

THE EFFECTS OF PERFORMANCE AIDS ON SELF-EFFICACY DURING
ANALOGICAL REASONING

by

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THE EFFECTS OF PERFORMANCE AIDS ON SELF-EFFICACY DURING

ANALOGICAL REASONING

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ABSTRACT

Recent theoretical shifts in instructional psychology have given rise to increased interest in a cognitive analysis of student motivation. Self-efficacy theory has enjoyed a prominent position in this shift, as researchers have turned their attention to the possible mediational effects that self-perceptions of performance competencies may have on task performance and persistence.

The purpose of the present investigation was twofold. First, to examine the effects of performance aids on the acquisition of self-efficacy during computer-assisted analogical reasoning. This analysis bears on the unexamined claim by self-efficacy theorists that self-efficacy will be attenuated by the usage of such prompts. This is hypothesized to occur because some or all of an individual's performance success may be attributed to the aid, and as such, reduce any increase in self-efficacy. The second purpose of the study pertains to an evaluation of the generalizability of self-efficacy theory. The vast majority of previous research has utilized well-defined behavioural tasks in its examination of the relationship between self-efficacy and performance. The present investigation examines this relationship on less well-defined cognitive tasks.

One hundred and fifty undergraduate students participated in the experiment. Each subject was assigned randomly to one of four prompted instruction groups or a no-prompt control group. An analysis of subjects' self-efficacy, problem-solving accuracy

and persistence during the sixty-minute computer assisted instruction generally revealed no attenuating effects of prompt usage on self-efficacy. This occurred despite the fact that subjects did generally attribute a reasonable amount of their performance success to the prompts provided during instruction. A comparison of the efficacy-performance correlations obtained in this study and those yielded from a meta-analysis of the self-efficacy literature indicated a considerable reduction in the magnitude of the obtained correlations. Moreover, a subsequent path analysis of learners' self-efficacy and problem-solving performance found that self-efficacy served a mediating role on only the initial performance trial during instruction.

The results of the study are discussed as possible limits to self-efficacy theory in general and more particularly, as limits to the promise of self-efficacy accounts of student motivation.

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CHAPTER I

INTRODUCTION AND OVERVIEW

Within the last decade instructional psychology has relied increasingly on a cognitive analysis of classroom learning and motivation (Calfee, 1981). Instructional psychologists interested in classroom learning have made large gains in understanding the cognitive demands of classroom tasks; in analyzing the ways that students represent such demands; and in exploring the general relationship between students' cognitive activity during instruction and their achievement (Doyle, 1983; Marx, Winne, & Walsh, 1985). Research on student motivation has developed in a similar vein, with renewed interest in how students' cognitions, such as achievement expectations, attributions, and perceptions of self-worth, might mediate academic performance (Covington & Berry, 1976; Schunk, 1984; Weiner, 1979).

Unfortunately, however, these two streams of research have tended to develop separately. Typically, researchers interested in exploring cognition and instruction have not attended to motivational concerns (Corno & Mandinach, 1983). Indeed, it is not unusual for researchers in this area to assume explicitly that students are highly motivated (Winne, 1983). Similar neglect is evident in studies which have focussed upon instruction and motivation, with little attention to learning.

In a general way, this study attempts to integrate these two streams of research by examining the effects of an instructional

treatment on both learning and motivation. More precisely, this dissertation examines the effects of performance aids on learners' problem-solving achievement and self-efficacy during computer-assisted instruction. Of central focus is an examination of how various types of performance aids might differentially affect both learners' estimates of their competence to solve verbal analogies, and their actual problem-solving performance.

Overview of the Dissertation

The dissertation begins with a review and meta-analysis of current research in self-efficacy. The scope of this review is broad, and includes approximately 100 theoretical and empirical investigations of Bandura's self-efficacy theory. Following an overview of this theory, the review chapter presents a detailed evaluation of Bandura's claims using the extant literature from clinical, educational, sports and laboratory studies. The first part of this examination is devoted to evaluating propositions concerning the relationship between self-efficacy and human performance. The second section discusses research on the acquisition of self-efficacy. In the closing section of the chapter, a number of methodological and substantive directions for future research are delineated.

With the broad backdrop furnished by chapter 2 in place, chapter 3 provides a more specific accounting of the scope and purpose of the dissertation study. In this chapter, some of the

substantive directions for self-efficacy research, which were mentioned generally in chapter 2, are refined into specific questions for investigation. An additional purpose of this chapter is to provide a rationale for the instructional task and treatment used in the study. This rationale relies heavily on Sternberg's recent work in the componential analysis of analogical reasoning (Sternberg, 1977, 1980; Wagner & Sternberg, 1984).

Chapter 4 describes the general procedures, experimental design, dependent measures and sample utilized in the study. As instruction in the study was computer-assisted, much of this chapter is devoted to a discussion of the operation of the five computer programs which delivered the experimental treatments. Technical details of the operation of these programs are contained in Appendix A.

The penultimate chapter of the dissertation is devoted to a detailed discussion of the results of the study. The chapter is organized around the central questions posed for investigation in the latter portion of chapter 3. As each question is once again brought forward, a detailed description of the statistical procedures and general findings is offered. The chapter closes with a general summary of the findings.

In the sixth and last chapter, the results detailed in chapter 5 are brought to bear on the theoretical issues raised in earlier sections. Here an attempt is made to integrate the findings as they pertain to future work devoted to a cognitive analysis of student motivation.

CHAPTER II

AN INTEGRATIVE REVIEW OF SELF-EFFICACY RESEARCH AND THEORY

The last decade in psychology has been typified by increased interest in a cognitive analysis of human behaviour. This shift has occurred not only at a theoretical level, but is also evident in applied areas (Mahoney, 1974, Meichenbaum, 1977) where psychological treatments that were once predicated on noncognitive theories (e.g., behaviour modification) have been augmented with cognitive components (e.g., as in cognitive behaviour modification). The current paradigmatic shift in psychology has also given rise to increased interest in how individuals' judgements about their behaviour affect performance (Covington & Berry, 1976; Deci, 1975; Weiner, 1977). It is in this vein that Bandura (1977, 1982) suggests that one's appraisal of one's capacity to perform a given behaviour, which Bandura designates as self-efficacy, constitutes an important mechanism of behaviour change. Bandura argues that self-efficacy may be of considerable value both as a unifying construct through which to view presently diverse treatments, and as a generative notion which may yield new treatment regimes.

Whether self-efficacy is able to unite behavioural and cognitive therapies under one theoretical umbrella or to engender novel treatments remains to be seen. What is clear, however, is that a considerable amount of related research has been generated since Bandura's theory of self-efficacy was

elaborated in 1977. In the intervening years, close to 100 theoretical and empirical papers have appeared on the topic.

In this literature, the notion of self-efficacy has been extended to nonclinical investigations in a wide range of psychological research. Studies have examined the role of self-efficacy in athletic performance (Barling & Abel, 1983; Weinberg, Gould, Yukelson & Jackson, 1981), academic achievement (Schunk, 1984), vocational choice (Betz & Hackett, 1983; Hackett & Betz, 1981), and salesmanship (Barling & Beattie, 1983). Work in clinical areas has not been neglected during this period. Initial investigations of phobias (Bandura & Adams, 1977; Bandura, Adams & Beyer, 1977) have been extended to studies of the relationship between self-efficacy and smoking cessation (Chambliss & Murray, 1979a; Condiotte & Lichtenstein, 1981; Diclemente, Prochaska & Gilbertini, 1985), heterosexual anxiety (Barrios, 1983), assertiveness (Pentz & Kazdin, 1982; Kazdin, 1979), depression (Davis & Yates, 1982; Kanfer & Zeiss, 1983), weight loss (Chambliss & Murray, 1979b), social skill training (Moe & Zeiss, 1982), and pain control (Manning & Wright, 1983).

This chapter reviews the growing body of research which has investigated self-efficacy. The chapter begins with a general discussion of the features of efficacy theory. From this initial discussion, a series of propositions are derived which form the basic tenets of Bandura's theory. Each of these propositions is then examined using the extant literature. Where possible, and in accordance with current meta-analytic techniques (Glass, McGraw & Smith, 1981; Green & Hall, 1984), an

effect size is calculated to summarize the evidence bearing on each proposition. The closing section of the chapter summarizes a number of methodological problems found in the current self-efficacy literature and offers a number of prospects for future research.

Self-efficacy Theory

The Nature and Dimensions of Self-efficacy

Bandura (1977) defines self-efficacy as "the conviction that one can successfully execute the behavior required to produce outcomes" (p. 193). Such convictions or expectations temper an individual's performance in a number of ways. People who exhibit heightened self-efficacy will, according to Bandura, persist longer at tasks and will expend more effort in the face of adversity. On the other hand, those who harbour low self-efficacy will expend little energy on a given task or in the extreme, may not engage in such activities at all. Given adequate skills and incentive then, Bandura suggests that self-efficacy will be an important determinant of an individual's performance.

It is tempting to align Bandura's notion of self-efficacy with other constructs, such as general self-confidence, self-concept, and levels of aspiration. The hardline skeptic may in fact go so far as to suggest that self-efficacy is a redundant notion which should succumb to Occam's razor. Although some have taken this line (Borkovec, 1978; Eysenck, 1978; Smedslund,

1978a, 1978b), Bandura contends that self-efficacy is a distinct construct. Despite its similarity to traits such as self-concept, Bandura regards self-efficacy as a situationally specific percept. It is not intended to represent a trait of any sort, although Bandura indicates that some generalization of efficacy across similar tasks is likely. Further, Bandura (1977) holds that self-efficacy differs from level of aspiration. On a conceptual level at least, this assertion would seem reasonable. As Bandura (1977) notes, the assessment of self-efficacy involves asking people what they can do, not what they aspire to do.

Since there has been some debate (Bandura, 1978a, 1984; Eastman & Marzillier, 1984; Marzillier & Eastman, 1984; Teasdale, 1978) and perhaps confusion on the relationship between self-efficacy and outcome expectations, some discussion is necessary on this point. Much of the previous work on expectancy has concerned percepts of the outcome of behaviour. Tolman first emphasized the importance of outcome expectancy in his early attempts to account for maze learning in animals (Tolman, 1932, 1951). Others have followed in a similar manner when positing theories of human performance. Rotter (1966), for example, regards beliefs about the causal relationship between actions and outcomes as central mediators of behaviour. Similarly, Maier and Seligman (1976) propose that individuals acquiesce to situations in which they believe their behaviour is unrelated to outcomes. Bandura's self-efficacy theory departs in a number of ways from this emphasis on expectations regarding

outcomes.

Although Bandura (1978a, 1978b, 1983) acknowledges that outcome expectations are important influences on behaviour, these expectations are distinct from percepts concerning one's capacity to perform. On a conceptual level, the referent of each expectation is different. Outcome expectations refer to the outcome of behaviour, while self-efficacy concerns the behavior itself. Examples of this distinction are not difficult to find. One may have sound knowledge about the outcome of a behaviour, for example, that a three-minute mile will win a gold medal, but have grave doubts about the capacity to perform such a feat.

Self-efficacy and outcome expectations can be contrasted further by their joint effect on behaviour. In cases where both outcome and efficacy expectations are high, both will predict effortful behaviour according to Bandura. However, in cases where outcome expectancies are low and self-efficacy is high, high rates of performance are predicted. This is contrary to outcome-based theories of expectancy. According to Bandura (1978), this will occur because individuals judging themselves to be highly efficacious will intensify effort despite low returns, and if necessary, seek to change unrewarding environmental contingencies. Thus, outcome expectations and self-efficacy may differ in their predictions of effort under some conditions.

Having clarified the nature of self-efficacy, questions naturally arise concerning the ways in which such expectations

may vary. According to Bandura, self-efficacy varies along three dimensions. First, efficacy expectations differ in strength. The strength of self-efficacy is assessed by asking research participants to rate the confidence with which they will be able to perform a given behaviour on a 100 point scale, varying in 10 point increments from 10 (highly uncertain) to 100 (completely certain). Typically, a series of tasks presented in ascending order of difficulty are rated and the strength of self-efficacy is the average of a participant's ratings across these tasks.

A second dimension of self-efficacy concerns its level, which again is usually assessed by presenting a series of tasks of ascending difficulty to research participants. A count of the number of tasks participants rate with a predetermined strength of efficacy constitutes the level of efficacy. For example, in Bandura and Adams' (1977) study, snake phobics responded to questionnaire items describing approach responses to a boa constrictor. Each item described increasingly more threatening situations, ranging from merely approaching a glass cage containing the snake, to passively allowing the snake to crawl on their laps. The level of self-efficacy was obtained by counting the number of tasks to which subjects indicated an efficacy strength greater than 10 on the 100 point scale.

Lastly, self-efficacy may vary across tasks in its generality. Ratings of the strength and level of efficacy across dissimilar tasks provides an index of generality. In the previously described study (Bandura & Adams, 1977), generality

was assessed, albeit in a limited way, by presenting a corn snake to phobic individuals after a systematic desensitization treatment, and examining efficacy strength and level.

Acquisition of self-efficacy

Much of self-efficacy research has scrutinized variables which affect the acquisition of efficacy expectations. Bandura (1977) lists four major sources of efficacy-related information: performance accomplishments, vicarious experience, verbal persuasion, and physiological states. Since many of Bandura's claims about self-efficacy involve its acquisition, a discussion of each source of efficacy information is particularly pertinent to this review.

An important source of efficacy expectations is prior direct and enactive experience with tasks. Successful performance generally enhances self-efficacy, while task failure attenuates efficacy expectations (Bandura, 1977). Since efficacy expectations are often the product of many interactions with tasks, Bandura suggests that efficacy producing self-appraisals aggregate across performances. In this way, a failure on a specific task after many previous successes may have little debilitating influence on self-efficacy. On the other hand, failure on initial task performances may be very salient and as such, substantially reduce efficacy expectations. The effect of success or failure is thus complex, with the timing and pattern of successes and failures determining the overall effect on

self-efficacy.

Changes in self-efficacy are not always related directly to performance (Bandura 1977). Indeed, Bandura points out that there is a crucial difference between performance as it actually occurs, and performance as it is perceived and processed cognitively by individuals (Bandura & Adams, 1977). For example, efficacy producing self-appraisals of performance incorporate information about the task situation. The mastery of tasks which are perceived as easy provide little reason for individuals to increase their self-efficacy, since performance accomplishments may be readily ascribed to task parameters. On the other hand, success with tasks which are perceived as moderately challenging instills a sense of personal mastery and increases expectations of competent performance. Similarly, tasks which contain many aids to performance may not imbue individuals with enhanced self-efficacy, despite successful performance. This will occur since some or all of the success may be attributed to situational aids.

The appraisal of successful performance may be tempered further by other attributions. Performance gains attributed to fortuitous events, for example, are unlikely to affect self-efficacy. Similarly, individuals who attribute successful performance mainly to high effort are likely to experience little gain in self-efficacy, while those who attribute successful performance to ability will have large gains in their performance expectations. Bandura (1977) speculates that this will occur because arduous performance connotes less ability and

less competence, and as such, lowers expectations of personal mastery.

