NOTICE

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VARIATIONS IN COGNITIVE ENGAGEMENT AS EVIDENCE OF SELF-REGULATED LEARNING

by

Dawn Cynthia Howard

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VARIATIONS IN COGNITIVE ENGAGEMENT AS INDICATORS OF SELF-REGULATED LEARNING

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ABSTRACT

A model of Self-Regulated Learning proposed by Corno and Mandinach (1983) was examined in this study. This model proposes specific variations in students' approaches to complex learning tasks, depending on the strategies available to them, their self-management skills, and the demands of the task. These variations in students' approaches to tasks, referred to as "forms of cognitive engagement," emphasize some cognitive processes over others and involve more or less mental effort overall. The component cognitive processes of this model are categorized as either acquisition processes or transformation processes. The acquisition processes are labelled *attending, rehearsal, monitoring,* and *strategic planning.* The transformation processes are labelled *selectivity, connecting,* and *tactical planning.* The four forms of cognitive engagement proposed in the model are defined by use of high versus low levels of acquisition and transformation processes.

Working in groups of three, students were presented with six academic tasks designed to vary in cognitive demands and motivational effects. Their use of acquisition and transformation processes was measured in three different ways. These were an SRL Rating Scale administered as a pretest, a Metacognitive Questionnaire specific to each task, and students' written "traces" of cognitive processes used during each task.

A multitrait-multimethod analysis was conducted on the three measures of component processes. Converging evidence among the three methods of measuring acquisition and transformation processes was not produced. Also, on the basis of these data, it was not possible to verify that the acquisition and transformation categories of processes are mutually exclusive. Two different measures of the component processes labelled strategic planning and connecting were correlated with pretest measures of ability and motivation. This may serve as some evidence that these two cognitive processes are important to self-regulated learning, regardless of variations in task demands.

The results of this study raise important questions about the level of analysis used in studying cognitive processing during learning and instruction. In particular, it may be that attempts to predict specific configurations of cognitive processes in the context of large, complex tasks are inappropriate, given the variability that is possible under such complex conditions.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

In recent years, the role of students' cognitions in mediating between teaching behaviors and student achievement has received increased attention in the literature (Calfee, 1981; Winne & Marx, 1980, 1982). In particular, the cognitive processes engaged by students to acquire and manipulate subject matter content and the appraisals they make in learning situations about self and task are considered critical influences on learning outcomes (Doyle, 1983, Peterson, Swing, Stark, & Waas, 1983; Winne & Marx, 1980). Researchers in education and psychology also have begun to expand notions of students' ability and motivation to include their capacity to set and achieve goals for learning (Bandura, 1982; Bandura & Schunk, 1981; Meichenbaum, 1977; Thoresen & Mahoney, 1974; Schunk, 1984).

Evidence accumulated so far points to important relationships between motivational variables and students' active use of cognitive skills and strategies to learn. These studies have led to some theoretical developments aimed at integrating the various factors involved. For example, some explanations have been proposed recently for how cognitive skills and self-appraisals interact with intrinsic motivation to learn to produce variations in academic success (e.g., Brophy, 1983; Schunk, 1984). Corno and Mandinach (1983) offered one such formulation in their model of Self-Regulated Learning (SRL). They hypothesized that variations in students' cognitive engagement during classroom learning are related predictably to motivational variables such as self-efficacy, ability, and achievement. More specifically, Corno and Mandinach (1983) propose that learners will engage particular combinations of cognitive processes in consistent and predictable ways under various circumstances. The four different combinations of cognitive processes proposed in the SRL model are labeled "forms of cognitive engagement."

The study described in this dissertation was designed to explore several aspects of Corno and Mandinach's (1983) model of SRL. The question of whether the four forms of cognitive engagement can be distinguished from one another consistently and reliably in the context of real academic tasks is addressed first. This investigation uses several measures of processes which comprise SRL proposed in the Corno and Mandinach (1983) model. These measures, taken over a series of tasks designed to vary according to the hypotheses put forward by these authors, are used to attempt to classify students' cognitive activity in terms of the four forms of engagement.

Students' use of the component processes of SRL, as reflected in the measures used here, are also compared to their scores on several aptitude variables which theoretically predict the use of self-regulated learning strategies. The aptitude variables include ability, achievement, and two variables typically associated with intrinsic motivation to learn: attributions for success and failure, and academic self-concept. Finally, this study examines whether students' performance on a number of academic tasks is predicted from their scores on measures of components of SRL used during those particular tasks.

In exploring the validity of this SRL model, questions are raised concerning the feasibility of predicting students' approaches to academic work by studying variables at as small a unit of analysis as specific cognitive processes. In particular, "real" academic tasks, of the kind students are asked to perform in school, are relatively large and complex compared to those used in typical laboratory studies of cognitive processing. Such tasks involve considerable variation in the cognitive demands they place on students as a consequence of existing variance in students' ability and prior knowledge. This variation also is exaggerated in classrooms, where social conditions add to the complexity of the "system." As a result, there arises some question about the likelihood of students engaging in combinations of component cognitive processes as predictably as Corno and Mandinach hypothesize. Even if such configurations do occur, the ability to detect them operating in classroom-like settings is highly questionable. Should it prove possible to predict patterned use of component SRL processes in this study, then the variations in cognitive engagement demonstrated by "successful" students might serve as the prototype on which to base future instructional studies that investigate means for helping less successful learners to approach tasks in more effective ways.

The Model of Self-Regulated Learning

Corno and Mandinach (1983) identify four qualitatively different approaches to learning that students use during classroom instruction. These different approaches, described as forms of cognitive engagement, are characterized by two features: different configurations of component cognitive processes, and the overall amount of cognitive activity. According to Corno and Mandinach's model, two main categories of component cognitive processes are distinguished: *acquisition* and *transformation* processes.

The acquisition processes are labeled *alertness, monitoring,* and *high-level planning*. Alertness is attending to and receiving incoming information. Monitoring involves continuously tracking information and its transformations, rehearsing information, and self-checking progress on a task. High-level planning consists of assessing task goals relative to constraints and making decisions about the use of time, effort, and external resources.

Three major processes are classified as transformation processes: low-level planning, selectivity, and connecting. Low-level planning involves organizing one's approach to a task as a sequence of "steps" or a performance routine. Selectivity is discriminating relevant from irrelevant information. Connecting is defined as searching for familiar knowledge which could be assembled with other information or actually linking familiar knowledge to incoming information.

In the present study, several variations and adjustments are made to the model of self-regulation that Corno and Mandinach proposed. In some cases the labels and definitions of acquisition and transformation processes were changed; in other cases, a cognitive component has been added or changed in status. The revised terms are listed in Table 1.

The reason for some of these alterations was to highlight distinctions between global (or general) and local (or specific) metacognitive processes. This was the case with planning (now referred to as strategic planning and tactical planning) and with monitoring processes (now referred to as global monitoring and cognitive regulating).

Strategic planning refers to the kind of planning one does at the beginning of a task. This type of planning involves evaluating the task to determine how much time and effort, and what kinds and amounts of resources will be required in order to complete it. Selecting general strategies to use in approaching the task also is part of strategic planning. In *tactical planning*, which is seen as more "local", the learner organizes a sequence of cognitive steps or decides to use a known routine or solution strategy to reach an immediate subgoal within the task.

Global monitoring refers to general assessments of one's cognitive status relative to the goal(s) of a task. It is the aspect of monitoring that Corno and Mandinach refer to as "continuous tracking of stimuli and transformations" (1983, p. 94). Global monitoring involves recognizing the general organization of and the salient information in one's mental

Table 1. **Classifications of Cognitive Processes**

Acquisition Processes	Transformation Processes
Alertness – Receiving/Tracking incoming stimuli – Attending	**Selectivity** – Discriminating among stimuli – Distinguishing relevant from irrelevant information
Rehearsal – Repeating information to oneself	
Global Monitoring – Self-checking of general level of understanding systematically	**Connecting** – Searching for familiar knowledge – Linking familiar knowledge to incoming information
Cognitive Regulating – Continuous tracking of stimuli and transformations systematically – Self-checking of specific transformations, e.g., inferences within task material, relationships among items of info.	**Organizing** – Representing information systematically – Making connections or drawing inferences within task material
Strategic Planning – Overviewing task – Assessing goals, constraints, and resources needed – Seeking outside resources where needed	**Tactical Planning** – Organizing a task sequence or performance routine

representation of new information, and determining its match to expectations which were established during strategic planning. For a learner, global monitoring might be manifested as asking whether a paragraph just read was understood. *Cognitive regulating*, on the other hand, more closely matches Corno and Mandinach's (1983) description of *self-checking*. Here, the learner monitors processes such as selecting or connecting to ensure that information is being represented and manipulated in a way that is sensible, accurate, and consistent with task goals.

As may be seen in Table 1, the process of *organizing* was added to the SRL model under the category of transformation processes. Corno and Mandinach allude to the importance of organizing information during learning, but describe evidence of it as "...showing use of selectivity and connective processes" (1983, p.95). The definitions and descriptions they supply for *selectivity* and *connecting*, however, do not include making connections or drawing inferences from information within the task. Nor do these descriptions involve categorizing information in a task or applying other organizational schemes to information (cf. selectivity and connecting). Since these are commonly recognized as organizational processes that learners use to understand and remember information, it was considered important to include this category here.

The final change in labeling the acquisition and transformation processes was to distinguish *rehearsal* as a component separate from monitoring. This change was made because rehearsal differs in important ways from both global monitoring and cognitive regulating. Specifically, rather than comparing aspects of one's cognitive representation of information to an expectation, as occurs in monitoring processes, rehearsing involves repeating information in order to enhance recall at a later time.

		Use of Acquisition Processes	
		HIGH	**LOW**
Use of Transformation Processes	**HIGH**	Comprehensive Engagement	Task Focus
	LOW	Resource Management	Recipience

Figure 1. Emphasis on Acquisition vs. Transformation Processes in the Four Forms of Cognitive Engagement.

The language used to describe the SRL model was changed in one other way. This change relates to the Corno and Mandinach's terminology for describing four "forms of cognitive engagement." They hypothesized that a student's relative emphasis on subsets of the acquisition or transformation processes on a given task or part of a task defined four qualitatively different forms of cognitive engagement: (1) Self-Regulated Learning, (2) Task Focus, (3) Resource Management, and (4) Recipience (see Figure 1 An example of how the four forms of cognitive engagement would be operationalized in an actual learning task is presented in Table 2. According to Corno and Mandinach,

> ...A student may display a form of cognitive engagement qualitatively different from self-regulated learning by emphasizing some self-regulation processes and deemphasizing or supplanting others. For a given classroom task, a student may use more or less of either the acquisition processes or the transformational processes. (1983, p.95)

In the present study, the highest form of engagement, which Corno and Mandinach label "self-regulated learning," is referred to as "Comprehensive Engagement." The rationale for this change is given in Note 1.

Table 2. Examples of forms of engagement in the context of a typical academic task.

Context: Students are given a text chapter to read, with the following instructions:

"Read this chapter in preparation for a discussion in class tomorrow. You will be marked on your participation in the discussion. Take any notes you wish and bring them along with you tomorrow. An outline of the chapter appears at the end. You are permitted to consult with other students or with any outside resources you wish."

Performance characteristics of each of the forms of engagement are hypothesized as follows:

RECIPIENCE

* Read through the chapter as quickly as possible, in a relatively passive way. *(alertness)*
* Would not stop reading to check out hunches or clarify confusions.
* Rehearse from the outline presented with the material. *(rehearsal)*
* If others were discussing the chapter, may listen in. *(alertness)*
* Consider generally whether he/she understood. *(global monitoring)*

TASK FOCUS

* Read chapter, jotting down questions that come to mind as potential discussion questions, highlighting or writing down important points. *(alertness/selectivity/connecting)*
* May add to outline that is provided. *(connecting)*
* May go back to parts of chapter to select or identify information that might answer discussion questions. *(tactical planning)*

Table 2. (Continued)

RESOURCE MANAGEMENT

* Overview chapter before reading; look for/jot down possible discussion questions. *(strategic planning)*
* Read through chapter and outline, rehearsing and self-checking while reading. *(alertness/rehearsal/cognitive regulating)*
* Try to find out from others (peer or instructor) what parts are most important or relevant.
* Try to get peers into discussion, then mainly listen rather than participate.

COMPREHENSIVE ENGAGEMENT

* Overview chapter before reading; look for/jot down possible discussion questions. *(strategic planning)*
* Read chapter, jotting down questions that come to mind as potential discussion questions, highlighting or writing down important points. *(alertness/selectivity/connecting)*
* May add to outline that is provided. *(connecting)*
* Go back to parts of chapter to check on understanding/clarify confusions. *(cognitive regulating)*
* May go back to parts of chapter to select or identify information that might answer discussion questions. *(tactical planning)*
* Go to other available resources, including peers and materials, to get additional information or varying perspectives.- may take notes on this also. *(strategic planning)*
* Rehearse using outline and own notes, may review chapter if time is available. *(rehearsal)*

Assumptions Underlying the Model

As noted earlier, the four forms of cognitive engagement are viewed as varying not only qualitatively, in that they involve more or less activation of specific acquisition and transformation processes, but also quantitatively in the sense that a learner engages in more or less cognitive activity overall. Specifically, Comprehensive Engagement involves high levels of all acquisition and transformation processes. Task Focus emphasizes transformation processes and involves little use of acquisition processes. Resource Management is characterized by mainly acquisition processes and little use of transformation processes, and generally less cognitive effort than Task Focus. Recipience involves little or no use of transformation, limited use of only a few acquisition processes, and thus calls for very little cognitive effort.

Because each form of cognitive engagement is qualitatively different from the others, continuously operating with Comprehensive Engagement is not predicted by Corno and Mandinach as a sufficient form of engagement across all types of learning tasks despite the fact that Comprehensive Engagement includes all the component processes found in the other three forms. Rather, according to Corno and Mandinach, it would be important for students to be able to use all four forms, shifting comfortably among them as needed. Learners who are capable of shifting their cognitive approach in response to task demands would be considered self-regulated learners.

Corno and Mandinach (1983) propose that certain types of tasks or task constraints are likely to elicit a particular form of engagement from some students, and that the approach elicited may or may not be optimal. "Optimal" would be defined as the approach which is most effective for long-term intellectual growth or functioning. It is important, both from the standpoint of the model's internal consistency and the implications that it may have for instruction, to determine the specific task conditions under which each form of engagement is appropriate. Some predictions can be made in this regard based both on logical task analysis and on research into expert-novice differences in problem solving.

In the literature on information processing, tasks are typically classified under two broad categories, usually referred to as well-defined or well-structured and ill-defined or ill-structured (Gagné, 1985; Reitman, 1964). From Corno and Mandinach's (1983) description, it appears that, under circumstances where high levels of cognitive effort are warranted and where social and other resources are easily available, it will be optimal to use Comprehensive Engagement for an ill-defined task and Task Focus for a well-defined task. The optimal forms of engagement would then be predicted to covary with task goals such as amount to be learned and interest or relevance to the individual; or with constraints such as time allowed or resources available. These predictions will be outlined in detail in Chapter Three as they pertain to the present study.

Motivation and Volition in SRL

The forms of cognitive engagement described by Corno and Mandinach (1983) can serve as operational definitions of the varying amounts and kinds of effort students may expend to participate effectively in instruction. As noted by Corno and Rohrkemper (1985),

> The assumption is made that all developmentally able students have the processes that define SRL within their cognitive repertoires, but that some students have not learned to make these processes operational in a given context, or to coordinate their application in appropriate task situations. Such students may fail to coordinate and control the use of SRL processes because of related motivational difficulties...(p. 61)

Self-regulated learning, then, can be seen as an adaptive combination of cognitive skill and effort. Not only does a self-regulated student have the ability to engage in the appropriate kinds of cognitive processes in optimal amounts for a given task, but this student also adapts the effort applied in this work to the task at hand. The SRL model hypothesizes that self-regulated learners are high achievers compared to their peers, and are high in intrinsic motivation to learn.

More specifically, students would be defined as self-regulated when they meet three criteria. First, they would be able to engage in each of the four forms of engagement; that is, they would have a repertoire of cognitive strategies which they are able to use and which they know to be useful in specific learning situations. Second, they would be motivated to employ one or another of these strategies depending on task constraints and personal goals. A third enabling component of the self-regulated learner's repertoire is that of volition, or action control.

Volition involves the ability to protect one's intentions, such as the intention to engage in a given strategy to complete a learning task, from competing motivational tendencies (Kuhl, 1984; 1985). Competing motivational tendencies might reflect social distractions, competing goals, or perceptions of task difficulty (Corno, 1986). Examples of a student's exercise of volition in classroom learning might be using positive self-talk during a difficult or frustrating task or arranging to move to a quieter area of the room when there is too much distraction.

Current conceptions of motivation generally cast learners' interpretations of their environments and themselves as predictors of motivated behavior (Ames & Archer, 1988; Bandura, 1977; Marshall & Weinstein, 1984; Tesser & Campbell, 1982; Weiner, 1979). Motivated behavior on the part of students would involve attempting and persisting at academic tasks (Corno & Mandinach, 1983, p. 91). However, to distinguish intrinsic from extrinsic motivation to learn, it is necessary to consider personal responsibility factors (Weiner, 1979) and some aspects of competence (Corno & Rohrkemper, 1985). The personal responsibility factors referred to by Weiner (1979) include succeeding at tasks through one's own efforts, delaying gratification for rewards, a decreasing self-consciousness or fear of failure (and increasing task involvement), and a growing sense of control over events. The aspects of competence that would contribute to intrinsic motivation include demonstrating the ability to learn academic material that is presented and using volitional control strategies such as positive self-talk (Corno & Rohrkemper, 1985; Meichenbaum, 1977).

Successful academic work over the long term thus involves the capacity to employ effective strategies for accomplishing learning tasks, the motivation that both drives and is a result of knowing one has a means of achieving success at a task, and the volitional control to protect one's attempts to learn from competing motivations. This conceptualization suggests that it would be possible to develop self-regulated learning through instruction aimed at three objectives: developing effective cognitive strategies specific to various kinds of tasks or task environments, learning to interpret events in ways that increase one's personal responsibility, and developing skills and strategies for maintaining volitional control while engaging in learning tasks.

On the other hand, it is easy to imagine how students might slide into less effective styles for learning, for example, by habitually using approaches that result in external attributions for success and failure, reduced self-efficacy, and thus decreasing personal responsibility. This sequence of events could occur where a student forms a habit of seeking assistance from the teacher or peers when a complicated part of seatwork is reached or, similarly, where he or she consistently leaves difficult homework problems until they are gone over in class. In such cases, the student allows the learning environment (e.g., teacher or peers in this example) to do the difficult transformation processing for her. The motivational implication of this is that the learner attributes success and failure on difficult academic tasks to outside factors rather than self. In turn, this reduces likely expectations for success on future challenging tasks and increases the likelihood of seeking external help the next time.

The SRL model predicts how cognitive strategies can be used to enhance motivation by enabling the learner to become more self-regulated or, alternatively, how the habitual use of one strategy and the decreasing sense of personal responsibility that results from it can lead to increasing passivity as a learner. This framework marks an important change from previous theory in learning and motivation because it addresses directly how learning and motivation may interact to influence long term outcomes. The practical advantage is that, if it is possible to describe the conditions under which students develop cognitive strategies that are effective for succeeding at complex learning tasks, development of personal responsibility may follow. Some successes in training learners to engage in volitional control strategies already has been reported (Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979; Meichenbaum, 1977; Weinstein & Mayer, 1986).

Overview

Chapter Two presents a selective review of recent literature on motivation and intellectual skills and their relationships to aspects of the Self-Regulated Learning model. The general goals of the dissertation are presented at the end of Chapter Two. The experimental design and specific research questions addressed in the study provide an introduction to Chapter Three. Chapter Three then describes in detail the methods used in the study, including descriptions of the experimental tasks and measuring instruments and their scoring procedures. The actual materials used in the study appear in the appendices, along with other details that are useful for replication. Chapters Four and Five are the Results and Discussion chapters. Implications for future research are included in the discussion in Chapter Five.

CHAPTER TWO: REVIEW OF THE LITERATURE

Educational research has a long history of studying aptitude variables in efforts to identify individual differences that predict success in learning. Corno & Snow (1985) delineate intellectual abilities, personality characteristics (such as motivation and anxiety), and cognitive styles as three broad categories of aptitude which have traditionally been studied. These authors also point out that while research has tended to focus on single aptitudes or one category of aptitude at a time, it is their combined effects that must be dealt with by teachers in adapting instruction in productive ways (1985, p. 606; Snow, 1987). This observation is supported by the fact that, where researchers have studied more than one aptitude complex at once, their combined predictive effect on response to instruction was stronger than a single complex alone (e.g., Peterson, 1977).

The Self-Regulated Learning model proposed by Corno and Mandinach (1983) may be viewed as an attempt to integrate the intellectual and personality aspects of individual differences into a comprehensive explanation of how motivated learning can develop and be maintained over long-term instructional experience. This chapter looks in turn at current literature on each of these types of aptitude variables to demonstrate how it bears on the questions explored in this study of the Self-Regulated Learning model.

Motivation and Cognitive Effort

Recent literature on academic motivation has focussed increasingly on students' cognitive self-appraisals and interpretations of learning tasks. Specifically, students' thought processes are frequently associated with motivated behavior such as persistence at a task or willingness to attempt difficult tasks (Bandura, 1982; Bandura & Schunk, 1981; Kuhl & Beckman, 1985; Weiner, 1979, 1986). The kinds of thought processes that predict these variations in motivation include maintaining high levels of self-efficacy or expectations for success, attributing one's performance to internal, controllable causes, and perceiving that one has control over a task. These types of motivated behavior in turn predict achievement.

Attributions, Conceptions of Ability, and Achievement Motivation

Research on attributions in the context of learning tasks has generally shown that "mastery oriented" people, who attribute success and failure to readily controllable causes such as effort (Diener & Dweck, 1978, 1980) or use of particular strategies (Clifford, 1984), are more likely to develop high self-efficacy (expectations for success) than are people who attribute success or failure to uncontrollable factors such as ability (Weiner, 1979, 1986). In turn, self-efficacy correlates with people's willingness to attempt difficult tasks and to persist in the face of failure (Bandura, 1980; Schunk, 1981).

Clifford's (1984) suggestion to include attributions about strategies in research on motivation in classrooms is pertinent to the present investigation and to the SRL model:

> Strategy explanations tend to turn failure outcomes into problem-solving situations in which the search for a more effective strategy becomes the major focus of attention. This search and exploration can be expected to elicit *increased* effort without the fear that subsequent failure will automatically imply low ability (p.112).

Also pertinent to the present investigation are various explanations of how a learner's self-appraisals interact with characteristics of the environment. This body of literature mainly focuses on the development of achievement motivation and varying conceptions of ability. For example, Nicholls (1984) proposes that evaluative, competitive, or test-like situations will render people "ego-involved" as opposed to "task-involved." Ego-involvement is normative—it is the state in which one's concern is to develop or demonstrate, either to oneself or others, high rather than low ability. Task-involvement, on the other hand, is a concern for mastery or improvement compared to one's own prior performance.

Using Nicholls' model, a number of predictions can be made regarding the task conditions under which a person will employ more or less effort. For instance, in the ego-involved state, task difficulty is defined with reference to the performance of peers: If many can do it, the task is easy; success at it does not indicate high ability and failure at it indicates low ability. Alternatively, if many cannot do a task it is considered difficult; success indicates high ability and failure does not indicate low ability. Learners who are ego-involved are likely to choose tasks which they consider to be either very difficult or very easy since, in this way, they can avoid the appearance of low ability. In task-involved states, however, more effort is seen as leading to more learning, which equates with developing ability. Tasks that appear to demand moderate to high effort offer the best opportunities to learn, and thus are predicted to evoke the greatest effort in the task-involved state.

Along similar lines, Covington (1984; Covington & Omelich, 1979) describes "capitalistic," competitive school environments, where good grades are a limited resource, as conducive to actively avoiding failure rather than striving for success. The general consensus among theorists in this area appears to be that, over the school years, children become more ego-involved, more concerned with achievement outcomes such as grades, and less concerned with achieving competence and intrinsic satisfaction (Covington, 1984; Nicholls, 1984; Rozenholtz & Simpson, 1984; Stipek, 1984). As a result, considerable attention is now being placed on efforts to determine the kinds of instructional environments that will promote intrinsic motivation to learn (Brophy, 1983).

A common suggestion made in the literature is to provide a mastery-oriented instructional environment that is characterized by a non-competitive, individualistic goal structure (Ames & Ames, 1984). In this milieu, the learner is likely not only to expend effort on tasks which offer the most opportunity to learn (Nicholls, 1984), but also to approach tasks in a qualitatively different way. Specifically, during and after tasks performed within an individualistic rather than a competitive goal structure, learners have been shown to report thoughts addressing self-instruction, self-monitoring, and planning more often (Ames, 1984; Diener & Dweck, 1978). Interestingly, Ames' (1984) study indicated that differences in the types of cognitions reported by students were related to the goal structure more than to students' levels of achievement. That is, in the competitive structure, high achievers were no more likely to make effort attributions or strategy-oriented self-statements than were low-achievers. In the individualistic structure, attributions to effort or strategy-oriented statements were more prevalent for the high achievers.

Research has shown that individual students' interpretations of their experiences in classrooms will vary within the same class (Blumenfeld, Pintrich, Meeces, & Wessels, 1982; Marshall & Weinstein, 1984). Moreover, recent findings indicate that students' perceptions of their classroom goal structures influenced their level of cognitive engagement (Meece, Blumenfeld, & Hoyle, 1988) and their motivational patterns and use of effective learning strategies (Ames & Archer, 1988). The latter authors found that students who perceived their classroom as emphasizing mastery as opposed to performance goals were more likely to report using effective learning strategies, to prefer tasks that offer challenge, and to attribute success to effort (Ames and Archer, 1988).

This evidence is important to the present study. The investigation conducted here did not examine students' interpretations of the overall goal structure within the experimental task situation. However, data were collected on students' self-conceptions of ability and their attributions for success and failure in academic contexts. These kinds of perceptions may be seen as outcomes of students' school experiences over previous years which may influence their use of affective and cognitive learning strategies here. In particular, students who have learned to attribute academic success and failure to effort or strategies used, and who have developed a view of themselves as academically capable would be expected to use self-regulated learning skills as required to adapt to task differences.

Intellectual Abilities and Skills

A pervasive conception of intelligence in current literature proposes two main factors or types of ability: processing or fluid (G_f) ability, and accumulated knowledge or crystallized (G_c) ability (Cattell, 1963; 1971; Horn, 1968; 1978). Fluid ability is essentially the same as Spearman's *g* or Thurstone's induction factor, while crystallized ability may be viewed as close to Vernon's "verbal educational ability" (Corno & Snow, 1985). The kinds of tests used to measure fluid ability usually involve inductive reasoning. These include items such as classification tasks, series completions, and analogies, either verbal or spatial. These types of tasks originally were considered as effective measures of intellectual ability because they were thought of as "knowledge-free;" that is, as measures of one's ability to induce structure on information given in the task, without the use of any particular subject matter or domain knowledge. Crystallized ability, on the other hand, usually is assessed through some form of achievement measure which taps the accumulated knowledge a person has in various subject areas.

The theories of intelligence that dominated the earlier part of this century, often referred to as "differential" theories (Sternberg, 1985), emphasized variations in performance outcomes on tests which were predictive of other kinds of performance, such as success in school or on the job. Recent views of intelligence, however, are characterized by attempts to identify specific knowledge structures and processes used in responding to various kinds of intellectual test items (Carroll, 1976; Estes, 1982; Hunt, Frost, & Lunneborg, 1973; Pellegrino & Glaser, 1980; Resnick & Neches, 1984; Snow, 1980; Sternberg, 1985). This shift in focus has an important advantage: developing process models of task performance which can be used to analyze individual differences may make it possible to design instructional conditions that will adjust to these individual differences. The cognitive analysis approach to studying intelligence thus redirects the focus from using test scores to predict differences in performance, such as school achievement, toward using them to prescribe instruction that will improve school learning (Corno & Snow, 1985; Glaser, 1982; Glaser & Pellegrino, 1987; Hunt et al., 1973; Pellegrino & Glaser, 1980). The ultimate goal, as pointed out by Glaser and Pellegrino (1987), is not to improve performance on intelligence test items, but to improve the cognitive skills that underlie successful performance on both aptitude tests and in the classroom.

Research by Sternberg and his colleagues (1985) exemplifies of the kinds of cognitive analysis currently found in the literature. Sternberg specifies individual differences in solving analogy problems in terms of latency parameters. His goal has been to develop and test a general model of analogical reasoning that specifies the cognitive processes common to all analogy tasks. Also, Pellegrino and Glaser (1987) report a number of studies that have used error analysis or instruction in specified component processes to isolate the knowledge and procedures which differentiate ability levels on various kinds of inductive reasoning tasks.

Two general outcomes of this research constitute important advances in our understanding of the nature of fluid ability and intellectual skill development. First, it appears that solving series completion tasks involves a set of specified processes which are combined into routines, and that instruction in these processes significantly improves performance (Holzman, Glaser, & Pellegrino, 1976; Simon & Kotovsky, 1963). Moreover, for subjects of lower initial ability, this improvement exceeds that resulting from mere practice (Glaser & Pellegrino, 1987). The critical features of this outcome are: (1) isolation of the cognitive steps involved in solving this type of problem, and (2) improvement resulting from instruction in these processes.

The second important finding is that domain-specific declarative knowledge, such as knowledge of numerical concepts and relationships, has an important influence on solving induction problems such as numerical analogies (Corsale & Gitomer, 1979; Pellegrino, Chi, & Majetic, 1978). Declarative knowledge of the constraints of the task itself also was found to differentiate performance on verbal analogies. In particular, lower performance was typically characterized by violations of the rules for identifying relations between relevant pairs within items (Heller, 1979). Declarative verbal or numerical knowledge as well as declarative knowledge of the goals and constraints involved in item types (e.g., analogies) is thus an important factor in fluid ability.

Taken in combination, research resulting in specifying the cognitive steps and domain knowledge required in performance on inductive reasoning tasks and findings concerning the instructional tractability of this declarative and procedural knowledge necessitates a reconceptualization of the nature of fluid ability as it is typically measured. This type of intellectual ability can no longer be viewed as "knowledge-free." In the context of the present investigation, it would be useful to establish connections, if any exist, between fluid ability and self-regulated learning skills. Specifically, SRL components such as selecting, making connections within, and organizing information presented in an academic task would be expected to covary with a standard measure of fluid ability.

Compared to methods for studying inductive reasoning based on response latencies, the methods used in this study more closely resemble those involving qualitative analysis of response protocols collected during work on intellectual problems or as a product of them. Heller (1979) conducted this type of study on verbal analogical reasoning tasks when solved by subjects of differing aptitudes. Similarly, some of the methods frequently used in studying the cognitive processing components of problem solving involve qualitative analysis. For example, studies of expert-novice differences have used methods such as analyzing think-aloud protocols collected during the course of solving physics problems (Larkin, McDermott, Simon, & Simon, 1980) and examining diagrams drawn by solvers while working on the problems (Chi, Feltovich, & Glaser, 1981). Think-aloud protocols of experts and novices in the social sciences were analyzed by Voss, Tyler, & Yengo (1983) to study the differences in the knowledge and skills they used in solving the kinds of ill-structured problems typically found in that domain.

These methods for studying individual differences involve analyzing the response or think-aloud protocols produced by problem solvers while working through problems, and describing them in terms of their qualitative differences. In these studies, variations in knowledge and skill components are reported more directly than in studies using response latencies, where some degree of extrapolation links the actual data to conclusions drawn about the processing differences they reflect. Also, in the problem solving studies, differences in domain specific declarative knowledge were identified as an aptitude variable, whereas in analogical reasoning studies it was procedural knowledge variation that was expected to result in performance differences. As further research on intellectual skills continues to unpack the constellations of procedural and declarative knowledge required for various kinds of tasks, the importance of accumulated knowledge of both kinds to the development of skills heretofore considered strictly procedural becomes more and more apparent. Individuals who are identified as intellectually competent, even in the sense of inductive reasoning, got that way as a result of developing a complex array of knowledge and skills over time. This points up the importance of identifying skills, such as those hypothesized by Corno and Mandinach (1983), which learners develop over time as cognitive resources to apply to the goals of learning.

