the protective cap on the opposite end from the actual needle.
Needle
Catheter
Catheter Hub
Plastic Needle Hub
Protective Cap

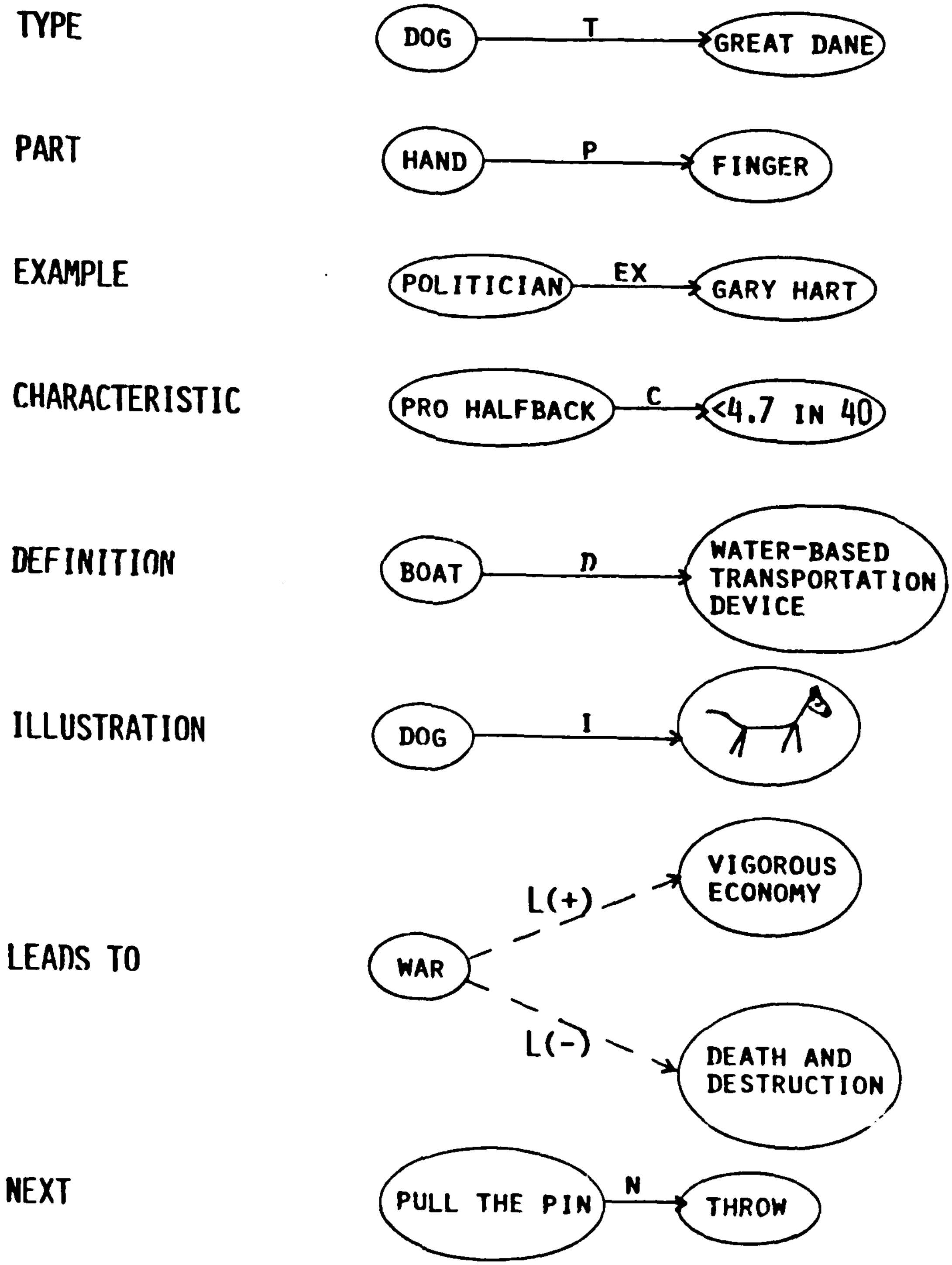


Prepare Equipment
P
Check Equipment
Bottle:
-no cracks in the container
-no sediment in the fluid
-medication is correct
-expiration date has not passed
Tubing packaging should be intact.
Needle:
-packaging should be intact
-needle tip should be smooth
Labeling
Tubing:
-date
-time
Bottle:
-patient's name
-room number
-medication
-drip rate
Patient's Name
Medication
Room Number
Drip Rate
Calculate the drip rate by dividing how much solution was ordered (in ml) by how much time is allowed for delivery and multiply this by how many drops equls one ml of solution. This is the drip rate.
Attach a "timing label" to the bottle.
1. Place a strip of adhesive tape vertically on the IV container.
2. Mark on the tape the time the fluid will reach the volume marks provided on the container.
Timing Label
E
N
I
Select Site
Site should allow for maximum movement of the patient.
Back of the ha d or forearm fo adults
Scalp for infants.
Vein should be:
-naturally supported by a bone
-accessible
-large enough for a needle
-away from the heart
-not over a joint


N
Prepare Patient
P
A. Explain Procedure
P
Why the IV is being given.
P
How the IV will be given.
P
B. Prepare Site
P
Cleanse site with an alcohol pad.
1. Start at entry site.
2. Move outward in a circular motion.
3. Allow it to dry.
1
P
Dilate the vein by
1. Placing the tourniquet 2"-3" above the site.
2. Ask the patient to open and close his fist.
3. Tap the vein.
N
Prepare IV Setup
P
A. Wash hands thoroughly.
P
B. "Spike" the container.
1. Remove the protective cap from the end of the tubing.
2. Insert tubing into the container.
3. The sound of a vacuum breaking should be heard.
4. Hang the container on the IV pole making sure the hook is secure.
1
POP
C
If no vacuum sound is heard, the container is not sterile. Discard it and get a new one. Hang the container on the IV pole making sure the hook is secure.
P
C. "Prime" the tubing
1. Squeeze the drip chamber until it is half full. The drip chamber is a flexible tube connected directly to the spike of the tubing, which has been inserted into the bottle.
2. Remove the cap from the tubing.
3. Release the clamp allowing fluid to run through the tubing until the air bubbles are gone.
4. Close the clamp and replace the cap.
5. Loop IV tubing so that it is out of the way.
1
Drip Chamber
C
C
C
Air bubbles in the bloodstream cause bloodclots. By removing air from the drip chamber and tubing, the probability a bloodclot will occur decreases.
N


Administer The IV
A. Attach the needle to the tubing.
1. Remove the protective caps from both the tubing and the needle.
2. Insert the tubing into the needle.
3. Release the clamp, allowing some fluid to to run through the needle.
4. Close the clamp.
B. Insert the needle
1. Insert the needle, bevel (slanted edge), side up, slightly to one side of the vein at a 30-45 degree angle.
2. Be careful not to perforate the vein.
3. Release the clamp.
C. Remove the tourniquet.
To check if the needle has been inserted properly, check for "blood backflow". Lower the container below the entry site.
If blood flows into the tubing, the needle has been inserted properly. Rehang the container and continue the procedure.
If blood does not flow into the tubing, the needle has been inserted improperly. Rehang the container, close the clamp, remove the needle and reinsert it.
Needle
30°-45° angle
Bevel
Vein
Secure the IV
A. Cover the site with a bandaid
B. Place a gauze pad under the needle to keep it properly positioned in the vein.
C. Tape the needle down, using the "chevron method".
1. Place the tape, adhesive side up under the needle.
2. Loop the tape onto the skin.
D. Loop the tubing near the site of entry to prevent pulling on the needle. Tape the loop down.
Chevron Method
Taped Loop
Looped Tubing
Maintenance of the IV
Document the procedure in the nurse's notes.
Check the IV setup frequently for:
-infiltration, or swelling, at the entry site
-level of fluid in the container
Do not let the container run dry.
If medications continue for long periods of time:
-change the container when directed to do so by a doctor, or when the container runs dry
-change the tubing every 2 days
When moving the patient, do so carefully, so the needle is not disturbed
P
N
C
I

EXAMPLES OF KNOWLEDGE MAP LINK TYPES



APPENDIX A

APPENDIX A

PRESENTATIONS

Dansereau, D. F. (1984). Cooperative learning strategies. Presentation, Conference on Learning and Study Strategies, Texas A&M University, College Station, TX, October.

Lambiotte, J. G., & Dansereau, D. F. (1985). Suggestions for facilitating transfer from cooperative to individual learning. Presentation, Annual Meeting, Southwest Educational Research Association, Austin, TX, February.

Larson, C. O., Dansereau, D. F., Goetz, E., & Young, M. D. (1985). Cognitive style and cooperative learning: Transfer of effects. Presentation, Annual Meeting, Southwest Educational Research Association, Austin, TX, February.

Larson, C. O., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., Lambiotte, J. G., & Rocklin, T. R. (1985). Technical training: An application of a strategy for learning structural and functional information. Presentation, Annual Meeting, American Educational Research Association, Chicago, March 30-April 1.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., & Larson, C. O. (1985). Cooperative writing: Direct effects and transfer. Presentation, Annual Meeting, American Educational Research Association, Chicago, March 30-April 1.

Hythecker, V. I., Dansereau, D. F., O'Donnell, A. M., Larson, C. O., Lambiotte, J. G., Rocklin, T. R., & Young, M. D. (1985). The development and evaluation of a strategy for procedure learning. Presentation, Annual Meeting, Southwestern Psychological Association, Austin, TX, April.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Larson, C. O., Rocklin, T. R., Lambiotte, J. G., & Young, M. D. (1985). Effects of monitoring on cooperative learning. Presentation, Annual Meeting, Southwestern Psychological Association, Austin, TX, April.

O'Donnell, A. M. (1986). Reading for action: A conceptual analysis of procedural learning. Presentation, International/National Reading Conference Symposium, San Antonio, TX, January.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Larson, c. O., Hythecker, V. I., Young, M. D., & Lambiotte, J. G. (1986). Individual editing or cooperation: Effects on an instruction writing task. Presentation, Annual Meeting, Southwestern Psychological Association, Fort Worth, TX, April.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Young, M. D., & Lambiotte, J. G. (1986). Individual differences in cooperative learning. Presentation, Annual Meeting, Southwestern Psychological Association, Fort Worth, TX, April.

Lambiotte, J. G., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., & Rocklin, T. R. (1986). Technical learning strategies: Acquisition of structural and functional information. Presentation, Annual Meeting, Southwestern Psychological Association, Fort Worth, TX, April.

Hythecker, V. I., Dansereau, D. F., Rocklin, T. R., O'Donnell, A. M., Young, M. D., & Lambiotte, J. G. (1986). The development and evaluation of a modified procedure learning strategy. Presentation, Annual Meeting, Southwestern Psychological Association, April, Fort Worth, TX.

Young, M. D., Dansereau, D. F., O'Donnell, A.M., Hythecker, V. I., Lambiotte, J. G., Skaggs, L. P., Hall, R. H., & Rocklin, T. R. (1986). Cooperative integration and review of technical procedures. Presentation, Annual Meeting, Southwestern Psychological Association, April, Fort Worth, TX.

Dansereau, D.F. (1986). Development of a cooperative learning technology. Presentation at the Annual Meeting of the American Educational Research Association, San Francisco, April.

Dansereau, D.F. (1986). Dyadic cooperative learning and performance strategies. Presentation, Special Interest Group Symposium on "Cooperation: Theory, Research, and Application," Annual Meeting of the American Educational Research Association, San Francisco, April.

O'Donnell, A.M., Dansereau, D.F., Hythecker, V.I., Larson, C.O., Rocklin, T.R., Lambiotte, J.G., & Young, M.D. (1986). Effects of various cooperative scenarios on amount and accuracy of text recall: Two's company, three's a crowd. Presentation at the Annual Meeting of the American Educational Research Association, San Francisco, April.

O'Donnell, A.M., Larson, C.O., Dansereau, D.F., & Rocklin, T.R. (1986). Effects of cooperation and editing on instruction writing performance. Presentation at the Annual Meeting of the American Educational Research Association, San Francisco, April.

O'Donnell, A.M., Rocklin, T.R., Dansereau, D.F., Hythecker, V.I., Young, M.D., Lambiotte, J.G. (1986). Amount and accuracy of information recalled by cooperative dyads: The effects of summary type and alternation of roles. Presentation at the Annual Meeting of the American Educational Research Association Meeting, San Francisco, April.

Hythecker, V.I., Dansereau, D.F., & Rocklin, T.R. (1986). Cooperative learning: Why is it effective? Presentation at the Annual Meeting of the American Educational Research Association, San Francisco, April.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1986). Comparison of individual and dyadic learning: The role of induction. Presentation, Annual Meeting, American Psychological Association, Washington, DC, August.

Dansereau, D. F. (1986). Cooperative training groups: New advances in theory, research, and application. Presentation, Region VII Conference of the American Society for Training and Development, Fort Worth, TX, October.

Dansereau, D. F. (1986). Technical learning strategies. Presentation, Frontiers in Education Conference, Arlington, TX, October.

O'Donnell, A. M. (1986). Seminar on technical training. Presentation, to faculty and graduate students, University of Texas, Department of Educational Psychology, Austin, TX, November.

O'Donnell, A. M. (1987). Project-related information presented to faculties of Virginia Institute of Technology, and Gallaudet University, January.

Dansereau, D. F. (1987). Workshop, presentation of research. Science and Engineering Faculty of the National Technical Institute for the Deaf, Rochester, NY, January.

Dansereau, D.F. (1987). Improving learning and thinking skills via dyadic cooperative interactions. Presentation at the Third International Conference on Thinking, Honolulu, Hawaii, January.

Hall, R. H., Dansereau, D. F., & O'Donnell, A. M. (1987). Subjective graphing of metacognitive, affective, and social processing. Presentation, Annual Meeting, Southwestern Psychological Association, New Orleans, April.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Skaggs, L. P., Lambiotte, J. G., & Young, M. D. (1987). Cooperative procedure acquisition: The effects of planning and prompting activities. Presentation, Annual Meeting, Southwest Educational Research Association, Dallas, January.

Skaggs, L. P., Rocklin, T. R., Dansereau, D. F., O'Donnell, A. M., Lambiotte, J. G., Young, M. D., & Hall, R. H. (1987). The implications of individual differences and social interaction variables for cooperative learning. Presentation, Annual Meeting, Southwest Educational Research Association, Dallas, January.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1987). Individual differences in the learning of structural/functional and procedural material. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

Lambiotte, J. G., Dansereau, D. F., O'Donnell, A. M., Young, M. D., Skaggs, L. P., & Hall, R. H. (1987). Manipulating cooperative scripts for teaching and learning. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (1987). The role of individual differences in procedure/skill acquisition. Presentation, Annual Meeting, American Educational Research Association, Special Interest Group on Text Design and Learner Strategies, Washington, DC, April.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (1987). Procedure/skill acquisition in cooperative dyads. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., & Rocklin, T. R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

Skaggs, L. P., Rocklin, T. R., Dansereau, D. F., O'Donnell, A. M., Lambiotte, J. G., Young, M. D., & Hall, R. H. (1987). Dyadic learning: Individual differences, interaction, and performance. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

Young, M. D., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., Skaggs, L. P., Hall, R. H., & Rocklin, T. R. (1987). Effects of cooperative compare/contrast and review strategies on the acquisition of technical information. Presentation, Annual Meeting, American Educational Research Association, Washington, DC, April.

Dansereau, D. F. (1987). Scripted dyadic communication. INVITED ADDRESS, Mid-Atlantic Conference on Cooperative Learning, Annapolis, MD, June.

Hall, R.H., Dansereau, D.F., O'Donnell, A.M., & Skaggs, L.P. (1987). The effect of textual disruption on dyadic and individual learning. Presentation, Annual Meeting, American Psychological Association, New York, August.

O'Donnell, A.M., & Dansereau, D.F. (1988). Predicting performance of concrete procedures. Presentation, Eastern Educational Research Association Annual Meeting, Miami, FL, February 1988.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Skaggs, L. P., Hythecker, V. I., Peel, J. L., & Rewey, K. L. (1988). Learning concrete procedures: The effects of processing strategies and cooperative learning. Presentation, Annual Meeting, American Educational Research Association, New Orleans.

O'Donnell, A. M., Dansereau, D. F. (1988). Learning concrete procedures: Cooperative planning and prompting. Presentation, Annual Meeting, American Educational Research Association, New Orleans.

Hythecker, V. I., Dansereau, D. F., Rocklin, T. R., O'Donnell, A. M., Larson, C. O., Young, M. D., & Lambiotte, J. G. (1988). A procedure learning strategy: Development and evaluation. Unpublished manuscript.

Dansereau, D.F., O'Donnell, A.M., & Lambiotte, J.G. (1988). Concept maps and scripted peer cooperation: Interactive tools for improving science and technical education. Presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

Hall, R.H. (1988). Individual differences and the procedural learner. Symposium presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

Hall, R.H., Dansereau, D.F., Lambiotte, J.G., O'Donnell, A.M., Skaggs, L.P., & Pitre, U. (1988). Individual differences in the use of scripted cooperation and concept maps. Presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

Lambiotte, J.G., Dansereau, D.F., O'Donnell, A.M., Young, M.D., Skaggs, L.P., & Hall, R.H. (1988). Effects of cooperative script manipulations on initial learning and transfer. Presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

O'Donnell, A.M., Dansereau, D.F., Hall, R.H., Skaggs, L.P., Hythecker, V.I., Peel, J.L., & Rewey, K.L. (1988). Learning concrete procedures: The effects of processing strategies and cooperative learning. Presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

O'Donnell, A.M., & Dansereau, D.F. (1988). Learning concrete procedures: Cooperative planning and prompting. Presentation, Annual Meeting, American Educational Research Association, New Orleans, LA, April.