Not all efficacy-building information is produced from enactive sources. Vicarious experience, that is experience gleaned from live or symbolic modeling, is also posited to have important effects on self-efficacy. Although vicarious experience may influence expectancy, its general effect is hypothesized to be weaker than enactive experience (Bandura 1977, 1982). This occurs because the information source itself, the model, may be discounted to some extent by the observer. To the degree that the successful performance of a model may be attributed to characteristics peculiar to that individual, an observer's self-efficacy is unlikely to be affected.

Several variables will affect the salience of efficacy-determining information derived from vicarious sources (Bandura, 1977, 1982). Generally, models who display more effortful performance will spawn higher self-efficacy in observers, when contrasted with models who demonstrate less effortful performance. Models displaying behaviour which is met with clear outcomes will more readily heighten self-efficacy in observers, than models whose behaviour is met with ambiguous consequences. In addition, increased similarity between the model and observer will enhance the transmission of self-efficacy information. Observers who perceive themselves as possessing characteristics similar to those of the model are less likely to ascribe the model's successful performance to features idiosyncratic to the model (Bandura, 1982). The use of

a number of different models also is hypothesized to aid the transmission of expectations in a similar way. An observer witnessing skilled performance by a number of models is less likely to attribute performance gains to the models' characteristics.

People are frequently induced toward efficacious performance by the verbal persuasion of others. Bandura posits such exhortation as yet a third source of self-efficacy information. Although verbal inducement by others may affect self-efficacy, its impact is predictably less than expectations derived from an enactive source. This appears to be reasonable; just as one may discount the performance of models, so too may the exhortative remarks of others be heavily discounted (e.g., "You are just saying that"). Generally, the more credible the source of persuasion, the more potent its effect on self-efficacy.

Efficacy-determining information also may arise from physiological sources. An individual's arousal when confronted with a task may suggest requisite preparedness (e.g., "getting up for the game"), or in cases of high arousal, may trigger high anxiety and contribute to a debilitating state. Bandura (1977) notes that the latter case is found frequently in phobics, where initially high arousal serves as a cue which leads to presaging judgements of poor performance on high-avoidance tasks (e.g., approach responses to fear-eliciting stimuli). These initially low expectations of performance may be lowered further by fear provoking thoughts which serve to increase performance anxiety (Meichenbaum, 1977).

In summary, Bandura offers a theory of behavioural change which postulates that one's beliefs about one's capacity to act are important determinants of behaviour. These expectations of competence constitute self-efficacy. Bandura views self-efficacy as a situationally specific percept, rather than a global trait or global judgement. Self-efficacy is acquired through a process of self-appraisal, which may incorporate information from enactive, vicarious, exhortative and physiological sources. Efficacy-related information may be tempered by individuals' causal attributions regarding their performance. In this way, self-efficacy is not merely a reflection of performance, but rather the result of an individual's interpretation of performance.

Review of Self-efficacy Research

With the preceding overview of self-efficacy theory in place, the discussion turns to a more detailed examination of empirical evidence bearing on Bandura's central claims regarding self-efficacy. These claims are grouped into two major sections. The first section is devoted to evaluating propositions concerning the relationship between self-efficacy and performance. The second section discusses research on variables which affect the acquisition of self-efficacy. Where possible, an effect size is included in the summary of evidence bearing on each proposition. Some caution is warranted when interpreting effect sizes calculated on a small number of studies (Rosenthal, 1979). Given this caveat, effect sizes reported in this review when based on a small number of studies

are meant to be an indication of the extant literature, and may well be confined in their generalizability.

Articles examined in this review appeared in 32 psychological or related journals between 1977 and 1985. A computerized search of Psychological Abstracts and ERIC yielded 69 published papers associated with the descriptor "self-efficacy". An examination of the reference lists of these studies, and a general hand search of journals which frequently publish self-efficacy studies (e.g. Cognitive Therapy and Research, Journal of Educational Psychology, Journal of Sport Psychology) yielded 29 additional studies. Of the 98 studies which comprised the total literature sample, 36 were theoretical discussions, while 62 were empirical investigations of self-efficacy.

Self-efficacy and Performance Research

A major tenet of self-efficacy theory is that the level and strength of self-efficacy bear a direct relationship to performance attainments. Numerous studies have addressed this fundamental proposition. For the most part, however, the relationship between efficacy and performance has been somewhat tangential, with the main intention of most studies being the examination of factors which affect self-efficacy acquisition. In order to avoid redundancy, the description of studies reviewed in this section will be terse, leaving fuller accounts of the studies to sections of the review which best subsume the

main intention of each investigation.

Many of the studies examining the relationship between self-efficacy and performance have incorporated correlational analysis or its variants, multiple regression and path analysis. Others have adopted Bandura's suggestion that an analysis of the relationship between self-efficacy and performance more suitably concerns the congruence between self-efficacy percepts and performance on a given task. Bandura (1980) calls for the adoption of this microanalytic technique in the following way:

To quantify relationships one can ... aggregate self-efficacy with performance scores. But evidence that a lot of efficacy judgements go together with a lot of behavior is of lesser interest if the research is aimed at clarifying how specific judgements of self-efficacy are linked to specific acts. (p. 265)

The clarity of the subsequent discussion will be enhanced by a slight digression to explain the general procedures involved in microanalysis. In the typical self-efficacy study, research participants are presented with a series of tasks arranged in a hierarchy of difficulty. In Bandura's work with phobics (Bandura & Adams, 1977; Bandura, Adams & Beyer, 1977), these tasks concerned approach responses to feared stimuli. In other studies, for example Schunk's (1981, 1982) research with underachieving children, the tasks consisted of arithmetic problems of increasing difficulty. Irrespective of the type of task, participants are usually asked to indicate whether they believe that they can perform the task by responding to questionnaire items and rating their performance confidence on a 100 point scale. Typically, the scale is partitioned into 10

increments, ranging from 10 (highly uncertain), through intermediate values, to 100 (complete certainty). Depending on the descriptors used in the scale, a level of self-efficacy which indicates a modicum of efficacy is chosen by the experimenter. In Bandura and Adams (1977), and Bandura, Adams and Beyer (1977), a level greater than 10 was designated as efficacious. In other studies, (e.g., Schunk 1981) a median-split method was used to dichotomize efficacious from nonefficacious expectancies. Regardless of the method employed, a count of the number of tasks toward which individuals feel minimally efficacious constitutes the level of self-efficacy. Microanalysis involves an analysis of the concordance between an efficacious rating of a certain task and the actual accomplishment of the individual when asked to perform that task.

To take a hypothetical case, suppose that a research participant had rated the first 5 tasks in a series of 10 with an efficacy of greater than 10 (an indication of at least minimal efficacy toward the first 5 tasks). In addition, suppose that the latter five tasks were rated less than 10. This series of judgements could be represented as a series of dichotomous values, say, + for efficacious judgements and -for nonefficacious judgements. In the present case, the self-efficacy of the hypothetical subject across the ten tasks would then be + + + + + - - - - -. Assume further that the hypothetical subject later completes the first 8 tasks successfully when they were once again presented. This

performance may be represented as + + + + + + + - -. The percentage agreement or concordance between the individual's efficacy judgements and performance would be 70%. The person's judgement and performance were mismatched on only 30% of the tasks (the sixth, seventh and eighth tasks). Notice that efficacy of a particular task is compared only to that task. A participant performing only the latter 5 tasks in a series of ten and who had specified efficacy on only the first 5 tasks, would have a concordance rate of 0%.

In general then, microanalysis consists of an examination of at least minimum expectancy and related performance across a series of tasks. Bandura argues that it is in this way that a finely grained analysis of the congruence between a person's self-efficacy percepts and performance is permitted. Additionally, researchers may also aggregate across individuals and specify group concordance rates.

Efficacy strength and performance studies. Twenty of the empirical studies reviewed report first-order correlations between efficacy strength and performance attainments. A summary of these studies is contained in Table 1. Several studies have been omitted from this list. These studies failed to include a measure of self-efficacy which was related to a specific performance, that is, they tended to treat self-efficacy as a trait, or alternatively, they failed to provide performance data, relying instead on self-reports of likely performance. An examination of this set of studies will be deferred until the end of this section, as these investigations

do not represent an adequate test of self-efficacy theory, at least as it is described by Bandura.

Of the twenty studies detailed in Table 1, the majority were conducted in laboratory or highly controlled settings. Eleven of the studies investigated approach or coping responses of phobics. Five others explored efficacy-achievement relationships in school children, typically in small group instructional settings outside the normal classroom. The remaining studies were conducted in somewhat less restrictive settings, ranging from regularly scheduled gymnastic competition (McAuley & Gill, 1983) to an unmodified freshman writing course (Meier, McCarthy & Schmeck, 1984).

Although the efficacy strength and performance correlations reported in Table 1 have a considerable range (.32 to .86), most are of moderate magnitude. The average correlation across these studies is .60 (median .55). Put differently, the strength of self-efficacy accounted for an average of 36% of the variance in performance across studies (range 10% to 74%). In general, the data show a moderate relationship between self-efficacy strength and performance attainment.

A closer look at Table 1 reveals that certain types of studies yield consistently higher correlations between self-efficacy and performance. In general, clinical investigations tend to report higher correlations than investigations which occur in educational or sport settings. The average correlation for clinical studies is .66, while average correlations for educational and sport studies are .53 and .48, respectively.

Table 1

Efficacy Strength and Performance Attainment

Study	Subjects	n	r	Performance
Bandura & Adams (1977) (Study 1)	snake phobics	10	.72	approach responses
Bandura, Adams & Beyer (1977)	snake phobics	33	.86	approach responses
Feltz, Landers & Raeder (1979)	university students	60	.37	back diving
Kazdin (1979)	nonassertive adults	45	.32	assertive behaviour
Bandura, Adams, Hardy & Howells (1980) (Study 1)	snake phobics	17	.74	approach responses
Bandura, Adams, Hardy & Howells (1980) (Study 2)	agoraphobics	11	.70	coping behaviour
Bandura & Schunk (1981)	underachieving children	40	.49	subtraction skills
Biran & Wilson (1981)	phobics	22	.74	coping responses
Pentz & Kazdin (1981)	adolescents	61	.41	assertive behaviour
Schunk (1981)	underachieving children	48	.57	division skills
Schunk (1982)	underachieving children	38	.73	subtractive skills
Barling & Abel (1983)	tennis players	40	.53	tennis skills
Barrios (1983)	heterosocially anxious males	20	.68	approach responses

Table 1 (cont'd)

Efficacy Strength and Performance Attainment

Study	Subjects	n	r	Performance
McAuley & Gill (1983)	gymnasts	52	.53	gymnastic skills
Schunk (1983a)	underachieving children	44	.51	subtraction skills
Schunk (1983c)	underachieving children	40	.35	division skills
Lee (1984b)	university students	33	.53	snake-handling task
Meier, McCarthy & Schmeck (1984)	university students	121	.42	composition skills
Williams & Watson (1985)	phobics	15	.77	approach responses

This difference is made more salient when viewed in terms of the average percentage of variance in performance accounted for by self-efficacy in each type of study. On average, self-efficacy accounts for 21% more variance in clinical performances, when compared to motor performance in sport settings, and 16% more variance when compared to academic performance.

It is somewhat hazardous to account for these differences as there are only a few studies of each type. Nevertheless, some speculation on this point may serve to highlight important differences between the various kinds of studies which have examined the relationship between self-efficacy and performance. One such difference lies in the settings in which the studies were conducted. Without exception, the clinical studies were conducted in highly structured laboratory settings, while the educational and sports studies took place in more natural settings. It is not too surprising that highly structured laboratory settings, which frequently involve close monitoring by the experimenter, yield a higher correlation between what individuals say they can do and what they actually do. It would be odd indeed, if research participants did not try to match predictions of their behaviour with commensurate performance under such circumstances. Much more will be said about the role of situational demand in self-efficacy research in a subsequent section of the review. For now, the important point is that the demand characteristics common to highly structured clinical studies may account for the higher correlations reported between self-efficacy strength and performance.

A second and equally important difference between the clinical investigations of self-efficacy and the remaining studies rests in features of the tasks toward which research participants make efficacy judgements. In clinical investigations, individuals appraise their efficacy on well-defined tasks, such as, holding a snake within 12 cm of their faces, or touching a snake with bare hands (Bandura & Adams, 1977). In addition, most clinical studies ensure that subjects are well acquainted with the exact nature of each task. This is accomplished either by directly exposing subjects to the tasks prior to self-efficacy appraisals (e.g., Bandura, & Adams 1977; Bandura, Adams, Hardy, & Howells, 1980) or by providing vivid verbal descriptions and examples of the performance tasks prior to efficacy appraisal (e.g., Barrios, 1983). Thus, by the nature of the clinical tasks and the procedures employed in most clinical investigations, the tasks are well defined and distinct.

In contrast, performance tasks in nonclinical studies are not as clearly defined. In Schunk's studies of the relationship between self-efficacy and academic achievement (Bandura & Schunk, 1981; Schunk, 1981, 1982, 1983a, 1983b), children make self-efficacy judgements on arithmetic tasks which require subtle distinctions. For example, in one study (Schunk 1981) children were presented with subtraction problems which involved either no borrowing, borrowing once, borrowing from one, borrowing twice, borrowing caused by a zero, or borrowing across zeros. After completing an arithmetic test, the children were

presented with subtraction problems of each type for 2 seconds, and asked to appraise their efficacy expectations. The appraisal of self-efficacy in this situation would appear to be substantially more difficult than similar appraisals made on clinical tasks. First, the tasks differ in subtle ways and as such, require the children to appraise their capacity with reference to subtle distinctions. The 2-second exposure of each problem type would also be expected to increase the difficulty of accurate efficacy appraisal. Additionally, it should be noted that the children in Schunk's investigations were underachieving students. One of the characteristics of children with generally poor arithmetic skills is that they display reduced skill at discriminating problem types which necessitate different computational procedures (Hammill & Bartel, 1975). All of these factors are likely to contribute to inaccurate self-efficacy appraisal and as such, are likely to attenuate the relationship between self-efficacy strength and performance reported in this group of studies.

Efficacy level and performance studies. As noted earlier, efficacy-performance relationships may also be explored by examining the relationship between the level of self-efficacy and corresponding performance. Sixteen of the studies reviewed report efficacy level and performance data (see Table 2). With the exception of two studies (Schunk, 1981 1983e), all of these are clinical investigations. The vast majority of these studies have been concerned with the approach responses of phobic individuals to fear-eliciting objects. The studies which have

explored the relationship between the level of self-efficacy and performance are thus more restricted than those studies which have examined the relationship between the strength of self-efficacy and performance. This restriction is evident both in setting (typically laboratory) and the specific performance (typically approach responses).