Task Characteristics, Aptitude Measures, and Learning Skills

Evidence that differences in ability predict variations in how effectively learners adapt their strategies to learning goals is not new. For example, a considerable research literature supports this contention in the context of reading abilities (Anderson & Armbruster, 1982; Ausubel, 1960; Gagné, Bing, & Bing, 1977; Just & Carpenter, 1980; Rickards & McCormick, 1977; Smith, 1967). There also is evidence that learners will shift their strategies in complex tasks, such as items on aptitude tests, depending on item difficulty and individual differences in aptitude (Snow, 1980; Snow & Lohman, 1984). This adaptive processing by learners in dealing with complex tasks may be seen as "response sampling" wherein assemblies of existing declarative and procedural knowledge are either retrieved and applied, or are used to construct and apply new component assemblies (Snow & Lohman, 1984; Sternberg, 1985). According to the model proposed by Snow and Lohman (1984), observed differences in G (or general intelligence, which would include both G_c and G_f) are the result of differences in the number and type of component assemblies, and in how they are organized, rather than simply the number of components or the speed at which they are invoked:

> As a function of more intensive learning history, these assemblies are more exercised and more controlled; they are more readily retrieved and applied as crystallized units in new performance situations similar to those experienced in the past. As a result of more extensive learning history, these assemblies are more readily reassembled to meet the demands of new performance situations dissimilar to those experienced in the past. The cognitive organizations of able learners are thus both more crystallized and more fluid and thus more easily adapted to complexity and novelty...(1984, pp. 369-70).

If Snow and Lohman (1984) and others who have come to similar conclusions (e.g., Glaser & Pellegrino, 1982; Sternberg, 1985) are correct, the route to increasing cognitive aptitude for academic learning is to help learners learn to control and manipulate their existing declarative and procedural knowledge in the context of novel tasks. In this situation, learners have the opportunity to invent or reassemble the response components already existing in crystallized form (Resnick, 1976).

This type of analysis has direct implications for SRL. In fact, the description offered by Snow and Lohman of the high-G learner matches the self-regulated learner so well that it is not surprising when they conclude that, "The cognitive phenomena that differentiate high- and low-G students and high and low achievers are essentially the same phenomena" (1984, p. 370). The self-regulated learner and the typical high ability student adapts to and handles novel learning situations by being able to evoke the knowledge and skills required to make sense of new information, then plan an approach and select strategies needed to organize, execute, and monitor his/her work toward a solution.

Convergence and Divergence of SRL and Intelligence

A critical advance in analyzing cognitive processes constituting intellectual functioning was the separation of metacognitive knowledge and skills from more basic cognitive processing used in manipulating and transforming information (Brown, 1978; Flavell, 1976; Sternberg, 1985). Metacognitive skills are the executive aspect of intellectual work wherein the person plans, monitors, and revises the selection and engagement of lower-order cognitive operations which acquire or manipulate information. Sternberg has identified a number of different "metacomponents" in intellectual functioning. These include such aspects of performance as deciding what the problem is, selecting an appropriate representation of the information given, and selecting a strategy that combines lower-order cognitive processes (1985, pp. 99-105). These metacognitive activities parallel directly certain component SRL processes such as selecting and strategic planning. The importance of metacognitive functioning has been demonstrated in studies showing marked developmental and individual (e.g., aptitude) differences in learner's use of these skills. Such differences have been found in a variety of learning contexts, including text comprehension (Armbruster, Echols, & Brown, 1983; Baker & Brown, 1984; Brown, Campione & Day, 1981; Palincsar & Brown, 1984), acquisition and retrieval of information (Flavell & Wellman, 1977), and problem solving (Chi, Glaser, & Rees, 1982; Flavell, 1976).

In addition to metacognitive skills, other aspects of self-regulated learning described in Corno and Mandinach's model have been shown to correlate highly with ability. For example, Gray (1982) found that higher ability secondary students were more likely to take notes containing elaborations, inferences, and organizational schemes than were lower ability students. Elaborating and making inferences are labeled "connecting" in SRL, and creating organizational schemes would be "organizing" in the conception of SRL explored here. Similarly, Reder's (1978) review cites elaboration and drawing inferences, and the speed of these processes, as key differences between the comprehension and retention of prose by good and poor readers. Sternberg (1985) also identifies the transformation processes of selectivity, connecting, and organizing as crucial to learning declarative and procedural knowledge in virtually all domains.

The two types of planning included in the SRL model differ in terms of their classification as metacognitive or lower-level skills. Specifically, strategic planning is considered a metacognitive activity which involves overviewing the task, assessing the requirements for cognitive processing and external resources, selecting both general and specific strategies to be used in accomplishing the task, and then evaluating and revising plans during the process of completing the task. Tactical planning, on the other hand, is selecting and implementing performance routines and local strategies at decision points during the task, but without referring explicitly to overall task goals or problem orientation. Sternberg and his colleagues have reported research on correlations between "global" and "local" planning, which might be compared to strategic and tactical planning in SRL terms, and tests of general reasoning ability . Sternberg (1985, p. 101) defines these two types of strategy planning as follows:

> Global planning refers to the formation of a macrostrategy that applies to a set of problems, regardless of the particular characteristics of a particular problem that is a member of a given set....Local planning refers to the formation of a microstrategy that will be sufficient for solving a particular problem within a given set. Whereas global planning is assumed to be highly sensitive to the context of the surrounding problems, local planning is assumed to be context-insensitive, applying to each item individually.

In several studies (Sternberg, 1977, 1981; Sternberg & Rifkin, 1979), it was concluded that individuals with better reasoning skills spent more time in global planning of a strategy for problem solution, but less time in local planning, as compared with less able reasoners (Sternberg, 1985).

While the literature reviewed so far in this section and the previous section identifies similar components within conceptions of SRL and general crystallized and fluid ability, several studies have produced evidence that component Self-Regulated Learning skills are related to achievement even with ability controlled. For example, after training students in organizational skills, which would be classified as transformation processes in SRL, Gray (1982) found that these students showed a lessened regression of outcome of training on ability than was shown for untrained students (see Corno & Mandinach, 1983). Peterson, Swing, Braverman, & Buss (1982) also found that some metacognitive skills affected achievement even with ability statistically controlled. Thus, while there appears to be a strong relationship between SRL component skills and general intellectual ability, SRL skills apparently contribute a unique portion of variance to learning outcomes.

Specific Features of the SRL Model

In Chapter One, the four forms of cognitive engagement of the SRL model were described. These are Comprehensive Engagement, which involves use of all the component SRL processes; Task Focus, which emphasizes transformation processes; Resource Management, which emphasizes acquisition processes; and Recipience, which involves minimal use of the component processes, primarily attending, rehearsal, and low-level monitoring. Corno and Mandinach (1983) emphasize that different types of academic tasks call for different forms of engagement. For example, in a situation where the task involves acquiring and manipulating large amounts of information, and where it is important that the learner gains a deep understanding of that information, a Comprehensive Engagement approach is hypothesized to be optimal. In this case, available external resources are used to supplement transformation processes used in comprehension (i.e., to help deepen the associative network), but are not used to supplant these processes. Acquisition processes such as strategic planning and monitoring would also be important in this type of task, where it is important for the learner to impose his/her own structure on the task by defining its goal(s) and sub-goals, and then to monitor progress toward these planned outcomes. Here again, Snow and Lohman (1984) describe aptitude differences in similar language:

> The most important of [these] aspects of the dynamic cognitive system, we hypothesize, are *assembly* and *control* processes—higher order strategic processes involved in the organization, reorganization, and monitoring of the component performance processes that make the dynamic cognitive system adapt or learn within a task. We predicted that these higher order process differences were a principle source of ability-learning correlations in education because such differences would become increasingly important as ability tests and learning tasks became more complex; it is the complex ability tests, after all, ... that correlate with learning from instruction. (p. 351)

On the other hand, on tasks or parts of tasks where going beyond the information given by using external information is unnecessary or inadequate, or where frequent self-checking (i.e., monitoring) is inefficient, a Task Focus approach would be considered optimal (Corno & Mandinach, 1983). In school contexts, this type of task would be found in some problem solving exercises or tests, such as in mathematics. It should be noted that, in many problem solving situations there may be call for both Comprehensive Engagement and Task Focus approaches for different phases of the same task. For instance, a problem may initially require strategic planning and metacognitive processing in order for the learner to develop an appropriate mental representation of it, but once this exists, a Task Focus approach may be most effective for accurate and quick solution of the problem.

These differences in task characteristics and requirements can be seen in terms of task structure (Reitman, 1964). While tasks cannot simply be dichotomized as either well-structured or ill-structured (Keen & Morton, 1979; Simon, 1960), there are variations along this dimension which influence the cognitive requirements for their solution. Generally, the more structured a problem or task is, the more its goals and possible routes to solution are defined (Gagné, 1985; Keen & Morton, 1979). This implies that the problem solver's existing knowledge in the relevant area of subject matter will partly determine the degree of structure perceived in a given problem. For example, it has been shown that novices in a particular domain of knowledge such as physics will solve problems in that domain much the way people solve novel problems in general. In contrast, experts in a domain will solve problems in that domain as people generally solve familiar problems (Larkin, 1982; Larkin, McDermott, Simon & Simon, 1980). Gagné (1985) describes the difference between solving novel and familiar problems as follows:

> ...In solving novel problems, a great deal of searching is involved. Various strategies are used to limit search to relevant areas of memory.

> One of the most powerful of these is means-ends analysis, in which one defines one's goal and then retrieves from memory known ways of reaching that goal. Solving familiar problems does not involve much search. Rather, the solver acts fairly automatically, recognizing a familiar set of conditions and carrying out the associated actions. (p. 279)

Thus, the degree of structure a task has for an individual is likely to be a function of the information given in or with the task and the prior knowledge the learner brings to the task. A well structured task is either very familiar or it contains most of the information necessary to eliminate the need for a search for goal(s) and path(s) to solution. The latter situation would be exemplified by a math quiz on computational problems that were covered during the previous week's lessons.

The need for strategic planning and monitoring of one's cognitive processes in relation to task goals when working on novel, and especially large, complex tasks is evidenced in a study by Lundeberg (1987). This study examined the strategies used by experts and novices in studying and analyzing legal cases. Given the complexity typical of legal cases, and the multiple possibilities for interpreting them, this task could be considered fairly unstructured, even for an expert (although it would be more structured for an expert than for a novice). Lundeberg (1987) found that legal experts engaged in considerably more metacognitive processing and strategic planning than did novices. In particular, she noted that the experts spent more time, proportionally, overviewing the case and reading the first page than did the novices in her study (p. 416). In overviewing the case, the experts were found to preview the decision, the length of the case, the actions taken, and the facts of the case more consistently than the novices. According to Lundeberg (1987, p.413), "The experts, on some level, knew that having this information prior to reading the rest of the case would be beneficial."

Sternberg (1977, 1985) reported that more successful students spent more time encoding problem information before attempting solutions than did less successful students. Other studies of differences between expert and novice problem solving (e.g., Chi, Feltovich, & Glaser, 1981; Voss, Tyler, & Yengo, 1983) have shown that experts tend to spend considerably more time than novices developing an abstract and relatively elaborate representation of the problem before attempting solutions. In addition, in solving social science problems, experts were found to propose fewer and more abstract solutions than did novices, and they also returned to the original problem representation each time they proposed a new solution in order to develop new ways of eliminating the cause of the problem (Voss, Tyler, & Yengo, 1983). This approach exemplifies experts' use of strategic planning and monitoring of strategies for solving a problem, which corresponds to Comprehensive Engagement in SRL. In contrast, novices' protocols evidenced immediate attempts at isolating possible causes and solutions without consideration of constraints on, or orientations to the solutions proposed (Voss, Tyler, & Yengo, 1983). In this example, the novices' approach to the problem corresponds to a Task Focus form of engagement as defined in SRL, an approach which was inadequate for such an ill-defined problem.

It appears then, that experts emphasize strategic planning and monitoring processes in order to impose structure (i.e., define the goal(s) and sub-goals and potentially useful paths to solution) on complex tasks or problems. In a more general way, self-regulated learners may be viewed as students who have learned to use a Comprehensive Engagement approach for those tasks and parts of tasks that require imposition of structure. These are the "experts" at school learning. While they may use a Task Focus approach to familiar types of problems, or ones that are very clearly structured in terms of response requirements, where quick, analytic responses are called for, they also know when more information or planning is needed, and are able to shift strategies accordingly.

Use of External Resources

Another important aspect of the SRL model described by Corno and Mandinach (1983) is learners' use of available social resources such as peers or the teacher, or material resources such as additional text materials or organizational aids. While external resources may be used effectively within a Comprehensive Engagement approach to complex tasks as a way of supplementing one's own cognitive work, they also may be used to supplant or short-circuit some cognitive processing (Salomon, 1979). When some of the learner's cognitive processes are short-circuited by the environment, information provided by others or in the presentation itself does some of the cognitive work for the learner. In particular, Corno and Mandinach define Resource Management as using outside assistance to supplant the learner's own transformation processes, while acquisition processes are evoked and used effectively by the learner. In contrast, a Recipient form of engagement relies on assistance for much of both the acquisition and transformation processes.

Cooperative group learning situations are likely contexts in which to observe students using peers as resources. In fact, there is evidence that some learners tend to avoid engaging in some of the cognitive processing required in academic tasks when working in small groups (Kerr, 1983; Kerr & Brun, 1983; Latane, Williams, & Harkins, 1979). Dansereau and his colleagues have recently reported studies showing that cognitive, affective, metacognitive, and social learning outcomes (CAMS) are enhanced when well-designed scripts are imposed upon cooperative learning dyads, rather than having them produce their own scripts (Dansereau, 1986; McDonald, Larson, Dansereau, & Spurlin, 1985; O'Donnell, Dansereau, Hall, & Rocklin, 1987). The term "scripts" is used here to mean a plan of the questions and points of discussion to be covered in the dialogue between the students in the dyad. The results of this research revealed that, while scripts generated by the participants produced adequate achievement outcomes relating directly to content in the task (i.e., the solution to a problem, a decision, or a report or procedure), they did not lead to learning outcomes that were independent of the task (Dansereau, 1986). Dansereau notes that,

> ...Participant-generated scripts that capitalize on task-relevant expertise may be relatively useful for content-dependent outcomes. However, since these scripts typically place people in familiar and comfortable information processing roles they do not provide significant opportunities for acquiring content independent CAMS. (1986, p. 7)

Other research on small group cooperative learning has shown that participants who take an active role in verbalizing information or assisting other students tend to perform better on achievement outcome measures than those who take a more passive role (Spurlin, Dansereau, Larson, &

Brooks, 1984; Webb, 1982). Webb's (1982) results with respect to mixed versus uniform ability groups suggest interesting questions with regard to the SRL model. In particular, she found that medium-ability students in homogeneous ability groups received more explanations in response to their errors and questions than those in heterogeneous ability groups, and they also had higher achievement test scores on average (Webb, 1982) when in homogeneous groups. The SRL model hypothesizes that, if some students habitually use explanations by others to succeed at learning tasks, they may be missing out on needed practice at some of the transformation processes required for complex tasks, even though they may produce adequate achievement outcomes in the short term.

Videotapes of social interaction among subjects who are working on academic tasks would provide a useful context for examining some of the effects of varied ability groupings, including the types of cognitive processing that are being taken over for students by others when they are given explanations about a task.

Task Features that Short-Circuit Cognitive Processes

Salomon (1979) reported the results of research showing that specific skills for encoding and transforming information are either activated or short-circuited depending on the presentation of information to be acquired. Salomon uses the term "coding elements" to refer to aspects of presentation that either model directly specific relationships within information or else make those relationships implicit . In one study (Salomon, 1979), he found that the skill of relating details to conceptual wholes (which would be an example of Connecting in the SRL model) was strongly related to learning outcomes on tasks where the relationship between the details and whole was not shown explicitly. However, on tasks where this relationship was made visually explicit for the learner, there was a much weaker relationship between the skill of relating details to conceptual wholes and learning outcomes. Another finding from the same investigation was that instructions or specified requirements of the task also will partly determine which cognitive processes are activated: "Task requirements, whether imposed or self-selected, determine what kinds of information are to be extracted, and this choice determines in turn what kinds of coding elements within the message are to be addressed " (1979, p. 108).

The literature thus supports the notion that the presentation of a task and its perceived requirements play major roles in what information a learner selects and focuses on (Pitchert & Anderson, 1977; Salomon & Sieber, 1970) and in which cognitive processes are activated (Salomon, 1979). It would follow from this that tasks in which the students are expected to create a cognitive representation that is an exact model of the information presented, and tasks which also carry low incentive for students to invest mental effort, would result in a relatively passive approach to acquiring and manipulating the information presented. In the present context this would mean that a Recipient approach would be expected.

Research on the SRL Model

Extending the research evidence concerning the component processes, a few studies now have begun to appear which have tested the SRL model more directly. One of these (Zimmerman & Martinez-Pons, 1986) found that 93% of the high school students sampled could be correctly classified as belonging to high- versus lower achievement tracks on the basis of self-reports about their use of 15 different self-regulated learning strategies. In particular, the strategies which best predicted achievement groupings were seeking information, keeping records and monitoring, and organizing and transforming information. These results provide some evidence that, compared to their lower-achieving peers, high-achieving students engage in more active, self-initiated behaviors across a variety of learning and studying situations.

A second study by the same authors (Zimmerman & Martinez-Pons, 1988) generated evidence of construct validity of several self-regulated learning strategies which they had identified in students' self-reports in their 1986 study. Here, converging evidence of SRL strategies was sought by comparing student self-reports from a structured interview to teachers' observations recorded on a 12-item rating scale. Correlations between students' reports of SRL strategies and a canonical root for SRL in teachers' ratings indicated good convergent validity for most SRL strategies identified. The strongest relationships reported were between students' and teachers' reports of "rehearsing and memorizing", "organizing and transforming", "seeking peer assistance", and "seeking information."

Divergent evidence between SRL strategies identified in teachers' ratings and scores on a standardized achievement test also was demonstrated.

While the evidence for validity of SRL strategies shown in these two studies is encouraging, an important caveat bears mention. That is, the strategies identified in both their students' and teachers' reports confound cognitive (i.e., covert) and behavioral (i.e., overt) activities. For example, students' interview responses coded as "organizing and transforming" included statements that showed either overt or covert rearranging of instructional materials to improve learning, such as making an outline before writing a paper (Zimmerman & Martinez-Pons, 1986). Combining cognitive and behavioral strategies may not detract from the validity or usefulness of these results; on the contrary, they may provide an accurate representation of classroom events. However, this approach does not allow the isolation of the component cognitive processes which Corno and Mandinach (1983) propose as hypothetically distinguishing forms of engagement. As such, these research findings cannot address the validity of the SRL model being examined here.

One other point needs to be made regarding the definitions of self-regulated learning strategies used by Zimmerman & Martinez-Pons (1986, 1988). They included help-seeking behaviors as SRL strategies in both students' and teachers' reports. Specifically, one category of response taken from student interviews was "seeking social assistance," while one item on the teachers' scale reflected seeking assistance from the teacher. The quote used to illustrate the student interview category of seeking social assistance was, "If I have problems with math assignments, I ask a friend to help." (Zimmerman & Martinez-Pons, 1986). The authors consider this help-seeking behavior as a part of self-regulation in that it reflects actively seeking information rather than passivity on the part of the learner (Zimmerman & Martinez-Pons, 1988). However, it is notable that in both students' and teachers' reports these categories of help-seeking were distinguished from seeking information, such as library resources or information about task requirements. The point to be made with respect to SRL is that help-seeking is not universally taken as a behavior that promotes or reflects cognitive engagement. In fact, it may be seen as a strategy which is used to *avoid* effort (Corno & Mandinach, 1983). For example, such behavior has recently been identified as characteristic of a "work-avoidant" goal orientation in which the main concern is to get the work done with a minimum amount of effort (Meece, Blumenfeld, & Hoyle, 1988).

Mandinach and Corno have reported some evidence (Mandinach, 1984; Mandinach & Corno, 1985) that students approached a computer game using primarily one or another form of engagement, although in a number of cases two or three forms were used in combination. Of the 48 students in the sample, 73% appeared to adopt and maintain the same form of engagement during all 24 of the games played in the study (Mandinach & Corno, 1985). In this study, students of higher ability tended to use a Self-Regulated Learning (i.e., Comprehensive Engagement) approach most often, while lower ability students used Recipience much more than the other three forms of engagement. Moreover, males and females differed in their response patterns such that high ability males typically used either

Comprehensive Engagement or Task Focus, while high ability females used either Comprehensive Engagement or Resource Management. Also, students who used Comprehensive Engagement were more successful at the computer game than were those using the other forms of engagement.

This research provided some support for Corno and Mandinach's hypothesized variations of cognitive engagement in one instructional setting. However, some limitations must be acknowledged in terms of the generalizability of this research and also with respect to the internal consistency of the SRL model itself. First, the occurrence of specific acquisition and transformation processes while playing computer games was inferred from students' verbal protocols, response patterns, and study aids (i.e., maps, diagrams, and notes created by students while playing the games). Students then were categorized according to judges' assessments of the primary and secondary forms of cognitive engagement used across game playing sessions. The judges based their assessments on "high" versus "low" scores on acquisition and transformation processes which they assigned. Mandinach's methods for classifying learners' use of acquisition and transformation processes *necessarily* dichotomizes them into one or another category at any given time. Specifically, when learners' performances are classified as "high" vs. "low" on the various acquisition and transformation processes, it is impossible for learners not to perform using one form of engagement or another (see Figure 1). Thus, this type of classification method does not actually test the SRL model in terms of whether students engage the component processes in the predicted configurations.

Second, Mandinach's research involved only one type of task: the computer game. Thus, while the computer game was claimed to require the use of all of the component processes of SRL, students' use of those processes were measured in only one task situation. It is no small surprise that most students were found to employ the same form of cognitive engagement across all instances of playing the game, since all instances represented the same type of task and task constraints. This interpretation is substantiated by the fact that some differences in the forms of engagement used were found in the instructional phase of Mandinach's study. For instance, when completing instructional examples, some of the lower ability students shifted from Recipience to a combination of Recipience and Task Focus, while some higher ability students shifted from combined use of Comprehensive Engagement and Resource Management to Comprehensive Engagement and Task Focus.

One other direct test of Corno and Mandinach's model of Self-Regulated Learning (Panagiotopolous, 1987) reported that students' use of acquisition and transformation processes could be reflected in audiotapes of dialogues during cooperative learning. The results of this study showed nine times as much use of acquisition processes as transformation processes, both in independent and cooperative learning situations, across language arts and mathematics instruction. There was, however, evidence of students' use of acquisition processes more than transformation processes when in cooperative learning situations, and the opposite trend in independent learning situations. This outcome supports Corno and Mandinach's (1983) contention that a Resource Management approach, which would be expected in cooperative learning conditions, involves an emphasis on acquisition over transformation processes.

Although the sample was too small in this study to base firm conclusions on the results, relationships between aptitude factors and cognitive engagement patterns were suggested. Specifically, students in the independent learning condition who measured higher in ability and achievement tended to show a slightly higher ratio of acquisition to transformation processes. These ratios were in the opposite direction for the middle- and lower- ability and achievement groups. Under the independent condition, students scoring high and low on motivation showed higher ratios of acquisition to transformation processes, while the opposite appeared for students of average motivation. In the cooperative condition, it was the students of average motivation who displayed the higher ratio of acquisition to transformation processes compared to those of high and low motivation.

Changes in students' use of SRL processes also were apparent over time within the cooperative condition. In particular, the ratio of acquisition to transformation processes appeared to increase during language arts instruction and decrease in math instruction. Again, the sample size and differences between groups were small in this study, rendering conclusions only speculative. Nonetheless, they suggest that complex engagement patterns occur depending on variations in student aptitudes, learning conditions, and subject matters.

Summary

Recent research on aptitude variables relating to motivation, intellectual skills, and self-regulated learning was reviewed in this chapter. The development of intrinsic motivation to learn, which is considered to be a characteristic of self-regulated learners in the SRL model, appears to be influenced by the goal structure present within the learning environment. In particular, an individualistic, cooperative goal structure, as opposed to a competitive goal structure, has been found to promote a mastery orientation to learning and to influence students' use of certain self-regulated learning skills, such as planning and cognitive monitoring. A mastery orientation has been found to be associated with students' self-reports of cognitive engagement. In addition, a mastery orientation to learning situations—attributing one's successes and failures to controllable factors such as effort and use of strategies, and high self-efficacy, or expectations of success—are associated with intrinsic motivation. In agreement with current research findings, the SRL model predicts that high ability, high-achieving students who also show high self-efficacy and make attributions for performance to effort and strategy use will adapt to changes in task environment more than students of lower aptitudes. This adaptability should be especially apparent when performance on tasks designed to elicit a Resource Management approach is compared to that on other tasks, since Resource Management tasks imply a cooperative goal structure.

Cognitive analysis of performance on intellectual tasks has been conducted using response latencies, error analysis, instruction, and descriptive analyses of think-aloud and other "direct" recordings of cognitive steps used while completing tasks. Using these methods, a number of the component skills in the SRL model have been shown to correlate highly with ability. These include metacognitive skills such as planning the use of strategies and resources in response to assessed task constraints and selecting, elaborating, and organizing information. The learner's response to variations in task constraints is considered a particularly important variable, with intellectual ability being associated with evoking prior knowledge and skills that are appropriate to the demands of the task at hand. The more novel and complex the task and the less the learner knows about the subject or the type of task, the less structured it is for the learner, and the more crucial are these intellectual abilities. Thus, in terms of SRL, self-regulated learners (e.g., high ability, high achieving, highly motivated learners) would be expected to adapt to differences in task demands intellectually, that is in terms of the cognitive skills and knowledge brought to bear on the task, as well as motivationally, as indicated above.

Direct tests of the SRL model are needed at this point. The few studies reported so far have indicated correspondence between aptitude variables and self-regulated learning behaviors or forms of engagement. However, in some cases only limited conclusions were possible due to small sample sizes or limitations in the experimental designs used. Specifically, one study (Mandinach, 1984) involved only one type of learning task and classified response protocols such that the four forms of engagement necessarily emerged. Another study (Panagiotopolous, 1987) provided limited evidence of students using different levels of acquisition and transformation processes depending on learning contexts (independent vs. cooperative) and on ability, achievement, and motivation level.

In other research (Zimmerman & Martinez-Pons, 1986; 1988) self-regulated learning strategies were associated with, but proved distinct from, achievement. These strategies also were validated across students' and teachers' reports (Zimmerman & Martinez-Pons, 1988). However, the definitions of SRL strategies used in these studies differed in important ways from those proposed in Corno and Mandinach's (1983) model. In particular, the definitions did not distinguish cognitive from behavioral strategies, which would be necessary in order to classify them as component SRL processes in Corno and Mandinach's model.

Goals and Design of the Present Investigation

The aim of this dissertation was to explore the feasibility of defining self-regulated learning in terms of configurations of cognitive processes, labeled acquisition and transformation processes, which can be used to classify students' approaches to learning tasks into "forms of cognitive engagement." Corno and Mandinach (1983) hypothesized that such configurations would distinguish the four forms of engagement identified in their SRL model, but to date there is little evidence to validate their hypothesis. By collecting data on students' cognitive processes using several different methods, an attempt was made to validate the acquisition and transformation processes as consistent and distinguishable components of self-regulated learning. Should these configurations prove valid, this would serve as justification for classifying students' cognitive approaches to learning tasks according to the four forms of engagement proposed in the SRL model.

This study also manipulated goals and environmental constraints over a series of tasks that students performed such that specific forms of engagement, which theory predicts to be optimal for these different tasks, should have been elicited. Thus, in the event that the four forms of cognitive engagement were shown to be viable, students' adaptive abilities in terms of cognitive engagement could be explored.

Another goal of this study was to test how well aptitude variables predict variations in SRL. Students' scores on measures of fluid ability, achievement, Corno's (1986) Self-Regulated Learning (SRL) Rating Scale, attributions for success and failure, and academic self-concept were compared to self-report and observation data on the cognitive processes they used during academic tasks. In this way, an attempt was made to determine whether these variables are reliable predictors of Self-Regulated Learning skills.

CHAPTER THREE: METHODS

Experimental Design

To serve as a context for observing students' use of component SRL processes, six academic tasks were designed. The tasks differed from one another in terms of their degree of structure, motivational features, and performance requirements, such that, theoretically, they would elicit one or another form or cognitive engagement (see Table 3). A sample of Grade 12 students, working in groups of three, worked on the tasks during four experimental sessions. Two measures were obtained of students' use of component SRL processes during the tasks. These were a Metacognitive Questionnaire (MQ), administered immediately after each task, and pre-specified "traces" of cognitive processes in students' notes (see Appendices B and C). "Traces" (Winne, 1982) are physical evidence of cognitive processing such as underlining of important parts of a text passage as evidence of selectivity. Evidence of students' use of social and material resources also was collected from videotapes of students while working on the tasks. One other self-report measure sought students' assessments of the characteristics of each task such as difficulty level, interest to them, and demands in terms of strategy or resources needed. This instrument is the Task Assessment Questionnaire (TAQ). This self-report instrument appears in Appendix D.

Several pretests were administered in a separate session before students worked on the tasks. These included a test of fluid ability (Raven, 1965), the Self-Regulated Learning Rating Scale (Corno, Collins, & Capper, 1982), and two measures of academic motivation. Students' most recent grade point averages (GPAs), obtained from school records, measured achievement, or crystallized ability. These aptitude measures were later used to examine how well scores on them would predict students' use of component SRL processes during the tasks presented here.

The measure of students' use of resources, derived from the videotapes, deserves special explanation. The use of external resources is predicted to be a general indicator of alertness, strategic planning, and global monitoring. It may be associated with either a Comprehensive Engagement or a Resource Management approach to learning tasks. When accompanied by evidence of the student's engagement in high levels of transformation processes (selecting, connecting, and tactical planning) and in cognitive regulating, a Comprehensive Engagement approach is indicated by students' use of external resources. On the other hand, when students use external resources to the exclusion of the transformation processes and cognitive regulating, a Resource Management approach is said to be operating.

It may be useful at this point to present more detail about the response patterns and performance outcomes hypothesized to appear when students use each of the four forms of engagement on the first two tasks presented to them. These predictions are outlined below. For purposes of illustration, the terms "failure" and "success" are used here as relative terms; that is, performance on a given task will be scored as a "failure" when it produces a response that is less than optimal, even though the same response may be considered acceptable in real classroom settings.

Students' performances on one well-structured and one ill-structured task were examined first. These tasks would be hypothesized to elicit a Task Focus and Comprehensive Engagement approach, respectively. Then, four other tasks were presented. These tasks were designed to explore students' use of acquisition and transformation processes under conditions designed to elicit varying forms of engagement. Specifically, these tasks were designed to be similar to the first two tasks in terms of their structure, but were designed to elicit either Resource Management or Recipience approaches as optimal.

Table 3. Response patterns and quality of performance expected when students use each of the forms of engagement on ill-structured and well-structured tasks.

Ill-Structured Task

1. Comprehensive Engagement is optimal—this approach produces a high quality solution *(success)*. There will be evidence that this learner engages in relatively high levels of all acquisition and transformation processes.

2. Resource Management also should produce a high quality solution *(success)* where external resources are made available. However, in this case there will be evidence that the learner engages in high levels of acquisition processes, but relatively low levels of transformation processes. This approach may be optimal under some circumstances, but if used consistently may reflect a lack of ability to use transformation processes.

3. Task Focus will not produce a high quality solution *(failure)*. There will be evidence of the learner using high levels of all transformation processes, but relatively low levels of acquisition processes. Students will not be likely to use available resources to help them organize the task or to clarify difficult or confusing aspects of the problem.

4. Recipience will not produce a high quality solution *(failure)*. There will be evidence of low levels of acquisition processes (mainly alertness, rehearsal and global monitoring) and low levels of transformation processes.

Well-Structured Task

1. Comprehensive Engagement approach should not be evidenced (according to theory, "self-regulated learners" should shift into a Task Focus approach when faced with this type of task). However, if a learner does not shift appropriately into a Task Focus approach, some performance deficit should appear (failure). Specifically, performance should be slowed due to response hesitancy (too much self-checking), so learner may not finish in time.

2. Task Focus will produce optimal performance *(success)*.

3. Resource management will not produce adequate performance *(failure)*, except where external resources (such as peers) can be used to carry out transformation processes (such as those needed to determine appropriate problem representation). If solutions can be reached using external resources, excess cognitive regulating (e.g., self-checking) will slow response rates.

4. Recipience will not produce adequate performance *(failure)*. Only alertness, rehearsal, and global monitoring should be evidenced.

Research Questions

The specific research questions addressed in this investigation are as follows.

1. Can the forms of cognitive engagement be identified reliably and consistently using three different measures of students' cognitive processing during academic tasks?