Dees, S.M., Dansereau, D.F., & O'Donnell, A.M. (1988). An analysis of affective responses to a cooperative learning task. Presentation, Annual Meeting, Southwestern Psychological Association, Tulsa, OK, April.

Hall, R.H., Dansereau, D.F., & Skaggs, L.P. (1988). Individual differences in affective and cognitive responses to anomalous text. Presentation, Annual Meeting, Southwestern Psychological Association, Tulsa, OK, April.

O'Donnell, A.M., Dansereau, D.F., Pitre, U. (1988). The effects of exposure to knowledge maps. Presentation, Annual Meeting, Southwestern Psychological Association, Tulsa, OK, April.

Rewey, K.L., & Dansereau, D.F. (1988). Knowledge maps and scripted learning: Effects on transfer of skills. Presentation, Annual Meeting, Southwestern Psychological Association, Tulsa, OK, April.

Skaggs, L.P., Dansereau, D.F., & Hall, R.H. (1988). The effects of learning scripts on initial learning and transfer. Presentation, Annual Meeting, Southwestern Psychological Association, Tulsa, OK, April.

Hall, R. H., Dansereau, D. F., Lambiotte, J. G., O'Donnell, A. M., Skaggs, L. P., Pitre, U. (1988). Knowledge map processing: Differential roles of spatial and verbal abilities. To be presented at the Annual Meeting, American Psychological Association, Atlanta, GA, August.

Hall, R. H., Dansereau, D. F., & Skaggs, L. P. (1988). The cooperative learner. To be presented at the Annual Meeting, American Psychological Association, Atlanta, GA, August.

O'Donnell, A. M., Dansereau, D. F., Lambiotte, J. G., Hall, R. H., Skaggs, L. P., Rewey, K. L., & Peel, J. L. (1988). Concept mapping impact on text recall and performance. To be presented at the Annual Meeting, American Psychological Association, Atlanta, GA, August.

Dansereau, D. F. (1988). Knowledge mapping and scripted peer cooperation: Tools for enhancing communication, learning, and thinking processes. INVITED KEYNOTE ADDRESS, "Thinking...for a Change" Conference, Edmonton, Alberta, Canada, August.

Dansereau, D. F. (1988). Knowledge mapping and scripted cooperation: Background, techniques, and usage. INVITED PRESENTATION, "Thinking...for a Change" Conference, Edmonton, Alberta, Canada, August.

ARCHIVAL PUBLICATIONS:

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Larson, C. O., Rocklin, T. R., Lambiotte, J. G., & Young, M. D. (1986). Effects cf monitoring on cooperative learning. Journal of Experimental Education, 54(3), 169-173.

Dansereau, D. F. (1987). Transfer from cooperative to individual studying. INVITED MANUSCRIPT. Journal of Reading, 30(7), 614-619.

Dansereau, D. F. (1987). Technical learning strategies. Engineering Education, 77(5), 280-284.

Dansereau, D. F. (1988). Cooperative learning strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), Learning and study strategies: Issues in assessment, instruction, and evaluation, pp. 103-120. New York: Academic Press.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., Larson, C. O., & Young, M. D. (1985). Effects of elaboration frequency on cooperative learning. Journal of Educational Psychology, 77, 572-580.

O'Donnell, A. M., Rocklin, T. R., Dansereau, D. F., Hythecker, V. I., Young, M. D., & Lambiotte, J. G. (1987). Amount and accuracy of information recalled by cooperative dyads: The effects of summary type and alternation of roles. Contemporary Educational Psychology, 12, 386-394.

Larson, C. O., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., Lambiotte, J. G., & Rocklin, T. R. (1986). Technical training: An application of a strategy for learning structural and functional information. Contemporary Educational Psychology, 11, 217-228.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Hythecker, V. I., Dansereau, D. F., & Rocklin, T. R. (1988). An analysis of the processes influencing the structured dyadic learning environment. Educational Psychologist, 23(1), 21-35.

Lambiotte, J. G., Dansereau, D. F., O'Donnell, A. M., Young, M. D., Skaggs, L. P., Hall, R. H., & Rocklin, T. R. (1987). Manipulating cooperative scripts for teaching and learning. Journal of Educational Psychology, 79, 424-430.

Lambiotte, J. G., Dansereau, D. F., Rocklin, T. R., Fletcher, B., Hythecker, V. I., Larson, C. O., & O'Donnell, A. M. (1987). Cooperative learning and test-taking: Transfer of skills. Contemporary Educational Psychology, 12(1), 52-61.

Lambiotte, J. G., Dansereau, D. F., O'Donnell, A. M., Young, M. D., Skaggs, L. P., & Hall, R. H. (1988). Effects of cooperative script manipulations on initial learning and transfer. Cognition and Instruction, 5(2), 103-121.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., & Rocklin, T. R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. Journal of Educational Psychology, 79, 431-437.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., & Larson, C. O. (1985). Cooperative writing: Direct effects and transfer. Written Communication, 2, 307-315.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Larson, C. O., Hythecker, V. I., Young, M. D., & Lambiotte, J. G. (1987). Effects of cooperation and individual rewriting on an instruction writing task. Written Communication, 4, 90-99.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Young, M. D., Hall, R. H., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Hall, R. H., Skaggs, L. P., Lambiotte, J. G., & Young, M. D. (1988). Cooperative procedural learning: The effects of prompting and pre- versus distributed planning activities. *Journal of Educational Psychology*, *80*(*2*), 167-171.

Dansereau, D. F., & O'Donnell, A. M. (Manuscript in progress, 1988). Student dyads: Cooperative scripts and strategies for enhancing learning and performance. To be published in R. H. Lazarowitz, & N. Miller (Eds.), *Interactions in cooperative settings*.

Dansereau, D. F. (Manuscript in progress, 1988). Review of knowledge maps (working title). *Educational Psychology Review* (Inaugural Issue, John Glover, Editor).

Hall, R. H., Dansereau, D. F., O'Donnell, A. M., & Skaggs, L. P. (in press). The effect of textual errors on dyadic and individual learning. *Journal of Reading Behavior*.

APPENDIX B

APPENDIX B

An Analysis of Subjective Reactions During

the Learning of a Concrete Procedure

Abstract

This work is an exploratory attempt (a) to assess the value of "graffects," a post-activity measure which cues the learner to recall subjective reactions at specific points during the learning process, and (b) to examine subjective reactions in the context of a procedural learning task and cooperative (dyad) learning strategies. Each of the 98 undergraduate psychology students who participated in the study was randomly assigned to one of four learning strategy groups: (a) no-strategy individuals, (b) prompting only dyads, (c) distributed planning plus prompting dyads, or (d) pre- (massed) planning plus prompting dyads. Participants learned how to set up and start an intravenous infusion; they were then asked to chart, via graffects, their subjective reactions over the course of this learning episode. At a later time, each completed written recall and performance of the procedure and responded to a questionnaire on subjective reactions to the task. Results indicated that (a) graffects provided unique information on changes in subjective reactions, and (b) learning strategy had significant impact on subjective reactions. The appearance of patterns of subjective responses by strategy group suggests that over a longer period of time the impact of these responses on outcome measures would be more apparent.

AN ANALYSIS OF SUBJECTIVE REACTIONS DURING THE LEARNING OF A CONCRETE PROCEDURE

Research to date suggests that subjective reactions, such as anxiety and feelings of competency, play important roles in the processes and outcomes of learning (Sarason 1987; Weiner, 1982; Wicklund & Gollwitzer, 1983). The possibility that these reactions may impact on a learning experience demands an attempt to understand the dynamics involved and specify critical variables. An understanding of this factor may add significantly to the precision with which we evaluate, develop, or prescribe particular curricula or learning strategies.

Tangible cognitive outcomes, such as recall or performance measures, are usually considered the "bottom line" in the evaluation of a learning or instructional strategy. We suggest, however, that even when negative reactions to a single learning experience show minimal effects on outcome measures, we should consider the effect of such a reaction over an extended period of time. If response to a learning strategy or instructional technique is negative, or negative during the course of learning, and positive only as the process concludes, can we expect such a strategy to be efficient and/or productive on a long-term basis? If not, then perhaps subjective reactions should be considered as supplements to objective measures and used as indices of individual performance patterns, ability to be a team player, and motivation for subsequent training.

Patterns of subjective reactions to a learning episode may suggest why certain training scenarios are successful or unsuccessful. Such indications might promote a reworking of the approach or allow more precision in its use. Patterns of reactions may also be useful in the tailoring or selection of instructional methods for specific individuals. A knowledge of how an individual reacts during the learning process may serve as a basis for selecting individuals for future tasks and/or training scenarios.

Our focus in this paper is on the impact of subjective reactions during the course of learning a concrete procedure, the administration of an intravenous injection. Our interest is in understanding differential impacts of subjective reactions with respect to cooperative (dyad) versus individual learning techniques.

A Working Definition of Subjective Reactions

We will use the term "subjective reactions" to refer broadly to the "feeling" responses of participants in a learning task. Table 1 delineates the particular responses we have considered here. These can be contrasted with objective measures such as the recall/comprehension of learned material or performance of a learned procedure.

While we have made no attempt to categorize these reactions as cognitive, affective, metacognitive, or social in nature, each reflects aspects of the "CAMS" conceptualization of dyadic learning, a model discussed in more detail at a later point in this paper. We have brought these together under the global heading of "subjective reactions" because all are reactions which might influence performance on a learning task, and none are readily observable responses to such a task.

Insert Table 1 about here

Our operational definition of a subjective reaction is clearly contingent on the tool we use to measure that reaction. A wide range of research efforts suggest that subjective reactions are difficult to document, and may, in fact, be altered by the nature of the instrument with which they are measured (Ajzen & Fishbein, 1977; Ericsson & Simon, 1980; Scheier & Carver, 1983; Wicklund & Gollwitzer, 1983). Our measurement device for the present study was a series of graphs called "graffects," a post-activity measure which cues the learner to recall processing states--feelings--at specific points in time during the learning task. This tool was developed by Dansereau and associates (Hall et al., 1987) in the course of research on dyadic learning strategies. Figure 1 shows a sample graph, and Table 1 indicates the question addressed by each graph.

Insert Figure 1 about here

Figure 2 shows the nine points on the graph that were used as scores in subsequent analyses. Learners were asked to chart fluctuations in feeling over time, rather than to produce a single, absolute value for response to an entire procedure. Although one aspect of analysis involved an average of these scores over time, the intent was to allow sensitivity to changes in feeling. Our operational definition of a subjective reaction, then, is a learner's response/score on a graffect graph.

Insert Figure 2 about here

Objectives

This work, part of a government contract to study the effect of dyadic learning strategies (learning in pairs) on the acquistion of procedural skills, focused on four primary objectives. These objectives consisted of exploratory attempts to accomplish the following:

1. Assess the value of graffects: How does this instrument differ from traditional posttask measures of

subjective reactions?

2. Determine the impact of subjective reactions in the context of a procedural learning task: How do subjective reactions relate to objective outcome measures?

3. Determine the impact of dyadic learning strategies on subjective reactions: Do different strategy groups show different patterns of subjective reaction over the course of the learning task?

4. Assess the impact of subjective reactions to partners: Are similarity of partners' subjective responses ("harmony") and awareness of partner's reactions ("transpersonal metacognition") important variables?

Prior Work on Subjective Responses in Learning

The relationship between subjective responses and learning has received notably less attention than the relationship between specific learning/teaching strategies and more efficient learning and/or better results on subsequent tests of that learning. As noted above, valid assessment of subjective responses is not a simple task. Perhaps the most difficult problem is that subjective responses are manifested in a variety of ways, including both covert responses that are not open to public inspection and overt responses that are open both to public inspection and misinterpretation.

Learning/teaching strategies, on the other hand, are more often straightforward, overt manipulations of learning behavior; effectiveness of strategies can be readily measured by evaluating such products as paper and pencil tests or physically performed tasks. Obtaining better test performance through strategy manipulation is a viable goal which has produced wide-ranging research and development efforts (Allen, 1971; Lambiotte et al., 1987). These efforts do not, however, give a complete picture of what happens during learning: we still cannot routinely predict with a high degree of accuracy an individual's test scores, academic performance, or job performance (Mitchell & Piatkowska, 1974; Stedman & Kaestle, 1987). Looking at ability level, a logical source of individual difference, still does not allow adequate prediction of learning and performance (Wagner & Sternberg, 1985). Nor does successful performance in one learning arena predict success in another: Traditional predictors of academic performance have only accounted for 8% to 13% of the variance in job performance (O'Donnell & Dansereau, 1988; Stedman & Kaestle, 1987). Clearly, there are influences on the learning process which go beyond basic ability level and the type of strategy used. Evidence suggests that at least one of those influences is the subjective reactions of the learner (Gilligan & Bower, 1984; Isen et al., 1987; Sternberg, 1987).

Studies dealing with the manipulation of affect to produce better learning/performance have been more limited in scope than those targeting strategies, but have yielded results suggesting that affect does indeed influence the learning process and product. Two studies by Bower and associates (Bower, Gilligan, & Monteiro, 1981; Bower, Monteiro, & Gilligan, 1978) indicate that memory for content of material studied is better when a learner's emotional state during testing matches his emotional state during the study phase. This effect has been obtained with a wide range of learners, from kindergartners and third graders (Bartlett et al., 1983) to psychiatric patients (Henry et al., 1973).

The Problem of Measuring Subjective Responses

In an initial study using the graffects instrument, Hall and associates (Hall et al., 1987) clearly outline the problems involved in the measurement of subjective responses. While psychophysiological measures such as GSR, heart rate, and brain wave activity are well documented as measures of subjective responses (Johnson & Donchin, 1985; Kramer et al., 1985), they involve use of expensive equipment and a physical intrusion on the task at hand. Use of trained observers can also be both expensive and intrusive. Perhaps the most serious problem with these two techniques, however, is that we have no knowledge of the internal mental processing which leads to or follows these observed responses.

Self-report instruments do provide a view of internal mental processing. Although that view may be clouded both by a lack of awareness of one's own processing and by the extent of any need to conceal the nature of that processing, self-report does add a dimension to our understanding. If nothing else, it provides an additional behavioral measure which can be taken during or at the end of a learning task. Like psychophysical measures and trained observers, however, self-report measures administered during a task can be intrusive, and can interfere with performance of the task (Cacioppo & Petty, 1981). On the other hand, post-activity (after the fact) self-reports have been shown to be inaccurate if the reporter's attention is not directed initially toward the information to be requested and of questionable validity if adequate retrieval cues are not provided (Ericsson & Simon, 1980).

Advantages of Using Graffects

Subjective responses listed in Table 1 reflect the four major aspects of a model of dyadic cooperative learning developed by Dansereau and his colleagues (Dansereau, 1988). This "CAMS" model asserts that a learning task which requires interaction between two people will elicit four types of responses:

1. (C) Cognitive/motor responses, focusing on evidence of comprehension, recall, problem solving, and skilled performance;

2. (A) Affective responses, such as pleasure, displeasure, anxiety;

3. (M) Metacognitive responses, dealing with monitoring and correcting the processes and products of the cognitive system; and

4. (S) Social responses, dealing with reactions to one's learning partner.

Within the CAMS model, all of these responses are expected to interact to a greater or lesser degree, depending on the nature of the task and characteristics of the learner, to affect learning. All four types of responses are tapped by graffects, thus providing not only a measure of change in these responses over the course of learning but also a theoretical framework to guide data analysis.

An initial study of graffects by Hall et al. (1987), done within the context of scripted cooperative learning, suggests that this assessment tool is internally reliable and reliable on test-retest. Factor analysis produced three independent and replicable dimensions which were consistent with the CAMS model: self-report, reaction to partner, and anxiety. When participants are sufficiently familiar with the tool (a critical factor also identified by Ericsson and Simon (1980), it is sensitive to both performance and situational manipulations.

Cooperative/Procedural Learning: A Viable Context for the Study of Subjective Responses

When two people must cooperate to accomplish a learning task, much of the learning process becomes public and provides a feedback mechanism not available to the individual learner alone. We might expect successes and failures to be more salient to partners than they might be to an individual learner. In the process of verbally elaborating learned material to his partner, a student may discover that he actually knows more (or less) than his private thoughts had indicated. He reveals this not only to himself, but to his partner as well. Thus, since the evaluation process may be heightened, there may also be an increased awareness of one's feelings: It is embarrassing to perform poorly, and ego-boosting to perform well.

While dyadic learning strategies provide fertile ground for subjective response, there is also a distinct advantage to studying these responses within the confines of procedural tasks: procedural tasks have discrete, concrete outcomes. What is to be learned (a procedure) is clearly delineated and readily measured via verbal/written recall and performance. Personal interpretations and inferences that increase the difficulty of evaluating outcome measures with respect to other types of learning tasks (such as comprehension of literary or historical expositions) are relatively absent from the procedural task. Dansereau and associates over the past ten years have focused extensive research efforts on dyadic learning strategies as applied to procedural tasks.