Twelve of the sixteen studies reviewed report efficacy-level performance correlations. These correlations are somewhat higher than those found in the efficacy-strength studies discussed earlier. The average correlation is .68 (median .72), with a range of .37 to .86. Approximately 46% of the variance in performance attainments examined in these eleven studies is accounted for by individuals' level of self-efficacy.

As mentioned earlier, Bandura has called for an analysis of self-efficacy level and performance in terms of the concordance rate between judgements and specific performances (Bandura 1977, 1980). Of the fifteen studies reporting efficacy-level performance data, eleven have included concordance information. Of these eleven, seven were conducted by Bandura. Further, all but one (Schunk 1981) were clinical investigations, and all of these were clinical studies of phobias. The literature exploring the rate of concordance between the level of self-efficacy and performance is thus very restricted, in terms of the author of the work (63% by Bandura and his colleagues), the setting (90% clinical), and the research participants (90% phobics).

Table 2

Efficacy Level and Performance Attainment

Study	Subjects	n	r	C.R. ^a	Performance
Bandura & Adams (1977) (Study 1)	snake phobics	10	.75	84%	approach responses
Bandura & Adams (1977) (Study 2)	snake phobics	6	--	92%	approach responses
Bandura, Adams & Beyer (1977)	snake phobics	33	.84	87%	approach responses
Kazdin (1979)	nonassertive adults	45	.40	--	assertive behaviour
Bandura, Adams, Hardy & Howells (1980) (Study 1)	snake phobics	17	.70	81%	approach responses
Bandura, Adams, Hardy, & Howells (1980) (Study 2)	agoraphobics	11	.78	88%	coping behaviour
Biran & Wison (1981)	phobics	22	.53	81%	coping behaviour
Gauthier & Ladouceur (1981)	university students with snake fears	40	.86	84%	approach responses
Pentz & Kazdin (1981)	adolescents	61	.37	--	assertive behaviour
Schunk (1981)	underachieving children	48	--	71%	division skills
Bandura, Reese & Adams (1982) (Study 2)	snake phobics	10	--	88%	approach responses
Bandura, Reese & Adams (1982) (Study 2)	spider phobics	14	--	89%	approach responses

Table 2 (cont'd)

Efficacy Level and Performance Attainment

Study	Subjects	n	r	C.R. ^a	Performance
Schunk (1983e)	underachieving children	34	.70	--	division skills
Lee (1984a)	university students	40	.73	--	assertive behaviour
Lee (1984b)	university students	33	.66	92%	snake handling task
Williams & Watson (1985)	phobics	15	.61	--	approach responses

^aC.R. is the concordance rate.

An examination of Table 2 indicates little variance between studies in the magnitude of reported concordance rates. The range of concordance rates is from 71% to 92%, with a mean value of 85%. The median concordance rate across studies was similar at 87 percent. Much of the agreement found across these studies may well be attributable to the highly similar settings and sample characteristics of the investigations.

At first glance the magnitude of the concordance rates reported in these studies is quite impressive, particularly since one might expect only a 50% chance concordance between independent dichotomous judgements of self-efficacy and task performance. As Kirsch (1980) has noted, however, the hierarchical nature of the tasks commonly employed in the assessment of self-efficacy renders efficacy judgements dependent. Further, Kirsch and Wickless (1983) furnish evidence that the degree of dependence is very high. In their analysis of Bandura's Behavioural Avoidance Test, coefficients of reproducibility¹ ranged from .97 to .99, indicating that performance and self-efficacy measures on this test are valid Guttman scales.

To illustrate the source of this dependence, consider Bandura's Behaviour Approach Test once again. Subjects are presented with a series of tasks arranged in an ascending order of difficulty. Their performance on a given task frequently necessitates successful performance on previous tasks. For example, one cannot hold a snake within 12 cm of one's face without completing the subordinate tasks of approaching the cage

and touching the snake. Successful performance on higher tasks requires successful performance on lower tasks. This task dependence renders subjects' efficacy judgements dependent in a similar way. One's judgement about one's ability to hold a snake within 12 cm of one's face is related to prior appraisals on subordinate tasks. It would be unlikely and exceedingly incoherent for an individual to maintain that he could hold a snake close to his face, but was unable to approach a cage containing the snake.

The dependent nature of the tasks utilized in the assessment of the concordance between self-efficacy and performance creates a number of difficulties. First, the chance rate of concordance is much higher than would be expected using independent tasks. In a most apt illustration of this, Kirsch and Wickless (1983) report a median concordance rate of 74% when efficacy judgements and performance on the Behavioural Avoidance Test were matched randomly for 36 research participants. The magnitude of the concordance rates reported in Table 2 obviously are rendered less impressive, and perhaps entirely uninformative by the high chance concordance rates resulting from high task dependence.

The evidence indicating that the Behavioural Avoidance Test is a Guttman scale also renders Bandura's call for the microanalysis of self-efficacy and performance unnecessary. By definition, all of the information about the relationship between task performance and self-efficacy judgements is contained in the total scores of performance and efficacy judgements, if each is a Guttman scale. Successful performance

or accurate judgements about performance capabilities on the n^{th} level of a Guttman scale implies a similar state of affairs on all previous task levels. It is therefore unnecessary to compute the concordance between efficacy judgements and performance within each task level. The same information is contained in total performance and total efficacy scores.

Lastly, it should be noted that the practice of using chi-square analyses of concordance rates, which is found frequently in the self-efficacy literature, is inappropriate for dependent observations. Given the hierarchical nature of the tasks used in the assessment of self-efficacy, researchers need to assess scale characteristics by calculating coefficients of reproducibility before applying chi-square analyses. Generally, coefficients of reproducibility of .85 or greater suggest valid Guttman scales (Ghiselli, Campbell & Zedeck, 1981) and indicate that the level of total self-efficacy and total performance should be the focus of statistical analysis. Alternative procedures for analyzing the concordance between self-efficacy and performance are offered by Cervone (in press).

To summarize, it appears that efficacy strength and efficacy level correlate moderately with performance. An examination of the 20 studies which report efficacy strength and performance correlations suggest that about 36% of the variance in performance is accounted for by individuals' self-efficacy. Self-efficacy level and performance correlations reported in 12 of the studies reviewed are generally higher, and indicate that the level of self-efficacy accounts for 46% of the variance in

performance. The generally higher correlations found in this latter set of investigations may be due to the relatively homogenous sample and setting of the studies. Those studies employing microanalysis report an average concordance rate of 85% between performance and self-efficacy level. Again, this group of studies was composed almost exclusively of clinical investigations of phobics and as such, the generality of this high concordance awaits future empirical evidence over a wider range of performance tasks. Moreover, the high concordance rates reported are due, to a very large degree, to the dependent nature of the self-efficacy tasks employed in this series of studies. This fact, coupled with associated statistical problems, renders much of the concordance-rate evidence suspect.

Generally then, and within the confines just described, self-efficacy level and strength have a moderate correlation with performance. This conclusion is consistent with Bandura's contention that self-efficacy is a determinant of performance. However, the correlational nature of these data prohibit a stronger interpretation that self-efficacy percepts bear a causal relationship to performance.

Efficacy strength and persistence studies. A second aspect of efficacy-performance relationships concerns behavioural persistence. As discussed in the introductory section, Bandura posits that individuals who judge themselves to be highly efficacious on a particular task will not only evidence higher performance, but will also persist longer when presented with arduous tasks. A summary of the studies which have assessed the

relationship between the strength of self-efficacy and persistence is contained in Table 3.

Eleven of the empirical studies reviewed have directly tested the relationship between self-efficacy strength and behavioural persistence. Despite being few in number, these studies are reasonably diverse in setting, participants and type of performance. As before, some of these investigations have occurred in laboratory settings and utilized rather contrived tasks. For example, Weinberg, Gould and Jackson (1979) and Gould and Weiss (1981) investigated the relationship between the strength of self-efficacy and the persistence of participants in extending their legs perpendicular to their torsos. Other studies have, however, examined self-efficacy strength and persistence under less contrived circumstances. For example, a series of studies (Condiotte & Lichtenstein, 1981; DiClemente 1981; McIntyre, Lichtenstein, & Mermelstein, 1983) report correlations between end of treatment self-efficacy and smoking abstinence at treatment follow-up. Manning and Wright (1983) add to this diversity by reporting correlations between self-efficacy and persistence in medication-free labour of 52 primiparous women.

It is perhaps due to the diverse nature of these studies that one finds concomitantly diverse results. Although the vast majority of studies exploring the relationship between self-efficacy and persistence report positive correlations, the range is quite large (-.30 to .78). In general, the magnitude of correlations reported in this set of studies tends to be lower

Table 3

Efficacy Strength and Persistence

Study	Subjects	n	r	Performance
Weinberg, Gould & Jackson (1979)	university students	60	.68	muscular endurance task
Bandura & Schunk (1981)	underachieving children	40	.42	subtraction problems
Condiotte & Lichtenstein (1981)	smokers	78	.59	smoking abstinence at 3 mos. follow-up
DiClemente (1981)	smokers	43	.42	smoking abstinence at 50 mos. follow-up
Gould & Weiss (1981)	university students	120	.26	muscular endurance task
Schunk (1981)	underachieving children	48	.30	division problems
Prochaska, Crimi, Lapsanski, Martel & Reid (1982)	smokers and recent nonsmokers	62	.78	smoking abstinence
Schunk (1982)	underachieving children	38	.48	subtraction problems
Manning & Wright (1983)	primiparous women	52	.42	percentage of time in labour without medication
McIntyre, Lichtenstein & Mermelstein (1983)	smokers abstinent at end of treatment	41	.37	smoking abstinence at 3 mos. follow-up
Schunk (1983a)	underachieving children	44	-.30	subtraction skills

than those reported between self-efficacy and performance. The mean correlation across studies is .47 (median .42). Stated another way, the general consensus of the studies reviewed is that the strength of self-efficacy accounts for about 22% of the variance in task persistence.

Schunk's (1983a) study warrants some discussion because his finding of a $-.30$ correlation between self-efficacy and persistence is at considerable variance with the rest of the research which has addressed this issue. In this study, 44 children who were identified by their teachers as possessing poor subtraction skills were assigned randomly to one of four treatments. The treatment consisted of the type of feedback (ability, effort, ability and effort, no feedback) given to children while they completed instructional materials designed to remediate their skill deficits. Pretest and posttest measures were taken on subtraction accuracy (number of correct solutions on a 25 item test), self-efficacy (assessed on each arithmetic item and summed across items) and persistence (average number of seconds per problem).

A closer look at Schunk's results suggests a possible reason for the inverse relationship between efficacy and persistence. Irrespective of the treatment condition, the children made large gains in their subtraction skills, from a pretest group mean of 4.47 correct problems, to a posttest group mean of 13.15 problems. The increased competence evidenced by the children renders the 25 item posttest of lesser general difficulty and as such, there would be fewer items requiring the children to

evidence persistent behaviour. Given this, it is not too surprising that when persistence is averaged across items the children evidenced less persistence. Simply put, there were fewer problems which required persistence, because of increased skill competence.

A general point needs to be made regarding the interrelationship of task difficulty, self-efficacy and persistence. Studies which examine self-efficacy and behavioural persistence run the risk of underestimating this relationship if an increase in behavioural competence also occurs. Researchers must analyze their data across tasks of equivalent difficulty as gauged by the skill level of the learner at the time the task is performed. Failure to do so will result in a confounding of effortful behaviour with task difficulty.

Efficacy level and persistence studies. Only two studies in the literature reviewed report data regarding the relationship between self-efficacy level and persistence. Schunk (1983e), in a study similar to the one just described, found a correlation of .43 between children's level of self-efficacy and their persistence at solving division problems. Gould and Weiss (1981) report a lower correlation of .31 in their study of persistence on a muscular endurance task (horizontal leg-extensions) with a group of 120 female university students.

In summary, the studies reviewed in this section indicate a moderate relationship between self-efficacy and persistence. The bulk of these studies have examined the relationship between

the strength of self-efficacy and persistence. The overall finding of these investigations is that efficacy strength accounts for about 22% of the variance in behavioural persistence. Few studies have examined efficacy-level persistence relationships. Those which have, Schunk (1983e) and Gould and Weiss (1981), report correlations of .43 and .31, respectively.

In general, Bandura's contention that self-efficacy is related to persistence finds some support in the data. The relationship is, however, less clear in those studies which attempt to increase self-efficacy by enactive means, because this results in increased behavioural competence and lessens the need for individuals to persist with tasks. The relationship between self-efficacy and persistence thus is more complicated than simply suggesting that self-efficacy increases will be met with increases in persistence. Additional empirical work is needed to address how task difficulty mediates self-efficacy and persistence.

Other studies of self-efficacy and performance. A number of studies have examined self-efficacy as a very general construct. This usually involves the development of self-efficacy scales which tap expectations toward large classes of behavioural performance, rather than specific behavioural tasks. Taking this tack, researchers have examined physical self-efficacy (Rychman, Robbins, Thornton & Cantrell, 1982), academic self-efficacy (Barling & Snipelisky, 1983; Keyser & Barling, 1981), mathematics self-efficacy (Betz & Hackett, 1983) and general

self-efficacy (Sherer et al., 1982).

Although these studies might be criticized for their failure to operationalize self-efficacy in accordance with Bandura's theory, that is, as a situationally specific percept, they warrant discussion on a number of counts. First, the self-efficacy literature contains a reasonably large number of these investigations and as such, they represent an excursion which is noteworthy in its own right. Second, the usefulness of self-efficacy theory would be enhanced greatly by the finding of a more general construct. This would enable researchers and clinicians to examine self-efficacy without the development of an extremely large number of efficacy probes (Kazdin, 1978). More importantly though, these studies provide an opportunity to examine whether Bandura's recommendation that self-efficacy be assessed as a specific percept has more utility in explaining human performance than do more general conceptualizations of self-efficacy. If Bandura is correct, more variance in performance would be explained by self-efficacy viewed as a specific percept than when it is construed in more global terms. Moreover, the extent to which situationally specific measures of self-efficacy are better predictors of performance is an important question. Even if Bandura is correct in his assertion that these measures are better predictors of performance, the added predictiveness may be of only marginal utility, given the effort which is required to generate self-efficacy instruments for an exceedingly large domain of behaviours.

In order to examine the relative merit of global versus task-specific measures of self-efficacy, comparisons might be made between those studies incorporating global assessment procedures and those discussed earlier. Since some variance in the relationship between self-efficacy and performance is due to the context in which the studies are conducted, it is perhaps prudent to contrast studies within similar settings. The following discussion takes this direction and as such, is somewhat of a selective comparison.

Keyser and Barling (1981) report data on the relationship between self-efficacy and performance using a global measure of self-efficacy. In their study, the academic self-efficacy of 504 children was assessed on a 20-item, 5-point Likert scale (Children's Self-efficacy Beliefs Scale). Items in the scale required children to judge their confidence in global areas, such as reading, arithmetic and school in general (e.g., I can pass well this year). Academic performance was measured by combining the composite scores on the spelling and arithmetic subtest of the Wide Range Achievement test. Among other findings, Keyser and Barling found no correlation between their academic self-efficacy scale and the children's academic performance.