If the answer to Question #1 is YES, the following questions are appropriate:

a. Can performance on the six tasks in this study be predicted by the use of the forms of engagement students use during work on each task?

b. Will students of high ability, high achievement, and high scores on a self-report measure of SRL adapt their cognitive engagement to varying task demands?

c. If b (above) is answered affirmatively, will these students consistently use the theoretically optimal form of engagement for a given task and learning context?

d. Will students who score high on self-report measures of academic self concept and internal-controllable attributions for success and failure be more likely than others to invoke theoretically optimal forms of engagement?

If the answer to Question #1 is NO, the following questions remain to be answered:

2. Can the use of component SRL processes on these tasks be predicted by measures of achievement, ability, SRL as measured by Corno et al.'s (1982) scale, academic self-concept, or internal-controllable attributions for success and failure? In other words, will students who

measure high on one or more of these predictor variables be differentiated from other students by the degree to which they engage certain processes while working on these tasks?

3. Can performance on these tasks be predicted by the use of one or more of the component SRL processes?

Sample

Participants for the study were selected from an initial pool of 180 students in two senior secondary schools in a medium-sized metropolitan area. Ninety grade 12 students in the first school were enrolled in a Western Civilization course. The pool of students in the second school consisted of 90 grade 12 students enrolled in a French course. Both of these grade 12 elective courses are accepted as credit toward admission at British Columbia's universities. Thus, while not all students in the two courses were bound for university, many took these courses with university entrance as a goal.

It was originally intended that this study would be limited to sampling high ability, high achieving students who would be predicted to be self-regulated learners. Two pretests were administered and students' GPAs were obtained in order to select a sample of these supposed self-regulated learners from the pool of 180 students. However, since there were too few volunteers who could be scheduled together in groups of three to make up a reasonable sample, this selection procedure was abandoned.

In the first school, 21 students volunteered to participate in the experimental part of the study. One student was omitted from the experimental sample due to a particularly low GPA (0.50 on a 4-point scale) and ability test score. Five other students could not be included due to constraints in their schedules. Thus, five groups of three students each were scheduled into six sessions for the remainder of the study. In the second school, 23 students volunteered to participate in the entire study. Of these, five withdrew before being assigned to groups. A total of 18 students, in 6 groups of 3 students each, were scheduled to complete the experimental tasks at the second school.

Measures

Pretests

Students were administered the Raven's Progressive Matrices (Raven, 1965), as a measure of fluid ability, and the Self-Regulated Learning (SRL) Rating Scale (Corno et al., 1982), a self-report measure of self-regulated learning activities used for school work. The SRL Rating Scale contains 20 items asking students to rate the extent to which they use the component SRL skills identified in the model during classroom learning. The response options for each item are "usually," "often," "sometimes," "almost never," and "don't know." The most recent available grade point averages on all 180 students was obtained from school records to be used as a measure of crystallized ability (Cattell, 1963, 1971), or general academic achievement.

Students in the final sample were administered the Test of Component Processes (TCT), designed for the present investigation. This measure was included to ensure that students were able to engage in each component SRL process (e.g., rehearsing, selecting relevant from irrelevant information, etc.) when called for specifically. Thus, in considering why students may have failed to engage some of the component processes while working to complete academic tasks, sheer inability could be ruled out as a cause. Data from this measure were not included in the analyses because several items were invalidated during data collection. On two items in particular, which were intended to measure students' alertness and rehearsal skills, a number of students misunderstood the instructions, rendering their responses invalid. In the absence of stronger data, it is assumed that the students in this study were able to engage each of the component processes, since they would be requisite skills for academic work at the grade 12 level. Moreover, as noted in Chapter One, it is generally expected that students will have the SRL processes in their "cognitive repertoires," but that they may not have learned to make them operational in a given context (Corno & Rohrkemper, 1985).

The final sample of students also completed three pencil-and-paper self-report measures. The first of these was an Academic Attribution Scale, adapted from the Learning and Computer Motivation Scale (Corno, Collins, & Capper, 1982) which Mandinach used in her dissertation. This scale measures students' attributions of their success and failure in a variety of school situations. This particular attribution scale was preferable because each item, in addition to including response options reflecting attributions to ability, effort, task difficulty and luck (e.g., help from others), included a strategy option. Thus, students were able to indicate whether they attributed successes or failures in school situations to their using or failing to use effective strategies, as one response option in each question. There were 18 items on this scale, each with five response options. Students' scores were the sum of all items in which either the "effort" or "strategy" option was chosen.

The second self-report measure administered was the Academic Self-Concept Scale. This scale was designed for this study to assess students' self-concept in terms of how well they manage in school. Students rated, on a 10-point scale, how good they thought they were at things like writing essays, solving math problems, concentrating during class, and getting help with difficult assignments when needed. There were a total of ten items on this scale.

Finally, students completed the Action Control Scale (Kuhl, 1984). This scale measures three different types of action versus state orientations: decision related, performance related, and failure related (see Chapter 2). Each of the three subscales consists of 20 forced-choice items. Internal consistency and discriminant validity data on the Action Control Scale are reported in Kuhl (1984). This measure was administered for purposes of a separate study, so will not be discussed further. All of the pretest measures except the Raven's Progressive Matrices and the Action Control Scale appear in Appendix A.

Task-Specific Measures

One source of data concerning students' use of the acquisition and transformation processes applied to tasks was the Metacognitive Questionnaire (MQ). This was a forced-choice instrument, designed for this study, which students completed immediately following each task. Each of the 17 items on the questionnaire described two nearly opposing cognitive processes that could have been used during the task. For example, item # 11 asked, "While working on this task, did you (a) focus on some parts or points more than others? or (b) concentrate equally on all of the information? Students were to select the one choice that characterized their approach to the task . The MQ appears in Appendix B.

A second source of data on students' use of the component SRL processes was that of traces (Winne, 1982). Students were instructed to write detailed notes and five specified traces of their cognitive processes while working on the tasks. Every page of each task provided a two-inch lined column down the right hand margin where traces were to be written.

Three of the specified traces were designed to reflect specific acquisition or transformation processes included in the SRL model. One of these was to write an "A" in the margin beside any place where a student noticed that his/her attention had been off-task. This trace provided a negative score for Attending. Students also were instructed to jot down what they were thinking at these times. The second trace reflecting a specific cognitive process was to underline any parts of the presented material or students' own notes which they considered more important than other information in the task. This trace reflected Selectivity. The third trace was to jot down thoughts that were triggered by the information presented in the task, such as examples or comparisons to prior knowledge or experience. This trace reflected Connecting.

The other two traces were less specifically targeted but were designed to capture, as much as possible, thoughts that reflected other acquisition and transformation processes. One of these was to jot down questions that came to mind while working on the task, including topics that were unclear or needed to be checked for accuracy. This trace could capture some Connecting, but was also intended to reflect Global Monitoring and Cognitive Regulating. The fifth trace was designed mainly to reflect Strategic Planning, but also captured thoughts reflecting a student's motivational level relating to the task at hand. This trace was prompted just before each main section of a task by instructing the student to "STOP and write your thoughts about this task in the margin before going further."

Finally, students were instructed to write out all the steps they completed during each task, rather than doing any work only "in their heads." The description given of the kind of notes expected was that of a "running commentary" of what was thought about while engaged in the tasks. From these notes it was possible to obtain indications of Tactical Planning, Rehearsal, Organizing, and references to peers and material resources for assistance. Information on the scoring of traces appears in the section on Scoring in this chapter. The instructions students were given for writing traces and the scoring manual for coding them appear in Appendix C.

The third source of data concerning students' approaches to tasks was the Task Assessment Questionnaire (TAQ). The TAQ was completed immediately after the MQ. This measure, designed for the present investigation, was intended to provide qualitative data on students' evaluations of task difficulty, and their response to the task in terms of effort and strategies. Information on scoring the TAQ appears in the Scoring section of this chapter. The TAQ appears in Appendix D.

Data from the TAQ were used as an aid in interpreting the data on cognitive processes used by students during tasks. More specifically, the TAQ provided information about students' perceptions of task features such as difficulty and similarity to regular school tasks, and about the strategies they used to complete each task. One item on the TAQ also provided a self-report measure of how much students used information from their peers during each task.

All work on the tasks was videotaped to record the extent to which participants used each other or the reference materials as resources. Specifically, the following data were obtained from the videotapes for each task: (a) the proportion of time spent obtaining information from other group members; and (b) the proportion of time spent looking through, copying from, or reading resource materials other than the task booklets.

Students' engagement in self-regulated learning processes thus was observed from four types of data. First, their use of material and social resources was observed and measured from videotapes of the sessions. Second, students' notes and traces contained indicators of specific cognitive (acquisition and transformation) processes they engaged. Third, students' own retrospective reports of their use of acquisition and transformation processes during the tasks were provided in responses to the MQ. Fourth, students' perceptions of task characteristics were recorded in the TAQ. The scores resulting from traces in students' notes and responses on the MQ are representative of the acquisition and transformation processes used while completing tasks. Data from the videotapes and scores on the MQ and traces were intended to be used directly to identify the form of engagement exhibited primarily, if any, on each task. Whether or not it would be possible to classify students' response profiles into the forms of engagement hypothesized by Corno and Mandinach (1983) would depend, however, on the stability and distinguishability of the acquisition and transformation subscales on each measure.

Tasks

Students completed a total of six tasks during the study. The first task was a well-structured task involving two problems in which students designed an exercise program and a special menu, given specified constraints and background information. Because it was highly structured, this task was predicted to elicit a Task Focus approach in students of high ability and motivation, that is, self-regulated learners. The second task was designed to be ill-structured, and thus to elicit a Comprehensive Engagement approach in students of high ability and motivation. In this case, students studied a short article on smoking as they would to learn it for class, then wrote an essay in response to several content-based questions.

The other four tasks presented to students were designed to vary situational demands across well-structured and ill-structured problems. Two of these tasks, a well-structured and an ill-structured task, were presented as videotaped lectures, followed by content-based questions. Each task was prefaced with instructions in which students were told to imagine that they were in a required class which they disliked, taught by a teacher they disliked. Because motivation was expected to be lowered by the instructions and because students were able to receive the lessons passively since they were presented via lecture, these two tasks were expected to elicit a Recipience form of engagement.

The other two tasks, a well-structured task and an ill-structured task, were presented with instructions designed to elicit a Resource Management approach. That is, they required the management of large amounts of information, and were intended to lend themselves well to group cooperation. In the well-structured Resource Management task, students were told that their group was competing against others to determine which group could reach a solution to the problem first. The problem was to find the "culprit" in a list of foods consumed at a picnic supper which was responsible for food poisoning. This problem was not difficult, but involved performing a large number of simple computations. Thus, the most efficient way to complete the problem was to work as a group, dividing the computations among the group members. Finally, in the ill-structured Resource Management task, each group was cast as a "task force" vested with a large and complex problem of developing a policy. This task required searching out information in available resource materials. Both tasks were designed so that students could complete them independently if they wished, but which would be completed more efficiently through group work.

Each of the six tasks thus was designed to elicit (optimally) a particular form of cognitive engagement while nonetheless allowing for the use of any of the four forms of engagement. Should forms of engagement prove to be a viable way of classifying students' approaches to these tasks, this design provides an opportunity to observe whether and under what circumstances students adapt or fail to adapt to changes in task demands by changing approaches. The tasks appear in Appendix E.

Procedures

In each school, pretesting took place within three intact classes during one hour of a single class period. In follow-up pretesting sessions, students in the final sample of 33 completed the test of individual cognitive processes included in the SRL model and the three self-report measures of attributions, self-efficacy, and action control.

Working in groups of three, participants completed experimental tasks during five sessions. The sessions were scheduled on successive days within one week wherever possible. Where this was not possible, or where a session was cancelled, sessions were scheduled on the next possible day. In two instances, two sessions were completed immediately following one another on the same day. The longest time span required to complete all five sessions was 18 days. The major portion of all sessions took place during the students' free time—before school, during spare periods, during lunch hour, or after school.

In the first school, all classes met every day. This meant that it was possible initially to schedule all five sessions for a group on successive days. However, in this school, few students had spare periods, requiring most sessions to take place during lunch hour or after school. In the second school, the class schedule was such that not all classes met each day. Thus, in this school it took approximately seven school days for a group to complete all task sessions. Most students in the second school did have spare periods, making it possible to schedule task sessions during these periods rather than at lunch or after school. In some cases, sessions ran over into the students' next class. Permission slips were provided by the school to allow for students to be excused in these cases.

When students came for the actual task sessions, they were informed that they were allowed to confer with one another as much as they wished during the tasks, as long as they handed in their own response at the end of the session. During each task, three sets of reference materials (one for each student) relating to the topic of the task were on the table. Participants were given two or three minutes to browse through these materials before each task in order to familiarize them with their general content.

Session One

In Session 1, students first were given a brief oral introduction and overview of the procedures involved in the study. The introduction was read verbatim, as follows.

> Before beginning, I would like to explain to you a little bit about the kinds of things we'll be doing, and the goals of the study. You may have gotten an inkling of this from the questionnaires you filled out last week. For instance, you were asked a lot about your thoughts relating to your schoolwork—how you find you do at it, why you think you do well or not in certain situations, and so forth.
>
> The rest of the time we are together over the next week will be spent finding out more specific details about how each of you approaches school tasks, and how you perceive those tasks. Eventually, I hope to develop ways of helping students become better at school subjects, but first I need to look carefully at the strategies and systems you use for your schoolwork. In order for the results of this study to be accurate and useful, its *very important* that you think carefully and report as accurately as you can, whenever you are asked how you went about something.
>
> I'm sure by now you're all wondering what you'll have to do next. Well, here's basically how things will work from now on. Each time we meet, you'll first be given a task to do, which will take anywhere from 15 minutes to half an hour. I'll have the videotape running while you're working on each task. Right after the task, you'll be asked to fill out a questionnaire called the METACOGNITITVE QUESTIONNAIRE, or "MQ" for short. This questionnaire asks you all sorts of questions about how you were thinking as you proceeded through the task you just did. Then you'll be asked to fill out one more questionnaire, asking you things about what you thought of the task itself. Together, these two questionnaires take about 20 minutes or so to fill out. On Thursday and Friday you'll go through this whole procedure twice, with two different tasks. On the other days you'll only have to do one task.
>
> That's the basic procedure. But there is one other thing I'll want you to do to help me to get a picture of how you go about problems, assignments, or test questions in school. Part of this is to take a lot of notes which will show HOW you do the tasks, not just what you end up with. I've also come up with some specific things called "TRACES" which I'll want you to write in the margins of the materials I give you. The traces will also show how you're thinking during the tasks. In a minute, I'll tell you about them, and then we'll do a warm-up task so you can try them out. I'll also get you to fill out the questionnaires today, so you can see what they're like.

Next, students were instructed on how to write traces as evidence of their cognitive processing during their work on the tasks. An overhead projector was used to demonstrate the appropriate situations in which to use each trace, and to show where traces should appear on the task responses (e.g., beside the place in the task where a particular thought occurred). The script for this lecture is provided in Appendix C. Immediately following the instruction on writing traces, students completed a Warm-up Task to familiarize them with the general format of the tasks, and to provide an opportunity to practice writing notes and traces. Finally, they completed the two questionnaires designed to measure the cognitive processes used and their perceptions of the experimental tasks, the MQ and the TAQ. Having students complete the questionnaires after the Warm-up Task was intended to equate reactive effects across subsequent tasks.

Session Two

During Session 2, participants completed the well-structured task involving the exercise and diet problems. The oral introduction for this session was read verbatim as follows.

> Today's task is about diet and exercise Before I hand out the task, take a minute or two to browse through the materials on the table. These materials may or may not be needed to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look right now just so you have an idea what is there.

(Waited two or three minutes while students looked at materials.)

> The task you will be doing today will take about half an hour. Please take your time and make sure you are writing the traces and step-by step notes of what your are thinking. Let's review the traces before we start, to be sure they are fresh in your mind.

A reminder card on the centre of the table, identifying each of the four traces was pointed out to the students. This card would remain on the table for each task.

> 1. Trace #1 is the Letter "A"—whenever you catch yourself letting your mind wander or thinking about something not related to the task, put an A in the margin. (You should take notes then about what you are thinking, too, if possible—for instance, you might think "Better read that over." or "Ok, come on—concentrate!" So in general, write down whatever you think as often as you can.
>
> 2. Trace #2 is to UNDERLINE anything you think is more important than other information. Do this in your notes as well as in whatever you are reading.
>
> 3. Number 3 is to jot down any QUESTIONS that come to mind, or anything that you think you should check out or clarify. Any questions about this one?
>
> 4. The fourth trace is noting things that you know or have experienced before that this reminds you of. It might be an example of a concept, or a comparison to something you are familiar with. I call this making CONNECTIONS between this information or this task and things you know from somewhere else.
>
> OKAY—Do you think you can remember to write all this stuff down as you work? I know it's hard to do it when you are concentrating on the task, but it is important to try your best.
>
> ONE OTHER THING— If you don't understand something, or you have a question about how to do a question, ask your group members before you ask me. I'll be in the vicinity if you get stuck, but rely on each other first. Also, keep in mind that you can work with each other on these tasks if you want to—as long as you each hand in an answer and notes of your own. So if you want to talk to each other about what you are doing, or interrupt another student to ask something, feel free to do that.

Immediately following the task, students completed the MQ and the TAQ.

Session Three

Session 3 followed the same sequence as Session 2 with the ill-structured task on smoking. The following oral introduction was given, then the instructions for writing traces were reviewed, exactly as in Session 2.

Today's task is about cigarette smoking. Before I hand out the task, take a minute or two to browse through the materials on the table. Again today, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Waited two or three minutes while students looked at materials.)

The task you will be doing today will take about half an hour. Please take your time and make sure you are writing the traces and step-by step notes of what your are thinking. Let's review the traces once more, quickly, before we start, to be sure they are fresh in your mind.

Pointed out reminder card on table. Traces instructions reviewed next.

Session Four

In Session 4, students went through the above procedures twice, completing a well-structured Recipience task and a well-structured Resource Management task. Each task took approximately 15 minutes to complete. In each case, the MQ and TAQ were completed immediately following the task. The oral introduction was read verbatim as follows.

Today there are two tasks to do. Each one takes about 15 minutes or so. The first one is about the risk of heart attack, and the second one is about food poisoning.

Before we start, take a look through the materials on the table. Again today, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Waited two or three minutes while students looked at materials.)

Again, each task today will take about 15 minutes. Take your time and make sure you are writing the Traces and step-by-step notes of what your are thinking. Let's review the traces once more, quickly, before we start, to be sure they are fresh in your mind.

Pointed out reminder card on table. Review of instructions for writing traces, as in Session Two, was summarized, as students were quite sure of what each trace stood for by this time.

Session Five

Again in Session 5, students completed two tasks. These tasks were an ill-structured Recipience task and an ill-structured Resource Management task. These tasks took approximately 15 minutes and 30 minutes, respectively, to complete. In each case, the MQ and TAQ were completed immediately following the task. The oral introduction for this session was read verbatim as follows.

> Today again there are two tasks to do. The first one takes about 15 minutes or so, and the second takes half an hour. The first task is about the the topic of stress. The second task is about treating and curing diseases.
>
> Before we start, take a look through the materials on the table. The same conditions apply to day as the other days—that is, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. As before, how much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Waited two or three minutes while students looked at materials.)

> Okay, ready to start? Remember to take your time and make sure you are writing the Traces and step-by-step notes of what your are thinking. I'll just name the traces today, since you've had lots of practice with them by now.

Pointed out reminder card on table. Then traces instructions were reviewed as in Session 4.

The five sessions were approximately 55, 60, 50, 65, and 75 minutes in length, respectively. The actual time allotted for each task was as follows: Warm-up Task (15 min.); Diet and Exercise (TF) task (35 min.); Smoking

(CE) task (30 min.); well-structured RE and RM tasks (15 min. each); and ill-structured RE and RM tasks (15 min. and 30 min., respectively).

Scoring

Coding of Traces

The operational definitions of trace scores obtained from student notes and traces written during tasks are described next. First, a negative Attending score was given for each instance of the "A" trace on a student's task. Also, any comments completely irrelevant to the task which were not accompanied by an "A" were scored as negative Attention. An example of a task-irrelevant comment is "I wonder what Joey's doing right now." The number of "A" traces and off-task comments were counted to form the negative Attending score. All other comments found in students' notes except positive and negative motivational self-statements reflected attention to the task. For this reason, all of the scores assigned for instances of engaging Acquisition or Transformation processes were aggregated to form a positive Attention score. A count of instances of verbatim copying of information presented in the task or nearly verbatim notes produced the score for Rehearsal. The score for Global Monitoring reflected the number of statements showing awareness of one's current and general level of understanding, or of progress toward overall goals of the task. "This task is confusing" and "I'm taking too long on this" are examples of Global Monitoring statements. The number of comments or questions indicating that the student was referring back to information previously encountered in the task in order to check, clarify, or correct an understanding or a response produced a score for Cognitive Regulating. Examples of this type of comment are, "Hard part—read that again," and "Oops, I forgot to include these figures in my answer." Strategic Planning was indicated by the number of statements showing assessment of task requirements and decision-making regarding resources and strategies to be used. This category also included comments anticipating the length or difficulty of the task. Also, these statements had to refer forward in the task. That is, only comments which referred to content or parts of the task not yet encountered were considered as Strategic Planning. When a comment such as, "This seems like it will be a tough one," was found beside the initial instructions for a task, it was scored as Strategic Planning.

Two other types of trace scores were included under Acquisition scores in addition to those described above. These were Material Resource and Social Resource scores. The number of comments indicating that students were discussing the task with peers or asking others questions about the task yielded a Social Resource score. An example of this was a student commenting, "Think I'll ask the others what they did for this part." Similarly, the number of statements indicating that a student was using or intending to use the available material resources produced a Material Resource score. "There's a pamphlet here on calories and exercise—I wonder if this will help," is an example of this type of statement.

Underlines or marks of information (e.g., with an asterisk or check mark) presented in the task or written by the student were counted to produce a Selectivity score. More specifically, underlining or marking of any or all information within a paragraph or within a single line in a chart or table was assigned a point. Also, statements indicating that the student considered particular information as more or less important or relevant to task goals than other information were scored as Selectivity. For example, "Who cares who said all this stuff?" written beside a citation in a text passage, and "Remember this part for later," would have been assigned Selectivity scores. Because rehearsing information also indicates that it was selected as important to task goals, all instances of Rehearsal were also scored as Selectivity.

Connecting scores were obtained from comments showing a relationship between information currently being encountered (e.g., beside the comment) and prior knowledge or experience. This included comparing current content or task characteristics to a previous task or to other school work. "We did this sort of thing when I was training for swimming competitions," is one example. It also included evaluative comments concerning the content, such as "Dropping from 16% to 6% after quitting smoking—that's quite a leap."

Statements demonstrating that a student was making connections and associations within the task, summarizing, or developing organized representations of information different from that presented in the task were counted to produce a score for Organizing. An example of an Organizing statement occurring beside statistics showing little reduction in lung cancer rates in smokers who quit after the age of 50 was, "So they should aim the 'quit smoking' campaign at middle-aged smokers."

Finally, Tactical Planning points were counted in instances of specifying the next steps toward solution of a problem being worked on, and to instances where routines such as computational sequences were applied. The kinds of comments that were scored as Tactical Planning statements were the following notes from a problem, where the goal was to plan an exercise program meeting specified calorie reduction requirements (each quotation was assigned one point): "Decide which activity to do first and when," "How much of this activity will I need to do?" "Skiing, about 30 min. out of each hour, 5 hours, means minutes=30 x 5 = 150."

Each comment or point in notes and traces, including units identified as instances of selecting or rehearsing, was coded only as one cognitive process, but also could be assigned a score indicating use of material (MR) or social resources (SR). For example, the comment, "I wonder if I'll need the resource materials for this question," would be coded as Strategic Planning and Material Resources (MR). Trace scores were summed across tasks, resulting in a trace score for each component process and for use of material and social resources on each task. A detailed description of the coding system for traces is presented in a Scoring Manual in Appendix C.

Scoring of MQ.

Each item on the MQ reflects at least one component process of the SRL model or the use of social resources. In 4 of the 17 items, both possible choices reflect one of the component processes. Wherever a student selected a target choice, a score of one was assigned for the component process that choice represented. Scores for each component process and for use of social resources were obtained by averaging the scores on the set of items reflecting those processes. Acquisition and Transformation subscales were then created by summing the respective component process scores.

Scoring of TAQ.

The TAQ contains some open-ended questions designed to elicit qualitative information about students' assessment of the task and their strategic and motivational approaches to it. In addition, a number of questions on this instrument involved rating scales or forced-choice questions. Scores on these items were the numeric option selected for each question. As will be discussed in Chapters 4 and 5, students' work on the tasks in this study could not be classified according the forms of engagement they used. As a result, only certain of the questions on the TAQ were deemed to be useful for aiding interpretation of the data. Thus, only these items will be discussed here.

evaluate the similarity of these tasks to tasks regularly assigned in school, item 9b was coded. This item asked, "what was different (if anything) about the method(s) you used to complete this task compared to the way you usually do math or science problems?" The question referred to math or science problems because the tasks here concerned health-related topics, and some involved computation. Students' responses to this item were given codes of 1 to 6, as follows: 1) Same or similar method(s), 2) Strategy differences noted, 3) Had to work harder on this task, 4) Did not have to work as hard, 5) Cared more about this task, 6) Did not care as much.

The only other responses used from this instrument were the students' rating of the difficulty of each task and the proportion of time they believed they used information from other students in their group during the task. The average score on each of these items was obtained.

Performance Scores.

Students' responses on each task were scored on a three-point scale, where a score of zero represented an inadequate response and a score of two represented an excellent response. For example, the criteria used to distinguish scores of 0, 1, or 2 on Task 3 concerned whether the two questions presented following a videotaped lecture were answered correctly. Specifically, answering both questions correctly resulted in a score of 2, answering one correctly resulted in a score of 1, and answering neither question correctly resulted in a score of zero. The specific criteria used to derive performance scores for each task appear in Appendix F.

Coding of Videotapes.

The videotapes of students working on tasks were coded to identify instances where a student used peers, experimenter, or materials as informational resources. Because the group interaction data from the videotape protocols were so rich, it was necessary to limit the coding of students' requests for information such that the scores reflected a global measure of this variable. Specifically, the percentage of the total time working on a task that a student spent engaged in any task-related discussion with one or both peers in his/her group was counted. Similarly, the proportion of total time working on the task during which a student was looking at the resource materials, other than the task pamphlet itself, was counted. In addition, a score was obtained which reflected the proportion of time on each task that a student spent off-task.

CHAPTER FOUR: RESULTS

The first section of this chapter includes descriptive statistics for the predictor variables used in the study. Also in this section are correlations among scores on measures of motivation developed specifically for this study and measures of achievement and ability found in previous research. The second section describes procedures by which several of the scores on traces and the MQ were collapsed as a result of consistent correlations among them.

The reliability of each of the three measures of SRL processes is examined next. These measures are the MQ, traces, and Corno et al.'s (1982) SRL Rating Scale. This section presents reliability estimates for the Acquisition and Transformation subscales for each of the three measures, first aggregated across the six tasks of the study, then for each task separately. Finally, estimates of the internal consistency of each measure of the component SRL processes are presented. Here, the measures of individual SRL processes, such as Rehearsal and Selectivity, are aggregated across the six tasks.

Following the section on reliability, the validity of the three measures of SRL processes is explored. To address the question of convergent validity, correlations among the Acquisition and Transformation subscales on the three different measures are presented. The convergent validity of the various measures of individual component SRL scores also is then examined by presenting correlations among these measures. Again, in each of these sets of analyses, the results are first aggregated across the six tasks, then presented for each task individually. Divergent validity of the three measures of SRL processes is addressed through correlational analyses within each of the three measures. Correlations between Acquisition and Transformation subscales on each measure are presented, followed by correlations among the component SRL processes within each different measure. Again here, analyses are presented on scores aggregated across tasks, then for each task separately.

The next section presents the results of correlational analyses aimed at revealing any relationships that may exist between SRL processes, as measured by each of these three methods, and measures of aptitude variables and task performance. The final part of the chapter analyzes the academic tasks designed for and used in this study in terms of their instructional and motivational features. This analysis, which is mainly qualitative in nature, is included to help interpret the findings of the study and to examine the validity of these tasks in terms of their objectives.

Desciptive Statistics and Validation of Measures

Descriptive statistics for the predictor variables appear in Table 4. Specifically, means, standard deviations, maximum, and minimum scores are given for measures of crystallized ability (GPA), fluid ability (Raven's Advanced Progressive Matrices, Raven's)), academic self-concept, and attributions for success and failure in academic work. Cronbach's alpha internal consistency estimates are included for the latter two measures.

Table 4. Descriptive statistics for measures of predictor variables. Guttman reliability estimates are included for the academic self-concept (10-item) and attribution (18-item) measures.

Measure	M	s	Max.	Min.	α
GPA	2.8	.7	4.0	1.3	
Raven's	25.3	5.3	33.0	14.0	
Academic Self-Concept Scale	7.7	.9	9.7	5.6	.86
Academic Attribution Scale	11.8	3.4	16.0	0.0	.88

Academic self-concept and attributions for success and failure frequently are associated with academic motivation and have been related to achievement in school and to success on intellectual tasks (Crandall, Katkovsky, & Crandall, 1965; Weiner, 1979, 1986). To validate the Academic Self-Concept Scale and the Academic Attribution Scale with the sample used in this study, scores on these measures were correlated with grade point average (GPA) and Raven's Progressive Matrices (Raven's). Correlations of .37 and .32 were found between the Academic Self-Concept Scale and GPA and Raven's, respectively. Both of these correlations were statistically reliable ($p < .05$). Correlations of .27 and .45 were found between the Academic Attribution Scale and GPA and Raven's, respectively. The first of these two correlations did not quite reach statistical significance ($p = .068$), while the second coefficient did. These correlations generally support the relationship of motivational variables to ability and achievement which have been found in previous research. In addition, the moderate size of these correlations indicate discriminant validity for these two measures of academic motivation relative to achievement and fluid ability.

Collapsing of Variables

Among the traces reflecting SRL component processes, a number of statistically reliable correlations appeared consistently between variables which are related conceptually. (See Appendix G-1 for the intercorrelation matrix for all traces scores.) For example, global monitoring and cognitive regulating correlated with each other reliably (r = .61 on scores aggregated across tasks). Similarly, the aggregated scores for strategic planning and organizing were correlated (r = .57), while use of material resources was correlated with both strategic planning (r = .36) and organizing (r = .51). The scores which consistently showed reliable correlations and also were related to one another conceptually were collapsed by summing them.

Two specific changes were that global monitoring and cognitive regulating were combined to form "monitoring" and organizing, and strategic planning and use of material resources were combined to form "strategic planning." The conceptual relationship between global monitoring and cognitive regulating is self-evident in that both reflect an aspect of monitoring, that is global versus specific (see Chapter One). Organizing and using material resources can be seen as aspects of strategic planning in that these activities may be necessary to gather information and format it so that it can be worked with easily in solving a problem or completing a task.

In Chapter One, organizing was identified as a Transformation process which Corno and Mandinach (1983) had claimed, "showed use of selectivity and connective processes" (p. 95). However, the evidence in the present study indicates that organizing is more closely related to strategic planning, which is an Acquisition process according to the SRL model. If organizing reflects the use of selectivity and connecting, then it is reasonable to claim that these transformation processes occur as part of the planning process and, as such, must be considered as Acquisition processes some of the time. This type of conceptual overlap or lack of mutual exclusivity between Acquisition and Transformation processes is discussed further in later sections.

In addition to these changes, a new score for "attention (-)" was formed because of the conceptual and statistical relationship among several separate scores. This new score combines, again by adding, the previous scores for attention (-) (i.e., off-task comments), vigilance (i.e., the symbol "A" indicating a student realized that s/he was off-task), and both positive and negative motivational remarks. The correlations of scores aggregated over tasks for vigilance and positive and negative motivational remarks with the original attention (-) were .85, .43, and .55, respectively. (All of these correlations were reliable at $p < .01$.) Conceptually, vigilance and motivational remarks, whether they are positive or negative, can be considered types of off-task comments, in the sense that they would occur only when a student was not cognitively engaged in the task itself.

Where they occurred, corresponding scores on the MQ were collapsed in order to allow comparisons between the two measures of SRL processes, even though in some cases the correlations between component scores on the MQ were not as high as they were in the traces. Specifically, MQ scores for global monitoring and cognitive regulating were collapsed to form a score for "monitoring," and scores for organizing and strategic planning were combined to form a score for "strategic planning." The correlation between scores for global monitoring and cognitive regulating on the MQ (aggregated across tasks) was .27 ($p=.06$). The correlation between organizing and strategic planning on the MQ (aggregated across tasks) was .65. These correlations appear in Table G-2 (see Appendix G). There were no scores for use of material resources or motivational remarks on the MQ and there was only one score relating to attention, which was a (+) attending score.