A recent study from this group (e.g., O'Donnell, Dansereau, Hall, & Rocklin, 1987) provides support for the concern that subjective reaction to partners may have long-term consequences: Partners with experience in scripted dyads had more positive attitudes toward subsequent partners than learners in unscripted dyads, and found later learning situations less anxiety-provoking than those who studied alone. Learners less sensitive to public opinion, as indicated by measures of public and private self-consciousness, recalled more information and did so with greater accuracy than those who were more sensitive to the opinions of others. This last result suggests that learners who are very sensitive to what others think of them may react adversely in a dyadic task, to the extent that learning outcomes may be negatively affected.

Recapitulation

Our intent here is to closely examine the role of participants' subjective reactions during the learning of a procedural task. We are concerned with the value of our measuring instrument, the extent to which subjective reactions may affect outcome, the manner in which learning strategy may affect subjective reactions, and, finally, the impact on outcome or process of subjective reactions to learning partners.

Method

Participants

Ninety-eight participants from undergraduate psychology classes at Texas Christian University completed all phases of the experiment. They received credit in their respective courses in return for their participation.

Materials

Participants were required to learn how to set up and start an intravenous infusion (IV). This procedure had been used in a previous experiment (O'Donnell et al., in press).

Information for performing the task was provided in a text passage divided into four sections of approximately equal length (450 words per section). Participants were provided with the necessary equipment (including a rubber arm). Participants were videotaped during training and test performances of the IV procedure.

Procedure

Each participant was assigned to one of four learning strategy groups. Each then took part in two experimental sessions (approximately 100 min each).

Sessions. During the first session, participants were familiarized with the graffects instrument and given strategy instructions (see strategy groups below). They were then allowed 60 min to learn and perform the IV procedure in accordance with their strategy instructions. At the end of this session, participants were asked to chart, via graffects, their subjective reactions over the course of the task.

During the second session, which occurred after an interval of five days, each participant took a written recall test over the text material studied at the previous session and performed the task of setting up and administering an IV. Participants were directed to describe what they were doing as they performed the administration of the IV, thus providing information about their ability to orally communicate about the procedure. Test order for the two tasks was counterbalanced within dyad, with one member of a dyad performing the procedure first and then recalling, while his or her partner did the reverse. Half of the participants in the individual no-strategy group were assigned to each of the test order conditions. Test performances were videotaped.

Strategy groups. The four strategy groups included one group of individuals and three groups in which participants learned in same-sex dyads, or pairs. All dyad strategy groups permitted partner prompting or feedback during "planning"--describing aloud the plan for performing the procedure--and during actual performance of the procedure. Groups varied with respect to initiation of the planning/performance procedures.

Group 1: No-Strategy Individuals (n=18). For this group there was no experimenter-provided strategy; participants studied IV materials alone and practiced the procedure alone.

Group 2: Prompting Only (n=26). Both partners in a dyad read a section of the instructions. One partner performed that part of the procedure described in the section and his/her partner prompted--provided feedback on any errors made. The material was divided into four such sections; partners alternated roles after each section.

Group 3: Distributed Planning with Prompting (n=27). After each section, one partner first planned, or described aloud how that part of the procedure would be done, and then performed the procedure. This partner was prompted by the second member of the dyad. Roles were reversed for the next section, until each of the sections was completed.

Group 4: Pre-planning with Prompting (n=27). After each section one partner planned aloud how that part of the procedure would be done while the other partner prompted. Roles were then reversed for the next section, until each of the sections had been studied and planned. Then each partner performed in turn the section he/she had planned.

Analysis

Variables/Statistical Techniques

Using SPSS, statistical measures included factor analyses, repeated measures and one-way ANOVAs, and correlations. With strategy group as the independent variable, dependent measures were delineated as follows:

Written Recall/Performance Scores

Both written recall and test performance videotapes were scored by trained raters, according to predetermined keys, and without knowledge of group affiliation. Scoring procedures were based on those developed by Meyer (1975) and by Holley, Dansereau, McDonald, Garland, and Collins (1979). The scoring key for the written recall consisted of a list of all propositions, or idea units, from the IV passage. The scoring key for test performance consisted of a list of all idea units from the written recall key which described an action to be completed while performing an administration of intravenous therapy. The written recall score was thus the total number of idea units recalled, while the performance score was the total number of actions performed during testing. Verbalizations during performance testing were also scored using the performance key, with total number of actions verbalized as the score.

Interrater reliability for scoring the written recall tests, the performances, and verbalizations during performance was established by having a colleague rescore a randomly selected subset of the videotapes (16%). Reliability coefficients of .91, .93, and .94 were achieved for recall, performance, and verbalization scores, respectively.

Individual Graffects Scores

An overall score was calculated for each graph for each subject based on the average of all nine data points (see Figure 2). In addition, three time period scores were calculated for each graph for each subject based on averages of the three data points within each of the three time periods of the learning procedure.

Harmony and Transpersonal Metacognition Scores

"Harmony" scores served as an index to the similarity of partner's fluctuations in feelings (e.g., for any one graph, did both feel more positive in the first period, less positive in the third?). Using the nine values (overall) or three values (time period) of equidistant graph points, a correlation was obtained between values for the first member of a dyad and values for the second member. This correlation served as the harmony "score."

For example, a correlation was obtained between the first member's nine values on graph 7 (How good was your concentration?) and the nine values produced by the second member on graph 7. A harmony score was obtained for each dyad for each of the 11 graphs in the series.

"Transpersonal metacognition" scores served as an index to participants' abilities to perceive changes in their partners' feelings. As with the harmony score, this involved using the nine or three values of graph points to obtain a correlation--the score--between values for the first member of the dyad and values for the second member. In this case the graphs used for the correlations were:

-- graph 4 (first member) and graph 8 (second member): How motivated were you?/How motivated was your partner?

-- graph 9 and graph 5: How aware was your partner of your reactions?/How aware were you of your partner's reactions?

-- graph 10 and graph 6: How How anxious was your partner?/How anxious were you?

-- graph 11 and graph 2: How do you think your partner feels toward you?/How do you feel about your partner?

Post-Questionnaire Items

Items on the post-questionnaire asked subjects to rate on a one to ten scale their responses to the overall learning process (a global response). Included were such items as "How motivated were you while learning/performing the intravenous therapy? How nervous were you?"

Results

Initial Data Analyses on Strategy

Initial data analyses with respect to strategy group are described in O'Donnell, Dansereau, Hythecker et al. (1988). The distributed planning group was found superior to the other three groups with respect to performance, oral communication of the procedure, and attitude towards their partners. No statistically significant between-group differences were found for written recall. Written recall of the procedure was enhanced by prior performance and performance was enhanced by prior recall (see Table 2).

Insert Table 2 about here

Value of Graffects

How does this instrument differ from traditional posttask measures? There are several findings which suggest that graffects are, in fact, different from the traditional post-questionnaire which was also administered:

1. Correlations of the graffects with items of the posttask questionnaire varied with time periods. For example, overall scores for feelings about material (graph 1) were significantly correlated with 16 of the 21 post-questionnaire items, as were 12 of the time period 1 scores and 12 of the time period 2 scores. However, only one post-questionnaire item was significantly correlated with time period 3 scores for graph 1 (see Table 3). This pattern generally repeated itself across all the graffects measures, with higher correlations between the first two time period scores and post-questionnaire items.

Insert Table 3 about here

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2. Factor analysis using overall averages of dyad data on all eleven graphs produced three clear factors: ratings of self, including feelings about performance (graph 3), material (graph 1), motivation (graph 4), and concentration (graph 7); ratings of feelings about partner (graphs 9, 5, 2, & 11); and anxiety (graphs 6 & 10; see Table 4). However, a similar factor analysis using time period averages (three scores, as opposed to one overall score, for each graph) produced four factors and indicated that self-ratings actually break into two factors, with the first and third time periods loading on separate factors

and the second time period spanning both. Partner awareness and anxiety again appeared as separate factors (see Table 5).

Insert Tables 4 & 5 about here

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3. Factor analysis of time period averages, based on data from all four groups and omitting partner ratings, again produced separate factors for first and third time periods for feelings about material, performance, and motivation. Anxiety and concentration appeared as separate factors (see Table 6).

Insert Table 6 about here

These results suggest that graffects do, in fact, add a dimension not available through a traditional post-task measure: they provide indication of changes in reactions during the learning process. A "one question" posttask measure may register the "average" reaction or the strongest reaction; in any case, patterns of reactions are lost, just as they are when graffects points are averaged.

Relation to Outcome Measures

How do subjective responses relate to objective outcome measures (i.e., recall and performance scores)?

Across all subjects and time periods, relationships between graffects and outcome measures appear relatively weak. Only two correlations of overall scores with outcome measures (performance) were significant: concentration ($r = .183$) and performance ($r = .173$). Correlations of three time period scores, period 1 concentration with recall outcome, and periods 2 and 3 performance with performance outcome, were significant. A closer look at strategy groups and time periods, however, reveals some additional significant correlations:

1. Positive feelings toward a partner and heightened awareness of partner were negatively correlated with both recall and performance scores for the prompting only group ($r= -.42$ to $-.51$). The opposite was true for the distributed planning group: the correlations were positive ($r > .50$).

2. The pre-planning group showed no similar partner effects; for this group there were significant positive correlations with outcome measures for concentration and motivation ($r = .37$ to $.55$).

3. These effects (in 1 and 2 above) are seen most clearly in the second and third time periods. This lends support to the conclusion that the graffects tool does tap changes in subjective responses over time, and that some of these changes are related to variance in outcome measures.

4. For the individual strategy group we found no significant correlations between subjective reactions and outcome measures, overall or for any of the time periods.

These results suggest that subjective reactions may be playing differential roles within strategy groups, making impact on outcome less immediately apparent. Partner effects are salient features for two strategies with respect to outcome, but in opposite directions, and for the third dyad strategy, pre-planning, these effects appear to play little role. Concentration and motivation figured in outcome for only the pre-planning group. Results here indicate the need for a closer examination of the role of subjective reactions within strategy groups (see following section).

Impact of Strategy on Subjective Response

Do the different strategy groups show different patterns of subjective reaction over the course of the learning task?

1. Using overall averages, a series of one-way ANOVAs were conducted. Only one statistically significant difference, $F(2, 77) = 4.33$, $p < .05$, $MSe = 11.59$, was found between strategy groups: members of the distributed planning group ($M = 7.47$) and prompting only group ($M = 7.60$) rated their partners more positively than did members of the pre-planning group ($M = 6.40$).

2. Given the results of factor analyses described in (1) and (2) of the "value of graffects" section above, we looked for differences between groups with respect to time periods. Seven 4 x 3 (Group x Time Period) repeated-measures ANOVAs were performed on self-rating graph data. Significant Group x Time Period interactions were found for motivation, material, and concentration, $F(6, 182) = 3.30$, $p < .01$, $MSe = 2.99$; $F(6, 184) = 2.58$, $p < .05$, $MSe = 3.00$; $F(6, 184) = 2.72$, $p < .05$, $MSe = 3.14$, respectively. Significant within-subjects differences were found for performance, $F(2, 184) = 3.12$, $p < .05$, $MSe = 3.16$). Significant group differences (as expected from results reported above) and significant within-subjects differences were found for feelings about partner, $F(2, 77) = 4.44$, $p < .05$, $MSe = 7.98$; $F(2, 154) = 11.73$, $p < .01$, $MSe = 1.51$, respectively. No differences were found for anxiety or awareness of partner.

For simplicity of presentation, we have here cautiously described the bases of these effects from graphs presented in Figures 3 through 7.

Insert Figures 3, 4, 5, 6, & 7 about here

Significant interactions. Significant interactions were found for three of the graffects measures.

Graffect #1: How did you feel about the IV material? Figure 3 indicates that the source of variance for this significant interaction lies primarily in the initial positive response to the material by the prompting only group, followed by progressively more negative feelings, and an opposite effect in the distributed planning group (a relatively negative initial response followed by an increasingly positive response).

Graffect #4: How motivated were you? Figure 4 shows increasing motivation for the two planning groups (distributed and pre-planning) in contrast to decreasing motivation in the prompting only group. Individuals registered a slight increase, but then dropped to a point well below that of the prompting only group.

Graffect #7: How good was your concentration? Figure 5 suggests that the major source of variance here comes from those participants who worked alone: only those individuals who worked without partners showed an initially high level of concentration followed by a dramatic decrease in concentration during the third time period. The three dyadic groups maintained relatively stable concentration responses.

Significant within-subjects effects. One significant interaction was found for within-subjects effects.

Graffect #3: How did you feel about your performance?

Feelings about performance declined for participants in the prompting only and massed planning groups from the beginning to the mid-point of the learning episode, then stayed roughly the same or declined slightly by the end point. Participants in the no-strategy individual group showed only a slight dip in these feelings at mid-point with a slight increase at the end point. In relation to the other three strategy groups, participants in the distributed planning group started at the lowest point, with respect to feelings about performance, then dipped at mid-point, and, finally, ended at the highest point in relation to the other three groups.

Significant within-subjects/within groups effects. One significant interaction was found for within-subjects/within-groups effects.

Graffect #2: How did you feel about your partner? Figure 7 shows that all subjects in dyad strategy groups felt increasingly more positive about their partners. Those in the pre-planning group showed the most dramatic increase but still finished the learning task with the least positive feelings about their partners of any of the three dyad strategy groups.

What we find with this analysis is a strong indication that learning strategy may indeed affect patterns of subjective reactions during the course of learning. What we cannot know from this single study is the extent to which these patterns would recur in a sequence of specific strategy-based learning tasks. If they do recur, we might expect impact of subjective reactions to affect the long-term impact of the strategy itself.

Impact of Reactions to Partners

Is "harmony" (similarity of partners' subjective reactions) an important variable? Assessment of graffects harmony scores followed the same pattern of analyses performed on overall and time period scores. Results here, however, were disappointing, suggesting that similarity of change in partners' subjective reactions may not be an important variable.

1. None of the harmony measures were directly correlated with individual outcome measures; motivation and perceptions of partner awareness were significantly correlated with the sum of the written recall scores for the dyad ($r = .30$ for both).

2. A series of one-way ANOVAs using mean harmony scores as dependent measures revealed no significant differences between groups.

3. Factor analysis using the 11 graphs produced two main factors which were not easily labeled: with performance, material, motivation, and feelings about partner in the first, and with anxiety, concentration, and

partner anxiety and motivation in the second. Groups did not differ significantly on these factors.

4. Factor analysis using time periods revealed only one easily labeled factor, anxiety, including in it all three time periods. A series of repeated-measures ANOVAs was performed, yielding no significant differences within subjects or significant Time Period x Group interactions.

Impact of Reactions to Partners

Is "transpersonal metacognition" an important variable?

1. None of the transpersonal metacognition measures was significantly correlated with outcome measures.

2. A series of one-way ANOVAs using mean transpersonal metacognition scores as dependent measures revealed no significant differences between groups, although mean scores suggested a within-subjects difference between perception of partner motivation and perception of partner anxiety.

3. A 2 X 3 repeated measures ANOVA confirmed a significant within-subjects difference between perception of partner motivation and perception of partner anxiety: participants were better judges of partner motivation than partner anxiety, $F(1, 75) = 4.85$, $p < .05$, $MSe = 1.67$.

Summary of Results

Value of Graffects

Patterns of correlations between graffects time period scores and items on a traditional subjective response measure (questionnaire), and the factor structure of graffects time period data suggest that graffects provide sensitivity to fluctuations in subjective response, something not usually provided by posttask questionnaires.

Relation to Outcome Measures

While not indicating any strong relationship between subjective reactions and outcome measures, the data do suggest the possibility of strategy effects on subjective responses.

Impact of Strategy on Subjective Response

There are patterns of responding that vary by group. These are hidden by an overall score averaging procedure, but are revealed when time periods/fluctuations in subjective response are considered. These patterns could have potential impact with respect to long-term use of a learning strategy.

Impact of Subjective Reactions to Partners

While there may be no systematic relationship of "harmony" and "transpersonal metacognition" to outcome measures or to strategy, there may be important individual difference trends which have yet to be uncovered in these data. It is interesting to note that participants appeared to perceive their partner's changes in motivation more accurately than partner's changes in anxiety.

Discussion

With this study we have focused attention on four aspects of concern with respect to subjective reactions in the learning of a concrete procedure: (a) the value of a measuring instrument, (b) the extent to which subjective reactions may affect learning outcome, (c) the impact of learning strategy on subjective reactions, and (d) the impact on either learning outcome or process of subjective reactions to learning partners. Two potentially useful findings have come from the present study.

First, we have found support for the use of graffects, a measurement tool which allows a respondent to chart his/her subjective reactions over the course of a learning episode. Time period scores from graffects provide information which is not available from a traditional post-questionnaire measure or from averaged (overall) graffects scores. As a result, patterns of responding can be documented, giving possible clues as to the effect of a particular learning strategy on users of that strategy.

Second, we found that learning strategy had a major impact on participants' subjective reactions during the learning of a concrete procedure. Concentration, motivation, and feelings about performance decreased for learners not assigned to work with partners. Concentration took an especially dramatic plunge downward for this group. Learners in the distributed planning (dyad) strategy group--those who obtained highest scores on the performance outcome measure--showed initially poor feelings about materials, performance, and motivation, but ended with the most positive feelings of any of the strategy groups on these measures.