In a similar study, Barling and Snipelisky (1983) explored the relationship between a modified version of the Children's Self-efficacy Beliefs Scale and academic performance as indicated by the average of the end of semester grades. Results of an analysis of 384 children in grades 2 through 7 suggest

that about 14% of the variance in academic grades is accounted for by self-efficacy as measured by their scale. This is a substantial reduction in predictiveness, when compared to studies in academic settings which have utilized task-specific measures of self-efficacy. These latter studies generally found that self-efficacy accounts for 28% of the variance in academic performance.

A more direct comparison of task-specific and global measures of self-efficacy is found in the work of McAuley and Gill (1983). In this study the Physical Self-efficacy Scale developed by Ryckman, Robbins, Thornton and Cantrell (1982) was compared explicitly to task-specific probes of self-efficacy. Fifty-two gymnasts completed both the Physical Self-efficacy Scale and task-specific measures of self-efficacy just prior to competing in four gymnastics events (vault, beam, floor and bars). Following the gymnastic meet, scores for each gymnast during each event were tabulated from the appraisals of official judges. Performance on only two of the four events, bar and floor routines, was related to scores on the Physical Self-efficacy Scale. Additionally, the correlations were low, with 6 and 8 percent of the variance in performance on bar and floor events being predicted by the scale. In contrast, significant correlations are reported for all task-specific measures of self-efficacy. The average correlation across events was .53. The magnitude of this correlation represents an average fourfold increase in the prediction of performance over general measures of self-efficacy.

Although there are other studies in the literature which have used global measures of self-efficacy, these typically have relied upon self-reports of likely performance as dependent measures, rather than upon actual performance measures. Since these studies do not measure actual performance, they are mute on the issue of whether global or task-specific measures of self-efficacy are better predictors of behaviour. Given this, and the limited number of studies which have explicitly contrasted global and task-specific measures of self-efficacy, any conclusions regarding the relative merits of these two assessment methods are tenuous at best. There is nevertheless some evidence that task-specific measures of self-efficacy are better predictors of performance. Admittedly, it could just as easily be concluded that existing global measures of self-efficacy are flawed. Regardless of how one views the present evidence, it is clear that more empirical attention is needed on this issue.

Studies of the reciprocal relationship between self-efficacy and performance. Before leaving the discussion of the relationship between self-efficacy and performance, some mention should be made of those studies which have examined the reciprocal nature of these variables. As noted previously, a central tenet of self-efficacy theory is that self-efficacy and performance are mutual determinants of one another. In this way, performance accomplishments lead to increased self-efficacy, which in turn increases subsequent performance, which once again heightens self-efficacy. Self-efficacy thus is

hypothesized to be an effect of previous performance and a cause of subsequent performance as both intertwine across time.

Much of the previously discussed research concerning self-efficacy and performance has been unidimensional in nature. These studies have typically analyzed self-efficacy and performance at the same time, rather than across time, and as such, they do not speak directly to the issue of whether there is a reciprocal relationship between these two variables. Of notable exception, however, are two studies conducted by Feltz (1982) and Feltz and Mungo (1983). Both of these studies employed path analysis to investigate the causal elements in Bandura's theory. Although path analytic studies cannot demonstrate cause and effect relationships, they are useful here in that they may provide data which lend indirect evidence bearing on the reciprocal nature of self-efficacy and performance.

The Feltz (1982) and Feltz and Mungo (1983) studies employed identical research procedures. In each study, the backdiving performance of 80 female college students was assessed and related to efficacy strength and physiological arousal (heart rate) over four trials. This procedure allowed for the decomposition of the reciprocal effects of these variables over time. Of most interest to the present discussion is the finding in both studies that there was a reciprocal influence between self-efficacy and performance over trials. This finding is tempered somewhat, however, by the additional finding that self-efficacy's influence on performance waned over trials, while the

contribution of previous performance increased. Given this, the data suggest that, while self-efficacy and performance do enhance one another in a reciprocal fashion, the mediational role of self-efficacy is reduced substantially over time. Further empirical work in different settings is needed to explain why this should be so.

Research on the Acquisition of Self-efficacy

The purpose of this section is to evaluate the claims made by Bandura about how individuals acquire efficacy expectations. The discussion begins with a general description and evaluation of those studies which have attempted to demonstrate changes in self-efficacy arising from the four main information sources delineated by Bandura (i.e., enactive, vicarious, exhortative, physiological). As the research pertaining to each of these sources of efficacy expectations is examined, particular attention will be paid to variables which have been found to enhance the acquisition of self-efficacy. The last task of this section is to review studies which have contrasted the four sources of efficacy information, and in doing so, highlight evidence bearing on Bandura's remarks regarding the relative potency of efficacy information gleaned from each source.

Studies of enactive acquisition of self-efficacy. It was mentioned much earlier in the discussion that a highly influential source of efficacy information is garnered from individuals' prior successful performance on tasks. Bandura

(1977) proposes that there are a number of different ways of inducing changes in self-efficacy which rely primarily on enactive sources of information. Of these various modes of induction, self-instructed performance and participant modeling have received empirical attention in the self-efficacy literature.

Eight studies provide evidence bearing on the acquisition of efficacy expectations by self-instructional means (Bandura & Schunk, 1981; Schunk, 1981, 1982, 1983a, 1983b, 1983c, 1983d, 1983e). This group of studies is highly homogenous, with all studies taking place in educational settings and all using underachieving children as research participants. Similarities are also apparent in the use of arithmetic tasks, either subtraction or division problems, both as performance measures and as the focus of self-instructional activity. In all cases, children worked without aid on self-paced instructional materials in either division or subtraction skills over a number of sessions. All of these studies report large and significant pretest to posttest gains in both the level of self-efficacy (Schunk, 1981, 1983d, 1983e) and the strength of self-efficacy (Bandura & Schunk, 1981; Schunk 1982, 1983a, 1983b, 1983c). Gains in self-efficacy occurred concomitantly with achievement gains, as evidenced by the moderate and positive correlations between self-efficacy and performance detailed earlier.

Of greater interest perhaps are findings related to variables which tend to enhance the acquisition of self-efficacy under self-instructional treatments. The differential effects

of four classes of variables have been examined to date. They are effects arising from differing attributional feedback (Schunk, 1981, 1982, 1983a), enactive monitoring procedures (Schunk 1983d), contingent reward (Schunk 1983e) and goal setting (Bandura & Schunk, 1981; Schunk, 1983b, 1983c). The discussion now turns to a closer examination of these investigations.

In a sound piece of research, Schunk (1983a) examined the relative effects of effort and ability feedback on the self-efficacy of underachieving children after they completed a self-instructional package designed to remediate weaknesses in subtraction skills. A comparison of the four groups created by the complete factorial combination of type of feedback (i.e., ability, effort, ability and effort, and no feedback), showed superior performance and stronger self-efficacy in the ability feedback group when contrasted to each of the other three groups. It is noteworthy that this finding adds some evidence to Bandura's claim that performance success which is attributed to ability will generally result in higher efficacy expectations. He hypothesizes that this will occur because effort attributions may communicate to individuals that a given task is beyond their current competencies, and as such, lower expectations of personal mastery.

The two additional studies of attributional effects have been concerned exclusively with effort feedback. In the first of these, Schunk (1981) presents data which suggest no differential effects of effort attributions on self-efficacy or

arithmetic achievement when contrasted to a no-feedback condition. In the second, and perhaps more interesting study, Schunk (1982) manipulated the temporal referent of the effort feedback given to children as they worked through a self-instructional program. Children in one group received effort feedback related to their past accomplishments (e.g., you have been working hard), while children in another group received feedback related to their future effort (e.g. you need to work hard). Two additional groups also were incorporated in the study. One group engaged in the self-instructional activities, but received no feedback and the other served as an uninstructed control group. Of principal interest to the present discussion are Schunk's findings of differential effects on self-efficacy and achievement produced by the attribution treatments. The group receiving effort feedback linked with past accomplishments evidenced substantially greater self-efficacy and greater achievement compared with all other groups.

The findings of this latter study are important on two counts. First, the relationship between effort feedback and self-efficacy appears to be complicated by additional features of the feedback. Given the frequent use of effort feedback, particularly in educational settings, further investigation of the kind of effort feedback which is most effective in inducing increased self-efficacy is definitely warranted. Second, this finding suggests that research which contrasts the relative effects of effort and ability feedback needs to attend to the kind of effort feedback which is contrasted. It may well be

that the superiority of ability feedback in engendering higher self-efficacy depends on the kind of effort feedback used as the comparison.

The effect of goal-setting during self-instruction on self-efficacy also has received empirical attention in a number of studies. In the earliest of these works, Bandura and Schunk (1981) provide evidence that children who set proximal goals during self-instructed arithmetic activities experience greater increases in self-efficacy than children in similar conditions who set distal goals, or no goals. Greater gains in arithmetic performance were also evident in the proximal-goal group when contrasted to each of the other groups. Again, both increased self-efficacy and achievement would be expected based on self-efficacy views of performance. Presumably, children in the proximal-goal group experienced heightened self-efficacy by frequently meeting attainable goals. In contrast, those children in the distal-goal group experienced gains in performance which were too discrepant from the goal to instill large gains in self-efficacy.

A second and important dimension of goal setting rests with the difficulty level of the goals. Self-efficacy theory predicts that goals of moderate to high difficulty precipitate judgements of greater self-efficacy than do more lenient goals. The attainment of difficult goals during self-instruction is hypothesized to impart an increased sense of personal competence; whereas, the accomplishment of easy goals communicates little reason for individuals to feel more

efficacious.

Schunk (1983b, 1983c,) provides some empirical evidence for this claim. In yet another study examining changes in self-efficacy as children complete self-instructional arithmetic material, Schunk reports greater increases in self-efficacy under conditions of greater goal difficulty. However, this finding is complicated by the additional finding that this relationship held only for conditions where the experimenter described the goal as being derived from his knowledge of the task. In conditions where the experimenter indicated that the goal was derived from his knowledge of the performance of other children (social comparative reference), no effects on self-efficacy were found to be due to goal difficulty.

To complicate matters further, Schunk (1983b) reports data which suggest that when moderately difficult goals are augmented with both task related and comparative goal-setting information, higher rates of arithmetic problem solving accuracy are found when compared to each condition considered separately. Differences in self-efficacy, however, were not found between the condition where both kinds of comparative information were included and the one in which only task-related information was used. This finding of achievement gains without increases in self-efficacy strength certainly requires additional attention.

The two remaining studies of the enhancement of self-efficacy by self-instruction have explored the effects of contingent reward and performance monitoring. As with goal-setting, both the receipt of performance related rewards and the

monitoring of performance are predicted to heighten expectations of personal mastery. Schunk's work generally supports these two contentions. In the first of these studies, Schunk (1983d) examined the effects of self-monitoring and external monitoring on both self-efficacy level and subtraction skill accuracy while children engaged in self-instructional activities. Relative to a no-monitoring group, large gains in self-efficacy and achievement were found for children who engaged in self-monitoring or who were externally monitored. No differences were present between the self and externally monitored groups. In the second study (Schunk, 1983e) children receiving performance contingent reward exhibited larger increases in self-efficacy level and achievement, than children who received rewards for participating in the study or who received unexpected rewards.

From the results of the studies just discussed, a number of variables appear to affect the acquisition of self-efficacy during self-instruction. Consistent with Bandura's claim, self-efficacy is enhanced more when individuals receive feedback which ascribes success to ability, rather than effort (Schunk, 1983a). The general effects of effort feedback on self-efficacy are somewhat complex, however, with some research (Schunk, 1982) suggesting that effort feedback which is linked to past accomplishments increases self-efficacy when compared to effort feedback which is linked to future success. The setting of proximal goals, rather than distal goals also tends to enhance self-efficacy (Bandura & Schunk, 1981), as does the setting of

more difficult goals (Schunk, 1983c). It should be noted that this latter finding appears to hold only for goals which are derived from task sources, rather than social comparative sources. Finally, both performance monitoring (self or external) and contingent reward tend to enhance self-efficacy (Schunk, 1983d, 1983e).

A second method of inducing changes in self-efficacy is participant modeling (Bandura, Jeffery & Wright, 1974; Bandura, 1977). This technique is quite specific in terms of its application and its scope. Phobics are guided through approach responses to fear-eliciting situations which are arranged hierarchically. This guided exposure begins with a modeling phase, where phobics witness a model engage in approach or coping responses. Following this vicarious exposure, the phobic is instructed to perform the same response. This second phase typically employs various response aids, particularly during the initial acquisition of the desired approach response. For example, in snake handling tasks, the snake phobic may be aided by the therapist holding the snake along with the individual. In addition, individuals may use gloves and other supporting aids to lessen the fear-evoking characteristics of the snake. The last phase of participant modeling is characterized by unaided performance by the phobic.

Some general differences between participant modeling and self-instruction need to be emphasized at this point. First, although participant modeling relies heavily on enactive exposure as a means of changing self-efficacy, it is clear that

it is not entirely an enactive means of conveying efficacy information. In contrast to self-instruction, many other sources of efficacy-bearing information are present in participant modeling. Individuals, for example, may glean estimates of their own capacities by observing a therapist's nonphobic reactions to objects which the phobic fears. Indeed, in line with Bandura's own account of self-efficacy theory, this source of self-efficacy is vicarious, not enactive. Further, during participant modeling, individuals may be exposed to the verbal persuasion of the therapist. Again, this renders participant modeling not entirely enactive. Participant modeling is thus mainly enactive, but not exclusively so.

Participant modeling can be contrasted further from self-instruction by the use of various modifications to tasks during induction. Following therapist modeling, various induction aids may be employed when individuals fail to exhibit appropriate approach responses. The use of these induction aids will depend on the individual's response, or more correctly his or her lack of response. In this way, the setting of enactive tasks is controlled and modified by the therapist depending upon the client's performance. This differs sharply from the task experience present during self-instruction, which remains the same across individuals.

Five studies in the literature reviewed here have investigated the effects of participant modeling on self-efficacy. The major focus of these studies have been confined to investigating the change in self-efficacy during the

acquisition of approach or coping responses to high-avoidance situations. The bulk of these investigations have been conducted either with snake phobics (Bandura & Adams, 1977; Bandura, Adams & Beyer, 1977; Bandura, Reese & Adams, 1982) or agoraphobics (Bandura, Adams, Hardy & Howells, 1980). One study (Feltz, Landers & Raeder, 1979) has investigated self-efficacy change following participant modeling of back-diving performance. All of these investigations report large and statistically significant gains in self-efficacy and performance resulting from participant modeling.

As noted earlier, participant modeling is a hybrid technique which incorporates a number of different sources of efficacy information. Although a complete analysis of the relative contribution of each of these information sources to the effects of participant modeling on self-efficacy has not been conducted, a closer look at two of the participant-modeling studies provides some data on this important question.