In the case of the MQ, the new scores were created by averaging the scores on all the original items reflecting the processes to be collapsed. The new scores for combined sets of items thus were not inflated in value compared to the scores for the remaining items.

Reliability of Measures of SRL

The first research question addressed in this study was: Can the forms of cognitive engagement be identified reliably and consistently using three different measures of students' use of Acquisition and Transformation processes during academic tasks? To determine the reliability of the three measures of Acquisition and Transformation processes, the respective subscales of the SRL Rating Scale, the MQ, and

Traces scores were tested for internal consistency using Guttman's lower bound reliability coefficients. These results appear in Table 5. The number in parentheses beside each coefficient reported in Table 5 reflects which of Guttman's six formulae was used to compute the lower bound estimate for that particular subscale. According to Guttman (1945), the true reliability of a scale will not be smaller than the largest of the six coefficients generated through his formulae. Thus, the largest coefficient is reported in each case.

The reliability estimates are given separately for Acquisition and Transformation scales, since these scales are hypothesized to reflect distinct sets of cognitive processes. Moreover, these subscales are the basis on which student work on a task was to be classified as one or another form of cognitive engagement. Thus, it is important to determine whether the two subscales are internally consistent and distinguishable from each other. The reliability coefficient for the SRL Rating Scale's Acquisition subscale was higher than the coefficient of .74 reported by Corno et al. (1982) for the total scale. However, the Transformation scale produced a considerably lower coefficient in this study.

Acquisition and Transformation subscales on the MQ were aggregated across tasks by summing the Acquisition totals for the six tasks and summing the Transformation totals for the six tasks. Thus, the reliability coefficients were computed on 6-item scales in each case, where an "item" reflected a total subscale score for one task. The Acquisition and Transformation subscales from traces were derived in exactly the same way as those for the MQ.

Table 5. Guttman reliability estimates for the Acquisition and Transformation subscales of the SRL Rating Scale, the Metacognitive Questionnaire, and Traces scores (N = 32).

Measure of Acquisition and Transformation Processes	Acquisition Scale	# of Items	Transform. Scale	# of Items	Total Scale
SRL RATING SCALE	.84(6)	13	.48(6)	7	.91(6)
METACOGNITIVE QUESTIONNAIRE	.66(5)	6	.71(5)	6	.73(6)
Task A (TF/structured)	.15(5)	5	*	3	
Task B (CE/ill-structured)	.24(5)	5	*	3	
Task C (REC/structured)	.40(5)	5	.22(5)	3	
Task D (RM/structured)	.15(5)	5	.66(5)	3	
Task E (REC/ill-structured)	.66(6)	5	.22(5)	3	
Task F (RM/ill-structured)	.61(5)	5	.34(5)	3	
TRACES SCORES	.50(5)	6	.26(5)	6	.67(6)
Task A (TF/structured)	.11(5)	5	.59(5)	3	
Task B (CE/ill-structured)	.46(4)	5	.11(4)	3	
Task C (REC/structured)	.70(4)	5	.29(4)	3	
Task D (RM/structured)	.54(4)	5	.40(5)	3	
Task E (REC/ill-structured)	.41(4)	5	*	3	
Task F (RM/ill-structured)	.42(6)	5	.25(5)	3	

* Coefficient generated was negative.

Note: Subscript numbers indicate which of Guttman's (1945) six formulae was used to obtain coefficient.

When the MQ and traces scales are considered for each task separately, the internal consistency appears generally quite low and shows marked variation across tasks. The questions on the MQ were the same for each task and the traces of students' notes were coded according to identical criteria on each task. The variation among the six within-task reliability estimates thus would suggest that the Acquisition and Transformation subscales in both the MQ and the traces were not reflecting the same construct from one task to another. However, when aggregated across tasks, the Acquisition and Transformation scales for the MQ showed reasonably strong internal consistency. The coefficients for the two subscales created from traces were not as high. Thus, there appears to be more variation in the underlying constructs being measured by the traces than by the MQ.

In three instances, negative reliability coefficients were generated for Transformation subscales; twice in the MQ and once in the traces. This outcome is not interpretable according to theoretical expectations regarding reliability. However, in all three cases, the subscales involved showed some, albeit modest, correlations with Acquisition and Transformation subscales on the other measures (see Tables 8, 9, and 12). Since scales that have no statistical reliability theoretically should not be correlated with any other variables, this result is perplexing. It may be that a suppression effect is operating in these cases. Since the other within-task Acquisition and Transformation subscales generally show low internal consistency (see Table 5), these subscales are not subjected to further analyses in this study. Therefore, the cause of these negative coefficients is not investigated further here.

When the component SRL processes were considered separately, as opposed to being combined into Acquisition and Transformation subscales, the MQ and Traces also showed reasonable internal consistency across tasks. Table 6 shows Guttman reliability estimates on the three different measures of corresponding component processes. Again in this case, the numbers in subscript indicate which of Guttman's (1945) six formulae for lower bound estimates was used. Corno et al.'s (1982) SRL Scale contained only one item reflecting each of Attention and Rehearsal. Also, this scale was administered only once, as a pretest, rather than after each task. Thus, it was not possible to estimate internal consistency for the items reflecting attention and rehearsal on this scale.

Table 6. Guttman reliability estimates for subscales reflecting component processes of Self-Regulated Learning.

SCALE	Reliability est.	# of items
SRL Rating Scale		
Monitoring	.81(4)	5
Strategic Planning	.69(4)	4
Selectivity	.15(4)	2
Connecting	.46(5)	3
MQ (across tasks)		
Attention (+)	.71(2)	6
Rehearsal	.64(6)	12
Monitoring	.62(6)	36
Strategic Planning	.67(5)	36
Social Resources used	.59(5)	12
Selectivity	.64(6)	12
Connecting	.76(5)	12
Tactical Planing	.31(5)	12
Traces (across tasks)		
Attention (-)	.87(5)	6
Rehearsal	.46(6)	6
Monitoring	.80(2)	6
Strategic Planning	.61(5)	6
Social Resources used	.84(5)	6
Selectivity	.66(6)	6
Connecting	.60(6)	6
Tactical Planning	.15(6)	6

Note: Numbers in parentheses indicate which of Guttman's (1945) six formulae was used to obtain coefficient.

Inter-rater reliability for coding the traces as component SRL processes was computed using a kappa coefficient (Cohen, 1960). This formula produces a more conservative estimate than does estimating percent agreement because it corrects for chance correspondence between the observers. The inter-rater reliability coefficient produced in this case was .75.

Validity of Measures of SRL

The validity of the three measures of SRL processes was investigated by correlating the scores on the two self-report measures of cognitive processes, that is the SRL Rating Scale and the MQ, and evidence of the same processes in the form of traces obtained while students were completing a task. The first self-report measure, the SRL Rating Scale, refers to mental activities students engage in generally while learning. This measure was administered as a pretest. The second self-report measure, the MQ, was completed by students immediately following work on each task. The third measure, that of students' written traces, was obtained while students actually were completing each task.

Thus, a multitrait-multimethod analysis was conducted using the Acquisition and Transformation subscales to represent separate "traits" and the SRL Rating Scale, MQ, and Traces as three "methods" for measuring the sets of component processes. Converging evidence for the model would be shown by high correlations among the three measures of Acquisition and among the separate measures of Transformation processes, respectively. Divergent evidence to support the distinguishability of the Acquisition and Transformation processes would be indicated by low correlations between the Acquisition and Transformation subscales within each of the three measures. Reliability of all the measures of each "trait" is expected to be high as an initial condition of multitrait-multimethod validity, already reported.

Convergent Validity

The correlation matrix for the Acquisition and Transformation subscales of the SRL Rating Scale, MQ, and Traces aggregated across tasks is presented in Table 7. Corresponding correlations within each of the six tasks are presented in Tables 8 through 13. It should be noted that the within-task correlations are limited by the low internal consistency estimates in most cases.

From Tables 7 through 13, it may be seen that there was little convergence among the three measures of Acquisition and Transformation scales in this sample. The MQ Acquisition scale correlated with Corno et al.'s Acquisition scale only on one of six tasks (Table 12). The traces of Acquisition processes correlated with Corno et al.'s Acquisition scale on two tasks (Tables 8 and 9) and when aggregated across tasks (Table 7). Note, however, that the traces of Transformation processes also correlated reliably with Corno's Acquisition scale, twice positively (Tables 10 and 12) and once negatively (Table 8). The MQ and traces measuring Acquisition processes did not show convergence at all. In fact, in one instance, these two measures showed a reliable negative correlation (Table 9).

Table 7. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are aggregated across tasks (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	14.6	3.2	22	07				
4. Transformation	11.1	2.2	-02	43*	-14			
Traces								
5. Acquisition	63.0	20.5	34*	-04	-09	-21		
6. Transformation	58.0	18.8	04	06	22	00	-15	

* p < .05. Decimal points in correlations omitted.

Table 8. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task A only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	2.8	.78	-07	-17				
4. Transformation	2.0	.57	-13	27	-33*			
Traces								
5. Acquisition	13.5	5.6	33*	16	02	-44*		
6. Transformation	17.1	10.2	-31*	-14	05	20	-19	

* p < .05. Decimal points in correlations omitted.

Table 9. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task B only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	2.1	.77	10	-22				
4. Transformation	2.3	.39	-01	21	-24			
Traces								
5. Acquisition	10.6	6.3	30*	-04	-33*	-13		
6. Transformation	19.4	8.3	08	-01	22	-27	-02	

* p < .05. Decimal points in correlations omitted.

Table 10. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task C only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	2.2	.91	15	12				
4. Transformation	1.7	.44	-20	-01	-20			
Traces								
5. Acquisition	8.8	4.5	19	-13	-03	04		
6. Transformation	11.5	3.9	34*	36*	26	-03	31*	

* p < .05. Decimal points in correlations omitted.

Table 11. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task D only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	2.6	.74	10	08				
4. Transformation	1.3	.75	02	32*	-14			
Traces								
5. Acquisition	6.8	3.0	18	-11	08	-04		
6. Transformation	2.4	2.3	04	-01	01	17	-19	

* p < .05. Decimal points in correlations omitted.

Table 12. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task E only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	1.9	1.0	34*	23				
4. Transformation	2.1	.60		30*	05			
Traces								
5. Acquisition	15.6	6.3	19	-10	00	-24		
6. Transformation	3.8	2.2	45*	24	26	10	03	

* p < .05. Decimal points in correlations omitted.

Table 13. Pearson Correlations among the Acquisition and Transformation subscales of the SRL Rating Scale, the MQ, and Traces, where MQ and Traces subscales are for Task F only (N = 32).

	M	s	1	2	3	4	5	6
SRL Rating Scale								
1. Acquisition	3.1	.44						
2. Transformation	2.9	.41	48*					
Metacognitive Questionnaire								
3. Acquisition	2.9	1.2	10	10				
4. Transformation	1.8	.59	25	49*	-22			
Traces								
5. Acquisition	7.7	4.0	16	04	-05	-09		
6. Transformation	4.5	4.2	20	19	38*	25	-21	

* p < .05. Decimal points in correlations omitted.

As for the measures of Transformation processes, the MQ correlated reliably with the SRL Rating Scale when aggregated across tasks and on three tasks (Tables 7, 11, 12, and 13). These same scales (i.e., MQ Transformation and SRL Transformation) correlated in the .20's on two other tasks, though these were not statistically reliable. The Transformation process traces correlated reliably with the SRL Transformation Scale on only one task (Table 10). The only reliable correlation between MQ and traces across the six tasks was a negative one between the MQ Acquisition scale and the Acquisition traces on one task (Table 8).

These results indicate that the Acquisition and Transformation subscales do not distinguish themselves consistently when measured using three different methods at three different times in relation to working on a task. Thus, convergent validity of the two subscales has not been demonstrated in this study. However, it is also appropriate to test the convergent validity of the individual component SRL processes across the three scales used in this study.

To test the validity of these three measures of the individual component processes of SRL, as opposed to their combination into acquisition and transformation subscales, correlations among the component process scores on the three measures were computed. The correlations between corresponding SRL processes as measured by the MQ and Traces for all six tasks aggregated together appear in Table 14. The corresponding within-task correlations appear in Tables G-3 through G-8.

The Traces and MQ items supposedly reflecting the same component SRL processes generally did not correlate reliably in this sample, with the exception of items reflecting Attention. It is noteworthy that, in general, where measures of component processes on the MQ did correlate reliably with those in the Traces, the relationships appeared just as strong across Acquisition and Transformation subscales as within them. For example, the trace score for Selectivity, which is a Transformation process according to the SRL model, correlated higher with items supposedly reflecting Acquisition processes on the MQ than with Transformation items on the MQ.

Table 14. Correlations Between MQ and Trace Component Scores, Aggregated Across Tasks

TRACES	MQ								
	Att(+)	Reh	Mon	S. Plan	SR	Sel	Con	TP	Perf
Off-task Comments	-53*	26	-13	22	15	23	12	-22	21
Rehearsal	-18	15	-16	03	21	29	-09	-25	-11
Monitoring	-21	-03	-18	-08	29	25	-19	02	-11
S. Planning	-24	-04	-08	34*	29	18	04	-13	-17
Social Resources Used	47*	-12	08	08	39*	-07	26	09	06
Selecting	-09	-13	-14	13	02	-05	-04	03	12
Connecting	-42*	14	-08	16	01	14	-15	05	-17
Tactical Planning	02	01	-04	-19	-48*	05	-09	-11	37*
Task Performances	05	14	-06	18	12	21	-13	14	

* p < .05 (Decimals omitted)

Table 15 displays correlations of aggregated MQ and Traces scores with Corno et al.'s Acquisition and Transformation scales. Again, the three measures of component processes do not show good convergent validity. Only one of the Acquisition processes, as measured by the MQ, correlated reliably with the SRL scale. The traces fared slightly better in terms of their relationship to the SRL scale. Two of the Acquisition traces correlated with the SRL Acquisition scale, while three of the Transformation traces correlated with the SRL Transformation scale.

Table 15. Correlations of MQ and Traces scores (aggregated across tasks) with Corno et al.'s Acquisition and Transformation scales.

	SRL Rating Scale Component	SRL Scale Acquisition	SRL Scale Trans.	SRL Total Scale
MQ				
Attention(+)	-11	32*	-02	19
Rehearsal	-14	-04	-12	-05
Monitoring	15	28	-08	16
S. Planning	10	20	22	26
Social Resources	---	-02	05	-01
Selectivity	20	16	12	21
Connecting	17	-10	05	-08
Tactical Planning	-09	-14	-15	-17
Traces				
Attention(-)	-09	-02	-02	0
Rehearsal	26	31*	12	33*
Monitoring	02	04	-02	06
S. Planning	27	35*	27	41*
Social Resources	---	-08	-15	-18
Selectivity	20	-02	39*	13
Connecting	17	13	47*	30*
Tactical Planning	-09	-32*	-32*	-35*

Note: The SRL Rating Scale does not contain any items reflecting use of social resources, therefore these correlations could not be computed.
In each case these correlations are with the corresponding component process scores on the SRL Rating Scale.

* $p < .05$ (Decimals omitted).

In looking at the data in Tables 7 through 15, it appears that, for the most part, what students claim they do cognitively during classroom instruction is not what they claim to have done when asked to reflect on their cognitive activity during an academic task they just completed. Moreover, neither of these self-report methods gives the same information about students' cognitive processing during academic work as is shown in traces of their thoughts written while actually working on a task.

Divergent Validity

Tests of the divergent validity of the Acquisition and Transformation subscales, indicated by the results of correlational analyses within each of the three measures, produced mixed results. In Corno et al.'s SRL Scale the Acquisition and Transformation scales were positively correlated. No relationship was found here between the Acquisition and Transformation subscales on either of the other two measures (i.e., MQ or Traces), either when aggregated across tasks or on any of the tasks (see Tables 7-13).

Tests of the divergent validity of the component SRL processes consisted of correlations among component process scores on the MQ and traces separately. The correlations among scores on the MQ, aggregated across tasks, appear in Table 16. The corresponding correlations for each task appear in Tables G-9 through G-14 (see Appendix G). The correlations among traces aggregated across tasks appear in Table 17. The corresponding within-task correlations for traces appear in Tables G-15 through G-20 (see Appendix G). Of the 168 correlations among MQ component scores on the six tasks, 57 were statistically reliable. In the case of component traces scores, 25 correlations were statistically reliable.

While these correlations indicate that the measures of the SRL processes used here are not completely distinguishable from one another in all cases, such that some of them vary with one another, there is limited support for the SRL model in these results. Specifically, most of these correlations reflect either positive relationships between processes identified by Corno and Mandinach (1983) as Acquisition processes and between processes identified as Transformation processes, or they reflect inverse relationships between processes identified as belonging to different subscales. In addition, six of the correlations on the MQ (none on traces) were negative correlations between "using social resources" and cognitive processes (i.e., attention, rehearsal, monitoring, planning, connecting, and tactical planning). In as much as students would have been interacting when using social resources, it is logical to imagine a negative correlation between this variable and cognitive processes that involve active mental work with the task materials. There were only six statistically reliable correlations on the MQ and five on the traces which did not fit any of these "logical" relationship expectations.

Table 16. Inter-Correlations Among Processes Measured by MQ, Aggregated Across Tasks.

	Att(+)	Reh	Mon	S. Plan	SR	Sel	Con	T. Plan
Attention(+)								
Rehearsal	17							
Monitoring	03	35*						
S. Planning	39*	42*	40*					
Social Res.	-22	-09	31*	-43*				
Selectivity	-07	-16	20	02	-17			
Connecting	21	-18	29	41*	-62*	32*		
T. Planning	-17	-13	-17	-58*	-08	26	-28	

* $p < .05$ (Decimals omitted)

Table 17. Inter-Correlations Among Processes Measured by Traces, Aggregated Across Tasks.

	Att(-)	Reh	Mon	S. Plan	SR	Sel	Con	T. Plan
Attention(-)								
Rehearsal	-32*							
Monitoring	51*	03						
S. Planning	-05	19	02					
Social Res.	07	13	-05	27				
Selectivity	-37*	19	-25	13	07			
Connecting	03	-05	04	03	-17	09		
T. Planning	-03	-11	13	05	-01	17	10	

* $p < .05$ (Decimals omitted)

In 35% of the MQ score comparisons and 15% of the traces comparisons, statistically reliable relationships were shown among the component process scores. This result indicates reasonably good discrimination among items or sets of items representing SRL processes. It should be noted that some correlations might be expected here, given that particular tasks may call for certain processes in combination. The Acquisition and Transformation subscales showed good divergent validity on the MQ and traces and a moderate correlation between them on the SRL Rating Scale.

The answer to the first research question appears to be no. The low correlations among measures of Acquisition and Transformation processes indicate a lack of validity in these subscales. However, it might be reasoned that one of the three measures could be selected on empirical grounds to use for identifying forms of engagement in students' response protocols. Two possibilities exist as reasonable means for making such a decision. First, if Acquisition and Transformation subscale scores on one measure could be predicted from achievement and/or ability measures better than the other two, this might serve as grounds for using that measure to identify students' forms of engagement. The rationale for this is that self-regulated learners are expected to be high in crystallized and fluid ability. A second alternative would be to select the measure which best predicted performance on the tasks in this study, if any. The validity of this procedure could be argued on the grounds that self-regulated learners are expected to be "successful" students. Neither of these options proved useful.

First, none of the three measures correlated consistently with ability or achievement, eliminating the possibility of using these predictor variables as indicators of validity of one measure over the others (see Table 18). In looking at the subscales of the SRL Rating Scale and the MQ and traces aggregated across tasks, only the Transformation subscale on the SRL Rating Scale and traces correlated reliably with achievement or ability. While these positive correlations are somewhat supportive of the validity of these Transformation scales, they would be expected to correlate more strongly with the Raven's than with GPA, since the former purports to measure fluid ability (Mandinach, 1984). This was not the case. Moreover, none of the three measures of Acquisition processes were predictable from measures of ability or achievement. Finally, neither of the subscales on the MQ correlated reliably with these predictor variables. Second, when Acquisition and Transformation subscales on the three measures were correlated with task performance (see Table 19), no consistent relationships appeared. Based on the results displayed in Tables 18 and 19, it is not possible to make an empirically-based decision concerning which of the three measures of Acquisition and Transformation processes to use for determining the forms of engagement students used in completing these tasks. Given this fact and the lack of convergence among the subscales in the three measures, there appears to be no empirical basis on which to classify students' response protocols into one form of engagement or another.

Table 18. Pearson correlations between measures of Acquisition and Transformation subscales, aggregated across tasks, and measures of crystallized (GPA) and fluid (Raven's Progressive Matrices) ability.

	SRL SCALE		MQ		TRACES	
	Acquis.	Trans.	Acquis.	Trans.	Acquis.	Trans.
GPA	-11	42*	13	25	-15	40*
Raven's	10	33*	16	15	19	12

* p < .05 (Decimals omitted)

Table 19. Acquisition and Transformation Subscales on MQ and Traces Correlated with Performance Scores on the Respective Tasks.

	PERFORMANCE SCORES						
	SUM	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
MO ACQ	-01	05	02	-03	-16	-05	10
MQ TRAN	07	18	-08	-06	-24	33*	11
TRACES ACQ	15	24	-09	30	10	20	30*
TRACES TRAN	15	17	18	-37	-06	-02	03

Note: the Acquisition and Transformation scales correlated with sum performance score are aggregated across tasks. The scales correlated with performance scores on each task are the corresponding within-task scales.

* p < .05

SRL, Aptitude, and Performance Variables

SRL Processes and Aptitude Variables

Although the lack of validity of the Acquisition and Transformation subscales demonstrated here prohibits classification of students' approaches to these tasks into forms of cognitive engagement, the component SRL processes did show limited reliability and validity. Thus, it is useful to explore the relationships of the component SRL processes to aptitude and performance variables. The second research question concerns whether students' use of any of the component processes identified in the SRL model can be predicted by their scores on Corno et al.'s (1982) SRL Rating Scale, GPA, Raven's, the Academic Self-Concept Scale, or the Academic Attribution Scale. The results of correlational analyses to explore this question appear in Table 20.

In examining Table 20, it appears that seven out eight MQ component scores (aggregated across tasks) were correlated with one or more of the predictor variables at a statistically reliable level. The component score which appears to be related to the most aptitude variables is that of planning. It was positively related to fluid ability (Raven's), the total score on Corno et al's SRL scale, and both of the academic motivation scales. The MQ score for connecting was positively related to the Raven's, the total score on the SRL scale, and the Academic Self-Concept Scale. Interestingly, the MQ score reflecting students' use of social resources (MQSR) was negatively related to both of the academic motivation variables. This outcome would suggest that students who are less confident of their

Table 20. Pearson Correlations Between Component SRL Processes and Predictor Variables.

	GPA	RPM	ACAD S.C.	ACAD ATTRIB.	SRL SCALE
MQ					
Attention (+)	28	21	20	17	-09
Rehearsal	03	-04	-02	27	26
Monitoring	-10	03	23	49*	02
Strategic Planning	05	47*	39*	36*	27
Social Resources Used	-06	-29	-35*	-43*	--
Selectivity	22	04	44*	12	20
Connecting	21	33*	36*	27	17
Tactical Planning	05	-28	-13	04	-09
Traces					
Attention (-)	-20	-15	01	-25	-11
Rehearsal	02	19	-26	13	-14
Monitoring	-23	10	14	09	15
Strategic Planning	19	46*	-03	16	10
Social Resources Used	10	23	-02	08	--
Selectivity	33*	03	24	13	08
Connecting	34*	13	11	03	06
Tactical Planning	02	13	15	05	-38*

* $p < .05$

academic abilities and who do not attribute academic successes and failures to internal, controllable causes are more likely than more confident students to obtain assistance from peers. A negative correlation ($r = -.29$ $p = .056$) also appeared between MQSR and fluid ability. This result may be interpreted as evidence that students who are lower in fluid ability use social resources more than those higher in fluid ability.

It appears that only three of the traces (aggregated across tasks) were correlated reliably with any of the aptitude variables. Again, two of the component processes involved were planning and connecting, while the third was selectivity. The trace score for planning was positively related to fluid ability (Raven's) and the trace scores for connecting and selectivity were related to crystallized ability, or achievement (GPA).

Thus, the second research question is partially answered in the affirmative. Five of the eight component SRL processes as measured by the MQ were correlated as predicted with at least some of the aptitude measures, while three of the traces scores were. What this implies is that, insofar as the MQ scores can be trusted, the overall degree to which students engage self-regulated learning processes during academic work varies with achievement, fluid ability, academic motivation, and their reported use of these processes in general, as reflected in the SRL scale.

SRL Processes and Task Performance

The third research question of interest was that of whether performance on the six tasks in this study could be predicted by the component SRL processes used by students during each task. To answer this question, MQ and traces scores for the component processes were correlated with performance scores on each task. In addition, correlations were computed on overall performance scores with MQ and traces scores aggregated across all six tasks. These results appear in Table 21.

Table 21. Correlations Between Performance and MQ and Traces Scores Within and Across Tasks.

Performance	(TP) TASK A	(CE) TASK B	(RECIP) TASK C	(RM) TASK D	(REC) TASK E	(R.M.) TASK F	TOTAL SCORE
GPA	29	13	-25	05	27	23	25
RAVENS	02	-02	-02	35*	-07	47*	19
ATTRIB.	42*	-07	-09	11	-09	17	14
ACAD. S.C.	09	19	-01	02	24	02	21
SRL-ACQ	13	23	-25	0	10	-41*	-06
SRL-TRAN	01	-05	-26	01	06	03	-08
MQ							
Attention(+)	14	-01	01	-10	-04	35*	05
Rehearsal	31*	18	-32	-30*	-08	0	14
Monitoring	-15	19	01	-03	-01	-13	-11
S. Planning	-16	-34	-08	-13	06	04	-17
Social Res.	-19	0	26	18	-05	-03	12
Selectivity	0	-01	23	-36*	28	16	21
Connecting	11	-23	-44*	-12	14	0	-13
T. Planning	25	16	-16	05	16	09	14
TRACES							
Attention(-)	-08	24	17	24	03	-26	21
Rehearsal	34*	-09	06	-12	17	24	-11
monitoring	-02	-06	22	-01	-01	-10	-11
S. planning	19	02	-17	24	42*	36*	-17
Social Res.	-01	-04	-02	17	-03	26	06
Selectivity	33*	23	-59*	-23	15	-03	12
Connecting	-01	06	37*	08	-20	06	-17
T. Planning	-05	25	-23	10	03	12	37*

* p < .05 (Decimals omitted)

The MQ component process scores showed positive reliable correlations with task performance in only 2 cases out of 48. Four other statistically reliable correlations between task performance and component processes as measured by the MQ were in a negative direction. Five out of six statistically reliable correlations between task performance and traces scores were positive. However, six reliable correlations out of a possible 48 represents little evidence for relating processes as measured here with performance on these tasks. In short, little relationship appears to exist between the use of specific cognitive processes, as measured here, and performance on the tasks.

Analysis of Experimental Tasks

In most instances, performance on the tasks in this study were not correlated reliably with crystallized (GPA) or fluid (Raven's) ability, with measures of academic self-concept or attributions for success and failure, or with measures of the component SRL processes. This apparent lack of relationship to variables considered important in self-regulated learning deserves some scrutiny. The tasks designed for this study thus are examined in this section in terms of their instructional and motivational characteristics. Features of the tasks are discussed from an instructional design perspective and from the perspective of students' perceptions.

The tasks students completed in this study were designed to meet several criteria. First, they were designed to elicit primarily one or another form of cognitive engagement. These specifications are described in detail in the previous chapter. The first two tasks were designed to vary in their degree of structure. This variation was intended to determine whether students defined by ability and achievement as self-regulated learners would adapt their approaches to academic tasks as predicted by the SRL model. A well-structured task was intended to elicit a task focus approach from self-regulated learners, while an ill-structured task was designed to elicit a comprehensive engagement approach from self-regulated learners. The remaining four tasks also were designed to vary along the dimension of task structure, but in addition were intended to inspire differing levels of motivation and use of social resources (i.e., peers). Thus, these tasks were designed to elicit either resource management or recipient approaches from the students.

It was not possible to classify students according to forms of engagement used on the tasks since the Acquisition and Transformation subscales were not validated here. Moreover, students' performance on these six tasks was not correlated consistently with use of the component SRL processes (see Table 21). In addition, performance on these tasks did not appear to be related to measures of fluid or crystallized ability, academic self-concept, or attributions for success and failure on academic work (see Table 21).

There are at least two explanations for the lack of these relationships in this study. One possibility is that the procedures were inadequate to allow any relationships that might exist to appear. A second possibility is that the tasks themselves were designed so that any existing relationships would be masked. These possible explanations are discussed further in Chapter Five, after other data relating to the characteristics of the experimental tasks have been presented.

The tasks used in this study also were designed to be ecologically valid. That is, it was considered important that these tasks be similar to the kinds of things the students normally were asked to do in school. The Task Assessment Questionnaire (TAQ), which was administered to students along with the MQ, immediately following each task, contained a question which asked students to compare the method(s) they used on the task to the methods they normally use on tasks in school. Because the subject matter content of these tasks was in the area of health, this question referred to the methods students normally use in "math or science classes." Students' responses to this question were coded into the following six categories: (1) same/similar methods used, (2) strategy differences noted, (3) had to work harder on this task, (4) did not have to work as hard, (5) cared more about this task, and (6) cared less about this task.

Generally speaking, when students noted differences in strategy use, they referred to different requirements of these tasks compared to those in math or science classes in particular, often indicating that the task at hand was more similar to tasks in some other subject. Only one student indicated that these tasks were different in any way from school tasks in general. The difference noted in that case was that the student was "unable to prepare beforehand" for these tasks, implying that in school tasks some preparation is possible. These results are some indication that the tasks used in the study were not foreign to students, in that they were perceived as similar to the kinds of tasks students were expected to complete in school.

Students also were asked to rate, on a scale of one to ten, the difficulty of each task compared to the work they were doing currently in their math and/or science courses. The average difficulty rating was 4.0. The maximum average rating for one task was 5.8 and the minimum average rating for a task was 2.7. Since the floor of the scale was one, not zero, it is useful to visualize these scores in relation to a midpoint of 5.5. Thus, on average, these tasks were seen as less difficult than those typically assigned these students in math and science classes. The difficulty ratings for each task are presented graphically in Figure 2.

It was noted above that one feature that was varied across these tasks was whether they called for the use of social resources, that is peers, in order to produce an optimal response. The use of social resources was measured in two ways. First, a question on the TAQ asked students to estimate how much they used information from other students in completing the task. The response options for this question were zero, 25%, 50%, and 100%. Second, the proportion of time within each task that students spent asking for or receiving information from others in their groups was recorded from the videotapes of their work on the tasks. The correlations between the proportions indicated on the TAQ and those on the videotapes were .39, .41, .12, .54, .23, and .46 for the six tasks respectively. These correlations are inconsistent enough to warrant questionning the validity of one or the other indicator of students' use of social resources. Since the videotapes show quite directly the interaction between students, it is reasonable to claim that the data from the videotapes is more valid than the self-reports included in the TAQ.