We found only weak correlations between subjective responses and outcome measures, and the impact of either harmony of changes in partner response or awareness of partner response is not clear, although learners appear to be better at recognizing a partner's motivation than his/her anxiety. We resist the temptation to look at low correlations between outcome measures and subjective reactions and discount the importance of the latter, or to discount partner harmony or awareness as important factors.

Knowing that a particular learning strategy produces patterns of subjective response may allow a better understanding of why that strategy does/does not work well over time, or does/does not work for particular individuals. We feel that, when considered in relation to significant strategy group differences in subjective response patterns, weak correlations between subjective responses and outcome point to a need for use of graffects in extended field studies. The present study has been limited to a single learning episode. Clearly, charting subjective reactions over several months of an extended learning experience would provide a more realistic understanding of the impact of these reactions on both process and outcome. Strategy group differences with respect to both outcome measures and subjective response patterns strongly suggest that, in the long run, subjective responses should have a significant impact on learning outcomes.

References

Allen, G. J. (1971). Effectiveness of study counseling and desensitization in alleviating test anxiety. Journal of Abnormal Psychology, 77, 282-289.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. Psychological Bulletin, 84, 888-918.

Bartlett, J. C., Burleson, G., & Santrock, J. W. (1982). Emotional mood and memory in young children. Journal of Experimental Child Psychology, 34(1), 59-76.

Bower, G. H., Gilligan, S. G., & Monteiro, K. P. (1981). Selectivity of learning caused by affective states. Journal of Experimental Psychology: General, 110, 451-473.

Bower, G. H., Monteiro, K. P., & Gilligan, S. G. (1978). Emotional mood as a context for learning and recall. Journal of Verbal Learning and Verbal Behavior, 17, 573-585.

Cacioppo, J. T., & Petty, R. E. (1981). Lateral asymmetry in the expression of cognition and emotion. Journal of Experimental Psychology: Human Perception and Performance, 7, 333-341.

Dansereau, D. F. (1988). Cooperative learning strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (eds.), Learning and study strategies: Issues in assessment, instruction, and evaluation. New York: Academic Press.

Ericsson, K. A. & Simon, H. A. (1980). Verbal reports as data. Psychological Review, 87, 215-251.

Gilligan, S. G., & Bower, G. H. (1984). Cognitive consequences of emotional arousal. In C. E. Izard, J. Kagan, & R. B. Zajonc (Eds.), Emotions, cognition, and behavior (pp. 547-588). London: Cambridge University Press.

Hall, R. H., Dansereau, D. F., & O'Donnell, A. M. (1987). Subjective graphing of metacognitive, affective and social processing: A preliminary examination within the context of cooperative learning. Unpublished manuscript, Texas Christian University, Ft. Worth, Texas.

Henry, G., Weingartner, H., & Murphy, D. L. (1973). Influence of affective states and psycho-active drugs on verbal learning and memory. American Journal of Psychiatry, 130, 966-971.

Holley, C. D., Dansereau, D. F., McDonald, B. A., Garland, J. C., & Collins, K. W. (1979). Evaluation of a hierarchical mapping technique as an aid to prose processing. Contemporary Educational Psychology, 4, 227-237.

Isen, A. M., Daubman, K. A., & Gorgoglione, J. M. (1987). The influence of positive affect on cognitive organization: Implications for education. In R. E. Snow,& M. J. Farr (eds.), Aptitude, learning, and instruction, Vol. 3, Conative and affective process analyses (pp. 143-164). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Johnson, R., & Donchin, E. (1985). Second thoughts: Multiple p300s elicited by a single stimulus. Psychophysiology, 22(2), 182-194.

Kramer, A. F., Wickens, C. D., & Donchin, E. (1985). Processing of stimulus properties: Evidence for dual-task integrality. Journal of Experimental Psychology: Human Perception and Performance, 11(4), 393-408.

Lambiotte, J. G., Dansereau, D. F., Rocklin, T. R., Fletcher, B., Hythecker, V. I., Larson, C. O., & O'Donnell, A. M. (1987). Cooperative learning and test-taking: Transfer of skills. Contemporary Educational Psychology, 12(1), 52-61.

Mitchell, R. R., & Piatkowska, O. E. (1974). Characteristics associated with underachievement: Targets for treatment. Australian Psychologist, 9(3), 19-41.

O'Donnell, A. M., & Dansereau, D. F. (1988, February). Predicting the performance of concrete procedures. Paper presented at the annual meeting of the Eastern Psychological Association, Miami, FL.

O'Donnell, A.M., Dansereau, D.F., Hall, R.H., & Rocklin, T.R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. Journal of Educational Psychology, 79, 431-437.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V.I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Hall, R. H., Skaggs, L. P., Lambiotte, J. G., Young, M. D. (1988). Cooperative procedural learning: Effects of prompting and pre- versus distributed planning activities. Journal of Educational Psychology, 80(2), 167-171.

Meyer, B. J. F. (1975). The organization of prose and its effects on memory. Amsterdam: North-Holland Publishing Co.

Sarason, I. G. (1987). Test anxiety, cognitive interference, and performance. In R. E. Snow and M. J. Farr (Eds.), Aptitude, learning, and instruction, Vol. 3. Conative and affective process analyses (pp. 131-142). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Scheier, M. F., & Carver, C. S. (1983). Two sides of the self: One for you and one for me. In J. Suls and A. G. Greenwald (Eds.), Psychological perspectives on the self (pp. 123-157). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Stedman, L. C., & Kaestle, C. F. (1987). Literacy and reading performance in the United States, from 1880 to the present. Reading Research Quarterly, 22, 8-46.

Sternberg, R. J. (1987). Intelligence and cognitive style. In R.E. Snow and M. J. Farr (Eds.), Aptitude, learning, and instruction, Vol. 3. Conative and affective process analyses (pp. 77-97). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Wagner, R. K., & Sternberg, R. J. (1985). Practical intelligence in real world pursuits: The role of tacit knowledge. Journal of Personality and Social Psychology, 49(2), 436-458.

Weiner, B. (1982). The emotional consequences of causal attributions. In M. S. Clark and S. T. Fiske (Eds.), Affect and cognition: The seventeenth Carnegie symposium on cognition (pp. 185-209). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Wicklund, R. A., & Gollwitzer, P. M. (1983). A motivational factor in self-report validity. In J. Suls & A. G. Greenwald (Eds.), Psychological perspectives on the self (pp. 123-157). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Table 1

Graffects Questions: Content of Graphs

Ratings of Self

#1	HOW DID YOU FEEL ABOUT THE IV MATERIAL?
	(very negative . . . . . very positive)
#2	HOW DID YOU FEEL ABOUT YOUR PARTNER?
	(very negative . . . . . very positive)
#3	HOW DID YOU FEEL ABOUT YOUR PERFORMANCE?
	(very negative . . . . . very positive)
#4	HOW MOTIVATED WERE YOU?
	(not at all motivated . . . . . very motivated)
#5	HOW AWARE WERE YOU OF YOUR PARTNER'S REACTIONS?
	(not at all aware . . . . . very aware)
#6	HOW ANXIOUS WERE YOU?
	(not at all anxious . . . . . very anxious)
#7	HOW GOOD WAS YOUR CONCENTRATION?
	(not at all good . . . . . very good)

Ratings of Partner

#8	HOW MOTIVATED WAS YOUR PARTNER?
	(not at all motivated . . . . . very motivated)
#9	HOW AWARE WAS YOUR PARTNER OF YOUR REACTIONS?
	(not at all aware . . . . . very aware)
#10	HOW ANXIOUS WAS YOUR PARTNER?
	(not at all anxious . . . . . very anxious)
#11	HOW DO YOU THINK YOUR PARTNER FEELS TOWARD YOU?
	(very negative . . . . . very positive)

Table 2

Raw Means and Standard Deviations of Written Recall Test Performance Scores, and Verbalizations as a Function of Experimental Group

GROUP		TASK		
		Recall	Performance	Verbalizations
No-strategy Individuals (n=18)	M	33.61	37.28	27.11
	SD	(13.77)	(13.99)	(14.03)
Prompting Only (n=18)	M	30.62	39.04	27.96
	SD	(12.07)	(7.38)	(8.64)
Distributed Planning (n=27)	M	33.66	44.74	32.11
	SD	(11.62)	(9.49)	(11.70)
Pre-Planning (n=27)	M	32.55	37.44	23.52
	SD	(14.39)	(10.89)	(10.79)

Table 3

Number of Significant Correlations* Between Overall/Time Period Graffects Scores and 21 Post-Questionnaire Items

Graph	Overall Graffects Scores	Time Period Graffect Scores Period 1	Period 2	Period 3
1. Material	16	14	15	1
2. Feel about partner	7	10	7	4
3. Performance	14	11	13	7
4. Motivation	14	11	17	8
5. Aware of partner	7	5	6	5
6. Anxiety	8	5	5	2
7. Concentration	11	10	9	1

*p > .05.

Table 4

Variables and Loadings for Factor Analysis on Overall Averages of Dyad Data (N=79)

Graph	Loading
Factor 1: "Self" Ratings	
1. Material	.877
2. Performance	.818
4. Motivation	.707
7. Concentration	.495
Factor 2: Partner Ratings	
9. Partner aware of your reactions	.796
5. Aware of partner reactions	.756
2. Feel about partner	.695
11. Think partner feels toward you	.556
Factor 3: Anxiety	
6. Anxious	.832
10. Anxious partner	.722

Table 5

Results of Factor Analysis on Time Period Averages of Dyad Data (n=79)

Graph	Time Period	Loading
Factor 1: Time Period 1 and 2		
1. Material	1, 2	.705, .657
3. Performance	1, 2	.729, .643
4. Motivation	1, 2	.734, .631
7. Concentration	1	.643
11. Partner feelings	1, 2	.657, .593
Factor 2: Time Period 3 and 2		
1. Material	3	.730
2. Feel about partner	3	.565
3. Performance	3, 2	.755, .523
4. Motivation	3	.833
7. Concentration	3	.629
8. Partner motivation	3, 2	.819, .579
11. Partner feelings	3	.507
Factor 3: Partner Ratings		
2. Feel about partner	2, 3	.713, .540
5. Aware of Partner	2, 3	.574, .568
9. Partner awareness	2, 3	.745, .600
Factor 3: Anxiety		
6. Anxiety	2, 3	.671, .655
9. Partner anxiety	2, 3, 1	.744, .741, .554

Table 6

Results of Factor Analysis on Time Period Averages From All Four Groups* (n=95)

Graph	Time Period	Loading
Factor 1: Time Periods 2 and 1		
1. Material	1, 2	.817, .588
3. Performance	1, 2	.828, .677
4. Motivation	1, 2	.735, .562
7. Concentration	1	.563
Factor 2: Time Periods 3 and 2		
1. Material	3, 2	.790, .605
3. Performance	3, 2	.838, .568
4. Motivation	3	.788
Factor 3: Anxiety		
6. Anxiety	2, 1	.838, .816
Factor 4. Concentration		
7. Concentration	2, 3, 1	.806, .729, .537

*Partner data excluded.

Figure Captions

Figure 1. Actual graph ("Graffects")

Figure 2. Graph scoring: Overall=mean of all nine points; time periods=mean of the three points contained within each period.

Figure 3. Graphing of mean graffect time period scores for graffect #1.

Figure 4. Graphing of mean graffect time period scores for graffect #4.

Figure 5. Graphing of mean graffect time period scores for graffect #7.

Figure 6. Graphing of mean graffect time period scores for graffect #3.

Figure 7. Graphing of mean graffect time period scores for graffect #2.

FIGURE 1. ACTUAL GRAPH ("GRAFFECTS")

HOW DID YOU FEEL ABOUT THE IV MATERIAL?

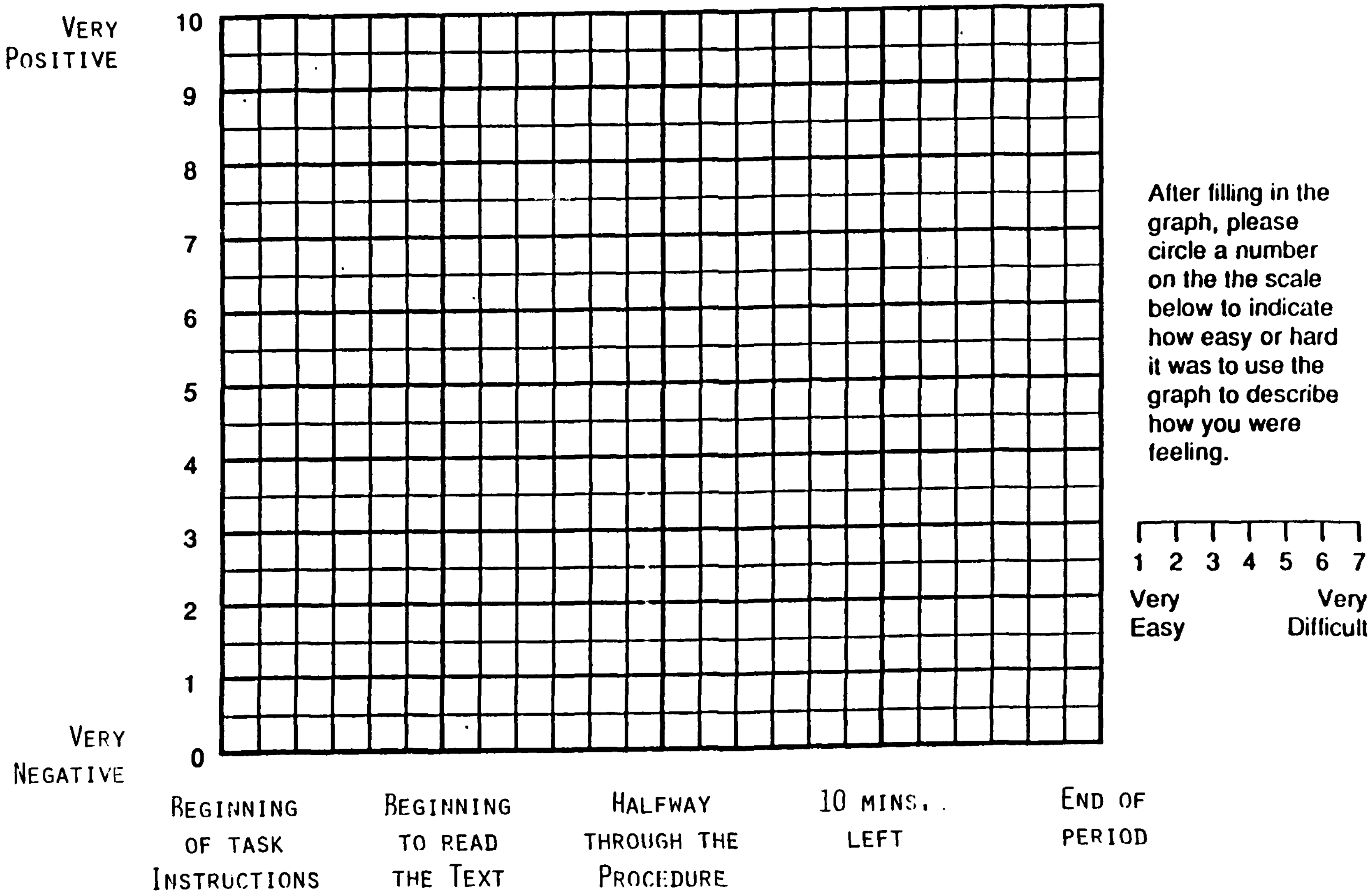

Figure 2. Graph scoring: Overall = Mean of all nine points; Time Periods = Mean of the three points contained within each period.