In the first of these studies, Bandura, Reese and Adams (1982) examined the changes in self-efficacy and approach responses of 10 snake phobics. In line with other investigations of participant modeling, Bandura et al. report large gains in self-efficacy due to the participant modeling treatment. Of particular interest is the additional finding that there was a 14% increase in perceived self-efficacy which was due solely to the first phase of participant modeling. It was alluded to earlier that this phase of participant modeling is characterized by the therapist modeling approach responses

and as such, is a vicarious rather than enactive component of participant modeling. Given the foregoing, Bandura's own work suggests that a vicarious component of what he describes as an enactive induction technique is responsible for some of the general change in self-efficacy produced by participant modeling.

All of the changes in self-efficacy produced by participant modeling, of course, are not due to the modeling phase of this treatment. Feltz, Landers and Raeder (1979) indicate that the second phase of participant modeling, guided practice, produces substantial changes in self-efficacy when compared to a modeling only phase. This study in part contrasted the back-diving performance of university students who received either a live modeling only or a live modeling with participant modeling treatment. An examination of performance over eight trials indicated that individuals receiving participant modeling evidenced greater gains in self-efficacy and back-diving skill, when compare to those receiving only the modeling treatment and unaided practice.

To summarize, the research generally supports Bandura's contention that participant modeling is an effective means of increasing self-efficacy (Bandura, 1977; Bandura, Adams & Beyer, 1977). In addition, some evidence for the more general claim that efficacy expectations are gleaned from enactive sources is provided by this research. Support for this latter claim, however, is weakened by the concurrent finding that increases in self-efficacy are produced by components of participant modeling

which are not enactively based. In this way, some, but not all, of the effects of participant modeling provide evidence for the enactive enhancement of self-efficacy.

Research which disentangles the relative impact of the various information sources present in participant modeling is definitely necessary. The general effects on self-efficacy of performance aids used during participant modeling warrants particular empirical work. On the one hand, such aids may increase efficacy expectations inasmuch as they function to enhance performance. On the other hand, performance made under aided conditions may result in little increase in personal agency as individuals may attribute their increased performance to the aid (Bandura, 1977). In addition, research which explores the effects of various types of attributional feedback during the guided performance phase of participant modeling would be a useful extension to some of the previous work which has explored these variables during self-instructed practice.

Studies of vicarious acquisition of self-efficacy. A second general source of efficacy expectations is found in vicarious experience. Bandura posits that as one observes the successful performance of others, one's sense of one's capacity to perform in a similar fashion is heightened. A number of studies have examined changes in self-efficacy arising from vicarious sources. These investigations can be divided into two general types: those which have examined effects arising from overt modeling and those which have investigated effects due to covert modeling. The discussion now turns to an examination of each of

these types of studies. As before, particular attention is paid to those studies that have investigated variables which affect the transmission of self-efficacy.

The general claim that overt modeling is an effective means of inducing changes in self-efficacy has received attention in several studies. In a clinical setting, Bandura, Reese and Adams (study 2, 1982) report large and statistically reliable gains in Behavioural Avoidance Test performance, and in the level and strength of self-efficacy exhibited by spider phobics following a treatment consisting of a therapist modeling approach and coping responses. In a similar investigation with snake phobics, Bandura, Adams and Beyer (1977) found increased performance and self-efficacy in a group receiving overt modeling when compared to a no-treatment control. In addition, their data suggest that the longer subjects were exposed to the modeling treatment, the greater were their gains in performance and self-efficacy.

Results which are contrary to the two studies just mentioned are found in the research of Pentz and Kazdin (1982). Again in a clinical setting, Pentz and Kazdin examined the effects of modelling type (covert, overt and no modeling) and of the number of models employed during treatment (single or multiple) on the assertive behaviours of 36 unassertive and 25 aggressive adolescents. Of particular relevance to the present discussion, is Pentz and Kazdin's finding of no significant pretest-posttest gains in self-efficacy level or strength due to the overt-modeling treatment with a single model. This occurred despite

large gains in assertive behaviour for this group. In part, the lack of statistically significant changes in self-efficacy reported in this study may be due to the small cell size (8 to 10) and resultant low statistical power present in the study.

The general effect of overt modeling on self-efficacy has received attention in a number of other contexts. Feltz, Landers and Raeder (1977) explored the effects of live and videotaped modeling on the backdiving performance of 60 university students. Both modeling treatments resulted in significant gains in self-efficacy and performance over a number of trials, although some caution is necessary in interpreting this finding, since modeling treatments included considerable enactive practice and feedback. In perhaps a more direct test of modeling effects, Schunk (1981) found that children who observed a model verbalize solution strategies while solving division problems evidenced increases in self-efficacy. As expected, children in the study also displayed increases in division skills and problem persistence.

The literature exploring overt modeling and self-efficacy has not been limited to demonstrating simply that efficacy expectations can be induced by vicarious treatments. Several other studies have examined specific aspects of modeling which serve to enhance the influence of modeling on self-efficacy. The chief focus of these investigations has been on the effects of model-observer similarity and on the effects of model verbalizations.

Research which addresses questions concerning the effects of model similarity on self-efficacy provides an opportunity to judge Bandura's claim that models who are similar to observers are a more influential source of self-efficacy than are models who are dissimilar. Two studies provide data which speak to this claim. In the first of these, Gould and Weiss (1981) explored the effects of gender similarity. In this study, female university students viewed a 60 second videotape of a male or female model perform a muscular endurance task (horizontal leg extensions while seated). An analysis of performance endurance, self-efficacy level, and self-efficacy strength revealed larger gains across these variables for those subjects who observed the same sex model. Indeed, the effects on self-efficacy were quite large with similar-model groups experiencing a twofold increase in efficacy strength over dissimilar-modeling groups.

In an analogous study, Brown and Inouye (1978) investigated the effects on self-efficacy of experimenter remarks which alluded to the similarity or dissimilarity of problem-solving competence present between observers and a model. In this study, 40 college students observed a model repeatedly fail to solve a series of anagrams. Prior to observing the model, the college students were led to believe that their anagram solving skills were either similar to those of the model, or were greater than those of the model. In addition to these two groups, a third group received no competency information, while another group served as a no-modeling control. Among other

findings, Brown and Inouye report that subjects who were lead to believe that they were similar in competence to the failing model exhibited lower self-efficacy and lower persistence when compared to their counterparts who were told that they were more competent than the model.

In general then, the results of both of these studies suggest that model similarity increases the transmission of efficacy expectations. It is interesting to note that such similarity is not restricted to observable characteristics, such as gender, but also extends to perceived similarities imbued by the comments of others, such as experimenter remarks regarding competence. These findings support Bandura's claim that the more concordant the model-observer match, the more predominant the impact on efficacy.

The effects of model verbalizations during the vicarious induction of efficacy expectations also has received empirical attention. In particular, Zimmerman and Ringle (1981) provide data which highlight the importance of model talk on self-efficacy. In their investigation, 100 first and second graders were assigned randomly to either one of four modeling groups or a control group. The children in the modeling groups witnessed a model attempt to solve a wire-ring puzzle. The model's behaviour and verbal remarks were varied systematically such that the complete factorial combination of high or low model persistence, and confident or pessimistic verbalizations were demonstrated to respective groups. After completing the modeling phase of the experiment, children responded to a

self-efficacy probe and were then asked to solve the wire puzzle. Because the performance measure of interest was persistence, Zimmerman and Ringle designed the wire puzzle to be insolvable. An analysis of the results of the study indicated that both model persistence and model comments affected children's subsequent persistence on the task. These effects, however, were not equal. The model's behavioural persistence accounted for 4% of the variance in children's persistence, while the verbal remarks made by the model (pessimistic or confident) accounted for 28% of the variance in children's persistence. Although the differential effects of model persistence and model verbalizations on self-efficacy were not as dramatic, there were hints of a similar relationship. Children exposed to the model who displayed pessimistic comments and high persistence had lower self-efficacy. Moreover, these children reported significantly less self-efficacy when presented with a novel problem-solving task. These latter two findings suggest that pessimistic verbalizations may attenuate efficacy expectations despite the general display of persistent problem solving by a model.

Gould and Weiss' (1981) research on model similarity, which was described briefly before, also contains data on the effects of models' statements on self-efficacy level and strength. As the college students who participated in the study viewed the 60 second videotape depicting performance on the muscular endurance task, they were exposed to one of four types of model verbalizations. In one condition, the model remarked that he or

she felt that the task was not difficult, that it could be done, and that he or she was doing quite well on the task. In direct contrast to these positive statements, a second condition employed a female or male model who made negative self-statements, such as, "I'm not very good at this"; "My leg is shaking already"; and "I can't keep this up for much longer." A third condition contained either a female or male model who made comments which were irrelevant to the task (e.g., "I bet kids would be good at this"). In the last condition, the models made no verbal statements. Analysis of the results of model verbalizations on self-efficacy level and strength revealed significant main effects due to these verbalizations. However, counter to expectations the group with the highest self-efficacy level and strength was the one witnessing models who engaged in irrelevant comments. To say the least, this is a curious finding. One would have expected that the group which was exposed to the model who displayed positive self-statments would experience the greatest gains in self-efficacy. This finding, coupled with Gould and Wiess' failure to find a significant model similarity by model talk interaction certainly needs empirical investigation. One possible reason for their findings may be that the 60 second exposure to the model was insufficient to induce the expected changes in self-efficacy.

As stated at the onset of this section, the general effects of covert modeling on self-efficacy has been of interest to a number of self-efficacy researchers. One study from this group, examined the effects of a covert modeling treatment on the self-

efficacy and approach responses of 17 snake phobics (Bandura, Adams, Hardy & Howells, 1980, study 1). In this treatment, phobics were asked to imagine a series of increasingly threatening scenes involving snakes. The specific procedures were as follows. Each scene was described by a therapist. Following this description, each subject was instructed to visualize the depicted scene and to signal when a vivid image was achieved by lifting a finger. Each client was instructed further to imagine four different models engaging in the threatening activities (i.e., a same age same sex model, a same age opposite sex model, an older same sex model, and an older opposite sex model). Each model's interaction with the snake was imagined twice. On the first occasion, the phobic imagined that the model performed the threatening activity with some trepidation. On the second occasion, the model was imagined performing in a confident manner. Bandura et al. report large pretest to posttest gains resulting from this treatment in both Behavioural Avoidance Test performance and in self-efficacy strength and level. In addition, the covert modeling treatment significantly reduced reported anticipatory fear and fear during performance.

In a very well designed study of covert modeling, Kazdin (1979) examined the effects of cognitive elaboration on the assertiveness and self-efficacy of 48 unassertive adults. Employing procedures similar to those found in the Bandura et al. study, subjects were asked to imagine a series of 35 assertive scenarios over a number of treatment sessions. The

study incorporated four experimental groups. The first group received the standard covert modeling treatment, that is, subjects were instructed to imagine a same age and same sex model engage in assertive responses to each of the 35 situations. Subjects also were instructed to narrate aloud what was imagined during covert exposure. As with all groups, each participant was asked to hold each image for 40 seconds on two consecutive trials. Procedures for the second group were the same with the exception that this group was instructed to elaborate on the scene when it was presented on the second trial. They were free to embellish the scene in any way under the sole proviso that such elaboration included an assertive response by the imagined model. In order to examine the effects of the content of the elaborated images used by individuals in the second group, a third group was utilized. Subjects in this group were instructed to imagine the elaborated scene created by a yoked partner in the second group. Lastly, a scene control group was instructed merely to imagine the various scenes without an imagined assertive response. An analysis of the results of these various treatments revealed superior post-treatment assertiveness in the cognitive elaboration group when compared to the other covert modeling groups. In addition, post-treatment assertiveness was superior in all covert modeling groups when contrasted to the scene control group. Treatment effects also were evident on self-efficacy variables. The unassertive adults who were exposed to either standard covert modeling or covert modeling with cognitive elaboration

experienced greater changes in self-efficacy level than did individuals exposed to the scene control condition. In terms of self-efficacy strength, only the covert modeling with elaboration group differed from the scene control group.

Contrary to the two studies just mentioned, Pentz and Kazdin (1982) failed to find increases in self-efficacy level following a covert modeling treatment. As described somewhat earlier, this study examined the effects of several modeling treatments (covert, overt and no modeling) and the number of models used during treatment (single or multiple) on the assertive behaviour of adolescents. Despite reasonably large pretest to posttest gains in assertive behaviour for both modeling groups, no statistically reliable gains in self-efficacy level were apparent in these groups. Some scattered gains were found in self-efficacy strength, particularly for the covert modeling group incorporating multiple models; however, these changes were slight (8-15%) when compared to performance changes across a number of assertive situations for the two modeling groups (13-29%).

As alluded to earlier, this failure to find generally significant treatment effects on self-efficacy may be due to the rather low statistical power produced by the small cell sizes present in Pentz and Kazdin's investigation. In addition, the length of treatment in their study was shorter than the treatment length found in studies which report gains in self-efficacy following covert modeling. Specifically, the treatment consisted of only three 55 minute sessions over a 17 day period.

In contrast, Bandura et al. (1980) employed 5 sessions of approximately the same length. Kazdin (1979) also incorporated a somewhat longer treatment (four 55 minute sessions). In general then, the relatively shorter length of treatment employed by Pentz and Kazdin coupled with small cell sizes may explain their failure to detect statistically significant gains in self-efficacy resulting from covert modeling.

In general, then, research on the vicarious induction of self-efficacy in clinical, sports, laboratory and educational settings supports the claim that changes in self-efficacy can arise from overt modeling (Bandura, Adams & Beyer, 1977; Bandura, Reese & Adams, study 2, 1982; Feltz, Landers & Raeder, 1977; Gould & Weiss, 1981; Schunk, 1981). In addition, there is evidence which suggests that increased similarity between the model and observer aids the acquisition of self-efficacy. It is interesting to note that such similarity is not restricted to physical features, such as gender, but that perceived similarity arising from verbal remarks during modeling also influences self-efficacy (Brown & Inouye, 1978). Although less attention has been paid to the effects of covert modeling on self-efficacy, preliminary evidence in clinical contexts indicates that covert modeling does enhance self-efficacy (Bandura, Adams, Hardy & Howells, 1980, study 1; Kazdin, 1979). Of particular note is Kazdin's (1979) finding that self-efficacy is enhanced especially under covert modeling conditions which require participants to embellish imagined scenes. This effect appears not to be due to the content of these elaborated scenes, but

rather to the cognitive processes involved in covert elaboration.

Studies of physiological sources of self-efficacy. Bandura proposes that self-efficacy is influenced by individuals' appraisals of their somatic states. Highly agitated visceral states usually serve to lessen one's belief that one can successfully execute tasks. It is important to note that while physiological arousal may be a source of efficacy information, its effect on self-efficacy is hypothesized to be determined by the manner in which such information is interpreted (Bandura, 1982; Bandura, Reese & Adams, 1982). For example, high levels of arousal may be viewed as innocuous by an accomplished actor who routinely relegates performance night anxiety to the commonplace. In sharp contrast, the same level of arousal may precipitate less seasoned actors to make presaging judgements of a disastrous performance.