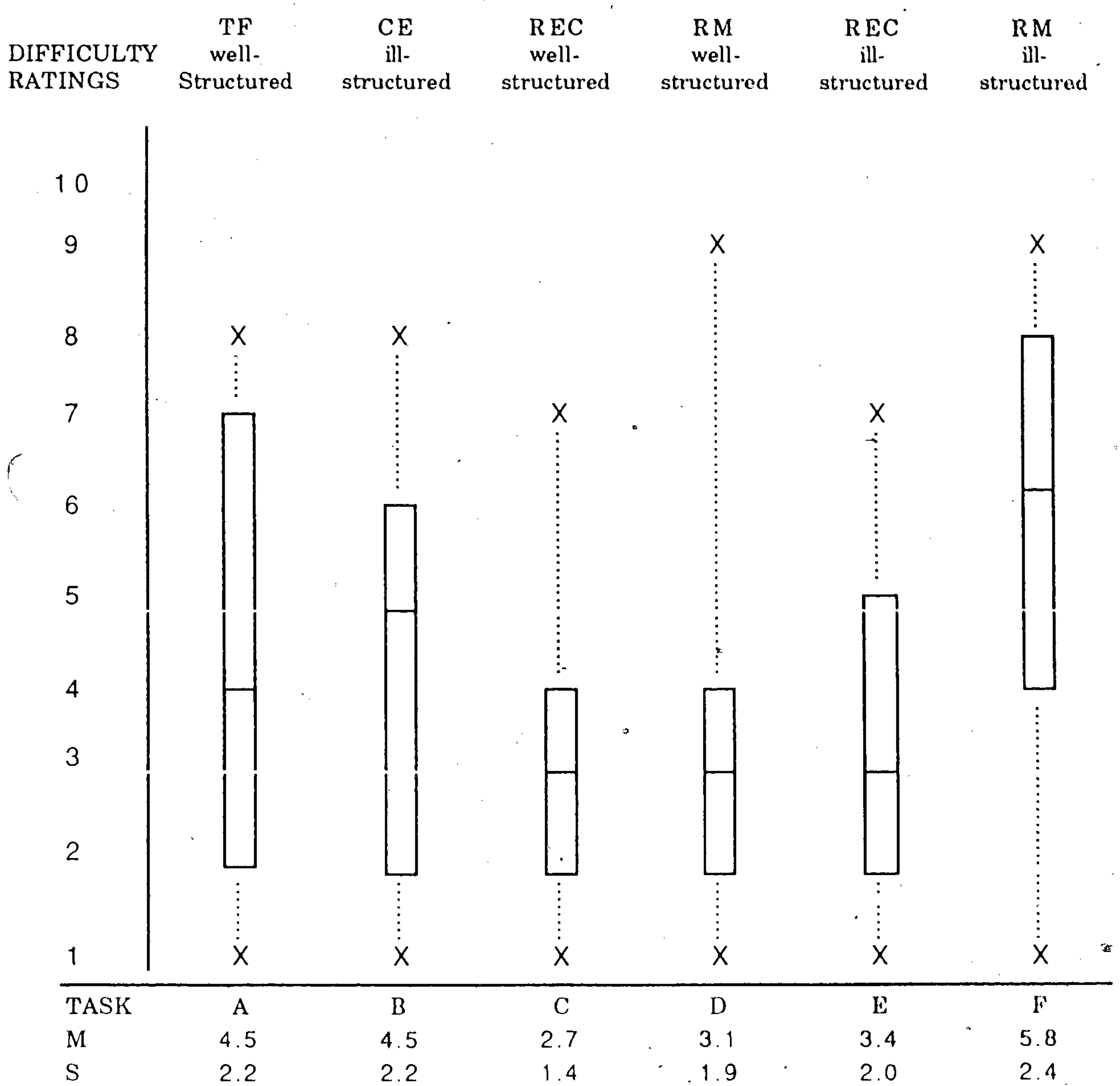

Figure 2. Box-and-dot plot showing Median and Upper and Lower Quartile difficulty ratings for experimental tasks compared to tasks normally encountered in grade 12 math or science classes by this sample of students.

CHAPTER FIVE: DISCUSSION

The model of self-regulated learning proposed by Corno and Mandinach (1983) is not generally supported by the findings of the present study. Three conclusions will be drawn in this chapter concerning aspects of the model which clearly were not supported. These relate to the convergent and predictive validity of the Acquisition and Tranformation subscales and the convergent validity of the measures of component processes. I explain these findings and draw implications for research in the area of SRL. Some aspects of the general construct of self-regulated learning proposed by Corno and Mandinach and others were supported in this study. These findings are discussed in light of theoretical questions concerning present conceptualizations of how self-regulated learning is used in successful intellectual work.

Failure to Support the SRL Model

Corno and Mandinach (1983) propose that two general classes of cognitive processes can be identified: acquisition and transformation. They describe the acquisition processes as largely metacognitive in nature in that they regulate the transformation processes. The hypothesized variation in students' use of acquisition versus transformation processes during academic work defines their approach to tasks in terms of the four forms of cognitive engagement. Thus, to classify students' performances into one or more of the forms of cognitive engagement, and thus to validate the model as Corno and Mandinach describe it, it is necessary to measure the use of acquisition versus transformation processes. However, the classes of cognitive processes referred to as acquisition and transformation appear to be ones that would be difficult to verify as mutually exclusive. For example, the authors indicate some difficulty in delineating the boundary between these two classes of processing when they discuss planning:

> The transformation processes also have both metacognitive and cognitive aspects, for they can call forth other cognitive schemata that may be relevant to the task. For example, planning processes are dubbed generic and metacognitive (Brown, 1978), but specific performance routines applied during planning derive from the cognitive (or lower-level) store, and vary with the task. (1983, pp. 94-95)

The first goal of the investigation reported in this study was to determine whether the acquisition processes can be distinguished from the transformation processes in the context of academic tasks. Specifically, the use of component acquisition and transformation processes by students was measured in three different ways, and the reliability and validity of these two classes of processing were then assessed.

As indicated in the previous chapter, it was not possible to verify these classes of cognitive processing as being mutually exclusive, consistent categories on the basis of data collected here. When aggregated across six tasks, the acquisition and transformation subscales on both the MQ and traces showed reasonably good internal consistency (see Table 5). However, it is not clear what constructs are measured using these two methods. Correlations between the MQ and traces and between these measures and Corno et al.'s (1982) SRL Rating Scale were very inconsistent. Moreover, few correlations appeared between measures of acquisition and transformation processes, on the one hand, and fluid or crystallized ability (achievement), motivation variables, or performance on the tasks on the other (see Tables 18 and 19). Thus, in the case of the acquisition and transformation subscales, the lack of convergent validity is accompanied by a lack of predictive validity.

Measures of individual component SRL processes showed acceptable internal consistency within the MQ across all tasks and within the traces across all tasks. A number of these component process scores also were predicted by aptitude variables such as ability, achievement, and measures of motivational constructs (see Table 20). However, here too, the various measures of supposedly the same processes demonstrated poor convergent evidence, as shown in Tables 14 and G-3 through G-8.

The lack of correlation between measures of cognitive processes in this study casts doubt on the validity of these measures. This is not a new problem to research on cognitive processes in learning (Ericsson & Simon, 1984; Nisbett & Wilson, 1977). The validity of self-reports of cognitive processes remains questionable unless corroborated by other form(s) of data, such as observations or the reports of others (Zimmerman & Manuel-Pons, 1988). In the present case, traces were used as observational data. However, a certain degree of subjectivity necessarily was involved in coding these data, since idiosyncratic comments by students had to be classified as reflecting one or another component process. Further discussion of the conditions under which SRL skills were measured in this study may be useful in interpreting these data.

The tasks in this investigation were designed to elicit varying levels of motivation, cognitive effort, and social interaction, so that variations might be observed in the forms of engagement students used. However, scores on several of the component SRL processes summed over tasks showed statistically reliable correlations with aptitude variables. In particular, strategic planning and connecting appeared to correlate fairly consistently with ability and motivational variables, regardless of changes in task conditions.

Specifically, in the case of strategic planning, both MQ and traces scores correlated reliably with fluid ability (see Table 20). These planning scores also correlated with each other (see Table 14). In addition, the MQ measure of strategic planning correlated with academic self-concept, attributions for success and failure, and Corno et al.'s (1982) Acquisition and Total scales. Connecting showed a similar pattern, except that the two measures of this process were not correlated reliably. Here, both the MQ and traces measures correlated with ability, while the MQ measure correlated with with academic self-concept and Corno et al.'s (1982) Transformation and Total scales. These results suggest that, if varying forms of engagement were used by highly motivated, high ability students in response to the tasks in this study, higher levels of strategic planning and connecting processes characterized their versions of the different forms of engagement. The configurations of cognitive processes which define the forms of engagement in the SRL model would need to be changed somewhat if this explanation were accepted.

Adequacy of Research Methods

Design of Experimental Tasks

Performance on the tasks in this study did not correlate reliably with other variables, such as ability, achievement, motivation constructs, or self-regulated learning skills. Since these tasks were designed to be similar to the kinds of tasks students are assigned in school, the lack of relationship shown between performance on these tasks and GPA is of particular interest. One explanation for this outcome might be that the tasks were poorly designed. That is, the tasks may have been constructed such that there was little similarity to regular school tasks. This could mean that their content or structure was very different from school tasks, or that these tasks were either extremely easy or extremely difficult. Evidence reported in Chapter Four contradicts these possibilities. Students reported on the Task Assessment Questionnaire that the strategies called for in these tasks was similar to those in various types of schoolwork. Some comments made in students' traces also indicated that at least some of the topics dealt with in these tasks were ones which they had encountered before (e.g., smoking, exercise planning). Students also rated the tasks as somewhat easier than school tasks in math or science, but not as extremely easy. Thus, obvious forms of systematic bias due to the factors mentioned were not likely operating to prevent the expected relationships from appearing.

A second possible explanation is that some procedures used in the study introduced systematic error into the performance scores. For example, it is possible that writing notes and traces throughout the time spent working on a task interfered with some students' performance. Two kinds of evidence appear to counter this hypothesis. First, no relationship was observed between total number of traces and performance (r=.15). Second, if it were the case that the problem was caused by interference with work on the tasks from writing traces, one would expect that this problem might lessen as students progressed through the tasks. As students became more accustomed to the activity of writing traces while they worked, stronger relationships between performance and other variables such as GPA might be expected. The results reported in Table 21 do not show evidence of this progression. For example, the highest correlation of task performance with GPA appeared in the first task. There does not appear, then, to be any clear evidence of interference in students' performance as a result of writing traces.

A third hypothesis remains as a possible explanation for the lack of relationship shown between performance on the tasks and school achievement. That is, students' prior knowledge about the subject matter contained in these tasks may have varied, even though the subject area of health was chosen deliberately to minimize the likelihood of such variation. It was reasoned that the topics included in these tasks would be ones with which all students would have some familiarity, but also ones on which students would be unlikely to focus in any particular high school course. However, since these tasks were not preceded by instruction common to all participants, as normally occurs in school courses, any prior knowledge variations that did exist were not controlled. Thus, it is possible that systematic bias due to prior knowledge of some students and not others was introduced into these results.

Adequacy of Measures

Metacognitive Questionnaire. The Metacognitive Questionnaire (MQ) showed reasonably good reliability in measuring the component SRL processes when responses were summ ed across all six tasks in this study. However, its apparent lack of convergent validity when scores for most component processes were compared with the SRL Rating Scale and the traces is problematic. It is possible that the low correlations with other measures of what are supposed to be the same processes were due to the level of specificity of the questions with respect to the tasks.

The items in the MQ developed for this study were, to some extent, based on questions in the SRL Rating Scale (Corno et al., 1982). For the MQ, the questions were designed to elicit responses pertaining to a specific task just completed by the respondent. The targeting of questions at this level of specificity differentiates the MQ from other self-report measures of student cognitive processing during instruction (Marx, Winne, & Walsh, 1985). Previous studies involving questionnaires or interviews appear to have questions focussed either on very specific points in a lesson or learning task (Leinhardt, 1983; 1983; Marx, Howard, & Winne, 1987; Winne & Marx, 1982) or on operations and strategies used generally over the course of many instructional events (e.g., lessons) (Baird & White, 1982; Brattesani, Weinstein, & Marshall, 1984; Peterson, Swing, Braverman, & Buss, 1982; Peterson, Swing, Stark, & Waas, 1983; Weinstein & Middlestadt, 1979;

Weinstein, Marshall, Brattesani, & Middlestadt, 1982). As is explained in detail in the next section, a considerable amount of processing is possible during a task such as those used here. An attempt was made to focus students' responses on sections of these tasks, but this may still have been too large a unit of analysis to allow accurate judgements about what cognitive processes were used. Such inaccuracy could have caused the observed lack of correlation between responses on the MQ and measures of the same processes on the SRL Rating Scale.

Traces. Some of the traces of SRL processes were derived logically from students' notes written during their work on tasks, while others were more direct reflections of cognitive processes. For example, the attention (-) trace score is considered to be a direct trace because it is based on comments in students' notes which demonstrate attention off-task. On the other hand, traces reflecting planning and monitoring processes were not as direct because they were coded on the basis of the meaning inherent in students' comments.

There is some question concerning the validity of these traces, particularly the "indirect" ones. It was considered important to code each comment as reflecting one and only one SRL process to ensure against confounding the resulting scores. However, in many cases it was extremely difficult to discriminate students' comments in terms of which SRL process they should be coded to reflect. This is seen as a clear demonstration of how much interplay there is among cognitive processes even during supposedly small steps in working on a task. There also was considerably weaker internal consistency shown by the Acquisition and

Transformation subsets of traces compared to that shown by the corresponding subscales on the MQ.

These reliability and validity problems indicate some question regarding the usefulness of this method of collecting data on students' cognitive processing during intellectual tasks. In previous cases where traces have been used (e.g., Winne, 1982), traces were contrived to be standard symbols which students either produced or did not produce. These symbols were direct reflections of a particular cognitive process, as were the direct traces described above. However, as indicated above, many of the traces in this study were inferred from students' comments. These "indirect" traces were open to more variation in terms of the constructs that underly them than the direct traces would be, because in each case the content of a student's comment is idiosyncratic. Future studies in which traces are used as reflections of students' cognitive processes thus should involve more advance specification of what traces will be used as indicators of which processes. Also, those specifications should be included in the training students receive about writing traces. Bearing in mind the cautions mentioned earlier concerning validity of self-reports of cognitive processing, this will provide at least some assurance that each trace students write will reflect only the cognitive process it is intended to reflect.

Nonetheless, as described in Chapter Four, the kappa coefficient obtained on the basis of agreement between the codes assigned by two coders was .75. This coefficient is acceptably large despite the conservative nature of the kappa coefficient (Cohen, 1960).

Is the SRL Model Empirically Testable?

The development of a model of self-regulated learning involves at least two requirements. First, predictions must be made about the configurations of cognitive processes involved in various kinds of learning tasks and situations. These predictions must meet the conditions for scientific adequacy. As such, they must logically relate to one another within a system that is internally consistent. Also, they must be testable in that it must be possible theoretically to falsify them (Popper, 1959). Second, valid data must be collected on subjects' cognitive processing while engaged in intellectual work so that the model can be tested.

In Chapter One it was suggested that previous attempts to validate the SRL model pointed to the possibility that it is unfalsifiable. The reason for this suggestion was that previous researchers (e.g., Mandinach, 1984) had assigned learners' performances to one or another form of engagement after classifying their work as either high or low in use of acquisition and transformation processes. This method of classifying students' responses necessarily places each of them into a form of engagement. However, it appears that more valid methods for testing the hypothesized variations in cognitive processing exist.

The present investigation attempted to determine whether the acquisition and transformation process categories were stable enough to be used in assigning students' work on tasks to the four forms of engagement. Had these two categories been validated, some cut-off score (e.g., .5 standard deviation above and below the mean on acquisition and/or transformation subscales) could have been determined as a means of assessing whether students' performances on particular tasks would follow the configurations predicted in the SRL model. It may be that some weaknesses in the methods used here, as outlined earlier, blurred distinctions between the acquisition and transformation processes. However, there is not enough evidence of such methodological weakness to conclude that this is the reason for the findings reported.

As just described, the predictions made in the SRL model appear to be testable, in that they could be falsified, theoretically. This model of SRL also includes hypotheses about learners' approaches to tasks which which are plausible and which have considerable intuitive appeal. For example, it is reasonable to predict that learners who consistently manage resources so that they themselves do little cognitive work will fail to become expert at using certain cognitive processes. Also, to identify certain kinds of processes as important in accomplishing complex academic tasks is not unreasonable. However, it is my contention that, for a number of reasons, it is neither theoretically nor practically feasible to predict configurations of cognitive processes as precisely as they are delineated in this model. In particular, the length and complexity of tasks and the amount and kinds of prior knowledge students bring to bear on those tasks would be expected to influence the degree to which certain cognitive processes will be used and also the sequences or combinations in which they are engaged. In the following section I argue this position based on what is currently known about cognitive processing during intellectual tasks. Then some suggestions will be made regarding the type of self-regulated learning model that may increase our understanding of how adaptive intellectual skills are learned, applied, and controlled by effective learners.

Identifying, Observing, and Predicting Cognitive Processes

Two problems are associated with collecting data to test theories about cognitive processing during learning. One problem, described earlier, is that the cognitive processes may be below the learner's conscious awareness, or in some other way unavailable for accurate recording by the learner. Since basic cognitive processes are thought to become automatized with overlearning (LaBerge & Samuels, 1980), it may be that the more expert a learner is, the more difficulty he or she will have in reporting accurately the micro-level processes engaged during a given task.

Another problem with collecting valid data on cognitive processing during learning tasks is that the processes may occur interactively and/or in such rapid succession that it may be difficult or even impossible to monitor and record them. For example, a seemingly simple distinction can be made between acquisition and retrieval tasks in instruction. Acquisition tasks are those in which students learn new information and retrieval tasks are those in which students recall knowledge and put it to use (Winne, 1984). While it is easy conceptually to see the difference between these two kinds of tasks, it may not be so easy to distinguish them in the context of real learning situations:

> Each type of task is probably rarely, if ever, carried out independently of the other. For instance, in taking notes from a lecture about cell reproduction, a student must retrieve a plan for organizing the information being acquired in order to take effective notes. In answering a textbook exercise that presents a previously unseen arithmetic word problem, the student must acquire information about how many marbles Pete has before Sally gives

> him hers. Thus, I assume that every instructional task whereby students learn new information inherently blends acquisition tasks with retrieval tasks. (Winne, 1984, p. 4)

It might be argued that, while acquisition and retrieval activities occur together in most or all learning tasks, they should nevertheless by distinguishable from one another in students' response protocols. Given what is known so far about learners' ability to monitor and accurately report on their cognitive processing, this appears somewhat questionable. However, it is possible that training learners in metacognitive skills may eventually allow researchers to place more faith in the self-reports they obtain from learners (Haller, Child, & Walberg, 1988).

Even if it is possible to collect valid data on learners' cognitive processes during learning, the problem of determining precisely what sequence or combinations of operations would be predicted the next time a student or, more realistically, some other student, goes to take notes on a lecture remains extremely complex. For example, in terms of self-regulated learning skills of the kind identified by Corno and Mandinach (1983), retrieving a plan for organizing information presented in a lecture and then implementing that plan during notetaking involves a number of different cognitive skills, most or all of which will be evoked repeatedly at various times during the lecture. These skills might include making connections from new to old information, selecting information, organizing information, and monitoring one's cognitive and physical (i.e., written) representation of information. The sequence and number of times particular skills such as these are evoked will vary radically from one time to another and from one student to another. This variation will occur because of differences in the content being presented, how quickly or clearly it is presented, the learner's prior knowledge, both of the topic and of learning skills, and so forth. Thus, while task analysis may allow us to predict what cognitive requirements a given task has, it does not always tell us what various strategies learners may have and use, and to what extent and in what sequence they may call them into play, to meet those requirements.

Research on Cognitive Strategies

The research on cognitive strategies has produced findings relating to two kinds of intellectual tasks or sets of conditions. First, it has resulted in findings that learners engage specific cognitive processes in the context of very limited, defined, and relatively brief kinds of tasks. Under these conditions it is possible to track the cognitive steps taken by subjects as they work through such problems. While this kind of detailed knowledge now exists about learners' cognitive processing within the context of certain specified kinds of tasks, such as inductive reasoning problems, it should be noted that it has not been obtained without effort. For instance, Sternberg (1985) and his colleagues conducted dozens of studies which were focused sharply on very specific questions about a given cognitive process before drawing conclusions about its use in producing a particular solution or product. This kind of information is invaluable to our growing understanding of the cognitive components of intellectual functioning on tasks such as inductive reasoning problems. However, not all tasks are understood as well.

The second type of research finding relates to cognitive strategies that are viewed at a somewhat more molar level. These include many of the same cognitive processes as the ones used in tightly defined tasks such as inductive reasoning problems, but in this case the tasks are larger, longer, and generally more complex. This is the research on problem solving in particular subject matter domains such as chess (Chase & Simon, 1973; Ernst & Newell, 1969; Newell & Simon, 1972), mathematics (Polya, 1954, 1957; Schoenfeld, 1982; Schoenfeld & Herrmann, 1982), physics (Chi, Feltovich, & Glaser, 1981; Larkin, 1982; Larkin, McDonald, Simon, & Simon, 1980; Clement, 1982), and medicine (Elstein, Shulman, & Sprafka, 1978; Patel & Groen, 1986). From this research we know much about the cognitive strategies used, for example, by experts and novices in a particular domain. The importance of the solver's knowledge base in the subject area of the problem was realized through this research. Experts were found to make use of that knowledge effectively while novices could not manage without it, even with knowledge of general strategies (often referred to as "weak methods," Perkins & Salomon, 1989).

In terms of the present discussion, the important difference between the two types of intellectual tasks just described is the extensive use of the knowledge base in the second kind of problem. This factor makes these problems very different intellectual contexts from the simpler, more limited reasoning tasks. These latter problems are much more like school work than are inductive reasoning tasks of the type Sternberg and others have studied, because they involve the use of strategies to manipulate large stores of information which the learner has acquired over time.

This difference in task parameters also provides the context for much richer, more complex cognitive processing patterns. For example, if all the information necessary for solving a given problem or completing a task is in memory and is organized in a way that enables easy access through recognition, the cognitive steps used by the learner will be much different than if it is not (Perkins & Salomon, 1989). A vast array of possible branches may be taken in such processing as learners face differing sets of informational conditions at every step of the way. The specific components needed by experts and novices may be the same, but the ways in which they are combined and used to operate on content is likely to differ markedly. It thus is much more difficult to track or predict precisely which cognitive processes will be required or used by a learner in tasks of this size.

Another example of the variation possible in complex tasks may help to illustrate this concept more clearly. Carroll (1976) identifies 20 different classes of cognitive operations and strategies which comprise production systems students use to perform intellectual tasks. For purposes of illustration, only a few of these will be named. They include (1) identify, recognize, or interpret the stimulus; (2) educe identities or similarities between stimuli; (3) retrieve a name, description, or instance of stimulus information; (4) store information in memory; (5) retrieve information from memory; and (6) retrieve or construct hypotheses. Carroll discussed how the various procedures in the learner's production systems were enacted during a task. In his model, the production system

> .... specifies the data available to the subject as he starts performing the task, and the changes in "data" that occur as he carries out the operations that are required ... These changes in "data" are, in the main, changes in internal memory states ... as the task is performed. (1976, p. 33)

In considering the cognitive operations and strategies in Carroll's model, it is easy to imagine the potential differences in learners' stores of declarative and procedural knowledge, including both the specific content at hand and the skills, strategies, and/or heuristics that may be required for solving a given problem. The kinds of heuristics that learners may or may not require or use can be seen in the problem solving protocols of experts faced with atypical or unfamiliar problems. Here, experts may resort to alternative strategies, such as retrieving analogous systems which they better understand, in order to figure out or "crack" the problem (Perkins & Salomon, 1989). Thus, at one point in the problem or task, a person with a particular knowledge base in the area of the problem will recognize a representation for getting to an eventual solution, while another person may search memory for a similar problem type that could be used to model the present information. Alternatively, the solver might need to review the information presented in hopes of finding some piece that was missed the first time it was considered. The important point here is that differences in the knowledge base and current thought patterns at any given time in the problem solving process can affect the cognitive operations and strategies that are used next and throughout subsequent parts of the task.

Cognitive Processing During Complex Tasks: A Dynamic System

The description just presented of cognitive processing in the context of complex tasks is one which might, with a little imagination, be likened to the behavior of physical phenomena operating in complex, dynamic systems. This kind of behavior has been labeled "sensitive dependence on initial conditions" or "the Butterfly Effect" (Lorenz, 1963, 1979; Poincaré, 1952). First described in the context of weather forecasting (e.g., Lorenz, 1963), this notion of non-linear, seemingly chaotic behavior of phenomena in complex systems became known as the science of "chaos" (Gleick, 1987). It has recently been applied to many more phenomena besides weather patterns, including biological systems.

Briefly, chaos works like this. In traditional science, the laws of probability are used to allow claims to be made about the behavior of phenomena in spite of small errors that are observed. "You don't have to account for the falling of a leaf on some planet in another galaxy when you're trying to account for the motion of a billiard ball on a pool table on earth" (Gleick, 1987, p. 15). Small errors, such as puffs of wind not measured during weather observation or small fluctuations in the price of gold in the study of economics, are expected to cancel each other out or be consumed by some larger, dominant trend in forces. The same logic is applied routinely in statistics used to validate research in the social sciences. It works well with linear systems. Linear relationships can be captured with a straight line on a graph; the equations that represent them are solvable. Linear systems can be broken down in to their component parts and the pieces will add up again (Gleick, 1987).

Chaos, on the other hand, deals with nonlinearity. Many systems in nature, the weather being a prime example, have plagued scientists for ages because they do not operate in neat, predictable, linear fashion. As Gleick explains,

> In fluid systems and mechanical systems, the non-linear terms tend to be the features that people want to leave out ... Friction, for example. Without friction a simple linear equation expresses the amount of energy you need

> to accelerate a hockey puck. With friction the relationship gets complicated, because the amount of energy changes depending on how fast the puck is already moving. Nonlinearity means that the act of playing the game has a way of changing the rules ... The twisted changeability makes nonlinearity hard to calculate, but it also creates rich kinds of behavior that never occur in linear systems. (1987, p. 24)

One example frequently used to illustrate chaos is that of a dripping faucet. When dripping very slowly, it is easy to observe the discrete droplets falling from the spout. However, when slightly more energy is added to the system, that is when the tap is turned on a little more, the drops appear to all run together in a way that is impossible to track or predict. Similar turbulence is observed in abnormal heart rhythms, such as ventricular fibrillations. These deadly events sometimes are the result of physical tissue damage, such as blocking of the arteries, but not always. Scientists now are beginning to find explanations for these strange, sudden changes in heartbeat patterns by studying the workings of the heart from the perspective of dynamic systems (Gleick, 1987). They are finding evidence suggesting that the "breaking of the wave" of a regular heartbeat which occurs in fibrillations may be due to an electrical surge that disturbs the normal periodic flow of the system.

An important concept in the science of chaos is that microscopic parts of the system, that is the local, micro-level relationships between variables, are understood and easily predicted; but the macroscopic behavior of the system remains a mystery. For instance, in the case of the fibrillating heart described above, many of the heart's individual components may be working normally. The pacemaking nodes may be sending out signals normally, and the individual muscle cells receiving and responding to signals for contracting and relaxing as they should. Fibrillation is a disorder of the system as it operates globally; muscle cells often show no physical damage at all. Thus, the longstanding, accepted tradition of classical science, where systems were looked at locally and the mechanisms isolated and then added together, does not appear to be useful in understanding some complex, dynamic, non-linear systems.

In applying the concepts of chaos to cognitive processing, it is possible to imagine that regular, predictable patterns of cognitive operations occur during simple, highly constrained tasks involving little external knowledge. On the other hand, more complex tasks may involve such varying amounts and kinds of interplay among processes, depending on "initial conditions" at any point in time during the task, that the processing itself appears chaotic. The acquisition and/or retrieval of external information to use in completing a task may be analogous to the added energy that renders the dripping tap unpredictable. In fact, differences in electro-encephalograph (EEG) readings have been reported to occur when the brain is more activated, that is when the subject is thinking intensively about something (Nova, 1989). The EEG pattern reportedly becomes more complex under these conditions. It also has been suggested that chaos, or turbulence, in brain activity may allow a person to bypass small-scale, less optimal solutions during problem solving, rather than locking onto the first possible solution encountered during a search. Moreover, it may be that patterns of cognitive activity functioning in chaotic form are what accounts for people reaching new insights: a phenomenon that remains unexplained by psychological research findings at this point.

As an illustration of how sensitive dependence on initial conditions might exist in the use of component SRL processes, consider students faced with a typical task in school, such as solving a set of mathematics problems. At a certain point in working on these problems, a student might be engaged in high levels of selecting, tactical planning, and connecting, but a low level of cognitive monitoring. It is probably safe to presume that the extent to which each of these processes is being used is influenced by numerous other factors in the cognitive and social systems. These factors would include variables commonly associated with motivation, the availability of social resources, the student's fluid and crystallized ability, his/her social skills, and so forth. If, however, the value of just one of the variables in the preceding list were changed, the configuration of component processes being used by the student might also change drastically. For example, suppose the student is motivated to work independently on the problems until solutions are reached. However, she gets stuck at a particular point in the third problem. In this case, she might evoke some monitoring operations to determine where her difficulty arises and to try to come up with a revised solution plan. Now her levels of processing have changed from high on selecting, tactical planning, and connecting to high levels of monitoring, connecting, and strategic planning, with some selecting and practically no tactical planning. Change this scenario now to one where the student becomes impatient with her progress, or where a peer leans over to see how far she has gotten with her task. In either of the latter cases, this student, who generally is motivated (and might be considered task focused), might now turn to her peer for assistance with the third problem and instantly change her level of use of several components. Now she might use high levels of strategic planning, rehearsal (to remember what her friend is saying long enough to use it when she goes back to working the problem), and connecting. These variations on the configurations of cognitive processes possible during a task point up the richness of the intellectual, motivational, and social conditions at work in classroom situations. More importantly, they show how component SRL processes might easily display sensitive dependence on initial conditions, making predictions over practically any length of time difficult or impossible.

Admittedly, the above suggestions with regard to cognitive processing are highly speculative at present. Nonetheless, they may serve as the beginnings of a useful model of how cognitive processing varies over the span of long and complex tasks. If, indeed, cognition is characterized by "sensitive dependence on initial conditions," then the longer a person is working intellectually, the less accurately will we be able to predict combinations of cognitive processes that occur over subsequent phases of the task. Questions such as those raised here may be the focus of much research in cognitive science over the next decade, as psychologists study cognition in more and more complex tasks (Resnick, 1987).

Predicting Achievement from Configurations of Micro-Level Processes

There are some cases where cognitive psychology research has enabled us to predict variations in long-term intellectual behavior in the context of larger tasks from knowledge of configurations of cognitive processes at the micro level. The predictability of school achievement from fluid ability is an example of this. The question thus arises as to why it is possible to make predictions about school performance on the basis of fluid ability, but not to predict performance or overall achievement on the basis of configurations of component SRL processes into Acquisition and Transformation scales, at least from the data presented here.

There are at least two possible explanations for this inconsistency, neither of which can be tested by the methods used in the present investigation. First, it may be that the Acquisition and Transformation scales simply are not accurate reflections of how processes configure themselves during intellectual work. This possibility cannot be ruled out, since the data do not exist at present to support or refute it.

A second possibility is that cognitive processes indeed configure themselves into Acquisition and Transformation subsets, but that they do not aggregate by simple summation as was done in this study. It may be, as implied by the earlier descriptions of how component processes might vary during a complex task, that when one process is required it necessitates a major increase or decrease in other component(s), some of which might also be in the same (Acquisition or Transformation) subset. This possibility has logical appeal, given what we know about the differential effects of variations in the learner's knowledge base (Perkins & Salomon, 1989).

Another argument for research having demonstrated the effectiveness of a hypothesized configuration of cognitive processes might be made with respect to studies showing performance gains after instruction in a particular strategy (Cavenaugh & Borkowski, 1979; Perkins & Salomon, 1989; Pressley, Forrest-Pressley, Elliott-Faust, & Miller, 1985). However, in most cases such research has differed from the present study in important ways. First, instructional studies generally involve step-by-step cognitive or metacognitive strategies, where there is little decision-making required by the learner concerning what to do next. For example, Pressley et al. (1985) report studies where learners have been asked to choose the best strategy for a particular learning situation, but the choices were made after instruction in only two optional strategies. Moreover, the "strategies" referred to in those studies are comparable to the component SRL skills described here, such as elaboration and rehearsal, rather than reflecting some combination of these skills.

Second, the tasks used in most cognitive and metacognitive training studies are very well-structured ones compared to those used here, and are matched cleanly to the strategies to be learned. Such tasks include memorizing vocabulary lists (e.g., Cavenaugh & Borkowski, 1979; Pressley, Levin, & Ghatala 1984), finding inaccurate or incongruous information in a text passage (Markman & Gorin, 1981; Elliott-Faust & Pressley, 1984), and solving mathematics word problems using clearly specified steps for coming up with appropriate representations before solving three different types of problems (Hutchinson, 1987).

In comparison to the present investigation, the above studies pertain to much simpler configurations of cognitive processes which are matched explicitly to the tasks used in those studies. They also do not involve nearly as much variation in the knowledge base required or used by students.

This is not a criticism of these research methods. The point being made is that such instructional research does not provide evidence of our ability to predict improved academic performance on the basis of knowledge of complex configurations of processes being used by learners.

An exception to the above examples is the research on training in reciprocal teaching of various reading comprehension and self-monitoring strategies (Bereiter & Bird, 1985; Palincsar & Brown, 1984). In these studies, learners used many component skills during reading sessions, including summarizing, questioning, and clarifying. However, while the results were very positive in terms of students' academic improvement, several authors have pointed out that it is still unclear what components of these training programs are the active ingredients in students' success (Palincsar & Brown, 1984; Pressley, et al., 1985; Resnick, 1987).