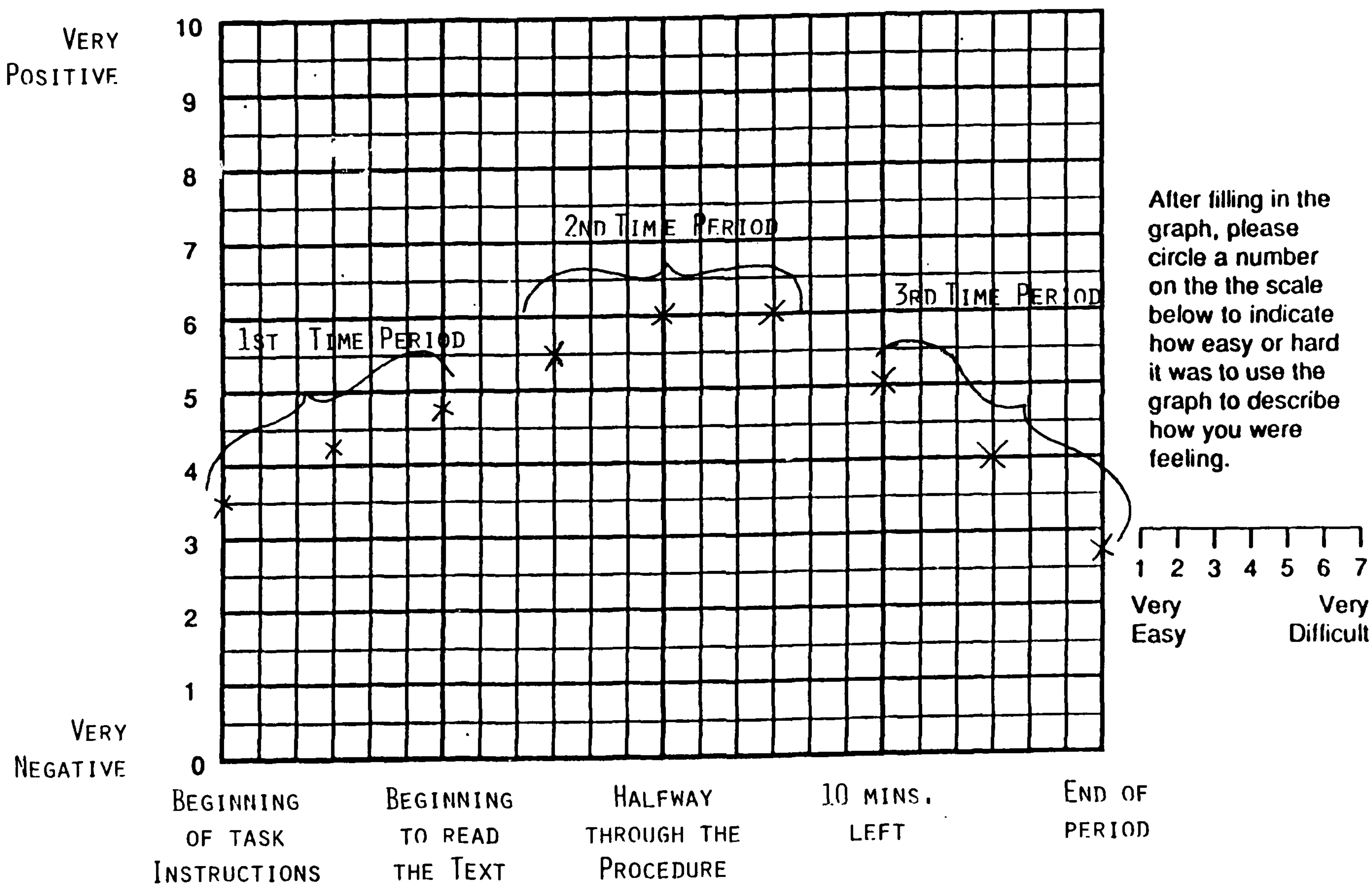

FIGURE 3. GRAPHING OF MEAN GRAFFECT TIME PERIOD SCORES FOR GRAFFECT #1.

#1. HOW DID YOU FEEL ABOUT THE IV MATERIAL?

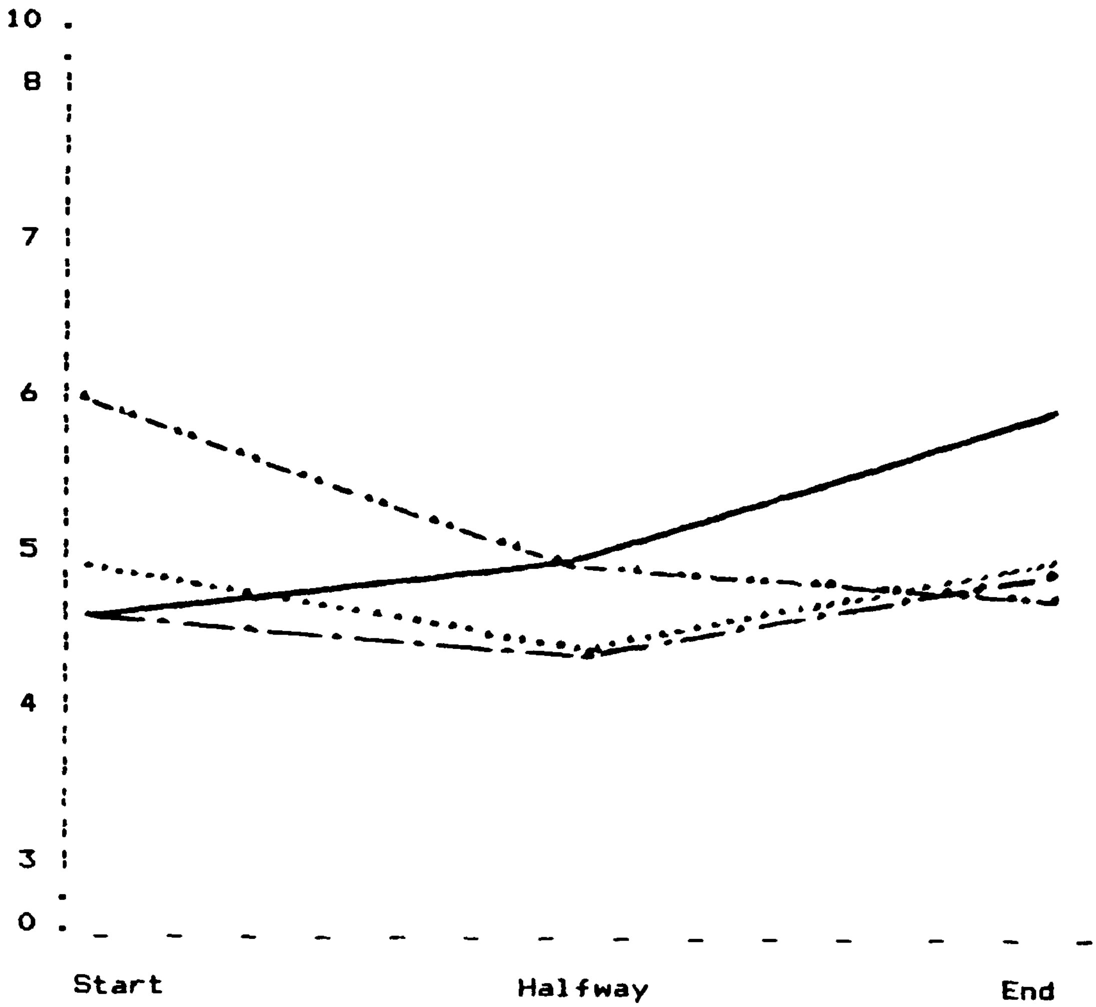

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FIGURE 4. GRAPHING OF MEAN GRAFFECT TIME PERIOD SCORES FOR GRAFFECT #4.

#4. HOW MOTIVATED WERE YOU?

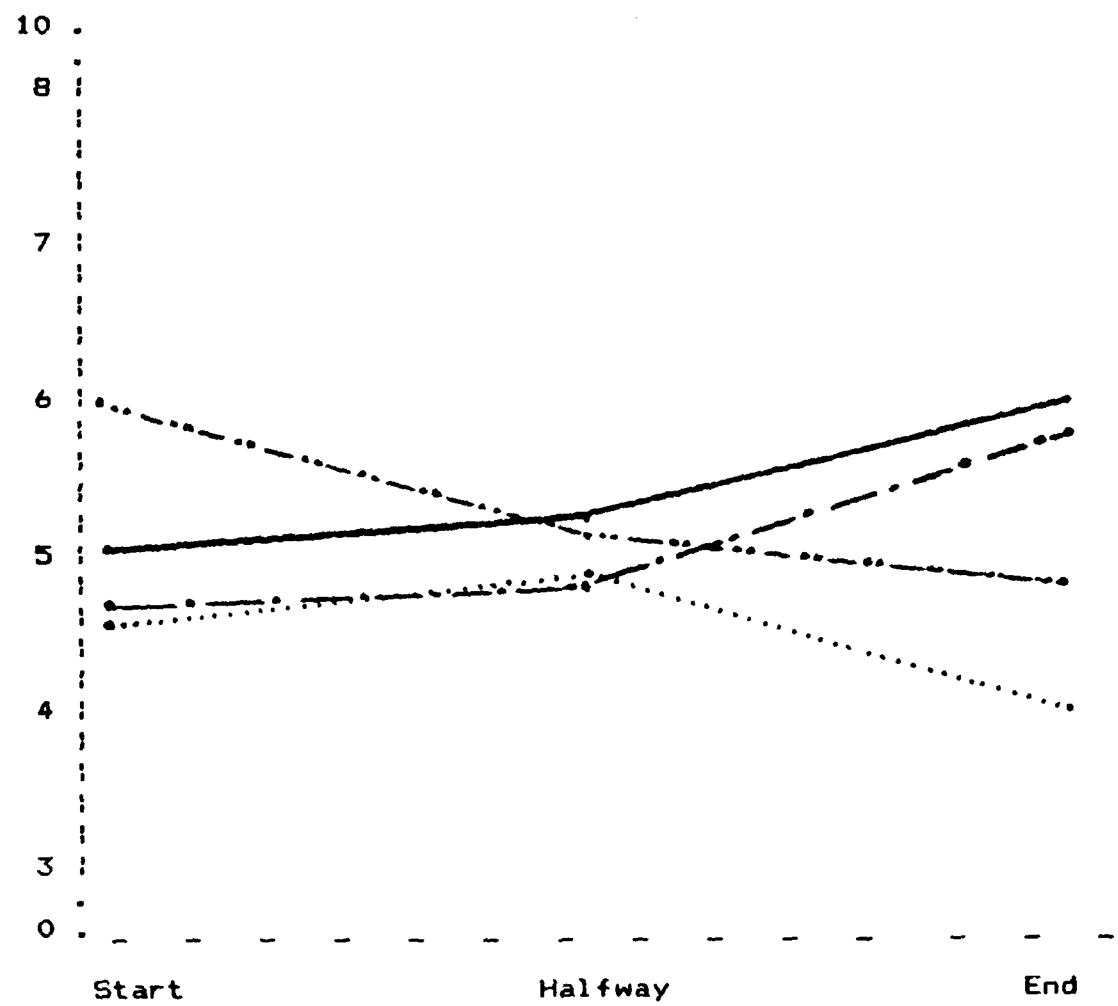

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Figure 5. GRAPHING OF MEAN GRAFFECT TIME PERIOD SCORES FOR GRAFFECT #7.

#7. HOW GOOD WAS YOUR CONCENTRATION?

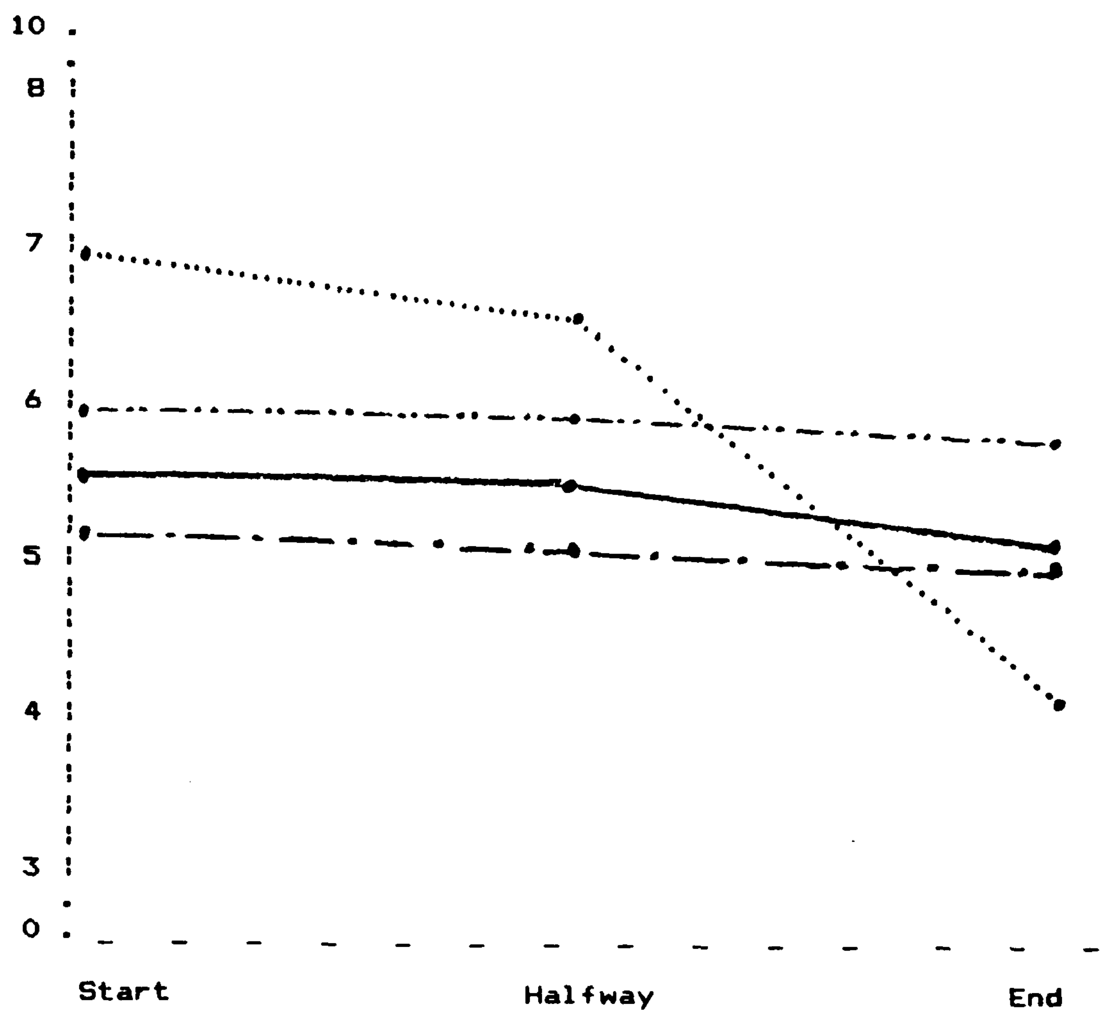

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FIGURE 6. GRAPHING OF MEAN GRAFFECT TIME PERIOD SCORES FOR GRAFFECT #3.

#3. HOW DID YOU FEEL ABOUT YOUR PERFORMANCE?