Investigations of the relationship between self-efficacy and physiological arousal have usually examined changes in these variables as research participants perform in fear-evoking situations. Some of these studies have been conducted with phobics (Bandura & Adams, 1977; Bandura, Reese & Adams, 1982; Biran & Wilson, 1981). Other investigations have used subjects who exhibit less than phobic dread, such as speech-anxious college students (Lane & Borkovec, 1984), heterosexually anxious males (Barrios, 1983) and college students engaging in aquatic backdiving (Feltz, 1982; Feltz & Mungo, 1983). An additional study has explored self-efficacy and arousal while college

students played a computer game (Lan & Gill, 1984).

In general, this set of studies has produced two sources of data bearing on the relationship between self-efficacy and physiological arousal. The first source of evidence is found in those studies which have measured physiological indices of arousal, such as heart rate, and examined changes in these indices arising from changes in self-efficacy. A second line of evidence is furnished by researchers who have relied on self-report measures of fear or anxiety as indicators of arousal. Although a number of studies provide data from both sources, it seems prudent to separate these two lines of evidence in light of Bandura's contention that physiological indices of arousal affect self-efficacy in accordance with how such arousal is appraised. Presumably then, products of appraised arousal, such as self-reported fear or anxiety should bear a stronger relationship to self-efficacy than uninterpreted physiological measures of arousal such as heart rate or blood pressure.

With the exception of one study (Bandura, Reese & Adams, 1982), studies exploring the relationship between self-efficacy and physiological indices of arousal have generally found no relationship between these two variables. Barrios (1983) in a study of heterosexually anxious males reports nonsignificant correlations between self-efficacy, and measures of heart rate and skin resistance. Incorporating identical physiological measures, Lane and Borkovec (1984) report the same results with a sample of speech-anxious college students. Feltz (1982) details similar findings in her path analytic investigation of

heart rate and self-efficacy changes during aquatic backdiving. A replication of this latter study yielded identical results, that is, heart rate was not found to be a predictor of self-efficacy, nor was self-efficacy related to subsequent heart rate over a series of trials (Feltz & Mungo, 1982). A number of other investigations add to this consensus (Biran & Wilson, 1981; Lan & Gill, 1984).

A second line of evidence for the relationship between self-efficacy and arousal is found in studies which have operationalized arousal in terms of self-reported measures of anxiety or fear. Many of these investigations report a statistically significant negative relationship between arousal and self-efficacy. For example in the Feltz and Mungo study just described, perceived autonomic arousal was correlated negatively with efficacy judgements of college students as they engaged in backdiving. In addition, their path analysis yielded a direct path from perceived autonomic arousal to self-efficacy, but no direct path to performance. This finding is consistent with Bandura's claim that arousal affects performance only inasmuch as it affects efficacy judgements.

Other investigations lend further evidence for an inverse relationship between self-efficacy and self-reported arousal. Bandura and Adams (1977) report moderately negative correlations between self-efficacy and fear assessed prior to and during the performance of snake phobics on the Behavioural Avoidance Test. Negative correlations of a similar magnitude between self-efficacy and measures taken on the Fear Survey Schedule (FSS;

Wolpe & Lang, 1964) are furnished by Biran and Wilson (1981) in their analysis of the comparative effects of cognitive restructuring and participant modeling on the self-efficacy of phobics. These findings are generally echoed by other investigators (Barrios, 1983; Lan & Gill, 1984; Lane & Borkovec, 1984).

From the two sources of evidence just discussed, it appears that raw physiological measures of arousal bear little relationship to self-efficacy. Consistent with self-efficacy theory, such indices inform an individual's sense of personal agency only when appraised as anxiety, fear or perceptions of autonomic arousal. Research that describes the precise nature of the cognitive interpretations of physiological arousal which lead to efficacy-reducing fear or anxiety is needed to bridge the gap between these findings. Recent advances in cognitive assessment, such as the various think-aloud techniques described by Genest and Turk (1981), may provide a useful methodology for analyzing the cognitions which mediate the appraisal of somatic information.

Studies of exhortative acquisition of self-efficacy. It is not uncommon for individuals to gain an enhanced sense of personal agency by attending to the verbal comments of others. Bandura suggests that such verbal persuasion represents yet another source of self-efficacy information. Although verbal persuasion may be partially present in some of the techniques alluded to earlier, such as participant modeling, it is most clearly exhibited in verbally based treatments, such as self-

instruction (Meichenbaum, 1977), cognitive restructuring (Emmelkamp, Kuipers & Eggeraat, 1978), rational restructuring techniques (Goldfried & Davison, 1976), and various interpretive regimes.

To date, only one study has scrutinized changes in self-efficacy arising from exhortative sources (Biran & Wilson, 1981). In part this investigation examined changes in the self-efficacy and coping behaviours of 11 phobics who received a cognitive restructuring treatment. This treatment consisted of three phases over a total duration of 250 minutes of individual therapy. Using a modified version of Emmelkamp et al. (1978) treatment, subjects were taught to reattribute their fears to their cognitive interpretation of feared situations, rather than to the situations themselves. Following this relabeling phase, the therapist discussed the irrational nature of the phobics' beliefs and aided the client in identifying specific irrational self-statements. In the third phase of treatment, clients' irrational self-statements were replaced with more rational and positive self-talk using standard self-instructional techniques (Meichenbaum, 1977). Biran and Wilson (1981) report moderately large gains in self-efficacy level and strength arising from their treatment. These gains in self-efficacy were maintained at both one-month and six-month follow-up assessments.

Biran and Wilson's (1981) findings lend some support to Bandura's remarks about the influence of verbal persuasion on self-efficacy. The general conclusion that verbal persuasion is a robust determinant of self-efficacy must await further

empirical research. In many respects the lack of research on the exhortative source of efficacy expectations is surprising given its ubiquity. Indeed, in everyday affairs and in many forms of therapy, the first attempts to induce confidence are usually of an exhortative nature. It seems exceedingly important both to describe more fully the general relationship between such persuasion and self-efficacy, and also to examine the relative impact of various types of verbal persuasion on self-efficacy.

Comparative studies of self-efficacy acquisition. Before leaving the discussion of the acquisition of self-efficacy, some mention should be made of those studies which have contrasted the relative effects of the various sources of self-efficacy beliefs. There are only a handful of comparative studies in the self-efficacy literature and they are limited to comparisons between enactive and other sources of efficacy expectations. Despite these two restrictions, an examination of this set of studies provides an important opportunity to adjudicate Bandura's contention that enactively based treatments generally produce larger increases in self-efficacy than do treatments based on other information sources.

Table 4 contains the results of studies which have explicitly contrasted enactive sources of efficacy beliefs with vicarious and exhortative sources. All of these studies have been described in earlier sections of the review, and as such, only summative comments will be offered here. The effect sizes reported in Table 4 generally support Bandura's contention that

enactive experience produces higher rates of self-efficacy when compared to other information sources. Comparisons between enactive acquisition and other forms of acquiring self-efficacy yielded an average effect size of .60 for efficacy level and 1.0 for efficacy strength.

Although the small number of comparative studies prohibits additional comparisons between these studies, some of the results reported in Table 4 point to fertile ground for empirical attention. In particular, Schunk's (1981) finding that self-directed instruction was inferior to overt modeling is interesting, inasmuch as it runs counter to self-efficacy theory. Replication of this finding would limit Bandura's remarks about the general superiority of enactive treatments to participant modeling only. It is interesting to note as well, that the effect sizes are generally larger for clinical studies, and wane as the setting of the studies becomes less structured and as the performance tasks become less discrete. A similar trend was noted earlier, where correlations between self-efficacy and performance were found to be generally higher in clinical settings. Whether the magnitude of the difference between various ways of acquiring efficacy information is dependent on the nature of the performance tasks and study settings is unclear given the small number of extant comparative studies. What is clear, however, is that future comparative

Table 4

Enactive Versus Vicarious and Exhortative Acquisition of Self-efficacy

Study	n ^a	Induction Comparison	Effect Size ^b	
			Efficacy Level	Efficacy Strength
Bandura, Adams & Beyer (1977)	22	participant modeling	1.00	1.52
		vs overt modeling	.89 ^c	.79 ^c
Feltz, Landers & Raeder (1979)	40	participant modeling	---	.79
		vs videotaped modeling		
	40	participant modeling	---	.47
		vs live modeling		
Biran & Wilson (1981)	22	guided exposure	.89	1.26
		vs cognitive restructuring		
Schunk (1981)	48	self-directed instruction vs.	-.10	1.26
		overt modeling	.17 ^c	---

^an is the total sample size used in the comparison

^bEffect sizes were calculated using pooled variance estimates, in cases where studies reported standard deviations or directly from F or t statistics, in case where standard deviations were not reported.

^cThese effect sizes are for efficacy judgements made on generalization tasks, that is, tasks not explicitly used during training.

work should be extended to additional settings and tasks.

Conclusions

Summary

Many of the major tenets of self-efficacy theory are supported by the research surveyed in this review. Studies in clinical, educational, sports and laboratory settings have consistently found moderate correlations between efficacy expectations and performance. Self-efficacy also has been found to bear a moderate relationship to task persistence. Although less well researched, it does appear that there is a reciprocal relationship between self-efficacy and performance. This evidence for the mediational role of self-efficacy is somewhat tempered, however, by the additional finding that the influence of self-efficacy diminishes over practice trials.

Research on the acquisition of self-efficacy is less complete. There is a general consensus that self-efficacy is enhanced by enactive and vicarious experience. Studies have also found that physiological information influences efficacy expectations. This is limited, however, to individuals' judgements about their arousal. Little support is present for a relationship between raw physiological indices of arousal (e.g., heart rate) and self-efficacy. Only scant evidence is available as to how self-efficacy might be influenced by verbal persuasion.

Researchers have generally paid less attention to variables which affect the acquisition of efficacy expectations. Schunk's work, however, does provide preliminary evidence for many of Bandura's remarks about how the transmission of efficacy information might be enhanced. In line with self-efficacy theory, efficacy expectations are increased when individuals monitor their performance or when their performance is monitored by others. In addition, self-efficacy is strengthened when individuals receive ability feedback, set proximal goals, and receive contingent rewards. Research on the vicarious induction of self-efficacy has found that increases in observer-model similarity enhance the acquisition of self-efficacy.

Problems and Prospects for Self-efficacy Theory

Throughout this review mention has been made of specific questions and problems which need to be addressed by self-efficacy researchers. The purpose of this section is to add to this list in a more general way. To be more precise, the aim here is to provide a general agenda for research. In doing so, this section attempts to lay bare some of the substantive and methodological lacunae present in the extant literature.

Several issues remain regarding the assessment of self-efficacy. First, the extent to which efficacy expectations should be construed and assessed as situationally specific precepts requires much more investigation. A central and largely untested tenet of self-efficacy theory is that one's

judgements about specific situations represents the most apt theoretical level at which to analyze human motivation. While some research suggests that the assessment of self-efficacy as a specific percept, rather than as a very global judgement does result in better predictions of performance, there may be some fruitful middle ground between these two extremes. It may be possible, for example, to develop self-efficacy instruments which sample across behavioural domains or situations. The practical benefits of such instruments would be large, as practitioners wishing to assess self-efficacy would not face the onerous task of generating an exceedingly large number of efficacy probes.

A second assessment issue arises from the manner in which efficacy judgements are assessed. In the vast majority of self-efficacy studies, individuals judge their self-efficacy on a series of tasks arranged in ascending order of difficulty. In addition to creating some statistical problems, which have already been discussed, this procedure tends to lessen the ecological validity of much of the self-efficacy research. In everyday situations, individuals are seldom presented with graduated tasks upon which they judge their efficacy. Efficacy judgements occur naturally in a very murky context. While individuals may use knowledge of the general difficulty of tasks when evaluating their competence to perform these tasks, this knowledge is provided by the individual and is not a function of the way tasks are organized for the individual. If self-efficacy research is to comment upon how self-efficacy mediates

performance in all manner of settings, then it must be extended to situations where individuals judge their competence on tasks which are not arranged in an ascending order of difficulty. Parenthetically, one wonders whether the correlations between self-efficacy and performance reported in the literature might be diminished substantially if research participants were presented with these tasks in a random, rather than an hierarchical order.

As has been mentioned by others, the role of experimenter and situational demands on efficacy assessment needs to be explored more fully (Borkovec, 1978; Kazdin, 1978; Poser, 1978; Tryon, 1981). It seems quite reasonable to suppose that research participants succumb to some situational demands when asked to perform tasks which they have just judged they can or cannot perform. Although some evidence suggests that situational demand may be negligible (Bandura & Cervone, 1983; Gauthier & Ladouceur, 1981; Telch et al., 1982), studies exploring this issue have typically employed small group sizes (8 to 10) and as such, may be somewhat statistically insensitive to the detection of demand influences. Moreover, there is some strong evidence which indicates that performance measures such as the Behavioural Avoidance Test are influenced by experimenter and contextual demands (Berstein, 1973; Berstein & Nietzel, 1973, 1974; Tryon, 1981). Given this evidence, it would be odd if individuals' performances were effected by demand, but not their judgements of performance capabilities.

A second set of agenda items for future research concerns factors affecting the acquisition of self-efficacy. Well-developed programmatic research of the kind that Schunk has provided in his exploration of the enactive acquisition of self-efficacy during self-instruction needs to be extended to participant modeling, vicarious and exhortatively based treatments. There are several lines of research which might be taken. First, research which explores the effects of various kinds of attributions individuals might make while acquiring efficacy expectations is needed. For example, the effects on self-efficacy of attributing the performance success experienced during participant modeling to various performance aids requires empirical scrutiny. Similarly, research which maps the effects of observers attributing the performance success of a model to abilities unique to the model may yield some interesting findings. Further it is likely that attributions play an important role in the effectiveness of various exhortative treatments. Verbal persuasion may fail to affect self-efficacy if individuals attribute such persuasion to the overly kind nature of a person. On the other hand, exhortative comments might be expected to enhance self-efficacy when an individual perceives that such persuasion is rooted in a perspicacious analysis of the individual's competencies. Attributions of this sort have been neglected by self-efficacy researchers.

Research is also needed which examines the differential effects of various patterns of success and failure on the acquisition of self-efficacy. Bandura's hypothesis that

successes which are more proximal to efficacy judgements will produce higher efficacy expectations has yet to be examined by researchers. Moreover, since Bandura posits several sources of self-efficacy, it is not too unreasonable to expect that individuals may occasionally need to reconcile contrary efficacy information. For example, beginning drivers are often faced with initial enactive failure while witnessing the successes of other drivers and perhaps experiencing the verbal inducement of friends. How individuals in such situations reconcile both efficacy debilitating and efficacy enhancing information is an intriguing and unanswered question.