To summarize, research has shown that certain components of self-regulated learning can be trained and that those skills produce improved performance on specified, well-structured tasks. Instructional research also has produced evidence of gains in academic performance when students learn to use self-monitoring and other comprehension strategies reading text materials. However, we do not yet know how complex configurations of processes are engaged during large, complex tasks, even though we may see improvement after instruction in the use of a set of cognitive and metacognitive skills.

Cognitive Science versus Instructional Psychology

The preceding discussion raises important questions about the appropriateness of using some of the research methods now common to seek understanding of how students learn from instruction. It may be that questions about the specific cognitive processing engaged during learning and problem solving can only ever be answered by careful laboratory study of the kind done by cognitive psychologists such as Sternberg, Pressley, Borkowski, and others. There is no doubt about the value of research on when and under what conditions specific cognitive processes are used. This is the work of cognitive psychology; it is the basic science on which instructional psychology rests. On the other hand, instructional psychology is an applied branch of cognitive science, much like engineering is to physics, chemistry, or computing science and medicine is to biological science. As in these other applied sciences, it may be that research on "real time" instructional questions, that is questions that involve the rich combination of factors operating in classrooms, cannot be addressed adequately by testing hypotheses from the more basic sciences.

If instructional psychologists must avoid using variables and testing hypotheses from the more basic science of cognitive psychology, what kinds of questions should they address instead? In order to advance the study of instructional psychology, we need to develop and test theory that involves variables at the appropriate level of generality for application to instructional problems (Marx, Winne, & Walsh, 1985). This means posing hypotheses that are testable in typical instructional environments.

Toward a Realistic Model of Self-Regulated Learning

It was noted earlier that the SRL model includes some reasonable and intuitively appealing hypotheses. These hypotheses refer to variations in students' approaches to learning under various instructional and motivational conditions. Contexts within which these variations are said to occur are complex, both socially and cognitively. It is in these contexts, then, where the predicted variations must be tested. As such, it may not be reasonable to rest definitions of these approaches to learning (i.e., forms of engagement) on differences in specific configurations of cognitive processes, such as acquisition and transformation, because it may not be possible to observe such microscopic variations in complex, applied settings. As suggested earlier, it is likely that only the accumulated findings of carefully controlled laboratory studies will determine the validity of such proposed configurations.

So far, we have learned some things about self-regulated learning skills from research in cognitive psychology. For example, it appears that certain component skills included in the SRL model are important to learning and performance. These include planning, monitoring, and connecting new information to that in memory (Pressley, et al., 1985; Resnick, 1987). However, in most learning situations the use of these skills occurs in very complex, interactive patterns as the learner moves back and forth through the acquisition and retrieval phases of a given task (Winne, 1984). This complexity is defined in part by the knowledge the learner has in memory and its accessibility (Perkins & Salomon, 1989); but also, it is increased by the learner's motivation and ability to use available resources to assist in meeting task goals.

The level and kinds of questions researchers can answer within the context of realistic classroom instruction are those which are framed in the language of instruction in classrooms. If we are interested in global differences in students' approaches to learning, such as are embodied in the four forms of engagement, we need to develop and test hypotheses relating directly to those differences, rather than at the level of cognition suspected to underly them. The forms of cognitive engagement proposed by Corno and Mandinach (1983) involve variations in the cognitive effort students put forth during learning, variations in the use of resources to supplement or supplant cognitive processing, and variations in motivation. The research that can test the validity of these variations can only be conducted effectively in classroom settings, where motivation and available resources vary naturally. The methods used should be ones that involve observing and asking students about these variations directly.

For example, a study designed to test hypotheses about forms of engagement could interview students about whether they sometimes try to get other students to do the hard parts of a task for them when working in a group and, if so, under what conditions. They could also be asked what parts of the task (or required thinking) they carry out themselves under these circumstances. Similarly, students could be asked whether they sometimes exert all of their cognitive abilities to the maximum, and what this involves in terms of strategies. Such interviews could be conducted following various kinds of tasks, such as those Corno and Mandinach predict to elicit certain forms of engagement. Students then could be probed about various hypothesized differences in motivation and task perception, such as perceived knowledge on the topic, interest in the task, enjoyment of the type of procedures involved in the task, perceptions of the importance of the task, and so forth. Such interviews could be conducted following tasks in which students were observed to appear highly task engaged, when they appeared to be uninvolved or uninterested (which might indicate a recipient approach), and when they appeared to be working hard to manage the available social resources. When these kinds of observational and interview data were examined in light of the same students' performance on those tasks and their scores on standard aptitude measures, questions could be answered that are both theoretically and instructionally important.

Students' self-reports about their cognitive processing would be corroborated by observation; but the aspect of this method that renders those multiple indicators valid is that the self-reports describe processing in language and at levels of analysis which are natural to the classroom setting. It is more reasonable to expect students to describe accurately their strategies and cognitive effort on school tasks when the descriptions relate to events and behavior that the students are familiar with, and which are global enough for them to monitor.

What is the next step in understanding how effective (i.e., self-regulated) learners control their cognitive and behavioral activity? While cognitive psychology is unravelling the mystery of how experts use general cognitive skills and strategies in the context of a particular knowledge base, instructional psychologists should be working in tandem with these advances. Equipped with the most recent and convincing conceptualizations of how learners operate at the micro-cognitive level, researchers can direct studies at questions about students' ability and propensity to use their skill repertoires adaptively in the classroom.

Summary

The study reported in this dissertation was aimed at determining the validity of Acquisition and Transformation processes as indicators of variations in self-regulated learning. The design of the study involved collecting data on students' cognitive processing during realistic academic tasks. The results showed that it was not possible to test the validity of this model of SRL in this investigation because the cognitive processes in question could not be measured adequately in the context of large tasks where students worked in groups. The proposed SRL model (Corno & Mandinach, 1983) hypothesizes about cognitive processing variations affecting students' behavior during classroom instruction—variations that cannot be tested directly in the context of such instruction.

The measures of SRL processes used in this study showed acceptable internal consistency when aggregated across tasks. However, convergent validity was not demonstrated for these measures. It is possible that the items on the MQ could not be answered accurately by students because they were focussed on specific differences in employment of various processes, but asked about those differences following too large a set of processing steps. By comparison, task-specific measures used by others (see Marx, Winne, & Walsh, 1985) have focussed on very immediate parts of a task, while the SRL Rating Scale asks about differences in processing during the student's school work in general. Difficulties were encountered in attempting to code student's comments into traces reflecting mutually exclusive categories of processes. However, an acceptable estimate of inter-rater reliability was attained. Thus, it appears that the measures developed for this investigation are not valid indicators of variations in SRL processes when used in the context of tasks of this size and complexity.

The difficulties connected with the measures in this study are a part of the larger problem in attempting to investigate questions concerning variations in micro-level cognitive processing in learning situations that resemble real classroom life. As such, the specific predictions about processing variations that comprise the SRL model cannot be tested through examining students' processing on tasks that are ecologically valid, or within a social milieu similar to a school. This is not to say that aspects of the model could not be investigated under these conditions. Students' approaches to school tasks in terms of such factors as cognitive effort, general strategies, perceptions of task features, and use of social resources could be explored within instructional contexts. However, the criteria by which the forms of engagement were defined would need to be changed if such a study were used to validate the SRL model. As currently delineated, the SRL model is based on predictions about cognitive processing that must rely on findings of more basic, controlled research conducted in cognitive psychology laboratories.

Implications for Further Research

As indicated above, two kinds of research are called for in testing aspects of self-regulated learning. Carefully-controlled laboratory studies are needed to provide more information about how learners manage large and complex problems under varying conditions of domain knowledge, task structure, motivational levels, and so forth. Instructional psychology research also is required if accurate information about variations in students' perceptions of classroom tasks and their strategic responses to those tasks is to be obtained. An example of the kind of classroom research that may help validate global strategy differences predicted in the SRL model was described earlier in this chapter.

It was noted earlier that one type of laboratory study that can demonstrate the effectiveness of a hypothesized configuration of cognitive processes is an instructional study, where performance gains can be shown after instruction in a particular configuration or strategy. In the case of SRL, students could be instructed to emphasize transformation processes such as selecting, connecting, and tactical planning on tasks designed to elicit task a focus approach as the optimal strategy. This instruction would also train students to avoid monitoring and strategic planning processes during this particular type of task (e.g., working familiar types of problems under time limitations). Performance gains would be expected in learners where this configuration of processes is commonly absent. An example might be learners who initially do poorly in this type of academic situation because they are emphasizing inappropriate cognitive skills such as monitoring.

Classroom research of the sort just described may be able to provide valid and informative tests of self-regulated learning models such as the one examined here. This type of instructional research, in concert with more structured laboratory investigations which may reveal more fine-grained detail in the cognitive processing used in learning and problem solving tasks, is what is needed to advance the complementary sciences of cognition and instruction.

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* *Note*: This is the ref. for the SRL rating scale. It was adapted from an instrument originally developed by Peterson, Swing, Braverman, & Buss, 1982.

APPENDIX A-1
SRL RATING SCALE

Name ________________________________
(Last, First)

Directions: Below are some questions about things you may think about or do to help you learn in school. Some of the questions are concerned with whether you (silently) say things to yourself or ask yourself questions during class or while studying. To answer the questions, try to think back to the actual situations the questions ask about. For each question, put a check (___) in the space under USUALLY, OFTEN, SOMETIMES, ALMOST NEVER, OR DON'T KNOW. There are no right or wrong answers. So, please answer each question as truthfully as you can.

	Usually	Often	Sometimes	Almost Never	Don't Know
1. During a class, do you repeat to yourself some of the things the teacher says?	____	____	____	____	____
2. When the teacher is explaining something in class, do you ask yourself questions about things s/he says? (For example, do you ever think of things like, "How did s/he get that answer?" or, "What did s/he mean just then?")	____	____	____	____	____
3. Do you think about things your teacher says at different times during a class, and try to put them all together so it all makes sense?	____	____	____	____	____
4. When a teacher is talking, do you think of things you learned in the past or already know and how they are *like* the new things being discussed?	____	____	____	____	____
5. Do you listen closely to what is being said during class?	____	____	____	____	____
6. If you don't understand something your teacher says, do you try to figure out *why* you don't understand?	____	____	____	____	____
7. When your teacher is explaining things, do you try to separate the main ideas from the examples given and remember the main ideas first?	____	____	____	____	____
8. Do you look for changes in things and try to figure out *how* those changes came about? (Like changes in the teacher's expectations or in the way things work in that class?)	____	____	____	____	____
9. When questions are asked during class and you hear the answers do you think to yourself, "I knew that," or "I didn't know that?"	____	____	____	____	____

	Usually	Often	Sometimes	Almost Never	Don't Know
10. When you make mistakes or lose marks on assignments, do you ask yourself, "What information do I need or what do I have to do differently to get it right?"	___	___	___	___	___
11. When you work on assignments do you consider all the things you should have done and check to make sure you did them before turning in the assignment?	___	___	___	___	___
12. When you begin to work on an assignment (or one question on it), do you think about what your response might look like *before* you start work?	___	___	___	___	___
13. Before actually starting an assignment, do you make a plan for how you should do it?	___	___	___	___	___
14. When beginning to work on an assignment, do you forget to review the instructions just before starting?	___	___	___	___	___
15. As you complete assignments, do you ask yourself questions along the way to make sure you are doing everything right? (For example, would you ask yourself things like, "Is this an appropriate answer?" or, "Did I use the right steps?")	___	___	___	___	___
16. When you see the work of other students (perhaps from some other course they are taking), do you think to yourself, "I can do that," or "I know how she did that?"	___	___	___	___	___
17. Do you try to figure out and specifically remember the important points in the things you read?	___	___	___	___	___
18. When you do assignment questions, do you find you can't remember the ways your teacher worked through similar problems or questions during class?	___	___	___	___	___
19. When you work on assignments, do you try to break the assignments into parts and decide which part to do first?	___	___	___	___	___
20. When you work on assignments, do you look over your responses and tell yourself something like, "Good, I'm doing fine," or, "That couldn't be right, I'd better do it over?"	___	___	___	___	___

APPENDIX A-2
ACADEMIC SELF-EFFICACY SCALE

FOR EACH OF THE FOLLOWING QUESTIONS, PLEASE RATE YOURSELF BY **CIRCLING** THE POINT ON THE SCALE WHERE YOU THINK YOU BELONG. 10 IS THE HIGHEST, AND 1 IS THE LOWEST. PLEASE ANSWER THE QUESTIONS AS HONESTLY AS YOU CAN, WITHOUT WORRYING ABOUT WHAT OTHERS MIGHT THINK OF YOUR RESPONSES, OR WHETHER OTHERS WOULD AGREE WITH YOU. ALL OF YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL.

1. In general, how good a student do you think you are?

   1 2 3 4 5 6 7 8 9 10

2. How good a student do you think you could be if you worked harder?

   1 2 3 4 5 6 7 8 9 10

3. How good are you at writing (such as reports, essays, etc.)?

   1 2 3 4 5 6 7 8 9 10

4. How well do you think you read?

   1 2 3 4 5 6 7 8 9 10

5. How good would you say you are at solving math problems?

   1 2 3 4 5 6 7 8 9 10

6. How good are you at thinking up and completing science projects?

   1 2 3 4 5 6 7 8 9 10

7. When you work in a group at school, how well do you get along?

   1 2 3 4 5 6 7 8 9 10

8. When an assignment is especially difficult, how good are you at getting help or finding out how to do it?

   1 2 3 4 5 6 7 8 9 10

9. How well are you able to concentrate during lectures?

   1 2 3 4 5 6 7 8 9 10

10. When you are asked a question, or you want to ask the teacher a question in class, how good are you at explaining what you mean?

    1 2 3 4 5 6 7 8 9 10

APPENDIX A-3
ACADEMIC ATTRIBUTION SCALE *

Pretend These Happened to You

DIRECTIONS: Below are some things that might have happened to you in school. You are to answer them as you would if they *did* happen to you. To answer the questions, you need to give reasons *why* each thing happened. For example, look at question number one. It says (imagine that) you didn't understand a lesson. There are five possible reasons why this may have happened to you. To answer the question, **circle the letter of the reason which BEST EXPLAINS why this might have happened to you.**

1. You didn't understand a lesson.
   a. You didn't pay attention
   b. You couldn't get it
   c. I t was difficult
   d. The teacher wasn't clear
   e. You didn't think it through

2. You played an educational game on a computer and won.
   a. You worked hard
   b. You are good at it
   c. It's an easy game
   d. You got help
   e. You used effective strategies while playing

3. You answered some questions wrong during a class discussion.
   a. You answered too quickly
   b. You couldn't understand that material very well
   c. The subject matter was complicated
   d. The teacher didn't help
   e. You didn't think of all the different ways of looking at a question

4. You made several errors on a homework assignment.
   a. You didn't put much effort into it
   b. You are not good at homework
   c. It was a tough assignment
   d. The assignment asked unfair questions
   e. You went about it the wrong way

5. You got an "A" on a major test.
   a. You studied hard
   b. You are a good student
   c. The test was easy
   d. The teacher helped you learn the material on the test
   e. You did some practice questions while studying

6. You got stuck on an assignment.
   a. You rushed through it
   b. You aren't good at doing homework
   c. The questions were hard
   d. The teacher didn't explain it well
   e. You didn't think about what the assignment was really asking you to do

7. You had problems understanding the work in one of your classes.
   a. You didn't listen carefully
   b. You just don't understand that subject
   c. The material you covered was complicated
   d. The teacher didn't teach it well
   e. You didn't think through how best to do the work

8. You didn't understand the directions for doing a homework assignment.
   a. You couldn't keep your mind on it
   b. You don't understand most assignments
   c. The assignment was complicated
   d. The teacher hadn't gone over it
   e. You didn't read it carefully and think about it before you began

9. You learned a particular unit really quickly.
   a. You listened carefully in class
   b. You are good at that subject
   c. It was an easy unit
   d. The teacher was very clear
   e. You figured out how the material in the unit was similar to what you already know

10. You read a chapter in a book real fast.
    a. You kept your mind on it
    b. You read well
    c. The chapter was easy
    d. The teacher had gone over it
    e. You looked for major ideas

11. You did poorly on a test.
    a. You didn't prepare well
    b. You didn't understand the material
    c. It was a particularly hard test
    d. The teacher had not explained what to expect
    e. You wasted too much time on a couple of questions

12. You got a low mark on a major class presentation.
    a. You didn't work hard to prepare for it
    b. You are a poor student in that subject
    c. The material you had to present was complicated
    d. You couldn't get any help in preparing for it
    e. You didn't plan carefully how you would present your information

13. You did really well on an in-class lab activity.
    a. You tried hard
    b. You are good at lab work
    c. The lab was an easy one
    d. The textbook showed how to do it
    e. You used what you learned in class

14. You read three library books in a week.
    a. You put your mind to it
    b. You read easily
    c. The books were easy ones
    d. The books were interesting
    e. You set aside some time every evening

15. You got a high mark on an essay-type test.
    a. You studied hard for it
    b. You are good at writing essays
    c. The subject was easy
    d. The teacher agrees with your ideas
    e. You planned carefully what you wanted to say in your answers

16. You did poorly on a test about a book you'd been assigned to read.
    a. You didn't try hard
    b. You don't read very well
    c. The book was hard
    d. The teacher didn't tell you what you needed to know for the test
    e. You didn't think about the strengths and weaknesses of the book

17. You did really well on a final exam.
    a. You studied as hard as you could
    b. You are a good student
    c. The exam was not very hard
    d. You had a great teacher in the course
    e. You worked through all the review questions when studying for the exam

18. You handed in a perfect assignment.
    a. You spent a lot of time on it
    b. You are good at that subject
    c. It was a simple assignment
    d. You got some help with it
    e. You thought hard about what the instructions said you should do for the assignment

* Adapted from Mandinach (1984).

APPENDIX B
METACOGNITIVE QUESTIONAIRE and SCORING INSTRUCTIONS

TASK A
METACOGNITIVE QUESTIONAIRE

General Instructions to Student:

These questions are unusual. This is because you probably are not often asked to explain *how* you work on tasks. Instead, people are usually interested mainly in what you learned or how well you did. This set of questions is different. These questions are about the things you thought about while you worked on the task, how you approached it, and what decisions you made as you worked on your answer.

Think carefully about each question before you answer it. There are NO right or wrong answers, but it is important that you indicate how *you* were thinking during the task. If you have trouble deciding between two choices given for a question, just check the box indicating the choice that is *closest* to the way you were thinking during the task.

There were two problems in this task. Remember back to when you were just reading each of the problems, to see what you were supposed to do. What were you thinking about at those times? (CHECK a. or b.)

1. Did you think about:
   __a. the steps you would go through or the extra information you might need to do the problem? **OR** __b. the very first thing you would do to get started?

2. Did you consider:
   __a. what the problem was asking you to do overall? **OR** __b. how you would work out the first part of the problem?

3. Did you think about:
   __a. personal experiences or other school work that these problems reminded you of? **OR** __b. whether other students in your group might be helpful to you in solving these problems?

4. Did you:
   __a. repeat some of the information to yourself in order to remember it better? **OR** __b. read the information without doing anything special to make sure you would remember it?

In completing each of the two problems, you had to do several different kinds of things—first you had to read the descriptions of the problems themselves, then you had to look at tables or charts, then you had to do some figuring, and so on. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

5. Did you:
   __a. plan how you would do each part of the problem as you came to it? **OR** __b. pay attention to what others were doing or saying, to get ideas about how to do some parts?

6. During various parts of the task, did you:
   __a. consistently pay attention to the problem and what you were doing? **OR** __b. try to pay attention, but find that your mind kept wandering?

7. Did you:
   __a. compare the information in this problem to something you knew about already? **OR** __b. see this information as new and keep it pretty much separate from things you knew already?

8. For parts of the task did you:

__a. create an outline, drawing, or other way of representing the information (either in your mind or on paper), to help you understand, remember, or work with it? **OR** __b. think about the information in just the way it was presented to you?

9. When you were working on a problem, did you:

__a. decide that some details given in the problem were not important for solving it? **OR** __b. consider every bit of the information as being important?

10. After reading or looking at a part of the problem, did you:

__a. consider whether you had the basic idea? **OR** __b. concentrate only on the content of the problem itself?

Now think about the task IN GENERAL, as ONE UNIT. As you worked on the task, which of the following did you tend to do? (CHECK a. or b.)

11. While working on this task, did you:

__a. focus on some parts or points more than others? **OR** __b. concentrate equally on all of the information?

12. Did you find that you:

__a. sometimes double-checked to make sure you were doing it right? **OR** __b. more or less just worked through the problems without needing to double-check things?

13. While working on the task, did you:

__a. pause to figure out the next few steps you would need to take? **OR** __b. work through the task without stopping to plan your next moves?

14. During the task, did you:

__a. think about whether you had a general understanding of things or not? **OR** __b. just concentrate on solving the problem?

15. Did you:

__a. sometimes check back or ask a question to make sure you understood, or to clear up some confusion? **OR** __b. work pretty much straight through without stopping to check things?

16. During this task, did you:

__a. try to organize the information in a way that would make it easier to remember or work with? **OR** __b. think about the information just as you saw it, without arranging it yourself in any particular way?

17. As a rule, did you:

__a. rehearse some pieces of information in order to remember them later?

OR

__b. study the information only once, in order to figure out what to do?

VARIATIONS IN SECTION INSTRUCTIONS TO ADAPT MQ TO DIFFERENT TASKS

Warm-up Task

1. Remember back to when you were just reading the instructions—where they told you about the red numbers in the Coroner's report, and how you were to match them to the Counterattack Notes. What were you thinking about at that time? (CHECK a. or b.)

2. In completing the task, you had to do several different kinds of things—first you had to read the instructions, the Coroner's Report, and the Counterattack Notes, then you had to do some thinking about the information you were given, then you had to do some matching, and so on. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

Task B

1. Remember back to when you were just reading the instructions—where they told you that you were to read the article on Smoking, take notes, and then write a response to some questions on the topic. What were you thinking about at that time? (CHECK a. or b.).
2. In completing the task, you had to do several different kinds of things—first you had to read the instructions, then read and take notes, then think about and answer the questions on smoking. During these different parts of the task, which of the following did you do MOSTLY? (Check a. or b.)

Task C

1. Remember back to when you were just reading the instructions, before the videotape started—the instructions told you how this was not your favorite teacher, but how you were expected to learn the material and take notes anyway. What were you thinking about at that time? (CHECK a. or b.)
2. In completing the task, you had to do several different kinds of things—you had to read the instructions, watch the videotape, study the chart, take notes, and answer questions. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

Task D

1. Remember back to when you were reading the first part of the problem—where you were told about the food poisoning situation and what had been done so far to track down the food responsible, and you were told what your task was. What were you thinking about at that time? (CHECK a. or b.)
2. In completing the task, you had to do several different kinds of things—like reading about the food poisoning situation and what you had to do, studying the table, doing some figuring, and answering the questions. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

Task E

1. Remember back to when you were just reading the instructions, before the videotape started—the instructions told you how this was not your favorite teacher, but how you were expected to learn the material and take notes anyway. What were you thinking about at that time? (CHECK a. or b.)
2. In completing the task, you had to do several different kinds of things—you had to read the instructions, watch the videotape, take notes, and answer different types of questions. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

Task F

1. Remember back to when you were just reading the instructions about the task—where they told you about being on a task force and that you were to read, discuss, and write about which diseases the money should be spent on What were you thinking about at that time? (CHECK a. or b.)
2. In completing the task, you had to do several different kinds of things—first you had to read the instructions, then read and take notes about the various diseases, then discuss, think about, and decide on a proposal. During these different parts of the task, which of the following did you do MOSTLY? (CHECK a. or b.)

SCORING OF METACOGNITIVE QUESTIONNAIRE

The cognitive processes reflected in each of the MQ items are as shown in Table B-1.

Table B-1. MQ items reflecting each of the component processes in the SRL model.

Item	Choice A	Choice B
1.	Strategic Planning	Tactical Planning
2.	Strategic Planning	Tactical Planning
3.	Connecting	(Use of) Social Resources
4	Rehearsal	
5.	Tactical Planning	(Use of) Social Resources
6.	Attention (+)	
7.	Connecting	
8.	Organizing	
9.	Selectivity	
10.	Global Monitoring	
11	Selectivity	
12.	Cognitive Regulating	
13.	Tactical Planning	
14.	Global Monitoring	
15.	Cognitive Regulating	
16.	Organizing	
17	Rehearsal	

Rules for Scoring

1. A score of one or zero was assigned for each of the item choices reflecting one of the above processes.

2. On some items, it was possible to obtain a score on only one of the two possible choices—the alternative choice was not scored, since it did not reflect a component process.of the SRL model.

3. On items 1, 2, 3, and 5, both choices represent one of processes.for which a score is assigned.

4. A score for each of the component processes in the SRL model and for "use of social resources" was derived by averaging the total scores for all items representing a single process. Thus, for example, a score for Strategic Planning was obtained by averaging the total score for items 1a and 2a, a score for Connecting was obtained by averaging the total score for items 3a and 7, and so forth.

5. Acquisition and Transformation subscale scores were created by summing the average scores on the appropriate component processes. As shown in Table 2, a total of 12 choices reflect Acquisition processes and a total of 10 choices reflect Transformation processes.

Table B-2. Total possible points for Acquisition and Transformation processes

Acquisition	**Transformation**
Attention (+) (2)	Selectivity (2)
Rehearsal (2)	Connecting (2)
Global Monitoring (2)	Organizing (2)
Cognitive Regulating (2)	Tactical Planning (4)
Strategic Planning (2)	
(Use of) Social Resources (2)	

APPENDIX C
SCRIPT FOR INSTRUCTIONS ON WRITING TRACES
CODING MANUAL FOR TRACES

Instructions on Writing Traces

As I explained earlier, the goal of this experiment is to learn about how students think as they work on learning tasks. This is a hard thing to find out about, because it's like trying to see inside someone's mind. An important way that you can help give me this kind of information is to take lots of notes and to leave some things called "TRACES" in your notes. Traces are special kinds of notes, which will show me how you are thinking as you work. You'll see that there are lines in the right-hand margin of all the tasks you will be working on. This is where you should write all of your notes and traces. You may need to go to the back of the page if you run out of room, and I'll show you what to do in that case in just a minute.

First, let's go over the traces themselves. There are 5 of them altogether, but you'll only have to remember 4 (you'll see why in a minute). There will be a card on the table all the time you are working, which will remind you of what they are. Let's go through an example of when you would write each one. Okay, here we go. Pretend I'm reading the information up here on the overhead (Feel free to ask questions while I'm going through these examples.)

[*Note: words in italics were not said aloud.*]

1. *(Attending)* The first trace has to do with whether or not you are **paying attention**. If you notice that your attention is or has been wandering at any time(s) during the task, put a big "**A**" (for "**Attention**") in the margin, beside the place where this occurred.

Example: So, I'm reading along, and somewhere in here I start thinking about what's going to happen after school today. Then I realize that I've been off-task. I find my place again, and that's when I write an A in the margin -here..

2. *(Selectivity)* The second trace is underlining **important** things. If you decide that some parts of the information you are reading or hearing are particularly important, show that by <u>underlining these, either in what you are reading, or in your notes.</u> (You won't be allowed to write in the extra materials on the table, so you may need to take notes from these.

Example: So, if I'm reading this question, I might think to myself, the important thing to figure out here is what exactly is meant by "wellness". So I'll underline the word '<u>wellness</u>'.

3. *(Cognitive Regulating)* The third trace is evidence of a **question**. As you read, listen, or work on a problem, you may come across a point or part where you aren't sure you understand something, or a question comes to mind. Jot that question down in the margin right away. It may be anything at all—a word you don't know, a sentence that isn't very clear, or it may be that you are wondering about a connection between this information and an experience you once had. You can shorten or abbreviate the question, but make sure I will understand it, and also be sure to show that it's a question by putting a <u>question mark</u> after it.

Example: Let's imagine I'm reading this last paragraph on the overhead. I come to "wellness", and I think, They seem to have a special meaning for the word 'wellness' here. I wonder what their meaning for it is." So I write: Wonder what <u>they</u> mean by wellness? (Remember the question mark, even if the wording you use is not really in question form.)

Another example might be: (read last sentence)—"I wonder if I would be considered healthy?" so I could quickly jot down: Am <u>I</u> healthy?

4. *(Connecting)* The fourth trace shows if you are making **connections** between this information and things in your memory. You might think of examples of things you are reading or hearing about, or comparisons might come to mind. For instance, during a tasks you might be reminded of something you experienced or learned before. If that happens, jot it down right away.

Example: Again in this last paragraph, I might note that my older brother's friend has diabetes, and he seems to feel okay whenever I see him. So I write: "Joe has diabetes, and he seems okay."

5. *(Strategic Planning)* The last kind of trace is to show what you are thinking just after you've read some instructions or an actual problem, and are about to begin working on it. You won't have to remember this trace because at each place where I want you to do it, you'll see instructions to **STOP! and WRITE YOUR THOUGHTS IN THE MARGIN BEFORE GOING FURTHER.** Do this each time. Sometimes these instructions will tell you to read the questions that follow and then write your thoughts in the margin before answering the questions.

Example: Pretend I've been reading along, come to the end of a paragraph, and I come to this instruction:

STOP!

Read the questions below, then write your thoughts in the margin before attempting to answer them.

---

1. What is the difference between wellness and absence of disease?

2. How can someone with a chronic disease like arthritis be "well"?

—So, I do that—I read the questions *(above instructions and several questions appear on overhead)*, then write my thoughts in the margin before answering the questions. *(Write: "These don't seem too hard, but I may have to go back to check this one. May need help from the other books too.")*

OKAY—Does everyone understand all this? Any questions?

In general, as well as writing these traces in the margins, I want you to take notes on **everything.** WRITE OUT ALL THE STEPS YOU GO THROUGH IN SOLVING A PROBLEM OR THINKING ABOUT THE TASK. DON'T DO ANYTHING "JUST IN YOUR HEAD"—WRITE IT DOWN. TRY TO GIVE ME A "RUNNING COMMENTARY" OF YOUR THINKING AS YOU GO THROUGH EACH TASK. (Make sure I can read your writing!)

If you run out of space, go to the back of the page. But it's important to identify what you're continuing where on the back, so do it like this: Put an arrow with a number, showing that you're turning the page over, then start with that number again on the back. Any questions about that?

Let's summarize now:

In addition to showing all your work in your notes, there are five traces altogether, and only four that you will have to remember—because this one *(point to Strategic Planning instruction in sample above)* will be instructed each time I want you to do it. As I noted earlier, there will be a card on the table at all times reminding you of the other four traces: IT IS REALLY IMPORTANT TO REMEMBER TO WRITE TRACES AND NOTES ON **EVERYTHING.** I NEED TO KNOW ALL THE THOUGHTS YOU HAVE AS YOU DEAL WITH THIS INFORMATION, IF POSSIBLE.

1. **A**...for whenever your **attention wanders,**

2. Underline any **important parts,**

3. **question?**...write down any questions that come to mind,

4. **Connections**..Jot down any examples or comparisons you are reminded of.

SCORING MANUAL FOR TRACES

Traces reflecting each of the component processes in the SRL model were defined operationally. The definitions included the physical *symbol*, if one was specifically identified, the *content* of the trace itself (i.e., of the comment or question actually written), the *function* of each process in the context of the task the student was working on, and the *direction*, in relation to the task content being focused on at the time. For example, Cognitive Regulating is a cognitive process that confirms or revises a cognitive representation of content (function). It consists of statements or questions indicating that the student is checking back to clarify or correct something (content). Its focus is backwards (direction), in that it refers to content previously encountered. In addition to these criteria, question marks (symbol) could be used to identify traces of Cognitive Regulating. It was not expected that all questions necessarily reflected Cognitive Regulating, but in combination with the functional and directional criteria, a question mark would serve as additional evidence of this cognitive process. Table 1 displays the operational definitions of each process trace, along with examples of each.

Each comment or point in notes and traces was coded only as one cognitive process, but also could be assigned a score indicating use of material(MR) or social resources (SR). For example, the comment, "I wonder if I'll need the resource materials for this question," would be coded as Strategic Planning and Material Resources (MR).

Initially, separate codes were identified for reference to *content* or to *task goals and constraints* in traces of Global Monitoring, Cognitive Regulating, and Connecting. However, it became apparent during coding that it was not possible to separate the references to content from those to task goals within a single comment (trace). One example of this occurred where a student was working on a menu for a pre-competition meal, using a food chart containing the nutritional composition of various foods. The goal of the task was to meet specified requirements for amounts of protein, carbohydrate and fat. The comment, "I think I need more carbohydrate," referred to content, but also to the response requirements set out in the task. Since each comment in a student's notes was coded as one, and only one, trace, it was necessary to collapse these categories.