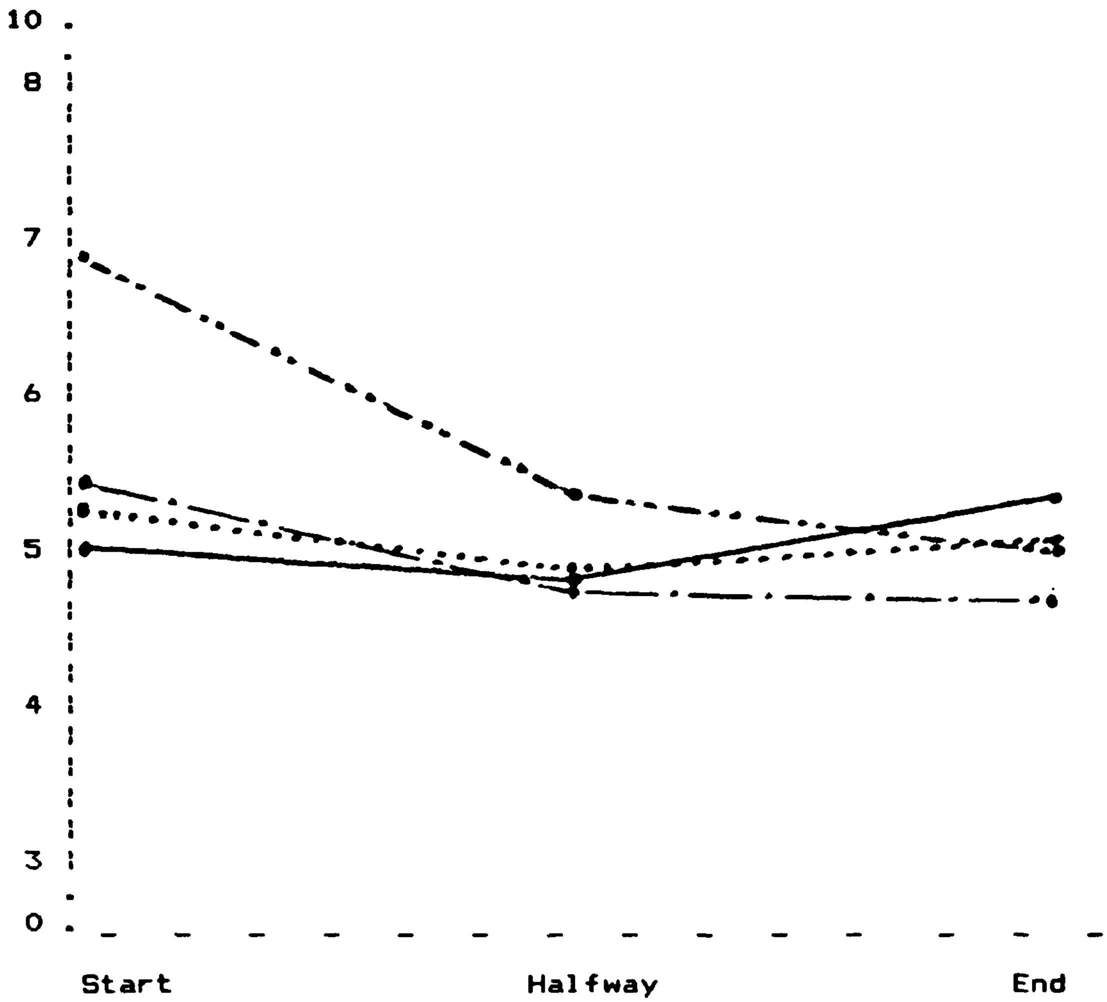

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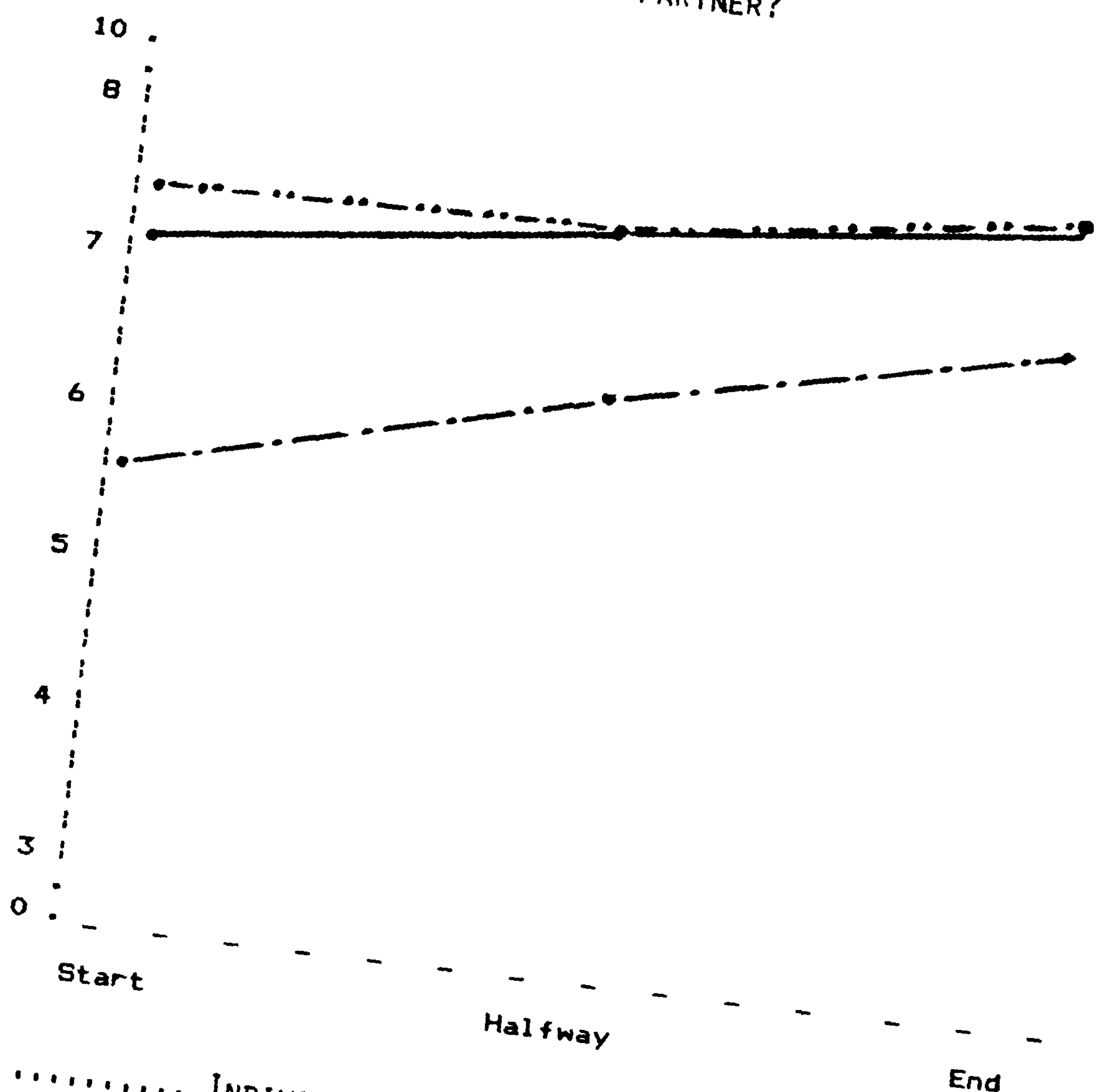
FIGURE 7. GRAPHING OF MEAN GRAFFECT TIME PERIOD SCORES FOR GRAFFECT #2.

#2. HOW DID YOU FEEL ABOUT YOUR PARTNER?



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APPENDIX C

APPENDIX C

Subjective Graphing of Metacognitive, Affective, and Social Processing: A Preliminary Examination Within the Context of Cooperative Learning

Abstract

The purpose of the present experiment was to conduct a preliminary examination of a subjective graphing measure designed to assess students' ongoing processing while studying. This measure offers several potential theoretical and pragmatic advantages over existing measures. The internal structure, reliability, and validity of this assessment tool were tested within the context of scripted cooperative learning. Results indicated that the measure could be described adequately by three relatively independent, replicable factors. In addition, these factors were consistent with a priori expectations based on Dansereau's (1986) model of learning task performance. Subjective graphing was found to be reliable in terms of both internal and test-retest analyses. Further, the validity analyses indicated that subjective graphing is sensitive to both performance and situational manipulations as long as students are given ample opportunity to become acquainted with the measure.

At present several tools exist to assess a student's ongoing processing while studying. There are a number of reasons why it is advantageous to make such assessments. These measures can be very helpful in diagnosing specific strengths and weaknesses in a given student's study methods. In addition, they have a great deal of potential for the remediation of processing deficits. Further, these assessment tools can aid in the creation and validation of theories of underlying mental processes accompanying studying and problem solving. Unfortunately, the measures presently available have weaknesses which inhibit their utility.

For example, psychophysiological measures (e.g., GSR, heart rate, and brain wave activity) have contributed significantly to our understanding of cognitive processes (e.g., Johnson & Donchin, 1985; Kramer, Wickens, & Donchin, 1985). However, such measures often require a great deal of equipment and large amounts of data reduction and analysis time. In addition, observation methods are often used to assess ongoing behavior (e.g., Ickes, 1982; Ickes & Barnes, 1977). When applying these measures, trained observers typically code the behavior of a student or group of students while they are performing a target task. These measures, while providing valuable information, are also quite expensive in terms of experimenter time and equipment. Moreover, these two techniques are relatively insensitive to any internal processing that is not manifested in overt behavior.

Self report instruments, on the other hand, can provide a unique insight into such processing. In using these methods, participants' underlying processing is measured through his or her verbal (e.g., Benjafield, 1971) or written (e.g., Galassi, Frierson, & Sharer, 1981) self report. Although the authors are not suggesting that self-report is a direct or preferred processing measure unto itself, such measures can add valuable information that is otherwise unobtainable. However, self-report measures which are administered intermittently during a target task can interfere with task performance (Cacioppo & Petty, 1981). Further, such reports are largely inaccurate when the information solicited was not attended to during the task (Ericcson & Simon, 1980). In addition, retrospective measures that do not offer adequate retrieval cues have questionable validity (Ericsson & Simon, 1980).

In order to retain the advantages of self-report data while eliminating some of the problems mentioned above, subjective graphing was developed by the authors. This measure of ongoing processing is administered immediately after the task and specific landmarks are embedded within the measure in order to aid recall of processing states. The participant is asked to graph his or her metacognitive, affective, and social states throughout the learning episode. (Figure 1 contains an example of one of these graphs.)

Insert Figure 1 about here

Several existing measures have limited themselves to the measurement of a single state or category of states. Subjective graphing, on the other hand, was developed to assess three different aspects of a given student's processing states in order to converge on underlying activities. These three areas were chosen as representing three of the four categories of behaviors required for the successful completion of many complicated learning and problem solving tasks within the context of cooperative learning (Dansereau, 1986).

These four behavioral categories are cognitive, affective, metacognitive, and social. In this scheme, cognitive activities are seen as task-relevant information processes such as comprehension, recall, and problem-solving. Metacognitive activities involve monitoring and correcting the processes and products of the cognitive system. Affective activities are associated with the interpretation and control of autonomic responses to the learning situation. Social processes involve monitoring, receiving, and generating communication with other group members. The graphs chosen for the present study were intended to measure the affective, metacognitive, and social aspects of Dansereau's (1986) model. The fourth component of the model, cognitive activities, was not explicitly considered in the present investigation. This cognitive portion of the model has been examined in more detail in a preceding experiment (O'Donnell, Dansereau, Hall, & Rocklin, 1987).

Another potential advantage of subjective graphing is the isomorphic relationship between the measure and the subjective representation of internal states. The most important aspect of the student's task is to graph changes in processing over time, while the absolute values of these states are not of as much importance. Most individuals would find it difficult to label metacognitive, affective, and social states with a single number, especially in comparison to others. On the other hand, subjective interpretation of such states over time is probably a much easier task for the students and is probably more representative of everyday processing interpretations (e.g. the "ups" and "downs" of mood swings). In addition, when using subjective graphing, participants are asked to represent their internal states with a continuous line rather than averaging states over a specified time span. It seems reasonable to assume that most persons subjectively view ongoing mental activity as continuous rather than discrete.

In order to provide an educationally relevant arena for the examination of subjective graphing, this measure was incorporated into an experiment which examined scripted cooperative learning (O'Donnell et al., 1987). This investigation of cooperative learning was part of a series of studies which have investigated the boundary conditions and parameters of cooperating peer dyads (e.g., McDonald, Larson, Dansereau, & Spurlin, 1985; O'Donnell et al., 1985; Spurlin, Dansereau, Larson, & Brooks, 1984). Since many of the parameters of the script manipulations used in this experiment are already known, the experiment served as an appropriate context for measurement validation.

After completing a series of individual difference measures, participants in this experiment studied initially in one of three treatment conditions: scripted dyad (SD), unscripted dyad (USD), or unscripted individual (UI). All participants then studied different material with a partner without using a script (such as Group USD in the initial study stage). In the final phase of the experiment participants completed recall tests over the material studied during the two study stages. For an in depth explanation of the rationale for the experimental manipulations see O'Donnell et al., 1987).

It has been proposed that subjective graphing can be a useful addition to the existing set of information processing assessment tools. The primary purpose of the present experiment was to empirically examine the internal structure, reliability, and validity of the measure. The first step in any such investigation is to examine the measure in the absence of any external criteria. In the present investigation this was carried out through factor analyses of the graphs and the data points within the graphs to determine the internal structure of the measure. This analysis was particularly important in the present experiment since the graphs were thought to represent three specific processing states. In addition, these factor analyses were performed in two different learning episodes in order to test the stability of the original factors over time. Coefficient alphas were calculated on the graph data points within the various factors and a test/retest correlation was calculated to assess the reliability of subjective graphing.

The second part of the analysis consisted of a test of the measure's sensitivity to appropriate external criteria, that is, a test of the measure's validity. Two criteria were used to test the validity of subjective graphing. First, the efficacy of the relevant graphs in predicting recall performance of material studied during the two study stages was tested. Second, the measure's sensitivity to situational factors (experimental group) was assessed. That is, the three experimental groups were compared using the graph scores as dependent measures.

In summary, the present experiment attempted to answer three basic questions. First, what is the nature of the internal structure of the subjective graphing measure? Second, is the measure reliable in terms of internal and test-retest reliability? Third, does subjective graphing relate to relevant, externally-based criteria?

Method

Participants

Ninety-three students recruited from undergraduate psychology classes at Texas Christian University participated in this experiment. They received class credit for their participation.

Materials

Subjective graphs. The students completed a single practice graph reflecting their general mood at the beginning of the experiment and eleven graphs after studying both the initial and transfer passages. On each graph used in subsequent data analyses the X-axis represented the time required to study a given passage. The Y-axis represented degree or magnitude of the given state which the graph was intended to measure. Along the X-axis five landmark points were delineated which corresponded to different parts of the study session (e.g., "beginning of task instructions" and "beginning to read section 1"). Equidistant numbers from 0 to 10 were listed along the Y-axis with the 0 point labeled to represent the minimum or most negative aspect of some state and the 10 labeled to represent the maximum or most positive aspect of some state. For example, on a graph which asked "How did you feel about the material as you were studying?", the 0 was labeled "very negative" and the 10 was labeled "very positive". There was a 24 X 24 line grid within each of the graphs with dark lines corresponding to each of the numbers along the Y-axis and each of the five sectional landmarks along the X-axis. The eleven graphs which corresponded to each of the study sessions asked the following eleven questions:

1) How did you feel about the material as you were studying?

2) How did you feel about your partner while you were studying?

3) How did you feel about your own performance

while studying?

4) How motivated/interested were you as you studied?

5) How anxious/nervous were you as you studied?

6) How well did you understand the material as you studied?

7) How good was your concentration while studying?

8) How motivated/interested was your partner as he or she studied?

9) How anxious/nervous was your partner while he or she was studying?

10) How well did your partner understand the materials as he or she studied?

11) How good was your partner's concentration as he or she studied? For Group UI, which studied the initial passage individually, each of the graphs which referred to partner asked, instead, about their "ideal" study mood. Figure 1 is an example of one of the subjective graphs.

Study passages. For the initial stage, students studied a passage which described the immune system. A passage on the blood was used for the study material during the transfer study stage. Both of the passages were extracted from nursing textbooks and were approximately 1,000 words long. In addition, both passages were divided into three sections of approximately equal length.

Free-recall tests. The participants completed free-recall tests over both study passages. For both tests the participants were asked to turn to a blank page on which the following instructions were written: "Write down all the information you can remember from the passage on the Blood [or Immune System]. Be as thorough and as accurate as you can."

Procedure

Session 1: study and subjective graphing. In the first session of the experiment participants began by completing consent forms. Following this, an experimenter gave verbal instructions on the use of the subjective graphs and participants completed the practice graph. Participants were then assigned to one of three treatment groups: (SD) scripted dyads (n=30); (USD) unscripted dyads (n=32); or (UI) individual (n=31). Each group was then assigned to different rooms where they received strategy instructions (those in Groups SD and USD were divided into same-sex dyads before receiving instructions).

Those in the scripted dyad group were trained in a strategy which has been shown to facilitate text processing in a number of studies (e.g., Hall et al., 1988; Larson et al., 1984; McDonald et al., 1985). When using this strategy, participants are first asked to read a section of the text, after which one partner recalls aloud all that he or she can remember without looking back at the text. Following this, the partner who does not recall notes and corrects any errors or omissions in the recall. Lastly, the dyad members review and elaborate the material together. These three stages are carried out at the end of each section of the text with the partners alternating the recalling and detecting roles. Previous research suggests that differences between strategy groups that are given instructions similar to those in the present experiment are not the result of differential strategy usage (O'Donnell et al., in press).

Those in Group USD were simply asked to work with their partner to learn the material using whatever strategy they felt was most effective. Those in Group UI were simply asked to learn the material on their own using whatever strategy they wished. Thirty-five minutes were allotted to this initial study stage, after which participants were required to complete the eleven subjective graphs mentioned above.

After completing the initial study stage graphs, those in the dyad groups were assigned a new partner from within their treatment condition. Those in the individual group were divided into same-sex dyads. Participants in all groups were then asked to work with their partner to learn the "immune system" material using whatever strategy they felt would be most effective (no scripts or strategies were given for this passage). All participants then completed the eleven graphs which corresponded to the transfer stage.

Session 2: recall tests. The recall session took place the following day. During this session participants first completed the free-recall test over the immune system, after which they completed the free-recall test over the blood passage. The participants were allowed 15 min to complete each of these tests.

Results

The results section will begin with an explanation of the recall test scoring procedure. Following this, a brief summary of between-group comparisons on recall will be presented. Lastly, the analyses which examined the internal structure, reliability, and validity of subjective graphing will be addressed.

Recall Scoring

Scoring of the free-recall tests was based on a procedure developed by Meyer (1975) and Holley, Dansereau, McDonald, Garland, and Collins (1979). Scoring keys were constructed for the free-recall test over the blood and immune system passages by dividing the original material into an inclusive set of idea units, each containing one fact, stated in the form of a simple declarative sentence. Two experienced scorers matched each of these idea units with every idea unit contained in a participant's free-recall test. For every unit on the key that also appeared on a given participant's free-recall test, the participant received from one to four points depending on the accuracy of the match. The total number of points that a participant received constituted his or her free-recall score. Reliability was established by drawing 10 tests at random for both the blood and immune system passages and having both of the raters score the 20 tests independently. Interrater reliabilities were $r=.96$ for the blood passage and $r=.95$ for the immune system passage.

Summary of Between Group Comparisons on Recall

Before presenting the analyses which specifically addressed the subjective graphing measure, it should be noted that significant experimental group differences were found on recall. More specifically, a significant main effect for treatment group was found for the number of idea units mentioned on free recall collapsed across both passages, $F(2,86) = 3.4$, $p<.05$. Post-hoc analyses indicated that the scripted and unscripted dyad groups significantly outperformed the individual group ($p<.05$, $p<.01$, respectively). A more detailed explanation of results associated with the script manipulations used in the present study can be found in O'Donnell et al., (1987).

Analysis of Subjective Graphing

Internal Structure/Reliability

In order to examine the internal structure and reliability of the subjective graphing measure, four analyses were performed: a factor analysis of the graph means for both the initial and transfer sessions; a factor analysis of the graph data points for both sessions; a test-retest correlation of the graph mean factors for those in the unscripted dyad condition; and coefficient alpha on the graph data points for each factor for both study sessions.

Five data points from each graph were used to assess a participant's mean for a given graph. The data points consisted of the number on the vertical axis of the graph which corresponded to the crossing of a participant's subjective graph and one of the five equidistant dark lines along the horizontal axis (see Figure 1). In the first internal structure analysis, the 11 graph means from the initial learning stage and the 11 sets of means from the transfer stage were factor analyzed separately. In the first factor analysis of the initial stage graphs, those in the individual condition were not included due to differences in the graphs (the individuals' graphs did not include graphs about feelings toward partners).