One last point needs to be mentioned. In his description of self-efficacy theory, Bandura repeatedly underscores the importance of individuals' cognitive appraisals of information arising from the four major sources of self-efficacy. At the same time, he proposes that the central mechanism of interest in human motivation is the product of such appraisal, that is, self-efficacy. While what is considered as a central mechanism in a theory is somewhat arbitrary, inasmuch as theorizing must cease at some point, the necessary relationship between cognitive appraisal and self-efficacy does suggest that it is cognitive appraisal which might best be designated as a central mechanism. After all, without the positive appraisal of information, self-efficacy remains unchanged. Research which emphasizes the central role of cognition in mediating self-efficacy may provide some exciting new directions for both self-efficacy theory and self-efficacy research.

In addition to more research on the cognitive mechanisms responsible for self-efficacy, Bandura must offer a more complete theoretical account of these mechanisms. Bandura can be criticised sharply for taking far too much for granted in his analysis of human motivation. Daniel Dennett (1978), in his recent work in the philosophy of mind, has made this point most aptly in the following:

Any time a theory builder proposes to call an event, state, structure, etc., in any system... a signal or message or command or otherwise endows it with content, he takes out a loan of intelligence. He implicitly posits along with his signals, messages, or commands, something that can serve as a signal-reader, message-understander, or commander, else his "signals" will be for naught.... This loan must be repaid eventually by finding and analyzing away these readers or comprehenders; for, failing this, the theory will have among its elements unanalyzed man-analogues..., and thus theory will postpone answering the major question: what makes for intelligence? (p. 12)

There are of course other interesting avenues that self-efficacy research might take, but the preceding is sufficient to show some of the major directions needed in the research. Although much of the extant literature supports the main tenets of self-efficacy theory, much remains to be done. With the territory of past and future self-efficacy work now more clearly charted, the continued and ordered evaluation of self-efficacy theory should be enhanced.

CHAPTER III

SCOPE OF THE INVESTIGATION

With the broad description of self-efficacy theory and research now in place, the purview of the dissertation narrows to present a more precise description of the present investigation. The chapter begins with a discussion of the major purposes of the study. In this section, a number of the agenda items for self-efficacy research, which were posited in the preceding chapter, are brought into more specific focus. Since a concomitant focus of the study concerns instruction in analogical problem-solving, the second section of this chapter details research and theory in this area. Lastly, the chapter closes with a series of questions which serve as the major foci of the investigation.

Purposes of the Study

One aim of the current study is to investigate the effects of performance aids on the acquisition of self-efficacy during computer-assisted instruction in analogical problem-solving. As noted in the last chapter, no empirical attention has been given to examining the general effects of performance aids despite what appears to be rather paradoxical predictions made by self-efficacy theory.

As has already been discussed, there is a wealth of research evidence which indicates that self-efficacy can be increased by enactive means (Bandura, 1977; Bandura, Adams & Beyer, 1977;

Schunk, 1982, 1983a, 1983c). Stated simply, as individuals engage in the mastery of tasks, they incur a heightened sense of their competence. Given that performance aids function to increase the successful mastery of tasks, it would not be too unreasonable to suppose that such aids would also function to increase self-efficacy. Indeed, there are examples in everyday life where performance aids are employed to increase confident performance by reducing performance errors. For example, young children frequently learn to ride a bicycle with the aid of training wheels. Similarly, in educational settings, children often rely on prompts, such as number lines, to increase their performance and confidence in problem solving. In summary then, there is at least some reason to believe that performance aids increase self-efficacy, inasmuch as such aids serve to increase performance success.

Running contrary to this position, there is the suggestion that performance aids may reduce self-efficacy (Bandura, 1977, 1978). According to Bandura, performance aids will decrease an individual's sense of self-efficacy, since any increase in performance success will likely be attributed to the aid, rather than to enhanced personal competence. Moreover, since aids generally reduce task difficulty, self-efficacy theory would predict relatively small increased efficacy as aided tasks are mastered. As was discussed earlier, Bandura holds that the mastery of easy tasks imbues individuals with less self-efficacy than the mastery of difficult tasks.

One of the major focal points of this study then, is to shed some empirical light on the relationship between changes in self-efficacy and performance, and the utilization of aids during instruction. The study attempts to disentangle the moderating effects of performance aids on self-efficacy by assessing the extent to which learners attribute their success to task aids, and by examining how such attributions might mediate the general effects of these aids on the acquisition of self-efficacy.

Aside from being theoretically important, there is some practical significance to examining questions regarding the relationship between efficacy expectations and performance aids. Instructional aids of many kinds are used extensively in educational settings (e.g., number lines in arithmetic and prompts which function to remind beginning readers of letter names and sounds). If Bandura is correct, the extensive use of aids in classrooms may have the concomitant danger that they reduce students' confidence in accomplishing classroom tasks. According to self-efficacy theory, this would lessen the amount of persistence and effort that students would display when presented with new tasks.

A second purpose of the study is to explore the differential effects on self-efficacy of the manner in which aids are delivered during instruction. While self-efficacy theory makes no predictions on this matter, it does seem that a comprehensive examination of the relationship between self-efficacy and performance aids must attempt to capture the variety of ways in

which such aids are used. A failure to represent this variety would obviously limit the extent to which general claims could be made about the relationship between aided instruction and self-efficacy.

Given the foregoing, a slight digression is necessary in order to distinguish a number of ways in which performance aids are employed during instruction. The following presentation distinguishes four aid-delivery systems. These different ways of delivering aids are the focus of experimental attention in the study. It is important to note that the concern here is to describe different ways of delivering performance aids and not different kinds of aids.

In classrooms and other instructional venues, performance aids are used in different ways. Sometimes these aids occur with classroom tasks. This is to say that embedded in the task itself, there is sometimes a hint or additional help of some form, which guides students' initial problem solving. For example, it is not uncommon for basal reading texts to contain pictures which guide students' understanding of textual material. In a similar way, blocks are sometimes used to represent arithmetic problems for young children. Irrespective of the kind of prompt that is used, there is a class of performance aids which are delivered invariantly with the task and prior to the learner responding to the task. For the sake of the discussion, these performance aids will be called task-dependent. The phrase "task-dependent" refers to the fact that these performance aids occur with the tasks or questions posed

to the students. In a sense, the presentation of the instructional aid becomes dependent upon the presentation of the task.

Sometimes performance aids are offered to students only when they commit an error. During classroom recitation for example, teachers frequently offer additional information to a student who has just failed to answer a question correctly. The question is then rephrased with the hope that this additional information will guide the student toward the correct answer to the question. Aid offered in such a manner is not task dependent, but rather error dependent. Students must err before receiving such help. This type of performance aid is called error dependent.

Thus far, performance aids have been distinguished by the two occasions upon which they are delivered, either with the task, or upon a student's error. A second dimension of performance-aid delivery concerns whether such prompts are instructor controlled, either directly by the teacher or indirectly by the curriculum, or whether the aids are used at the discretion of the student (i.e., student controlled). Aids of the former sort occur regularly during instruction, as performance prompts are present invariantly across students (e.g., as is found in rebus-based reading programs). Occasionally, prompts are, however, under the control of the learner. For example, students may have multiplication tables on their desks and may or may not make use of such help. Aids delivered in this manner are designated as learner controlled,

while aids which are fixed by the curriculum or by the teacher are referred to as instructor controlled.

Of course, the two dimensions of performance-aid delivery can be combined to yield four specific patterns of delivery. Performance prompts may be under the control of the learner or the instructor, and may be delivered with the task or upon error. While this list does not exhaust all possible ways in which aids might occur during instruction, the foregoing is sufficient to capture many of the ways such aids are used in instructional settings, and in doing so, sufficient to represent the variety of aids which may affect self-efficacy. It is this variety of aid delivery which is one of the foci of the present investigation.

There are a number of additional purposes of the study. First, this research represents a much needed extension of self-efficacy research into the area of complex problem-solving. As detailed in the preceding chapter, the vast majority of self-efficacy research has investigated the relationship between efficacy expectations and performance on rather simple behavioural tasks (e.g., approach responses to fear-evoking objects). While these investigations are important, a rigorous test of the generalizability of self-efficacy theory requires that efficacy expectations are examined using tasks which are both cognitive and complex. If self-efficacy theory is to explain fully how and why individuals allocate their effort, then it must be extended to the myriad of complex cognitive tasks which regularly confront individuals. Such an extension

obviously is important for education, as a major function of schools concerns increasing children's higher-order problem-solving skills. If efficacy expectations are not found to bear a relationship to performance on tasks that make demands at this level, then the value of self-efficacy accounts of student motivation would be limited severely.

Second, the present study provides an opportunity to extend some of the previous work which has furnished evidence on the mediational role of self-efficacy. The central tenet of self-efficacy theory is that efficacy expectations mediate performance. Despite the importance of this claim, only two studies have examined the mediational function of self-efficacy over a series of trials (Feltz, 1982; Feltz & Mungo, 1983).² Both of these studies have occurred in sports settings and both have utilized backdiving as the performance of interest. Although these studies have, in general, yielded path-analytic models which are consistent with the view that self-efficacy does mediate performance, this finding needs replication in a different setting and with a different task. Again, such an extension and replication is an important and necessary step prior to incorporating self-efficacy into a theory of student motivation.

In summary, this study investigates new territory by examining the effects of performance aids on learners' analogical problem-solving. Of particular interest is how individuals' attributions of their successes to performance aids might relate to their self-efficacy. A related issue concerns

whether performance aids delivered in different ways have different effects on performance and self-efficacy. Lastly, the study attempts to extend self-efficacy research into the area of complex problem-solving during computer-assisted instruction. This extension will provide an opportunity to assess the generalizability of self-efficacy theory to a class of tasks which parallels some of the higher-order problem solving found in classrooms.

A Cognitive Analysis of Analogical Reasoning

The use of analogies as the experimental task in the present study necessitates some discussion of the nature of analogical problem-solving. The purpose of this section is to provide a general sketch of the cognitive processes that comprise analogical reasoning. This sketch of component processes will, toward the end of this section, be used to justify both the overall instructional treatment and specific performance aids employed in the study.

Numerous models of cognition might be used to describe the mental activity of learners as they solve analogies. Indeed, analogical reasoning could be described in terms of figurative, operative and executive schemes (Case, 1974), or various production systems (Newell & Simon, 1972), or test-operate-test-exit models of cognition (Miller, Galanter & Pribram, 1960). Although each of these different models could provide an appropriate theoretical backdrop, the following discussion is

limited to Sternberg's account of analogical reasoning as detailed in his more general componential analysis of intelligence (Sternberg, 1977, 1980; Wagner & Sternberg, 1984). Limiting discussion in this way is, however, not unduly restrictive. Sternberg's cognitive task-analysis of analogical reasoning incorporates many of the major notions present in other models of cognition, albeit in somewhat different language.

The basic theoretical unit in Sternberg's general analysis of intelligence and specific conception of analogical reasoning is the component. Sternberg (1977) describes a component as an elementary cognitive process which operates on internal representations of objects or symbols. Components function in a number of ways. They translate sensory information into conceptual representations, transform a conceptual representation into another kind of representation, or translate a conceptual representation into a motoric response. Components in general, are information-modifying processes and are roughly analogous to what others have called production systems (Newell & Simon, 1972) or operations (Doyle, 1983).

Sternberg (1977, 1980; see also Wagner & Sternberg, 1984) lists three major classes of cognitive processes. The first of these are metacomponents. These cognitive operations are higher-order processes which are responsible for the general planning and decision making during problem solving. More specifically, they concern overarching operations which identify problem types, dictate how problems are represented, and select

how lower-order problem solving routines are to be ordered and executed during problem-solving.

In contrast to metacomponents, which are overarching in function, the second category of cognitive operations is more specific to a given set of tasks. In general, these performance components are the problem-solving procedures and routines that yield problem solutions. These cognitive operations act on particular aspects of a given problem, and may include operations such as encoding problem parameters, drawing inferences between aspects of a problem, or verifying the correctness of an answer.

The last kind of component processes concern knowledge acquisition. They may include selective encoding of problem-relevant information, the retrieval of pertinent information and generalization of prior learning to new problem-solving situations. Cognitive processes in this class are the most general of all and represent the basic information handling routines.

In order to illustrate how these component processes might be used to describe analogical problem solving, consider the following analogy: Lawyer is to client as doctor is to (a) medicine, (b) judge, (c) patient or (d) physician. A number of performance components are required to solve this analogy successfully. The terms of the problem must be encoded and information related to problem features must be retrieved from memory. In the current example, attributes of the concept of lawyer must be retrieved. Second, an inference must be made

regarding the relationship between the elements of the first part of the analogy (i.e., between lawyer and client). This would concern inferring that lawyers provide professional services to clients. Having inferred the relationship between the elements in the first part of the analogy, the problem solver must map this relationship onto the second half of the analogy. Knowledge of this mapping relationship must then be applied. In the example, this amounts to answering the question, to whom do doctors provide service? In the final stage of analogical problem-solving, individuals must justify their response choices in light of the various options present in the question.

Metacomponent operations also play an important part in analogical problem-solving. Consider the example once again. If the problem solver judges the problem demands as requiring only an associative mapping, then the response selected would likely be "medicine". Indeed, Sternberg and Rifkin (1979) report data which suggests that this is precisely what occurs when young children solve analogies. This is to say, that young children tend to make simple associative connections between elements in the second half of an analogy, rather than inferring the relationship between elements in the first word pair and attempting to map this relationship onto the second word pair. Such mistakes represent, in part, a failure to analyze the problem demands, that is, a failure in metacomponent processing.

As stated at the onset of this section, the instructional treatment and performance aids employed in this study rely to a

large extent on the preceding analysis of analogical reasoning. Although much more will be said about the specific instructional procedures in the next chapter, one general aim of instruction was to offer learners practice and corrective feedback during problem-solving. Corrective feedback consisted of an explanation which described the specific mapping relationship that was present in a given analogy. Since this feedback was corrective in nature, it occurred only when learners made an error on an analogy question. According to the preceding analysis of analogical reasoning, feedback of this sort should guide learners' inferencing on similar subsequent problems.

In contrast to the practice and corrective feedback which aimed at increasing performance components of analogical reasoning, the performance aids received by some groups in the study were aimed at modifying metacomponential processes. Essentially, the purpose of these prompts was to aid learners in initial problem identification. These prompts provided information which classified the type of analogy question. For example in one group, learners were told that the analogy was of a certain type, say a part-whole analogy, before they were requested to solve the problem. Classifying the problem for the learner in this way should increase problem-solving accuracy and decrease solution latencies. Knowing that the analogical relationship is of a certain type, say part-whole, lessens the need for learners to infer the mapping relationship between the first elements in an analogy question. Given this, solving analogies under prompted conditions demands only that the

learner apply the given relationship to the second half of the analogy item. Of course, errors may still occur during this application and in the initial encoding of the terms of the analogy; nevertheless, the prompt should reduce the cognitive requirements of the task.

Specific Questions Addressed in the Study

In order to summarize the major purposes of this study, the chapter closes with a list of specific questions which are addressed in the investigation. For now, these questions remain somewhat broad and await additional refinement in chapter 6, where the results of the study are discussed.