In some instances, students wrote out main points twice—once in their final answer, and once in the margin or on the previous page. In these cases, the notes or traces containing the main points were coded as Tactical Planning. Also, some comments did not reflect any of the component processes, but were coded as Motivational Remarks. These could be either positive (+) or negative (-). Examples of positive Motivational Remarks are, "This is interesting," and "Better get started." Examples of negative Motivational Remarks are, "How boring," and "I hate writing essays!"

Table C-1. Operational definitions and examples of traces.

Cognitive Process	Criteria/Indicators
Attending (- score)	* Content: a) Comments in notes that are task-irrelevant, b) Comments about task materials or video lecture indicating attention to features irrelevant to content or task goals.
Attending (vigilance)	* Symbol: "A" * Direction: Current * Function: Noting that attention has been off-task
Attending (+ score)	* Content: (applies to Task C only • see note) Marks on chart showing that info on video lecture was being followed (1 pt for each category marked) * Direction: Current
Rehearsing	* Content: Copying text or lecture phrases verbatim, very close paraphrase * Direction: Current * Function: Maintaining content in working memory, helping to store in long term memory
Global Monitoring	* Content: a) Statements showing awareness of one's general understanding; b) Statements showing awareness of progress toward goal; may include summary comments at end of section or task. * Direction: Current (Note: thus, comments like, "Seems easy" would only fall into this category when referring to current work on the task -if comment precedes the part of the task it refers to, it is coded as Strategic Planning.) * Function: Assessing overall progress toward task goals in terms of time available, general comprehension of material, or other task performance criteria.
Cognitive Regulating	* Symbol: Question mark (?) * Content: Comments or questions indicating that learner is checking back to clarify or correct something, rereading after attention has wandered, or self-checking accuracy of response;- must show that student is engaging some cognitive operation(s) that replaces or adjusts the representation of that content; * Direction: backwards * Function: Review of material previously encountered or produced in order to confirm or revise cognitive representation or product.

Table C-1. (Cont'd.)

Strategic Planning	* Content: a) Statements showing decision-making re: how task should be accomplished, what will be required to meet goals stated in instructions (e.g., resources, etc.) b) Comments anticipating length or difficulty of task; * Direction: forward (Note: If reference is made back to instructions while performing some part of the task, comment will be scored as Cognitive Regulating.) * Function: Assessing task goals and constraints, considering potentially useful resources and strategies;
Selectivity	* Symbols: a) Underlining in text, task materials, or notes(One point assigned for any or all information marked or underlined within a paragraph, or within a single line in a chart or table); b) Marking, as with a * or √, items of information in charts or tables; c) Notes taken during video lectures *(1 pt per idea unit ••); * Content: Statements indicating focus on some information more than other information; * Direction: current * Function: Identifying, focusing on information important to task goals
Connecting	* Content: a) Comments indicating use of prior knowledge or experience, connecting or comparing this information to own examples, or comparing current task to previous task(s); b) Indication of surprise or question relating to content given (showing that search made in memory for matching or related information), c) Evaluative comments made concerning content; * Direction: Current * Function: Helping to organize and store content in long term memory or to match with information in memory in order to aid understanding and performance on current task.
Organizing	* Content: a) Comments about structure or format of information given or of own thoughts, response, or representation;- May include making connections or associations within content given, including summarizing; b) Representation of information in schematic, chart, outline, or pictorial format to organize or reorganize it—can include work toward final solution, but not answer to question or end product of task; c) Reference to format of content or of student's own response; * Direction: Current * Function: Identifying patterns in information, imposing structure on it to facilitate storage and retrieval; also to allow manipulation, combining new and existing knowledge.

Table C-1. (Cont'd.)

Tactical Planning	* Content: a) Specification of next few steps toward solution; b) Consideration of required resources, criteria for solution;—may include questions about where to write response, etc., where this information not specified in task. * Direction: current * Function: Assessing immediate demands, constraints while working on task, activating procedures, routines to meet immediate goals

Notes.

- In Task 3, marks on chart matching those identified by the teacher in the video lecture are not counted as Selectivity, but rather, as Attending (+). These marks indicate only tracking of information in the lecture, which has already been identified as important. Thus, selection of specific categories of heart attack risk is done for the student.. On the other hand, points are given for selectivity where a student has marked categories representing his/her own heart attack risk factors.
- An idea unit is defined here as an item of information that would normally constitute a line or point on an outline, if one were taking notes.

EXAMPLES

Attention (-)	a) "How soon do we get out of here?" "Wonder what Joey's doing right now" "I hope we play floor hockey in P.E.today" b) "It looks like she's reading from notes on the table."
Rehearsal	(in planning an exercise program): "Don't repeat the same exercise more than twice ~~during~~ one week."
Global Monitoring	a) "I don't get it;" "This task is confusing;" "Seems easy;" "Just read a whole paragraph and didn't get a thing;" b) "I'm taking too long to do this."
Cognitive Regulating	"Hard part—reread;" "Go back and check numbers again;" "Read directions again—I think this is wrong;" "Oops, forgot something to drink."
Strategic Planning	"This seems longer than yesterday's task," "Sounds easy enough;"
Connecting	a) (when planning a pre-competition meal): "Think about kinds of things Brian eats before he races,;" "This sounds just like me;" b) "16 to 6 by quitting smoking is quite a leap;" or "Why did doctors drop the most?" c) "I see they've come to their senses."

Table C-1. (Cont'd.)

Organizing	a) (e.g., task 3 Identification of a Degree of Risk category below chart shows that scores for the categories of Cardiac Risk were added to arrive at total, then total matched to appropriate category); c) "Description not in proper format."
Tactical Planning	(when planning exercise program): "Decide which activity to do first and when;" "How much will I need to do?- What totals that gives me. Next activity, same time & totals...Skiing about 30 min. out of the hour, 5 hrs, minutes = 30 x 5 = 150. How many calories per minute? 10 = 1500;"

APPENDIX D
TASK ASSESSMENT QUESTIONNAIRE (TAQ)

Compared to the math or science problems you find on this year's math and science tests,

1. How would you rate the difficulty of the task you just completed? (1 = easiest, 10 = most difficult)

|______|______|______|______|______|_____|______|_____|______|
1 2 3 4 5 6 7 8 9 10

2. What things about this task were especially easy (if any)? ____________________

____

3. What things about this task were especially difficult (if any)? ____________________

____

4.. Still comparing this task to your math and science tests this year in school, would you say this task had (check one choice from each pair):

_ a. More difficult words?	OR	_ e. Less difficult words?
_ b. More difficult math?	OR	_ f. Less difficult math?
_ c. More material to think about?	OR	_ g. Less material to think about?
_ d. A goal that wasn't as clear?	OR	_ h. A goal that was more clear?

5. For how much of your work on this task did you use the resource materials to help you?

|______________|______________|______________|______________
Not at All 25% 50% 75% 100%

6.How much did you use information from the other students during this task?

|______________|______________|______________|______________
Not at All 25% 50% 75% 100%

7. (a) Sometimes people care more about doing a good job on a task than at other times. This might be because of the mood they are in at the time, because they are or aren't interested in the task, or whatever. On a scale of 1 to 10, how much would you say you cared about doing well on the task you just did? (1 = didn't care at all, 10 = cared a lot.)

|______|______|______|______|______|_____|______|_____|______|
1 2 3 4 5 6 7 8 9 10

(b) Why did you feel the way you did about this task? ____________________

____

8. (a) If you were doing this task in a real school situation, how much would you have cared about doing well on it? (1 = didn't care at all, 10 = cared a lot.)

|______|______|______|______|______|_____|______|_____|______|
1 2 3 4 5 6 7 8 9 10

(b) Why would you have felt that way? ____

____

9. (a) Please describe in your own words the method you used to complete this task. (Be as specific as you can.)

____

____

____

____

(b) What was different (if anything) about the method(s) you used in this task compared ;to the way you usually do math or science problems?

____

____

____

10. (a) How much did your mind wander during this task? (1 = not at all, 10 = a lot of the time.)

|______|______|______|______|______|_____|______|_____|______|
1 2 3 4 5 6 7 8 9 10

(b) What (if anything) did you do to help yourself concentrate, or get back to the task when you attention wandered?

____

____

(c). Sometimes people say things to themselves (mentally) to remind themselves of what they are supposed to be doing. Did you do anything like this?

__ YES __ NO

(d) Sometimes people realize that their attention has wandered because they were not clear on some point, so they check with someone else or check back to the material to get focussed again. Did you do anything like that?

__ YES __ NO

APPENDIX E
EXPERIMENTAL TASKS and
ORAL TASK INTRODUCTIONS

READ THIS FIRST!

TASK A—INSTRUCTIONS

There are two problems in today's task. The first problem appears all on one page. The second problem includes a chart that is several pages long, which you will need to refer to. Problem 2 itself is no longer than Problem 1.

Do everything that the problems ask you to do. If it says to read certain information or to include certain types of information in your response, then do that. An important part of academic work is to follow instructions, so that you understand what you are expected to do, and you get all the information you need.

Remember to do the following things:

1.) Write down ALL your thoughts in your NOTES and TRACES.

2.) Use the materials if you think they will help you do a better job.

3.) Talk to each other as much as you wish.

4.) Don't ask the researcher questions unless you can't get the answer from each other.

STOP!
Write your thoughts about today's task in the margin before going further.

Problem 1.

You've decided that you want to lose 16 pounds in the next 8 weeks, through a combination of diet and exercise. In order to lose the weight steadily (at 2 lbs. per week), you will need to reduce your daily calories from 3000 to 2000 (a reduction of 1000 per day, or 7000 per week).

You have already decided on a diet which will reduce the calories you take in by 3500 per week. Now you need to plan an exercise program to take care of the remaining 3500 (you can go over this number a little if you feel energetic!). Using Table A-1 (below), plan a weekly exercise program involving some exercise on at least 5 different days of the week. Do not include the same exercise more than twice during one week. Be sure to indicate how long you will engage in each activity each time you do it (e.g., 10 minutes, 20 minutes, etc.). The space to write your answer is at the end of the problem.

REMEMBER: TAKE LOTS OF NOTES, SHOW ALL YOUR STEPS, AND WRITE TRACES IN THE MARGINS.

Table A-1. Calories spent in different types of activity. (Adapted from Edlin, G. and Golanty, E. (1985). *Health & Wellness.* Boston: Jones and Bartlett, p. 171.)

CALORIES PER MINUTE	ACTIVITY
4	Walking (2 k/hr)
7	Walking ((3 k/hr)
8	Swimming
7	Cycling (6 k/hr)
10	Cycling (9 k/hr)
20	Running
4	Canoeing
10	Jogging
5	Softball
5	Volleyball
10	Skiing
4	Golf
10	Mountain Climbing
10	Tennis
8	Roller skating
10	Racquetball
10	Ice Skating

STOP!
Write your thoughts about this problem in the margin before going further.

Write your answer below

Problem 2.

A good kind of meal to have before a big athletic competition is one that is high in carbohydrates and low in protein and fat. This type of meal, which is often referred to as a "pre-competition meal", is best because carbohydrates are digested much more quickly than are fats and proteins. The recommended total of these ingredients to be included in a pre-competition meal are listed below, in Table A-2.

Using the list of foods and their content values (on the pages that follow), plan a sensible pre-competition breakfast for a runner who is about to enter a big race. The breakfast you plan should include something to drink, and at least one thing from each of the different food groups on the list. Also, if you expect the athlete to have things like butter or jam on toast, or sugar or cream in coffee, these must be included in your calculations.

Table A-2. Appropriate amounts of carbohydrate, protein, and fat for a pre-competition meal. (Amounts are given in grams.) (From: *Food Power: A Coach's Guide to Improving Performance*. National Dairy Council, Rosemont, Ill., 1983.)

FOOD CONTENT	PROPER AMOUNT (in grams)
Carbohydrate	75-120
Protein	15-30
Fat	0-20

STOP!
Write your thoughts about this problem in the margin before going further.

Write your answer below

COMPREHENSIVE LIST OF FOOD GROUPS

	Calories	Carbo -hydrate (grams)	Protein (grams)	Fat (grams)
MILK GROUP				
Buttermilk, 1 cup	99	12	8	2
Cheddar Cheese, 1 oz./1 slice	114	0	7	9
Cottage Cheese, 1/2 cup	109	3	13	5
Swiss Cheese, 1 oz./1 slice	107	1	8	8
Cocoa, 3/4 cup	164	19	7	7
Ice Cream, Vanilla, 1/2 cup	135	16	2	7
Milk, 1 cup	150	11	8	8
Chocolate Milk, 1 cup	208	26	8	8
Skim Milk, 1 cup	86	12	8	0
Milkshake, choc., 10 oz.	356	63	9	8
Chocolate Pudding, 1/2 cup	161	30	4	4
Strawberry Yogurt, 1 cup	225	42	9	3
MEAT GROUP				
Bacon, 2 slices	92	1	5	8
Refried Beans, 1/2 cup	142	26	9	1
Roast Beef, 3 oz.	182	0	26	8
Beef liver, 3 oz.	195	5	23	9
Bologna, 1 slice	86	0	3	8
Fried Chicken, 3 oz.	201	2	26	9
Fried Egg, large	83	1	5	6
Hard Boiled Egg, large	79	1	6	6
Scrambled Egg, large	95	1	6	7
Frankfurter, 2 oz.	172	1	7	15
Baked ham, 3 oz.	179	0	26	8
Meat Loaf, 3 oz.	230	13	15	12
Hamburger Patty, 3 oz.	186	0	23	10
Peanut Butter, 2 Tbsp.	186	6	9	16
Peanuts, salted, 1/4 cup	211	7	9	18
Fried Perch, Breaded, 3 oz.	193	6	16	11
Pork Chop, 3 oz.	308	0	21	24
Sausages, 2 links	135	0	5	13
T-Bone Steak	212	0	29	10
Tuna, 3 oz.	168	0	25	7
FRUIT/VEGETABLE GROUP				
Apple, medium	80	20	0	1
Applesauce, 1/2 cup	116	30	0	0
Apricots, dried, 4 halves	39	10	1	0
Asparagus, 4 spears, 1/2 cup	12	2	1	0
Banana, medium	101	26	1	0

	Calories	Carbo -hydrate (grams)	Protein (grams)	Fat (grams)
Green Beans, 1/2 cup	16	3	1	0
Lima Beans, 1/2 cup	94	17	7	0
Broccoli, 1/2 cup	20	4	2	0
Cabbage, 1/2 cup	13	3	1	0
Cantaloupe, 1/4 medium	29	7	1	0
Carrots, 1/2 cup	22	5	1	0
Cauliflower, 1/2 cup	13	3	1	0
Celery Sticks, 8" stalk	10	2	1	0
Coleslaw, 1/2 cup	82	3	1	8
Corn, 1/2 cup	70	16	2	1
Corn, 5" ear	114	26	4	1
Fruit Salad, 1/2 cup	99	25	2	1
Grapefruit, 1/2 medium	48	13	1	0
Grapes, 1/2 cup	48	12	0	0
Lettuce, 1/2 cup	10	12	0	0
Okra, 4 Pods, 1/2 cup	12	3	1	0
Orange, medium	65	16	1	0
Orange Juice, 1/2 cup	56	13	1	0
Peaches, 1/2 cup	100	26	1	0
Pear, Medium	101	25	1	1
Green Peas, 1/2 cup	54	9	4	0
Pineapple, large slice	90	24	0	0
Baked Potato, large	132	30	4	0
Boiled potatoes, 2 small	79	18	2	0
French Fries, 20 pieces	233	31	4	11
Mashed Potatoes, 1/2 cup	63	13	2	1
Sweet Potato, 1/2 medium	78	18	1	0
Raisins, 4 1/2 Tbsp	123	33	1	0
Summer Squash, 1/2 cup	16	3	1	0
Winter Squash, 1/2 medium, 1/2 cup	56	14	2	0
Strawberries, 1/2 cup	28	6	1	0
Tomato, 1/2 medium	22	5	1	0
Tomato Juice, 1/2 cup	26	5	1	0
Tossed Salad, 3/4 cup	13	3	1	0
Watermelon, 1 cup	52	13	1	0
GRAIN GROUP				
Bagel	165	28	6	2
Biscuit, Baking Powder	103	13	2	5
Bread, white, sliced	61	12	2	1
Bread, whole wheat, slice	55	11	2	1
Cornbread, 2 1/2" X 3"	191	30	6	5
Cornflakes, 3/4 cup	72	16	2	0
Graham Crackers, 2	54	10	1	1

	Calories	Carbo -hydrate (grams)	Protein (grams)	Fat (grams)
Saltine Crackers, 5	60	10	1	2
Egg Noodles, 1/2/ cup	100	19	3	1
Oatmeal, 1/2 cup	66	12	2	1
Pancake, 4" diameter	61	9	2	2
Rice, 1/2 cup	112	25	2	0
Roll	119	21	3	2
Toast, white, 1 slice	61	12	2	1
Tortilla, Corn, 6" diameter	63	14	2	1
Waffles, 2, 3 1/2" X 51/2"	130	17	4	5
COMBINATION FOODS (Made with ingredients from more than one food group)				
Baked Beans	156	24	8	3
Beef and Vegetable Stew, 1 cup	209	15	15	10
Chile Con Carne with Beans, 1 cup	333	31	19	15
Custard, Baked, 1/2 cup	152	15	7	7
Macaroni and Cheese, 1/2 cup	215	20	8	11
Pizza, Cheese, 1/4 of 14" pie	354	43	18	13
Soup, Chicken Noodle, 1 cup	59	8	3	2
Soup, Cream of Tomato, 1 cup	173	23	7	7
Spagetti & Meatballs, 1 cup	332	39	19	12
Taco, Beef	216	15	17	10
"OTHERS" Category (Fats, Sweets)				
Bar, Milk Chocolate, 1 oz.	147	16	2	9
Butter, 1 Tsp.	36	0	0	4
Cake, Chocolate, 1/16 of 9" cake	234	40	3	9
Cake, Sponge, 1/12 of 10" cake	196	36	5	4
Chocolate Syrup, 2 Tbsp	93	24	1	1
Coffee, Black, 3/4 cup	2	0	0	0
Cookie, Sugar, 3" diameter	89	14	1	3
Doughnut, Cake Type,	125	17	2	6
Jelly, Currant, 1 Tbsp	49	13	0	0
Mayonnaise, 1 Tbsp	101	0	0	11
Apple Pie, 1/6 of 9" pie	403	60	4	18
Popcorn, plain, 1 cup	23	5	1	0
Potato Chips, 10 chips	114	10	1	8
Roll, Danish Pastry	274	30	5	15
Sherbet, Orange, 1/2 cup	135	29	1	2
Soft Drink, Cola, 1 cup	96	25	0	0
Sugar, 1 tsp	14	4	0	0

(Adapted from: *Food Power: A Coach's Guide to Improving Performance.* National Dairy Council, Rosemont, Ill.,1983.)

READ THIS NOW!

TASK B INSTRUCTIONS

There is only one problem in today's task. This problem is one that can be answered in many different ways, and still be done correctly.

As in yesterday's task, do everything that you are instructed to do. If the task says to read certain information or to include certain types of information in your response, then do that. An important part of academic work is to follow instructions, so that you understand what you are expected to do, and you get all the information you need.

Review the following things so you don't forget to do them:

1.) Write down ALL your thoughts in your NOTES and TRACES.

2.) Use the materials if you think they will help you do a better job.

3.) Talk to each other as much as you wish.

4.) Don't ask the researcher questions unless you can't get the answer from each other.

STOP!
Write your thoughts about today's task in the margin before going further.

TASK B

Read the article on Smoking which appears on the next few pages. Take whatever notes you normally would, if you were assigned this to read for a class in school. You will then be asked to write a one- or two-page response to some questions on this topic. The questions are given immediately following the article you are to read.

STOP!
Write your thoughts about this problem in the margin before going further.

Smoking

It is an unequivocal fact that cigarette smoking is this nation's number one injurious personal habit. Smokers expose themselves to over 1,000 different chemicals each time they light up, increasing the risk of:

Lung cancer: Up to a 20 times greater chance that heavy smokers will develop this number one cancer killer, versus non-smokers—not to mention an increased chance of developing *mouth, lip, voicebox, pancreas, and urinary bladder cancer.*

Heart attack: A two to three times greater chance of dying from a heart attack than a non-smoker—and given the fact that more than 600,000 Americans die of a heart attack each year, doubling or tripling the risk is no small item. The exact reasons for this association are not clear but most experts agree that carbon monoxide (which decreases the amount of oxygen the blood can carry) is a major contributor.

Stillbirths and sick infants: A twofold increase in risk for spontaneous abortions (miscarriages) in smoking mothers. Children born to smoking mothers weigh 200 grams less on average than children born to non-smokers. And studies in Britain and Israel show that infants of mothers who smoke are more likely to be admitted to the hospital during the first year of life for bronchitis or pneumonia.

Wrinkles: Dermatologists are starting to report observations that women who smoke are more likely to develop facial wrinkles as they grow older; this may be the most convincing argument for those who tend to worry more about how they look than about how they feel.

Money up in smoke: The cost of a two-pack-a-day habit now approaches $600 a year—enough to buy two tailor-made suits or a week at a resort.

Etc.: Not to mention a decreased sense of smell and taste, a constant cough, an increased chance of dying in bed from a fire, a tell-tale odor on clothes and breath and in the home and car, etc., etc., etc.

DOES IT PAY TO QUIT? That question is often asked by a smoker seeking motivation to fight the cigarette habit. And it is eloquently answered by Dr. Richard V. Ebert of the University of Minnesota in the November 10, 1978, issue of the *Journal of the American Medical Association*—in an article worth reading in its entirety.

Dr. Ebert summarizes some of the pertinent findings of the now classic report of Doll and Peto who followed 34,000 British physicians for 20 years to determine the effects of smoking—and to measure the results in those who quit. Among the more pertinent findings:

(1) The annual death rate for cancer of the lung in physicians who continued to smoke cigarettes was 16 times that of lifetime non-smokers. The death rate for those who had successfully broken the habit for 5 to 9 years was only six times that for non-smokers. And those who had not smoked for more than 15 years had a death rate from lung cancer only twice that of non-smokers.

(2) Relatively few cancers occurred in those who had smoked cigarettes for less than 20 years; *after 20 years of smoking, cancer rates rose rapidly.*

(3) Persons who ceased smoking before 54 years of age had a lower death rate from coronary artery disease than those who continued. Quitting after age 54 did not affect the death rate from coronary artery disease.

Ebert concludes that "there is overwhelming evidence of the danger of smoking after the age of 40 years." He goes on to suggest that we should concentrate our efforts to help people stop smoking on the middle-aged smoker who has been smoking for less than 20 years. Do you qualify? If you would like information on how to stop smoking, contact your local American Cancer Society office or write to the Office on Smoking and Health, Room 158, Park Building, 5600 Fishers Lane, Rockville, Maryland 20857.

(Incidentally, the results from a 1975 survey of smoking habits, when compared to a similar survey in 1967, indicate that the proportion of physicians who smoke dropped from 30% to 21%; dentists, from 34% to 23%; and pharmacists from 35% to 28%.)

Cigarette Advertising

By now, most people have been exposed to the content of the Surgeon General's report on smoking—probably to the point of boredom. Our Advisory Board goes on record as supporting any reasonable effort—even the publication of a 1200-page government document—that might aid persons in stopping a habit so clearly injurious to their health. However, we would also seize this opportunity to point out that the most effective tactics in the war on smoking are those designed to prevent young people from starting in the first place—versus those addressed to a lifelong struggle against tobacco addiction. We have no quarrel with the "right" of a consenting adult to engage in hazardous living—as long as that choice does not infringe on the rights of others. (Some would argue, of course, that smoking does just that—in terms of both personal annoyance and health costs.) However, we would point out that the combination of seductive advertising and enormous peer pressure often makes the choice of a teenager less than truly informed. Therefore, we respectfully call upon appropriate government officials to move vigorously to accomplish the following:

(1) Programs that reduce the availability of tobacco to minors.

(2) Elimination of *all* advertising that presents smoking in an enticing manner and an intensification of educational programs to portray the often horrible results of smoking.

We are realistic enough to know that tobacco will not be eliminated from the face of the earth. However, we feel it *is* appropriate to protect those whose choices are not entirely informed. We think it proper to protect our young from fire, malnutrition, and alcohol. Why not tobacco?

WHO'S COME A LONG WAY? Some alarming statistics have emerged from the Connecticut Cancer Epidemiology Unit. Between 1946 and 1949—when male smokers predominated—lung cancer in men was almost five times greater than in women in Connecticut. By 1974, the ratio had dropped to less than two to one. And in 1975, for the first time, there were more cases of lung cancer in women than in men in the age group 35–44.

What makes this report even more frightening is some evidence that women smokers are more susceptible to lung cancer than men smokers. The Third National Cancer Survey indicated that women who smoke heavily have a 16 times greater chance of getting lung cancer than women non-smokers—versus an increased risk of tenfold between comparable male groups.

Surveys continue to show that while the proportion of male smokers is declining, more women are smoking. Unless this pattern changes, it seems that those who predict a new lung cancer epidemic secondary to increased numbers of women smokers are going to be tragically correct. This killer disease, which now strikes more than 100,000 new victims each year in this country, will claim even more—as women pay the price for lighting up.

From: Johnson, G.T. & Goldfinger, S.E. (Eds.). (1981). The Harvard Medical School Health Letter Book. Cambridge, Mass.: Harvard University Press. Reprinted by permission.

Questions

The article you just read describes five major risks associated with smoking (lung cancer, heart attack, Stillbirths and sick infants, Wrinkles, and Money up in smoke). The first part of this task is to add two more risks to the list, giving a brief description of each.

The second part of the task is to write about the two recommendations at the top of page 13. Do you think these are a good idea? If so, how would you put them into action?

If you disagree with one or the other of these two suggestions, explain why, and tell what you would recommend instead.

(Go to next page)

STOP!
Write your thoughts about this problem in the margin before going further.

Write your response below

READ THIS NOW!

INSTRUCTIONS FOR TASKS C AND D

The first task today involves watching a videotape of a class lesson on HEART ATTACK RISK. The specific instructions will be found on the next page (read this page first!). The second task is a problem about FOOD POISONING.

As in previous tasks, do everything that you are instructed to do. If the task says to read certain information or to include certain types of information in your response, then do that. An important part of academic work is to follow instructions, so that you understand what you are expected to do, and you get all the information you need.

Review the following things again today, so you don't forget to do them:

1.) Write down ALL your thoughts in your NOTES and TRACES.

2.) Use the materials if you think they will help you do a better job.

3.) Talk to each other as much as you wish.

4.) Don't ask the researcher questions unless you can't get the answer from each other.

STOP!
Write your thoughts about today's task in the margin before going further.

TASK C

As you watch this videotape, imagine that you are in a Health Issues class. You are expected to take notes in this class, and the teacher collects them at the end. Personally, you are not very interested in this subject, and the teacher is not one you particularly like. Even so, you have to take the course, so there's no getting out of it. After giving the lesson, your teacher normally asks you a few questions about what she talked about.

Remember to WRITE NOTES AND TRACES in the margins, as you did in the other tasks. Otherwise, do whatever you would normally do in this situation.

STOP!
Write your thoughts about this problem in the margin before going further.

(Watch videotape now)
(Cardiac Assessment Chart appears on next page, for reference)

A number of different factors in people's lifestyle, medical history, and physical and emotional condition have been shown to affect the health of their heart. The chart I.m putting up on the overhead shows 8 different categories that are considered when assessing a person's susceptability to a heart attack. The numbers in the small boxes (*here*) are the "points one accumulates for each category. Follow along as i work my way through my own Cardiac Risk Assessment.

First, my age is between 41 and 50, so I'll give myself 4 points in the age category.

In the second category, let's see—I have one relative with cardiovascular disease under the age of 60. (My Dad's younger brother had a heart attack last year, and he's only 56!)

My weight, as you can see, is not a problem—one point for standard weight.

Unfortunately though, I'm a chronic smoker: 20 cigarettes = a pack a day, so I get 3 points there.

Also, I'm just too busy to exercise much, so I'll have to take 6 points for that category.

How am I doing in points so far? Do you think I'm shaping up for a bad Cardiac Risk? Without being too cruel, how would you suggest I reduce the risks I've identified so far? (If you want to ask each other their ideas or discuss this a minute or two, just push the STOP button, and then hit the PLAY button when you want to resume watching.)

As for Category 6, I'm not sure about my exact cholesterol level. It says up here *(point to top of chart)* that less than 200 mg is normal for a college student of normal weight. Well, I'll give myself a 2 on this one, since I don't go too overboard on fatty foods.

My blood pressure? Well, last time I had a check-up it was high, but I've been watching my salt intake, so it may be a little better now. A 140 upper reading is the high end of the "normal" range, so I'll give myself a 3 for blood pressure.

The last one is easy—or is it? Am I a female 1 or a female 2? (Don't know why they would have two levels of a category the same, ... oh, well.) I think I'm worth being a #1, so that's my choice, since it doesn't seem to matter.

I'll leave it to you to figure out my degree of Cardiac Risk, using the table given to you. What do you think is my biggest area of concern?

(WATCH VIDEOTAPE)

A Cardiac Risk Assessment

Listed below are eight categories that pertain to the health of your heart. Select the number in each category that applies to you. If you don't know your blood cholesterol level, assume that it is less than 200 mg, which is the case for most college students of normal weight. You can estimate your risk by comparing your score with the risk table shown at the end of the test.

1. Age	10 to 20 [1]	21 to 30 [2]	31 to 40 [3]	41 to 50 [4]	51 to 60 [6]	61 to 70 and over [8]
2. Heredity	No known history of heart disease [1]	1 relative with cardiovascular disease over 60 [2]	2 relatives with cardiovascular disease over 60 [3]	1 relative with cardiovascular disease under 60 [4]	2 relatives with cardiovascular disease under 60 [6]	3 relatives with cardiovascular disease under 60 [8]
3. Weight	More than 5 lbs below standard weight [0]	Standard weight [1]	5–20 lbs overweight [2]	21–35 lbs overweight [3]	36–50 lbs overweight [5]	51–65 lbs overweight [7]
4. Tobacco smoking	Nonuser [0]	Cigar and/or pipe [1]	10 cigarettes or less a day [2]	20 cigarettes a day [3]	30 cigarettes a day [5]	40 cigarettes a day or more [8]
5. Exercise	Intensive occupational and recreational exertion [1]	Moderate occupational and recreational exertion [2]	Sedentary work and intense recreational exertion [3]	Sedentary occupational and moderate recreational exertion [5]	Sedentary work and light recreational exertion [6]	Complete lack of all exercise [8]
6. Cholesterol or percent fat in diet	Cholesterol below 180 mg. Diet contains no animal or solid fats [1]	Cholesterol 181–205 mg. Diet contains 10% animal or solid fats [2]	Cholesterol 206–230 mg. Diet contains 20% animal or solid fats [3]	Cholesterol 231–255 mg. Diet contains 30% animal or solid fats [4]	Cholesterol 256–280 mg. Diet contains 40% animal or solid fats [5]	Cholesterol 281–330 mg. Diet contains 50% animal or solid fats [7]
7. Blood pressure	100 upper reading [1]	120 upper reading [2]	140 upper reading [3]	160 upper reading [4]	180 upper reading [6]	200 or over upper reading [8]
8. Sex	Female [1]	Female [2]	Male [3]	Bald male [4]	Bald short male [6]	Bald short stocky male [7]

Your total score ________

Degree of Risk

6 to 11 = Very low risk
12 to 17 = Low risk
18 to 25 = Moderate risk
26 to 32 = High risk
33 to 42 = Dangerous risk
42 to 60 = Extremely dangerous risk

STOP!
READ THROUGH the questions below,
THEN write your thoughts in the margin
BEFORE attempting to answer the questions.

1. (a.) What ~~is~~ the total amount of points accumulated by the teacher on the Cardiac Risk Assessment? ____________

   (b.) Which risk level does this place her in?

   ____

2. Which category did she score highest in?

   ____

TASK D

For this problem the three people in your group are competing against those in several other groups, to see which group can solve the problem correctly first. You may work independently or with others in your group, as you wish. The first correct solution will count as your group's entry.

Don't forget to take notes and leave "traces', as you did in the other tasks.

STOP!
Write your thoughts about today's task in the margin before going further.