A three factor solution with a varimax rotation was selected for both of the factor analyses due to the logical groupings and clear differentiation of factors. For both analyses the same factors emerged with the same graph means loading on each factor. The three factors were: "feelings about self," "feelings about partner," and "anxiety/nervousness." Therefore, the factor structure appears to be consistent over time. Further, the three factors are representative of the three categories the graphs were purported to measure. That is, "feelings about self" can be thought to represent metacognitive states; "feelings about partner" is representative of social states; and "anxiety/nervousness" is representative of affective states. Table 1 contains the graphs and their factor loadings for both of the factor analyses.

Insert Table 1 about here

To further converge on the internal structure of the graphs, a factor analysis was performed on the individual graph points which composed the graph means. Again, with both the initial and transfer stage graphs the same three factors emerged.

The first phase of the reliability analysis consisted of an assessment of the test-retest reliability of the subjective graphs for the unscripted dyad group which studied under substantially the same condition during the initial and transfer stages. The graph mean factors for the initial stage were correlated with their corresponding graph factors for the transfer stage (unit weights were used in the calculation of factor scores). The "feelings about partner" factor was not included in the analysis since the participants studied with different partners during the two stages.

Correlations were $r=.71$ and $r=.65$ for the "feelings about self" and the "anxiety/nervousness" factors respectively. Due to the fact that the latter factor included a graph on partners' anxiety/nervousness, a third correlation was calculated with this graph eliminated. This correlation was $r=.70$. Therefore, when exposed to a similar situation at a later time, participants appear to use the graphs in a similar manner.

The final phase of the reliability analysis consisted of coefficient alpha performed on the graph data points for each of the graphs included within each of the three factors for both stages. Coefficient alphas for the initial and transfer stage for the "feelings about self" factor were .93 and .97, respectively; for the "feelings about partner" factor, .95 and .97 for the two stages; and for the anxiety/nervousness factor, .90 and .92.

Validity

To provide a preliminary examination of the validity of the graphs, the relationship between the graph that asked students about their understanding of the material and recall performance was assessed. In addition, the sensitivity of the graphs to situational factors within the learning situation was examined.

Relationship of graphs to recall performance. This part of the validity analysis consisted of two stages. The first phase consisted of correlations between the "understanding" graph means and total recall for both passages. The second phase consisted of the correlations between the individual graph data points and the recall of the sections of the passage which corresponded to these data points.

In the first phase of the graph/recall analysis the understanding graph means were correlated with the appropriate recall test. That is, participants' means for the initial study session were correlated with the free recall of the passage which was studied in that session and participants' understanding means for the transfer stage were correlated with the recalls for the passage studied in that session. The mean understanding/total recall correlations were significant for both initial and transfer study (r = .32, $p < .01$ and $r = .30$, $p < .01$).

In the second phase of the graph/performance analyses the understanding graph data points were correlated with their corresponding sectional recall. Recall for these analyses was scored in the same manner as described at the beginning of the results section, with the exception that the recalls were divided into three sections. Scores for the idea units from Section 1 of the passage constituted Section 1 recalls, the second, Section 2 recalls, and the third, Section 3 recalls. Since there were five data points in each of the graphs, these also had to be combined in order to perform the graph data point/sectional recall correlations. These three scores were created by summing the second and third graph data point and dividing by two, summing the third and fourth graph data point and dividing by two, and summing the fourth and fifth graph data point and dividing by two (the first data point was not included since it corresponded to participants' feelings before the study session began; again, see Figure 1). Each of these three graph sectional scores were then correlated with the sectional recall to which it corresponded. For the correlations involving the initial stage, only the first section graph/recall score was significant ($r = .30$, $p < .01$). For stage two, the understanding graph data points significantly predicted Section 2 ($r = .23$, $p < .05$) and Section 3 ($r = .39$, $p < .001$) recall.

Sensitivity of graphs to situational factors. The second and final approach to the analysis of validity included a comparison of treatment groups on their graph mean factor scores.

In the first phase of these analyses, two one-way analyses of variance were computed for 2 of the 3 graph factors (feelings about partner and anxiety/nervousness) which corresponded to both of the study stages. In both of these ANOVAs, treatment condition served as a between-subject independent variable and 1 of the 3 graph mean factor scores served as the dependent variable. In addition, a two-way repeated-measures ANOVA was computed for the "feelings about self" factor with stage (initial vs. transfer) as a within-subject variable. Since this factor did not include any graphs asking about partner, Group UI's scores from the initial stage could be included.

No group differences were found in either of the two-way ANOVAs for the initial study stage. For the transfer stage, there were significant differences between the three groups in the "feelings about partner" ANOVA, $F(2,80) = 4.75$, $p < .05$, $MSe = 37.39$. Although there were not significant differences between groups in the "anxiety/nervousness" ANOVA for this stage, the results were suggestive, with the means for the SD group ($M = 5.13$) and the USD group ($M = 5.12$) substantially lower than Group UI ($M = 6.91$), $F(2,80) = 2.99$, $p = .056$, $MSe = 9.81$.

A Tukey post hoc test (Hays, 1981) was performed to compare the means within the "feelings about partner" ANOVA for the transfer stage. This analysis indicated that the mean for the SD group was significantly higher than the mean for Group USD. No other significant group differences were found. Table 2 includes the means and standard deviations of the cells in the "feelings about partner" ANOVA.

Insert Table 2 about here

In the repeated measures ANOVA in which feelings about self was a factor, there was not a main effect for experimental group. However, there was a significant main effect for stage, $F(2,81) = 20.50$, $p < .0001$, $MSe = 84.19$, with scores on "feelings about self" increasing across all three groups. Therefore, although the graphs were not sensitive to treatment group differences on "feelings about self," they were sensitive to changes over time. Table 3 includes summary statistics for the cells within this ANOVA.

Insert Table 3 about here

Discussion

The discussion of the subjective graphing results will be organized in the same order as the experimental questions posed at the end of the introduction, that is, internal structure, reliability, validity as measured by prediction of performance, and validity as measured by sensitivity to treatment group differences. Following this, suggestions for future research will be discussed.

Three conclusions can be drawn from the results of the factor analyses which were performed to investigate the internal structure of the subjective graphs. First, the eleven graphs can be represented adequately by three distinct factors. This conclusion is supported by both the statistical and logical nature of the solutions. Second, this factor structure appears to be quite stable, as opposed to being simply an artifact of the treatment conditions corresponding to the initial stage of the experiment. Nearly identical factor solutions were found for the second passage and for the data points within the graphs. Third, the factor analyses were consistent with a priori expectations based on Dansereau's (1986) model. Specifically, the three factors, "feelings about self," "feelings about partner," and "anxiety/nervousness," can be thought to represent the metacognitive, social, and affective components of the model.

Reliability is indicative of a measure's repeatability, that is its stability over a variety of conditions in which the same results would be expected (Nunnally, 1978). The high coefficient alpha scores for each of the graph factors indicates that the graphs which measure these factors are internally valid. The subjective graphing measure also appears to be reliable over time. This is indicated by the high correlation between Group USD's graph scores for the initial stage and their corresponding scores on graphs completed during the transfer stage. These two tests of reliability indicated that the subjective graphing measure was measuring the same constructs for different groups of people within the same administration session and for the same group of persons administered the measure at different times.

The correlations between recall performance and graph scores indicated that the subjective graphs of understanding correlated moderately, albeit reliably, in 5 of the 8 correlations computed. Although this prediction appears to be fairly consistent, the magnitude of the correlations were not as high as expected. In future experimentation alternative graphs (e.g., memorability of the test segment) and/or combinations of graphs should be examined as predictors of performance.

The analyses of subjective graphing's sensitivity to group differences indicated that the measure was sensitive to such differences in the transfer but not in the initial study stage. Specifically, there appeared to be substantial treatment group differences on 2 of the 3 graph factors for the transfer stage, but no differences in the initial stage. The lack of differentiation in the graphs for the initial stage can probably be attributed to inexperience in using the graphs. Further, the fact that Group SD was among the highest groups on "feelings about partner" and among the lowest on "anxiety/nervousness" is consistent with previous research which indicates that there are positive consequences associated with scripted-cooperative learning which transfer to subsequent non-scripted learning (McDonald et al., 1985).

Although the repeated measure analysis of variance on "feelings about self" did not find group differences, a main effect for study stage indicated that the graphs were sensitive to situational factors in terms of changes over time. The fact that scores on the "feelings about self graphs" (e.g., graphs asking about feelings toward material, concentration while studying, and understanding of material) increased for all groups from the initial to transfer stage is to be expected due to two aspects of the differences between the stages. First, participants probably felt much more comfortable in the last stage of studying in the experiment since they knew what to expect and already had some study experience in a related situation. Second, the passage which served as the study material for the transfer stage (a passage on the blood system) was substantially less difficult than the initial passage (a passage on the immune system).

The results of this preliminary examination of the subjective graphing measure suggest extension into five basic areas of research. First, although the reliability of the measure has been largely established, further refining and testing is required in order to better establish the measure's relationship to external criteria. This can be done by experimenting with alternative graphs, and by providing participants with more exposure to the graphing technique. Once the convergent validity of the measure is more firmly established, a second area of research would involve a comparison of the measure with other measures of ongoing processing. Is this measure able to provide additional information above and beyond existing measures of the same type? That is, does subjective graphing demonstrate adequate discriminant validity?

A third area of investigation warranted by the present experiment is a test of the measure's generalizability to other learning situations. The learning conditions for which this measure is most appropriate should be more closely investigated. The relationship of subjective graphing to relevant individual differences is a fourth important area for future research. First, are certain individuals able to more accurately utilize the measure? Second, can the subjective graphing measure itself (intended as a measure of temporary states) serve as a measure of individual differences. That is, when the situation is held constant, is the variance between participants representative of some enduring individual difference trait? The fifth area for the extension of the present study is a test of the applicability of the measure for diagnosing and remediating processing weaknesses. Is this measure a useful tool for psychologists and educators in an applied setting who are attempting to measure and correct students' processing deficits?

References

Benjafield, J. (1971). Evidence for a two-process theory of problem solving. Psychonomic Science, 23, 397-399.

Cacioppo, J. T. & Petty, R. E. (1981). Social psychological procedures for cognitive response assessment: The thought-listing technique. In T. V. Merluzzi, C. R. Glass, & M. Genest (Eds.), Cognitive Assessment. New York: Guilford Press.

Dansereau, D. F. (1986, April). Dyadic cooperative learning and performance strategies. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Ericcson, K. A. & Simon, H. A. (1980). Verbal Reports as Data. Psychological Review, 87(3), 215-251.

Galassi, J. P., Frierson, H. T., & Sharer, R. (1981). Concurrent versus retrospective assessment. Journal of Consulting and Clinical Psychology, 49(4), 614-615.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L., O'Donnell, A., Lambiotte, J., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material.

Journal of Educational Psychology, 80, 172-178.

Hays, W. L. (1981). Statistics (3rd ed.). New York: Holt, Rinehart, and Winston.

Holley, C. D., Dansereau, D. F., McDonald, B. A., Garland, J. C., and Collins, K. W. (1979). Evaluation of a hierarchical mapping technique as an aid to prose processing. Contemporary Educational Psychology, 4, 227-237.

Ickes, W. (1982). A basic paradigm for the study of personality, roles, and social behavior. In W. Ickes & E. S. Knowles (Eds.), Personality, roles, and social behavior (pp. 305-341). New York: Springer-Verlag.

Ickes, W. & Barnes, R. D. (1977). The role of sex and self-monitoring in unstructured dyadic interactions. Journal of Personality and Social Psychology, 35, 315-330.

Johnson, R. & Donchin, E. (1985). Second thoughts: Multiple p300s elicited by a single stimulus. Psychophysiology, 22(2), 182-194.

Kramer, A. F., Wickens, C. D., & Donchin, E. (1985). Processing of stimulus properties: Evidence for dual-task integrality. Journal of Experimental Psychology: Human Perception and Performance, 11(4), 393-408.

Larson, C. O., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., & Rocklin, T. R. (1984). Verbal ability and cooperative learning: Transfer of effects. Journal of Reading Behavior, 16(4), 289-295.

McDonald, B. A., Larson, C. O., Dansereau, D. F., & Spurlin, J. E. (1985). Cooperative dyads: Impact on text learning and transfer. Contemporary Educational Psychology, 10(4), 369-377.

Meyer, B. J. F. (1975). The organization of prose and its effects on memory. Amsterdam: North-Holland.

Nunnally, J. C. (1978). Psychometric Theory (2nd ed.). New York: McGraw-Hill.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Rocklin, T. R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. Journal of Educational Psychology, 79, 431-437.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Lambiotte, J. G., Larson, C.O., & Young, M. D. (1985). Effects of elaboration frequency on cooperative learning. Journal of Educational Psychology, 77(5), 572-580.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T., Hythecker, V. I., Young, M. D., Hall, R. H., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

Spurlin, J. E., Dansereau, D. F., Larson, C. O., & Brooks, L. W. (1984). Cooperative learning strategies in processing descriptive text: Effects of role and activity level of the learner. Cognition and Instruction, 1(4), 451-463.

Table 1

Subjective Graph Factors: Graphs and Loadings

Factor Graph	Initial Loading	Transfer Loading
1. Feel About Self		
Feel About Performance	.88	.85
Motivated/Interested	.84	.77
Feel About Material	.79	.85
Concentration	.76	.80
Understanding	.67	.83
2. Feel About Partner		
Motivation of Partner	.89	.84
Understanding of Partner	.85	.65
Concentration of Partner	.83	.75
Feel About Partner	.49	.64
3. Anxiety/Nervousness		
Anxiety/Nervousness of Partner	.80	.81
Anxiety/Nervousness of Self	.76	.80

Table 2

ANOVA: Group on Feel about Partner Transfer Stage

Experimental Group	Mean	SD
Scripted Dyad	26.80	4.92
Unscripted Dyad	21.74	7.64
Unscripted Individual	23.52	5.45

Table 3

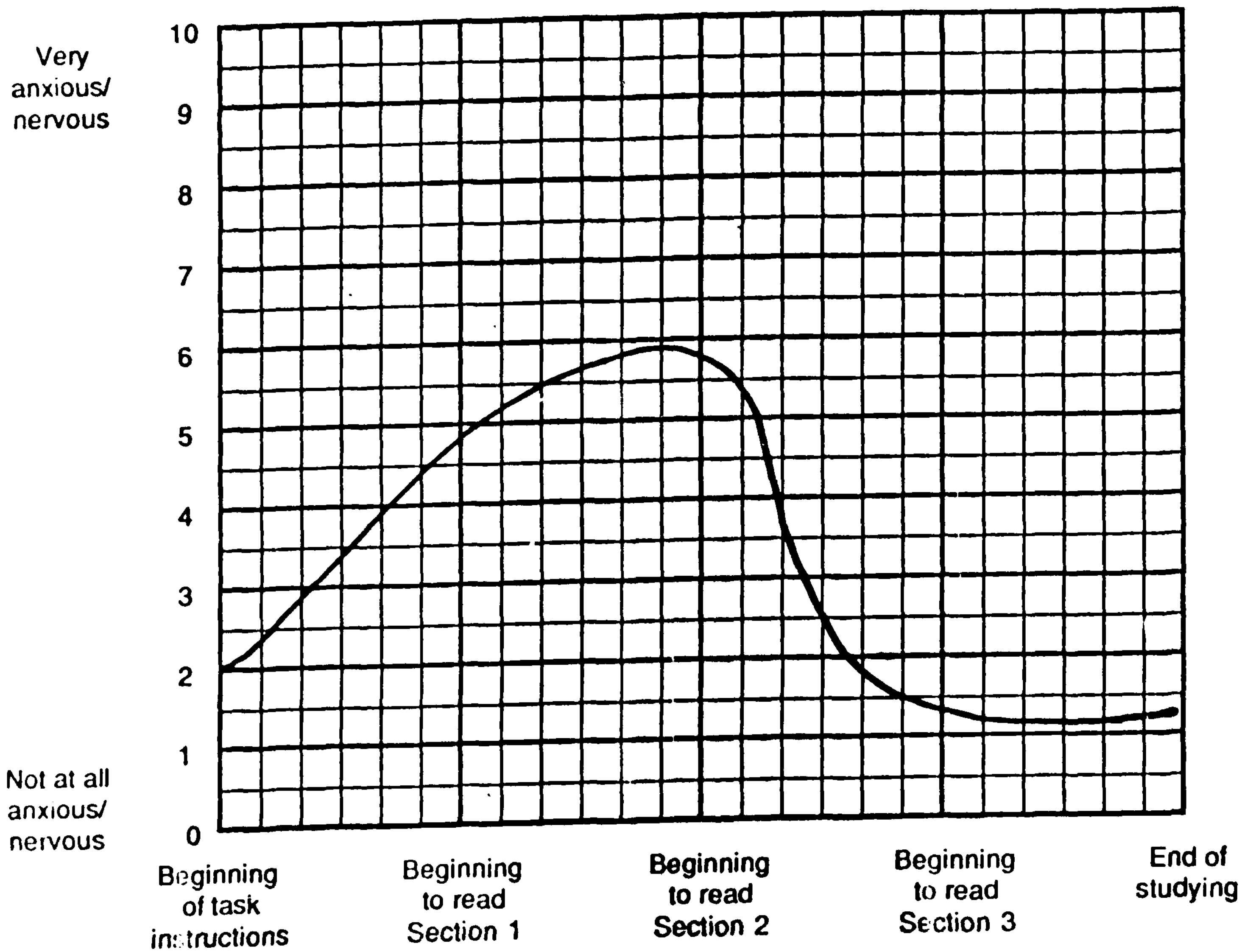
ANOVA: Group X Stage on Feel About Self

	Stage			
	Initial		Transfer	
Experimental Group	Mean	SD	Mean	SD
Scripted Dyad	24.23	6.88	29.95	7.71
Unscripted Dyad	23.56	7.67	26.26	8.42
Unscripted Individual	26.98	6.75	29.41	7.16

Figure Caption

Figure 1: Example of a subjective graph.