Imagine that you are the doctor assigned to investigate a situation where several people have been diagnosed with food poisoning. The people with the symptoms all had attended a church supper the night before. The supper consisted of baked ham, spinach, mashed potatoes, cabbage salad, Jell-O, rolls, milk, coffee, cakes, vanilla ice cream, chocolate ice cream, and fruit salad.

To determine which food is the likely culprit, you have surveyed all the people who attended the supper, and listed exactly what they ate, and whether or not they got ill. Then, for each food on the list, you have divided the people into two groups: those who ate the food (Group A) and those who didn't eat it (Group B). This way you could figure out the "attack rate" for each of the foods within the two groups.

The attack rate for people who ate a particular food is found by dividing the number ill by the total number who ate the food. Similarly, the attack rate for those who did not eat a particular food is found by dividing the number ill by the total number who did not eat that food. Some of your calculations are given in the chart below.

	Group A—persons who ate a particular food				**Group B** — persons who did not eat a particular food			
Food or Beverage	Ill	Not ill	Total	Attack rate (%)	Ill	Not ill	Total	Attack rate (%)
Baked ham	29	17	46	63	17	12	29	59
Spinach	26	17	43	____	20	12	32	____
Mashed potatoes*	23	14	37	____	23	15	38	____
Cabbage salad	18	10	28	____	28	19	47	____
Jell-O	16	7	23	____	30	22	52	____
Rolls	21	16	37	____	25	13	38	____
Milk	2	2	4	____	44	27	71	____
Coffee	19	12	31	____	27	17	44	____
Cakes	27	13	40	____	19	16	35	____
Vanilla ice cream	43	11	54	____	3	18	21	____
Chocolate ice cream	25	22	47	____	21	7	28	____
Fruit Salad	4	2	6	____	42	27	69	____

(From: *Health Behaviors*, pp. 431-433.)

STOP!
Write your thoughts about this problem in the margin before going further.

Have you done that? Okay, now do this:

READ THROUGH the questions below, THEN write your thoughts in the margin BEFORE attempting to answer the questions.

1. What are the attack rates for each food for Group A (those who ate the foods)? **Fill them in on the chart.**

2. What are the attack rates for each food for Group B (those who *did not* eat the foods)? **Fill them in on the chart.**

3. What is your conclusion as to which food is suspect? (Hint: It's the food that has the highest attack rate for Group A and the lowest attack rate for Group B.) **Write it on the line below.**

READ THIS NOW!

INSTRUCTIONS FOR TASKS E AND F

The first task today involves watching a videotape of a class lesson on STRESS. The specific instructions will be found on the next page (read this page first!). The second task is a problem about CURING AND TREATING DISEASES.

As in previous tasks, do everything that you are instructed to do. If the task says to read certain information or to include certain types of information in your response, then do that. Remember, an important part of academic work is to follow instructions so that you understand what you are expected to do and you get all the information you need.

Review the list below once more, so you don't forget to do them today:

1.) Write down ALL your thoughts in your NOTES and TRACES.

2.) Use the materials if you think they will help you do a better job.

3.) Talk to each other as much as you wish.

4.) Don't ask the researcher questions unless you can't get the answer from each other.

STOP!
Write your thoughts about today's task in the margin before going further.

Task E

You are about to watch a short videotaped lecture on the topic of Stress. You are expected to take notes on this lecture, which the teacher collects at the end of class.

After watching the tape you will be asked to write a paragraph or two, related to the information in the lecture. As with the last videotaped lesson, this is not your favorite class or your favorite teacher, but you need the course to graduate, so there's no getting out of it.

Remember, it's very important that you write notes and "traces" in the margins, showing how you're going through the task.

(WATCH VIDEOTAPE NOW)

Stress Lecture—Task E

<u>What is stress?</u>

When you are confronted with some challenge in life—getting good grades in school, starting a new job, becoming involved in personal relationships, dealing with problems or painful experiences, or making a large purchase, your feelings of equilibrium and balance are disrupted. These disruptions of what we call "mind-body harmony" usually are quickly gotten over, as you figure out ways of reaching your goals satisfactorily.

However, sometimes the state of disruption is especially severe or prolonged, and then you could say you were in a state of stress.

Nearly everyone has experienced stress and its unpleasantness at one time or another. Unusually severe and recurrent stress can itself becomes a problem, and it can even lead to a variety of illnesses.

But not all stress is harmful. Sometimes very positive growth experiences result from stressful events or situations.

There are also many ways that you can prevent stress-related illnesses, by reducing the persistent stressful interactions and experiences in your life. In the next few minutes I will tell a little about the nature of stress-related illness and how it can be prevented.

<u>Three Stages of Stress Reaction</u>

Hans Seyle, a pioneer in research on stress, explained that stress cannot be defined in terms of particular life situations, but must instead be seen as a *reaction* by a person to any disruptive influence or event. According to Seyle, if you experience any situation or change that requires you to *adapt*, you are experiencing stress. It doesn't matter whether the event is a "good" one or a "bad" one—it might be something very pleasant, like getting married or going on vacation. The key is whether or not you have to adapt in order to regain your mind-body harmony or balance.

The typical response to stress is called the *general adaptation syndrome*, or GAS for short. Gas has three stages to it, which I'll show you on the board in a moment.

* Stage 1 is *alarm* —you might recognize it as the "fight or flight" response. That's what happens—you have an initial reaction to stress of either wanting to stand and fight it off, or run away and hide from it.
* The second stage is *resistance*. Here, your body responds to continued stress by increasing its resistance—all your body's defence mechanisms get to work (like your immune system, raising of your blood pressure, and tensing of your muscles). This stage can last for a long time -even years sometimes, but eventually, your resistance runs down...
* ..and you enter Stage 3, *exhaustion*. This is when stress-related illnesses can set in.

Watch what happens to your body's resistance during the three phases of experiencing stress .... (show on overhead) ... Here's your normal level of resistance (this straight line). It drops momentarily during the alarm phase, then it goes up higher than normal for a while, as your body continuously adapts to the stress being there. Finally, it drops again, to lower than normal, and your reserves are gone.

It's easy to see, then, how illness can take over when you've used up your body's resources by combatting continued stress. Interestingly, the kinds of illnesses usually associated with stress, such as ulcers and heart attacks, result directly from over-use of the body's self-defense mechanisms.

Also, infections and even cancer can result from the body's having overtaxed its immune system. (The immune system is the body's defence system that fights against infection and disease.)

Dealing with Stress.

There are basically two ways to reduce the stress you experience in life:

* One is to avoid those situations that are stressful for you (and these vary a lot from one person to the next).

* The other is to change the way you experience life events, by changing your attitudes and responses to them.

It's really quite simple to understand—though not as easy to do! If you take a good look at what things cause you stress in life, you can decide whether you want to change your lifestyle to avoid those experiences from now on, or learn to face them differently.

How do you face things differently? Well, if you are an athlete, winning is your highest goal, but if it's your only goal, then you may end up with an ulcer from worrying about losing. If you don't want to stop being an athlete, you may want to try emphasizing the quality of your performance, rather than the outcome of the competition. You can get a lot of satisfaction from beating your own record, even if you don't win the race.

Another way of dealing with stressful situations that you can't or don't want to remove from your life is to use the power of the mind, such as in relaxation techniques or meditation, to help you cope on a regular basis.

By learning and using these kinds of techniques, you can lower the level at which your body's defense mechanisms are working on a day-to-day basis. If you have a stressful—but rewarding job, you may need to go for a walk or a run at lunch hour, or meditate in the evening, to allow your body and mind some relief.

There are other ways to reduce the effects of stress, but I've run out of time, so I'll leave you with these basic ideas. Remember, it's not the events or situations in your life that dictate how much stress you experience, it's how you see them and react to them that does it!

READ THROUGH the question below, THEN write your thoughts in the margin BEFORE attempting to answer the questions.

1. What are the three stages of the General Adaptation Syndrome?

1.) ______________________

2.) ______________________

3.) ______________________

READ THROUGH the question below, THEN write your thoughts in the margin BEFORE attempting to answer the questions.

2. Identify 2 or 3 events in your own life that have been or are stressful. Then describe several ways in which you could have or can cope with the stress you experienced. Explain why you think the coping method(s) you chose would be effective.

Task F

The task before you is a difficult one. You are members of a special international task force on World Health. You have been given a large quantity of information about current life-threatening diseases and their presence in various parts of the world. The information is not very well organized, and comes in many different formats, since it has been submitted by a variety of interest groups, researchers, medical people, and the like. However, you must make sense of it quickly, because you have a limited amount of time in which to come up with your plan.

At the end of this meeting you must have some recommendations—either a single proposal of the group, or separate recommendations from each of you. You may or may not trust the group to come up with the best solution, so you'll have to decide whether you want to work together or alone. However, keep in mind that some members may have important knowledge that you don't have.

STOP!
Write your thoughts about today's task in the margin before going further.

Your task is to decide how a budget of $100 Million is to be spent. There are eight diseases listed on the board. You are to choose three or four of the eight diseases to spend the money on, and decide how much should go toward research or treatment for each. In your answer, describe a little bit about each of the diseases you chose, and explain why they are more serious or deserving of the money than others.

You have a total of 30 minutes to do the following:

1. Read as much as you wish of the information on diseases provided
2. Discuss with your group if you wish.
3. Write your response. State which three or four diseases you selected, describe each of them, and tell how much of the money should be spent on each, and why.

Don't forget to take notes and leave "traces," as you did in the other tasks.

Diseases on blackboard:

1. *Alzheimer's Disease*
2. *Arthritis*
3. *Cancer—Leukemia*
4. *Cancer—Lung*
5. *Cystic Fibrosis*
6. *Diabetes*
7. *Heart Disease*
8. *Multiple Sclerosis*

STOP!
Write your thoughts about this task in the margin before going further.

Write your response below (Everyone in the group should write the response, even if it is a group proposal)

Is this a group response? yes ___ no ___

TASK INTRODUCTIONS
(All given orally)

GENERAL INTRODUCTION

Before beginning, I would like to explain to you a little bit about the kinds of things we'll be doing, and the goals of the study. You may have gotten an inkling of this from the questionnaires you filled out last week. For instance, you were asked a lot about your thoughts relating to your schoolwork—how you find you do at it, why you think you do well or not in certain situations, and so forth.

The rest of the time we are together over the next week will be spent finding out more specific details about how each of you approaches school tasks, and how you perceive those tasks. Eventually, I hope to develop ways of helping students become better at school subjects, but first I need to look carefully at the strategies and systems you use for your schoolwork. In order for the results of this study to be accurate and useful, its very important that you think carefully and report as accurately as you can, whenever you are asked how you went about something.

I'm sure by now you're all wondering what you'll have to do next. Well, here's basically how things will work from now on. Each time we meet, you'll first be given a task to do, which will take anywhere from 15 minutes to half an hour. I'll have the videotape running while you're working on each task. Right after the task, you'll be asked to fill out a questionnaire called the METACOGNITIVE QUESTIONNAIRE, or "MQ" for short. This questionnaire asks you all sorts of questions about how you were thinking as you proceeded through the task you just did. Then you'll be asked to fill out one more questionnaire, asking you things about what you thought of the task itself. Together, these two questionnaires take about 20 minutes or so to fill out. On Thursday and Friday you'll go through this whole procêdure twice, with two different tasks. On the other days you'll only have to do one task.

That's the basic procedure. But there is one other thing I'll want you to do to help me to get a picture of how you go about problems, assignments, or test questions in school. Part of this is to take a lot of notes which will show HOW you do the tasks, not just what you end up with. I've also come up with some specific things called "TRACES" which I'll want you to write in the margins of the materials I give you. The traces will also show how you're thinking during the tasks. In a minute, I'll tell you about them, and then we'll do a warm-up task so you can try them out. I'll also get you to fill out the questionnaires today, so you can see what they're like.

(Instructions for Leaving Traces given at this point)

TASK A INTRODUCTION

Today's task is about diet and exercise Before I hand out the task, take a minute or two to browse through the materials on the table. These materials may or may not be needed to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look right now just so you have an idea what is there.

(Wait two or three minutes while students look at materials.)

The task you will be doing today will take about half an hour. Please take your time and make sure you are writing the traces and step-by step notes of what your are thinking. Let's review the traces before we start, to be sure they are fresh in your mind. (Point out reminder card on table.)

1. Trace #1 is the Letter "A"—whenever you catch yourself letting your mind wander or thinking about something not related to the task, put an A in the margin. (You should take notes then about what you are thinking, too, if possible—for instance, you might think "Better read that over." or "Ok, come on—concentrate!" So in general, write down whatever you think as often as you can.

2. Trace #2 is to UNDERLINE anything you think is more important than other information. Do this in your notes as well as in whatever you are reading.

3. Number 3 is to jot down any QUESTIONS that come to mind, or anything that you think you should check out or clarify. (Any questions about this one?)

4. The fourth trace is noting things that you know or have experienced before that this reminds you of. It might be an example of a concept, or a comparison to something you are familiar with. I call this making CONNECTIONS between this information or this task and things you know from somewhere else.

OKAY—Do you think you can remember to write all this stuff down as you work? I know it's hard to do it when you are concentrating on the task, but it is important to try your best.

ONE OTHER THING—If you don't understand something, or you have a question about how to do a question, ask your group members before you ask me. I'll be at the back if you get stuck, but rely on each other first. Also, keep in mind that you can work with each other on these tasks if you want to—as long as you each hand in an answer and notes of your own. So if you want to talk to each other about what you are doing, or interrupt another kid to ask something, feel free to do that.

TASK B INTRODUCTION

Today's task is about cigarette smoking. Before I hand out the task, take a minute or two to browse through the materials on the table. Again today, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Wait two or three minutes while students look at materials.)

The task you will be doing today will take about half an hour. Please take your time and make sure you are writing the traces and step-by step notes of what your are thinking. Let's review the traces once more, quickly, before we start, to be sure they are fresh in your mind. (Point out reminder card on table.)

(Summarize the following):

1. Trace #1 is the Letter "A"—whenever you catch yourself letting your mind wander or thinking about something not related to the task, put an A in the margin. (You should take notes then about what you are thinking, too, if possible—for instance, you might think "Better read that over." or "Ok, come on—concentrate!" So in general, write down whatever you think as often as you can.

2. Trace #2 is to UNDERLINE anything you think is more important than other information. Do this in your notes as well as in whatever you are reading.

3. Number 3 is to jot down any QUESTIONS that come to mind, or anything that you think you should check out or clarify. (Any questions about this one?)

4. The fourth trace is noting things that you know or have experienced before that this reminds you of. It might be an example of a concept, or a comparison to something you are familiar with. I call this making CONNECTIONS between this information or this task and things you know from somewhere else.

OKAY—Will you remember to write all this stuff down as you work again today? Yesterday you all did a good job. Let's see if you can remember to write just as much of your thinking down this time.

ALSO, REMEMBER AGAIN—If you don't understand something, or you have a question about how to do a question, ask your group members before you ask me. I'll be at the back if you get stuck, but rely on each other first. Also, keep in mind that you can work with each other on these tasks if you want to—as long as you each hand in an answer and notes of your own. So if you want to talk to each other about what you are doing, or interrupt another kid to ask something, feel free to do that.

TASK C/D INTRODUCTION

Today there are two tasks to do. Each one takes about 15 minutes or so. The first one is about the risk of heart attack, and the second one is about food poisoning.

Before we start, take a look through the materials on the table. Again today, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. How much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Wait two or three minutes while students look at materials.)

Again, each task today will take about 15 minutes. Take your time and make sure you are writing the TRACES and STEP-BY-STEP NOTES of what your are thinking. Let's review the traces once more, quickly, before we start, to be sure they are fresh in your mind. (Point out reminder card on table.)

(Summarize the following):

1. Trace #1 is the Letter "A"—whenever you catch yourself letting your mind wander or thinking about something not related to the task, put an A in the margin. (You should take notes then about what you are thinking, too, if possible—for instance, you might think "Better read that over." or "Ok, come on—concentrate!" So in general, write down whatever you think as often as you can.

2. Trace #2 is to UNDERLINE anything you think is more important than other information. Do this in your notes as well as in whatever you are reading.

3. Number 3 is to jot down any QUESTIONS that come to mind, or anything that you think you should check out or clarify. (Any questions about this one?)

4. The fourth trace is noting things that you know or have experienced before that this reminds you of. It might be an example of a concept, or a comparison to something you are familiar with. I call this making CONNECTIONS between this information or this task and things you know from somewhere else.

OKAY—Will you remember to write all this stuff down as you work again today? Yesterday you all did a good job. Let's see if you can remember to write just as much of your thinking down this time.

ALSO, REMEMBER AGAIN—If you don't understand something, or you have a question about how to do a question, ask your group members before you ask me. I'll be at the back if you get stuck, but rely on each other first. Also, keep in mind that you can work with each other on these tasks if you want to—as long as you each hand in an answer and notes of your own. So if you want to talk to each other about what you are doing, or interrupt another kid to ask something, feel free to do that.

TASK E/F INTRODUCTION

Today again there are two tasks to do. The first one takes about 15 minutes or so, and the second takes half an hour. The first task is about the the topic of STRESS. The second task is about TREATING AND CURING DISEASES.

Before we start, take a look through the materials on the table. The same conditions apply to day as the other days—that is, you may or may not need these materials to complete the task, but you might find that you can do a better job by using them some of the time. As before, how much you use them, if at all, is up to you, but take a look so that you have an idea what is there.

(Wait two or three minutes while students look at materials.)

Okay, ready to start? Remember to take your time and make sure you are writing the TRACES and STEP-BY-STEP NOTES of what your are thinking. I'll just name the traces today, since you've had lots of practice with them by now. (Point out reminder card on table.)

(Summarize the following):

1. The letter "A" is for when your attention wanders.

2. Trace #2 is to UNDERLINE anything you think is more important than other information.

3. Number 3 is to jot down any QUESTIONS that come to mind, or anything that you think you should check out or clarify.

4. The fourth trace is making CONNECTIONS—showing when you are reminded of t=something you already know or have experienced.

OKAY—Remember to write all this stuff down EVERY TIME IT HAPPENS. Today is the last day, so put all your thoughts into it!

ALSO, REMEMBER AGAIN—If you don't understand something, or you have a question about how to do a question, ask your group members before you ask me. If you want to talk to each other about what you are doing, or interrupt each other to ask something, feel free to do that.

APPENDIX F
Task Performance Scoring Criteria

Task A

SCORE	CRITERIA
	<u>Problem 1</u> a) must include exercises for at least five days b) each exercise may be included a maximum of twice in plan c) length of time for each exercise must be given d) calories expended must fall between 3500-5000 calories <u>Problem 2</u> a) must include at least one food from each food group (combination group may be omitted) b) must include something to drink c) menu should add to appropriate amounts of carbohydrate, protein, and fat
2	* no omissions in meeting criteria above * maximum of 2 calculation errors permitted
1	* 1-3 omissions or errors in meeting criteria * maximum of 4 calculation errors * total max omissions + errors = 4
0	* more than 3 omissions or errors in meeting criteria * (or) more than 4 omissions/errors total * (or) one problem not attempted

Task B

SCORE	CRITERIA
	a) two extra risks (which are reasonable)must be mentioned b) description of each risk must be included c) either i or ii (below) i agreement with points and action plan given ii. logical argument against recommendation(s) and logical alternative(s) given
2	* must meet all of **a**, **b**, and **c** (above)
1	* must meet **a** and **b** * OR must meet **c** (above)
0	* anything less that criteria for a score of 1

Task C

SCORE	CRITERIA
2	* questions 1 and 2 must be answered correctly
1	* question 1a or 1b wrong or missing * OR Question 2 wrong or missing
0	* more than one answer wrong or missing

Task D

SCORE	CRITERIA
2	* attack rates correct with maximum of one calculation error * correct identification of food responsible
1	* 2-5 errors in calculating attack rates * OR incorrect identification of food
0	* incorrect identification of food and 3-5 errors n attack rates * OR more than 5 errors in attack rates

Task E

SCORE	CRITERIA
	a) all three answers correct b) 2 events described c) 2 coping methods identified d) rationale for each coping method
2	* all of criteria above met, one weak rationale allowed
1	* maximum of 1 criterion not met (at all), may be weak in second criterion (or partial) * may be weak or partial on three criteria, but then no criteria can be omitted completely.
0	* anything less than criteria for score of 1

Task F

SCORE	CRITERIA
2	a) at least 3 diseases identified b) all 3 diseases described c) amount of $ to be spent on each identified d) logical argument as to why spent $ this way * may be weak in **b** or **d**, but some attempt made
1	(ONE of the following): * at least 2 diseases identified with descriptions, $ spent, and some argument * at least 3 diseases with descriptions, $ spent, and no argument as to why * at least 3 diseases with descriptions, arguments included but no amounts of $ allotted * at least 3 diseases with descriptions, some argument and some amounts of $ allotted, but both the latter incomplete
0	* anything less than criteria for score of 1

Appendix G

Tables G-1 to G-20

Table G-1 Correlations Among Traces (Summed Across Tasks).

	ANEG	REH	GM	CR	SP	SR	SEL	CON	ORG	TP	VIG	A+	MR	MOT+	MOT-	(COLLAPSED) ATT	MON	PLAN
ANEG																		
REH	-30*																	
GM	52*	07																
CR	32*	-04	61*															
SP	-05	24	08	0														
SR	10	13	-08	0	29													
SEL	19	19	-40*	0	09	07												
CON	02	-05	13	-08	06	-17	09											
ORG	-19	09	-13	12	57*	28	17	-13										
TP	-02	-11	14	08	06	-01	17	10	-06									
VIG	85*	-35*	25	18	-09	15	-18	-13	-11	-01								
A+	-20	-18	-24	-18	-09	-09	-21	05	-24	05	-15							
MR	-22	-09	-12	-03	-06	-06	09	08	51*	10	-20	-04						
MOT+	43*	-19	56*	31*	-11	-11	-46*	06	-03	-09	15	-28	-10					
MOT-	55*	-27	33*	-11	15	15	-47*	-05	03	05	57*	-27	-06	41*				
(COLLAPSED)																		
ATT	/	-32*	/	/	/	07	-37*	03	/	-03								
MON	/	03	/	/	/	-05	-25	04	/	13						51*		
PLAN	/	19	/	/	/	27	13	03	/	05						05	02	

(* p ≤ .05 Decimals omitted)

Table G-2 Correlations Among MQ Scores Representing Component Processes Aggregated Across Tasks.

SUMS	Att	Reh	GM	CR	SP	SR	Sel	Con	Org	TP
Attention(+)										
Rehearsal	17									
Global Mon.	08	38*								
Cog. Reg.	-04	17	27							
S. Planning	38*	37*	44*	28						
Social Res.	-22	-09	-25	-25	-46*					
Selectivity	-07	-16	-03	37*	01	-17				
Connecting	21	-18	28	17	44*	-62*	32*			
Organizing	33*	39*	26	20	65*	-32*	02	30*		
T. Planning	-17	-13	-29	04	-68	-08	26	-28	-38*	

* p ≤ .05

Table G-3 Within-Task Correlations Between MQ and Trace Scores, Task A (N=32)
[Correlations with task performance are also shown.]

TRACES	MQ Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT(-)	-56*	01	03	-17	45*	-06	-39*	11	-08	Off-task Comments
REH	04	02	-21	04	-34*	-14	09	02	34*	Rehearsal
MON	01	19	0	-04	25	-41*	-30*	23	-02	Monitoring
PLAN	03	20	-10	15	-07	-29	07	-10	19	Planning
SR	13	-04	19	28	14	20	14	-30*	-01	Social Resources Used
SEL	31*	31*	-39*	-10	-10	01	0	09	33*	Selecting
CON	11	15	-24	-10	19	29	-21	02	-01	Connecting
TP	09	-16	-07	-15	02	22	12	11	-05	Tactical Planning
PERF	14	31*	-15	-16	-19	0	11	25	/	Task Performance

Table G-4 Within-Task Correlations Between MQ and Trace Scores, Task B (N=32)

TRACES	MQ									
	Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT	-47*	20	09	02	06	02	18	-24	-06	Off-task Comments
REH	-30*	-20	-17	-08	40*	-25	-01	-25	13	Rehearsal
MON	-25	-19	-17	05	18	-03	19	-31*	12	Monitoring
PLAN	-04	-17	-20	-07	-16	-18	34*	05	-06	Planning
SR	-13	21	01	10	22	14	08	-39*	-01	Social Resources Used
SEL	14	06	21	01	22	-24	-35	-11	14	Selecting
CON	10	-19	-03	17	-16	-02	29	18	0	Connecting
TP	10	18	26	07	-28	-26	06	05	40	Tactical Planning
PERF	38*	06	11	25	-12	-04	-08	-04	/	Task Performance

Table G-5 Within-Task Correlations Between MQ and Trace Scores, Task C (N=32)

TRACES	MQ									
	Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT	-15	-07	-20	-12	31*	-20	-39*	-09	-20	Off-task Comments
REH	03	17	06	-05	-14	25	01	33*	-11	Rehearsal
MON	-03	-15	03	21	-18	31*	-05	-05	05	Monitoring
PLAN	02	03	10	14	-18	17	03	21	04	Planning
SR	27	0	51*	17	19	-02	14	-34*	-02	Social Resources Used
SEL	05	10	12	07	-10	-08	34*	-18	08	Selecting
CON	05	13	0	04	12	18	-38*	12	32*	Connecting
TP	19	18	32*	37*	19	-28	07	-38*	-08	Tactical Planning
PERF	04	10	-22	05	19	11	-13	04	/	Task Performance

Table G-6 Within-Task Correlations Between MQ and Trace Scores, Task D (N=32)

TRACES	MQ Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT	-06	-19	18	19	05	15	31*	-04	-16	Off-task Comments
REH	15	12	-01	35*	-06	-09	-01	-07	10	Rehearsal
MON	-01	-21	-28	07	07	-11	17	-05	-36*	Monitoring
PLAN	12	14	05	-13	27	-09	-26	-23	0	Planning
SR	17	-03	-01	04	41*	-18	-24	-21	10	Social Resources Used
SEL	13	15	20	-17	-33*	29	18	14	06	Selecting
CON	27	-27	43*	-07	-14	-08	12	03	-17	Connecting
TP	10	-11	-06	-35*	12	-17	-26	16	-02	Tactical Planning
PERF	35*	-04	-17	-24	-01	-16	-22	27	/	Task Performance

Table G-7 Within-Task Correlations Between MQ and Trace Scores, Task E (N=32)

TRACES	MQ Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT	-35*	-26	-31*	-23	44*	09	-56*	12	-29	Off-task Comments
REH	33*	15	-04	-02	-20	-30*	29	05	01	Rehearsal
MON	29	22	-19	02	-28	-40*	0	08	05	Monitoring
PLAN	-11	09	-03	15	-11	24	10	-03	30*	Planning
SR	17	12	-04	-04	-14	-08	14	17	-22	Social Resources Used
SEL	01	38*	27	02	-24	10	22	09	36*	Selecting
CON	07	05	11	12	20	18	0	-20	-04	Connecting
TP	13	05	-08	-16	-02	-29	-17	05	06	Tactical Planning
PERF	-07	20	02	09	26	22	03	06	/	Task Performance

Table G-8 Within-Task Correlations Between MQ and Trace Scores, Task F (N=32)

TRACES	MQ Att(+)	Reh	Mon	Plan	SR	Sel	Con	TP	Perf	
ATT	-50*	-24	-31*	-23	15	08	-38	03	-11	Off-task Comments
REH	23	25	16	09	-05	0	12	04	15	Rehearsal
MON	-22	-18	14	-21	02	01	-17	-09	-10	Monitoring
PLAN	37	-11	-27	10	-06	17	0	06	-09	Planning
SR	12	05	12	32*	35*	16	-17	-40*	-07	Social Resources Used
SEL	40*	36*	42*	39*	09	18	11	04	23	Selecting
CON	11	07	-06	-26	-34*	-21	36*	27	-02	Connecting
TP	06	-04	-17	11	06	22	-02	01	-08	Tactical Planning
PERF	35*	17	22	09	05	03	-13	15	/	Task Performance

Table G-9 Correlations Among MQ Scores Reflecting Component SRL Processes, Task A (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	18							
MON	-20	-13						
PLAN	18	09	26					
SR	-35*	06	05	-09				
SEL	05	-22	-04	-24	29			
CON	35*	-37*	-05	09	-64	-06		
TP	02	14	-16	-67	-18	-02	-09	

(* P ≤ .05 Decimals omitted)

Table G-10 Correlations Among MQ Scores Reflecting Component SRL Processes, Task B (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-17							
MON	-02	62*						
PLAN	09	21	17					
SR	-22	-15	-08	-23				
SEL	-09	09	-22	00	11			
CON	-22	-03	-10	17	-43*	-24		
TP	29	-09	10	-35*	-32*	07	-12	

(* $p \leq .05$ Decimals omitted)

Table G-11 Correlations Among MQ Scores Reflecting Component SRL Processes, Task C (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	05							
MON	33*	10						
PLAN	44*	-13	31*					
SR	-14	06	-07	-14				
SEL	01	-15	01	27	-23			
CON	31	-03	21	17	-43*	07		
TP	-37*	08	-13	-52*	-39*	21	-11	

(* $p \leq .05$ Decimals omitted)

Table G-12 Correlations Among MQ Scores Reflecting Component SRL Processes, Task D (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-15							
MON	-11	36*						
PLAN	-03	-06	16					
SR	-10	11	-17	-21				
SEL	-22	11	39*	31*	-29			
CON	01	-18	22	36*	-71*	56*		
TP	-08	16	11	-48*	38*	-01	10	

(* P ≤ .05 Decimals omitted)

Table G-13 Correlations Among MQ Scores Reflecting Component SRL Processes, Task E (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	27							
MON	03	55*						
PLAN	41*	47*	44*					
SR	-62*	-31	10	-22				
SEL	-12	05	09	-10	07			
CON	33*	34*	32*	36*	-24	10		
TP	02	-04	-32*	-56*	-34*	18	-17	

(* P ≤ .05 Decimals omitted)

Table G-14 Correlations Among MQ Scores Reflecting Component SRL Processes, Task F (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	38*							
MON	09	20						
PLAN	41*	68*	36*					
SR	07	-16	05	06				
SEL	-05	-06	11	14	-12			
CON	06	18	11	18	-79*	11		
TP	04	-23	05	-40*	-47*	-07	29	

(* P ≤ .05 Decimals omitted)

Table G-15 Correlations Among Traces Scores Reflecting Component SRL Processes, Task A (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-15							
MON	19	-06						
PLAN	-18	03	08					
SR	-17	-09	-02	07				
SEL	-17	05	-18	-01	04			
CON	-01	-01	03	16	-03	29		
TP	-13	-17	01	-22	14	40*	10	

(* P < .05 Decimals omitted)

Table G-16 Correlations Among Traces Scores Reflecting Component SRL Processes, Task B (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-01							
MON	34*	24						
PLAN	-02	05	-06					
SR	29	-02	-10	-02				
SEL	-17	12	-11	10	12			
CON	03	-04	-05	25	03	-02		
TP	-12	06	-07	13	-12	21	23	

(* P ≤ .05 Decimals omitted)

Table G-17 Correlations Among Traces Scores Reflecting Component SRL Processes, Task C (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-01							
MON	25	40*						
PLAN	26	59*	30*					
SR	06	-12	09	16				
SEL	-06	21	17	39*	17			
CON	06	-08	23	-16	07	-26		
TP	22	-01	03	29	33*	36*	-06	

(* p ≤ .05 Decimals omitted)

Table G-18 Correlations Among Traces Scores Reflecting Component SRL Processes, Task D (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-12							
MON	51*	-22						
PLAN	-25	-18	-29					
SR	-01	-15	-11	62*				
SEL	-03	-04	-34*	16	-21			
CON	14	01	01	-09	-19	17		
TP	-05	-15	-02	00	-16	11	43*	

(* $p \leq .05$ Decimals omitted)

Table G-19 Correlations Among Traces Scores Reflecting Component SRL Processes, Task E (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-32*							
MON	17	36*						
PLAN	05	06	-18					
SR	-13	18	-02	15				
SEL	-17	22	-01	42*	-15			
CON	10	-25	-13	-06	02	-15		
TP	21	26	50*	-05	-14	08	-16	

(* $p < .05$ Decimals omitted)

Table G-20 Correlations Among Traces Scores Reflecting Component SRL Processes, Task F (N=32)

	ATT	REH	MON	PLAN	SR	SEL	CON	TP
ATT								
REH	-30*							
MON	35*	00						
PLAN	-18	-20	39*					
SR	-17	38*	33*	24				
SEL	30*	-03	-23	07	03			
CON	-10	-05	-02	-10	-38*	05		
TP	31*	-11	12	27	-20	28	-05	

(* P ≤ .05 Decimals omitted)