How anxious/nervous were you as you studied?



APPENDIX D

APPENDIX D

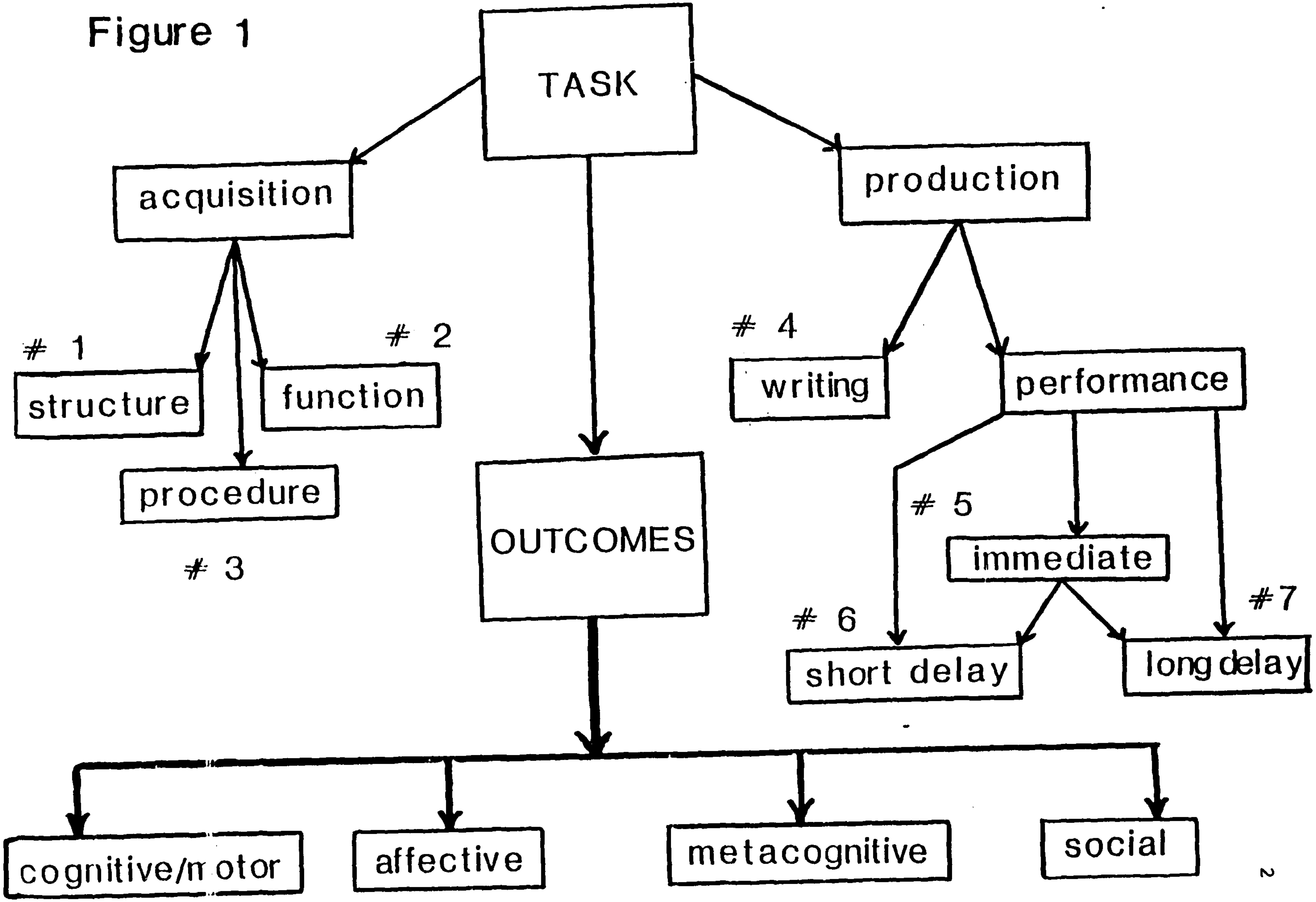
MODIFYING THE PROTOTYPICAL SCRIPT

An outline of possible tasks which might be included in a technical training environment is presented in Figure 1 of this appendix. This outline summarizes the kinds of tasks explored in the current research program. Two major categories of tasks are identified: acquisition and production tasks. Acquisition tasks include learning structural, functional, and procedural information. Production tasks explored in the current research program include writing and performance. Possible outcomes include cognitive/motor, affective, metacognitive, and social outcomes.

The remainder of this appendix presents information on what aspects of the prototypical script were adapted to meet the specific demands of the task, how they were adapted, and with what effects.

Note: All aspects of the CAMS framework were not assessed in each experiment.

Figure 1


TASK
acquisition
production
1
structure
2
function
procedure
3
OUTCOMES
4
writing
performance
5
immediate
6
short delay
7
long delay
cognitive/motor
affective
metacognitive
social

PROTOTYPICAL SCRIPT

1. Both partners read a section of the target text.
2. Both partners put the material away.
3. Partner A reiterates (recalls) the information read.
4. Partner B provides feedback to Partner A.
5. Both partners elaborate on the information.
6. Both partners read the second section of the target text.
7. A and B switch roles for the second section of the text.
8. A and B continue in this manner until they have completed the entire text.

Task:	# 1: Acquisition of technical information.
Presentation of information:	Pictures and text (e.g., aircraft control panel).
Locus of script adaptations:	Elaborations.
How adaptations are made:	The participant visualizes the piece of equipment and images the location of each part of the equipment.
Outcomes:	
cognitive/motor:	Use of the script results in more accurate recall of the pictures. Cooperation among peers is effective for initial acquisition and in promoting transfer.
affective:	Not specifically assessed.
metacognitive:	Scripted groups make less errors of omission.
social:	Participants who use scripts report and increased preference for working cooperatively compared to those who did not use scripts.
Individual differences to consider.	Induction ability is more important for learning in dyads than for individual learning. Induction ability is predictive of the recall of structural information.

References: Publications/Conference presentations.

Hall, R. H. (1988, April). Individual differences and the procedural learner. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Lambiotte, J. G., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., & Rocklin, T. R. (1986, April). Technical learning strategies: Acquisition of structural and functional information. Paper presented at the Annual Meeting of the Southwestern Psychological Association.

Larson, C. O., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., Lambiotte, J. G., & Rocklin, T. R. (1986). Technical training: An application of a strategy for learning structural and functional information. Contemporary Educational Psychology, 11, 217-228.

Task:	# 2. Acquisition of functional information.
Presentation of information:	Pictures and text (e.g., sailboat).
Locus of script adaptation:	Elaborations.
How adaptations are made:	The participant visualizes the piece of equipment, mentally activates one component of the equipment and visualizes what happens to other parts of the system as a consequence of the activation of one component.
Outcomes:	
cognitive/motor:	Use of the script results in more accurate recall of the text describing the functions of the parts of the equipment.
affective:	Participants using scripts reported higher levels of motivation.
metacognitive:	Scripts incorporating dynamic imagery result in less omission errors when recalling the functional information.
social:	Scripted groups exhibited an increased preference for cooperative study.
Individual differences to consider:	Induction ability is more important for learning in dyads than for individual learning. Induction ability is predictive of recall of structural information.

References: Publications/Conference Papers.

Hall, R. H. (1988, April). Individual differences and the procedural learner. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Lambiotte, J. G., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., & Rocklin, T. R. (1986, April). Technical learning strategies: Acquisition of structural and functional information. Paper presented at the Annual Meeting of the Southwestern Psychological Association.

Larson, C. O., Dansereau, D. F., Hythecker, V. I., O'Donnell, A. M., Young, M. D., Lambiotte, J. G., & Rocklin, T. R. (1986). Technical training: An application of a strategy for learning structural and functional information. Contemporary Educational Psychology, 11, 217-228.

Task:	# 3. Acquiring procedural information.
Presentation of information:	Presented in pictures and text (e.g, giving an intramuscular injection, operating an MA-1 respirator).
Locus of script adaptations:	Elaborations.
How adaptations are made:	Participants mime the actions of operating the equipment necessary for the performance of the procedure.
Outcomes:	
cognitive/motor:	Scripting appears to be necessary in order to learn from procedural text. Simulated movement promotes the best outcomes. Those who used mime were best able to describe a procedure learned (i.e., giving an injection) after a delay of some weeks.
affective:	The affective outcomes from exposure to procedural text depend on the substrategies used and the interest of the task itself. Both negative and positive attitudes have resulted.
metacognitive:	Not specifically assessed.
social:	Not specifically assessed.
Individual differences to be considered:	Dyads who receive high scores on a measure of social orientation outperform individuals on recall of procedural information. Unlike the acquisition of structural or functional information, induction ability is not related to recall of procedural information, whereas a measure of "deep processing" is.

References: Publications/Conference papers.

Hall, R. H. (1988, April). Individual differences and the procedural learner. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Hythecker, V. I., Dansereau, D. F., O'Donnell, A. M., Larson, C. O., Lambiotte, J. G., Rocklin, T. R., & Young, M. D. (1985, April). The development and evaluation of a strategy for procedure learning. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Austin, TX.

Hythecker, V. I., Dansereau, D. F., Rocklin, T. R., O'Donnell, A. M., Young, M. D., & Lambiotte, J. G. (1986, April). The development and evaluation of a modified procedure learning strategy. Paper presented at the Annual Meeting of the Southwestern Psychological Association, Fort Worth, TX.

Skaggs, L. P., Rocklin, T. R., Dansereau, D. F., O'Donnell, A. M., Lambiotte, J. G., Young, M. D., & Hall, R. H. (1987, April). Dyadic learning: Individual differences, interaction, and performance. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, D. C.

Task:	# 4. Writing technical instructions.
Presentation of information:	Participants wrote instructions about familiar tasks (e.g., driving a car). This process is analogous to what is required of subject matter experts in technical environments.
Locus of script adaptations:	Not applicable. This particular research was exploratory in nature and examined the efficacy of some important components of the script, that is, cooperation among peers, and feedback. Participants were simply instructed to cooperate with each other to write a good set of instructions.
How adaptations are made:	Not applicable.
Outcomes:	
cognitive/motor:	Cooperating participants wrote more communicative instructions than individuals working alone. Feedback in the form of editing improves the completeness of the instructions.
affective:	Not assessed.
metacognitive:	Skills learned in cooperative interaction transferred to a subsequent individual task.
social:	Not assessed.
Individual differences to consider:	Vocabulary level and a measure of cognitive style (field-independence/dependence) were not strongly related to outcomes.

References: Publications/Conference Presentations.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Lambiotte, J. G., Hythecker, V. I., & Larson, C. O. (1985). Cooperative writing: Direct effects and transfer. Written Communication, 2, 307-315.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Larson, C. O., Hythecker, V. I., Young, M. D., & Lambiotte, J. G. (1987). Effects of cooperation and individual rewriting on an instruction writing task. Written Communication, 4, 90-99.

Task:	# 5 Immediate performance of a procedure. If the goal of reading the instructions is simply to perform the procedure well on a single occasion, the kinds of adaptations to the general script which are necessary are not the same as those needed if long term retention of the procedure is required.
Presentation of information:	Information about the procedure (e.g., administering an intravenous infusion) is presented to participants via text which may or may not include visual representations.
Locus of script adaptations:	Recall and Elaboration phases.
How the adaptations are made:	The script does not include a planning (recall) phase. Participants go from a reading of a section of the text into a performance of that part of the procedure. The performance itself serves as an elaboration of the participant's understanding of the material read. The performers may refer to their instructions or partners for assistance when performing. Unscripted cooperative scenarios also work well for immediate performance.
Outcomes:	
cognitive/motor:	Participants who refer to their instructions while engaged in an initial performance perform the procedure well. The critical ingredient in producing a good "first time" performance seems to be the availability of other resources.

affective:	Participants who refer to their materials exhibit positive attitudes to the materials and the learning situation.
metacognitive:	Those who "prompt" their initial performance make less errors of omission but more errors of accuracy than those who do not "prompt" their initial performance.
social:	Pairs of participants who work in an unscripted cooperative setting do not like each other as much as those who work with a script.
Individual differences to consider:	Field dependent participants perform better in "prompting" conditions than in situations in which they must rely completely on memory.

References: Publications/Conference papers.

O'Donnell, A. M., & Dansereau, D. F. (1988, Februrary). Predicting performance of concrete procedures. Paper presented at the Annual Meeting of the Eastern Educational Research Association, Miami, FL.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Skaggs, L. P., Hythecker, V. I., Peel, J. L., & Rewey, K. L. (1988, April). Learning concrete procedures: The effects of processing strategies and cooperative learning. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Hall, R. H., Skaggs, L. P., Lambiotte, J. G., & Young, M. D. (1988). Cooperative procedural learning: The effects of prompting and pre- vs. distributed planning activities. Journal of Educational Psychology, 80(2), 161-171.

O'Donnell, A. M., Dansereau, D. F., & Rocklin, T. R. (1988). Individual differences in the cooperative learning of concrete procedures. Manuscript submitted for publication.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

Task:	# 6 Performance of a procedure after a short delay.
Presentation of information:	Information about the procedure (e.g., a medical procedure) is usually presented in text with or without supporting illustrations.
Locus of script adaptations:	Recall, Elaboration, Feedback.
How adaptations are made:	Participants first plan their performance and then actually perform. They are allowed to refer to their instructions or partners when doing so. The inclusion of both planning and performance provides two opportunities for the performer to receive feedback.
Outcomes:	
cognitive/motor:	Participants who use a script which involves planning and performing retain the procedure and perform well after a five day interval.
affective:	Participants who use scripts involving planning, prompting, and performance are more motivated and exhibit more positive attitudes to the materials and learning situations than those who use scripts which do not involve all of these components.
metacognitive:	Participants who use the script which involves planning and performance with prompting make less errors both during the immediate performance of the procedure and after a delay of five days.
social:	The use of the script described above results in positive attitudes towards the partner and these attitudes are positively related to performance.

Individual differences to considered:

The addition of "prompting" or allowing participants to refer to their instructions or their partners facilitates the performance of field dependent participants. Verbal ability is an important individual difference measure to be considered but it less important for performance than for recall.

References: Publications/Conferences papers.

O'Donnell, A. M., & Dansereau, D. F. (1988, Februrary). Predicting performance of concrete procedures. Paper presented at the Annual Meeting of the Eastern Educational Research Association, Miami, FL.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Skaggs, L. P., Hythecker, V. I., Peel, J. L., & Rewey, K. L. (1988, April). Learning concrete procedures: The effects of processing strategies and cooperative learning. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

O'Donnell, A. M., Dansereau, D. F., Hythecker, V. I., Hall, R. H., Skaggs, L. P., Lambiotte, J. G., & Young, M. D. (1988). Cooperative procedural learning: The effects of prompting and pre- vs. distributed planning activities. Journal of Educational Psychology, 80(2), 161-171.

O'Donnell, A. M., Dansereau, D. F., & Rocklin, T. R. (1988). Individual differences in the cooperative learning of concrete procedures. Manuscript submitted for publication.

O'Donnell, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Hall, R. H., Young, M. D., Skaggs, L. P., & Lambiotte, J. G. (in press). Promoting functional literacy through cooperative learning. Journal of Reading Behavior.

Task:	# 7. Recall of a procedure after a long delay (6 weeks).
Presentation of information:	The information was presented in instructions which included descriptions of the equipment and procedures necessary for the administration of an intravenous infusion. Pictures and text were included in the instructions.
Locus of script adaptations:	In this case, the script adaptation involved the target material, focus on the equipment or the procedure descriptions.
How the adaptations are made:	Participants were directed to begin with either the description of the equipment or that of the procedure.
Outcomes:	
cognitive/motor:	The typical script was effective in promoting recall of the target information after a six week interval. Those who had started their training by focusing on the procedural description recalled more of the information relevant to the actual performance of the procedure, suggesting that they were likely to have performed the procedure better.
affective:	Not assessed.
metacognitive:	The participants who explicitly used the general script tended to make more correct decisions in selecting equipment. Text based cues (e.g., I remember the description in the text) were related to recall of the procedure whereas imagery scores were related to the recall of the equipment information.

Individual differences to be considered: Individual differences in imagining ability and ability to use cues from the text appear to be important in the long term retention of information about the procedure.

References: Publications/Conference Papers.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., Skaggs, L. P., Hythecker, V. I., Peel, J. L., & Rewey, K. L. (1988, April). Learning concrete procedures: The effects of processing strategies and cooperative learning. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.