1. Does the computer-assisted instructional treatment produce increases in learner's analogical reasoning performance and perceived self-efficacy?
2. What is the relationship between learners' efficacy expectations, and their speed, accuracy and correct rate of analogical problem-solving prior to, during and following computer-assisted instruction?
3. What is the relationship between learners' self-efficacy and their persistence on a set of insolvable analogy problems?
4. To what extent do any increases in self-efficacy occurring during instruction generalize to types of analogy problems which were not the subject of instruction?
5. Is the path-analytic model, generated by examining changes

in self-efficacy and problem-solving performance during instruction, consistent with the contention that self-efficacy mediates performance?

6. What are the relative effects on analogical problem solving performance of the different prompt delivery systems used during computer-assisted instruction?
7. Are there differential effects on self-efficacy arising from the type of prompt delivery used during instruction? To what extent do learners' prompt usage and performance attributions attenuate self-efficacy?

CHAPTER IV

METHOD

Subjects

One hundred and fifty students, who were enrolled in education courses at Simon Fraser University during the Fall of 1985, participated in the study. Of the 150 research participants, 109 were female and 41 were male. All subjects were solicited on a voluntary basis and were paid seven dollars each for their participation in the study.

Subjects were assigned randomly, and in equal numbers, to one of four treatment groups or to a control group (n = 30, per group). The assignment of subjects to conditions was determined by a list of random numbers generated by a computer prior to the commencement of the study.

Instruments and Apparatus

The entire experiment was conducted on three Apple II Plus microcomputers. This included the presentation of experimental directions, pretest and posttest items, efficacy probes, attribution questions, and practice items. The computers also recorded all pertinent performance data as participants proceeded through the experiment.

The computer programs for each of the five conditions are appended to the dissertation in disk form. Documentation for all programs is found in Appendix A.

All subjects completed a pretest and posttest during the course of the study. The pretest consisted of three different types of analogy questions ³ (synonym, part-whole and similar-function analogies; see Appendix B). Four items of each type were present in the pretest. In addition to these 12 items, eight generalization questions were included (see Appendix C). These generalization items, which were of a type not subject to instruction, consisted of two kinds: worker-tool analogies and numeric analogies. Finally, three of the analogies presented in the pretest were unsolvable (see Appendix D). Subjects' response latencies on these items served as a relatively pure measure of problem-solving persistence. Purity here refers to the use of a measure of persistence which would not be affected by increases in learners' problem-solving skills.

To ensure that the pretest items were generally of equivalent difficulty to those used during the instructional phase of the study, all items were drawn randomly from a large item pool of analogy questions. The source of this item pool was a series of Miller Analogies practice tests (Gruber & Gruber, 1976). The order of analogy questions present in the pretest was determined randomly, as was the position of the correct answer.

The posttest items were exactly the same as those found in the pretest, with the sole exception that the ordinal position of the response choices was different. As in the pretest, this was randomized to reduce pretest-posttest practice effects which might have reduced artifactually posttest response latencies.

In addition to the pretest and posttest measures, individual performance on a series of practice trials was assessed during the instructional phase of the study. Each of these four trial blocks contained 15 analogy questions. Three types of analogies, part-whole, synonym and similar-function types, were present in equal numbers during each practice trial block. As was the case in the pretest, these items were selected randomly from a large pool of analogy questions. The order of both the analogy items and the correct response to each item was also randomized.

At various points during the investigation, a series of efficacy probes and attribution questions was presented by the computer program. These measures are described more fully under the procedures section of this chapter.

Design

The study consisted of a 2 x 2 complete factorial design with an additional covariate factor (pretest). In this manner, four treatment groups were formed in accordance to all unique combinations of the two grouping factors. A fifth group served as a no-prompt control group. Each of the treatment groups and the control group contained 30 individuals.

The first experimental factor pertained to the position of the prompt or performance aid present during instruction. In the first level, the prompt was presented with each analogy question. In the second level, the prompt occurred only after

an error had been made on a specific question. The two levels of this factor represent what was described in Chapter 3 as task dependent and error dependent prompts.

The second experimental factor concerned whether the prompt was learner controlled or instructor controlled (in this case, computer controlled). In the first level, the learner had the option to call-up the prompt whenever he or she felt it was appropriate. In the second level, the prompting was fixed by the computer program.

A no-prompt control group was also incorporated in the design. This group did not receive any performance aids during instruction, but completed the same practice items with corrective feedback when questions were answered incorrectly.

Several dependent variables were recorded by the computer as subjects worked through the computer program. These variables included: (a) all item responses, (b) response latencies for each item, (timed from question onset to question response) (c) total scores for pretest, posttest and the four practice trial blocks, (d) number of times the performance aids were used in each practice trial for those groups where this was learner controlled, (e) efficacy ratings on each item of the pretest, posttest and practice trials, (f) attributional responses and (g) individuals' overall achievement expectations on both the

pretest and posttest.

Procedures and Treatments

Overview of the General Procedures

The study consisted of four specific phases. A brief sketch of each of these phases will enhance the clarity of the subsequent and more detailed description of the general procedures. Procedures in the first phase served to introduce research participants to the general task requirements of the study. Following this general orientation, individuals judged their self-efficacy on each of the pretest analogy items and then solved the set of pretest items. In the next portion of the study, subjects engaged in self-instruction activities which closely parallel those employed by Schunk (1981, 1982, 1983a, 1983b). Unlike Schunk's self-instruction, however, participants in the treatment groups received performance aids, in addition to the practice and feedback normally found in self-instruction. In the last phase of the study, individuals completed the same posttest measures as were found in the pretest.

Orientation procedures. Before beginning the experiment, each person was asked to sign a consent form (see Appendix F) and to read a brief description of the study (see Appendix E). Subsequent to this, individuals were directed to one of three computers located in partitioned cubicles. A brief overview of the operation of the computer was then given to each person.

This overview described the general operation of the computer program during the experiment.

Irrespective of the experimental group, the computer program proceeded in the following way. First, a series of general directions and practice analogies was displayed. This portion of the program oriented subjects to the nature of the responses which they were required to make during the experiment.

Appendix G contains a listing of this portion of the program as it appeared to subjects on the computer screen.

Pretest procedures. The pretest phase of the experiment began with an assessment of individuals' self-efficacy on each of the pretest items. These procedures followed those used by Shunk (1981, 1982). More precisely, each of the 23 pretest analogy questions was displayed for a period of eight seconds. During this eight-second period, participants were instructed to look at each question carefully and to judge their efficacy expectations for the problem. Immediately following each pretest item, a ten-point rating scale was displayed on the screen (see Appendix G for an example of the efficacy scale). Individuals were asked to record their efficacy judgements using this scale, which ranged from very unsure (1) to very sure (10). In order to enter their ratings, participants moved a large cursor line through the various points in the scale. When the cursor was on the value which represented their confidence, they were instructed to enter that value by pressing the return key on the computer. In this way, subjects had to remain attentive to the numerical values and scale descriptors as they moved the

cursor along the rating scale.

In order to obtain a general measure of achievement expectations, subjects were asked next to estimate the number of items they would solve correctly in the twenty-three item pretest. Next, subjects were asked to answer the pretest questions. Each item was presented on the screen and individuals indicated their response choices by pressing a number which corresponded to one of the four response choices displayed with the question. In this section of the program, subjects' problem-solving was not constrained by a time limit.

Instructional procedures. The instructional segment of the computer program was comprised of four practice trial blocks, each of which consisted of 15 analogy items. The major purpose of the sixty-minute instructional session was to provide learners with practice and descriptive feedback during analogical problem-solving. The focus of instruction was on guiding learners' problem solving by providing inferencing aids which mapped the logical relationship between the word pairs present in analogies. As noted in the previous chapter, the inferencing of mapping relationships has been shown to be a critical performance component in recent cognitive analyses of analogical reasoning (Sternberg, 1980; Wagner & Sternberg, 1984).

In terms of presentation, each practice trial proceeded in much the same way as the pretest. Analogy items within each trial block were displayed, subjects judged their self-efficacy on each of the 15 items, and then solved the set of analogies.

As research participants solved the practice items, they received descriptive feedback. That is, in the event that an error was made, the computer displayed the correct answer and offered a brief explanation of why this was the correct response. When the question was answered correctly, the computer responded by sounding a tone and displaying a message indicating that the answer was correct. The subject's total number of correct responses was displayed at the end of each practice trial block.

In addition to the preceding, research participants in those groups which received performance aids were requested to answer a series of attribution questions regarding the extent to which they perceived that their success on the practice items was due to the hints given by the computer. These attribution questions were presented at the end of each trial block. Each practice trial ended with a rest period of one minute to lessen subject fatigue.

Posttest procedures. After the four practice trials were completed, posttest items were presented in the same manner as in the pretesting procedures. More precisely, individuals rated their self-efficacy on each of the posttest items, predicted their overall score on the posttest and finally, solved the posttest items.

Upon completing the posttest, each person was thanked for his or her participation, and received a full explanation of the purpose of the study.

Procedures for Computer-controlled Prompt Groups

In addition to the general procedures just described, two experimental groups received a prompt or performance aid along with each analogy question presented during the practice trials. This prompt contained a brief description of the type of analogy displayed (e.g., "HINT: This is a part-whole type of analogy"). This description identified the mapping relationship evident in the analogy and as such, should serve to increase correct problem solving by guiding learners' inferencing during problem-solving.

As mentioned earlier, one of these groups received the prompt at the same time as the question was displayed. In this way, individuals' problem solving was guided from the onset of the analogy question. A second group received the prompt only after an error had been made on an item. Individuals in the group were then directed to attempt the question once again, bearing in mind information contained in the hint. Since the intention of the study was to examine aided performance, subjects in this group who made an error had their second response recorded only.

Procedures for Learner-controlled Prompt Groups

In these two groups, the learner controlled when the prompt information was displayed. In one group, subjects had the option to have the prompt displayed immediately after the question was given (i.e., before an initial response was made).

In the second group, the subject was given the option to call-up the prompt after an error had been committed. As in the other group which received the prompt after error, participants in this group were directed to attempt the question again bearing the prompt in mind. Once again, it was the second response that was recorded when subjects in this group made an error.

Procedures for the No-prompt Control Group

The procedures for this group were identical to those described under the general procedures section. Individuals in this group did not receive any of the performance aids or prompts during the practice trials. As with all groups, however, they did receive descriptive feedback. Specifically, if learners were correct, they were told so; and if they were incorrect, they were given the correct answer and its justification. In contrast to the prompted groups, the no-prompt control group received no information prior to responding to aid their inferencing. Moreover, they were not told the general mapping relationship between the analogy pairs, as was the case with the prompted groups.

CHAPTER V

RESULTS

The results of the study are discussed in four major sections. The first section reports findings regarding the correlational relationship between self-efficacy and a number of problem-solving performance measures. The second section describes the changes in self-efficacy and problem solving which were produced by the various instructional treatments. The focus of the last section is upon findings which address the question of whether self-efficacy mediated learners' analogical problem-solving during computer-assisted instruction. Finally, the chapter closes with a general summary of substantive findings.

The Relationship between Self-efficacy and Problem-solving

One of the purposes of this study was to examine the extent to which self-efficacy is related to analogical reasoning. Such an examination is of considerable importance, inasmuch as it bears on the generalizability of self-efficacy theory to tasks which require complex verbal problem-solving. In this section, data are presented which describe the relationship between self-efficacy and learners' accuracy, correct rate, latency and persistence during problem-solving.

Before detailing these data, some mention should be made of the reliability of the various scales used to measure problem-solving achievement and self-efficacy. The pretest and posttest

reliabilities for the achievement tests, using Guttman's (1945) lower-bound estimates, were .70 and .65, respectively. Guttman coefficients for the self-efficacy measures were .85 for the pretest and .89 for the posttest.

Table 5 contains correlations between learners' estimates of self-efficacy (summed across items) and their problem-solving accuracy (total correct) on pretest and posttest measures, and over the four practice trials of the study. These correlations were all reliably different from zero, with the sole exception of the correlation between learners' self-efficacy and problem-solving accuracy at trial 4. The average correlation between self-efficacy and accuracy was reasonably small (.28, median .29, $N = 150$) and suggests that about 8% of the variability in performance was accounted for by learners' estimates of their efficacy.

Correlations between learners' efficacy expectations and their response latencies (summed across items) are also reported in Table 5. Prior to calculating these efficacy-latency correlations, all latencies were transformed to Napierian logarithms to reduce the positive skew present in the distribution of the latency variables⁴ (Erickson & Nosanchuk, 1977). All correlations between self-efficacy and learners' response latencies were negative and significantly different from zero ($p < .05$). The average Pearson correlation was $-.28$ (median $-.275$, $N = 150$).

In order to examine the joint relationship between self-efficacy and learners' speed and accuracy of problem solving, a

Table 5

Self-efficacy and Problem-solving Performance Correlations

Trial	Performance Measures		
	Accuracy	Latency	Correct Rate
1	.26	-.36	.43
2	.29	-.30	.42
3	.29	-.25	.31
4	.13 (ns)	-.18	.19
Pretest	.30	-.23	.33
Posttest	.38	-.33	.42

Note. N = 150

variable consisting of the number of analogies solved correctly per minute was computed for the pretest, posttest and each trial⁵. The correct rate variable serves as a particularly sensitive measure of performance efficiency, inasmuch as it incorporates information about both learners' changes in speed and accuracy of problem solving. The correlations between this composite performance measure and self-efficacy were all positive, but again, reasonably small in magnitude (see Table 5). The average correlation was .36 (median .375, $N = 150$). In other words, about 13% of the variance in learners' rate of correct problem-solving was related to their efficacy expectations.

While the correlations between total self-efficacy and total response latencies described above yield some measure of the degree of relationship between self-efficacy and persistence, a more exacting test requires that this relationship be explored on highly difficult tasks. This is required since Bandura's claim is that individuals with high self-efficacy will intensify their efforts and persist longer when task requirements are very demanding. Indeed, there is a sense in which one would expect the relationship between self-efficacy and persistence to be inverse on cognitive tasks of low or medium difficulty. Simply put, when highly efficacious individuals approach such tasks, there is little reason to persist at length.

In order to explore learners' persistence on highly demanding tasks, three of the analogy questions presented during the pretest and posttest were unsolvable (see Appendix D). The

correlation between learners' total self-efficacy on these items and persistence, as measured by their total response latencies on the items, was not significant at pretest ($\underline{r} = -.11, p > .05, \underline{N} = 150$) or posttest ($\underline{r} = -.09, p > .05, \underline{N} = 150$).

A complete correlation matrix for all dependent measures is contained in Appendix H.

Treatment Effects

In this part of the chapter, results are brought forward which test Bandura's claim about the attenuating effects of performance aids on self-efficacy. Of principle interest here is an examination of any differential effects on self-efficacy that arose between groups receiving instructional aids and the no-prompt control group. This section also presents a detailed look at the performance changes which were generally present following instruction, as well as an analysis of the generalization of self-efficacy to noninstructed analogy problems.

Means and standard deviations for all pretest and posttest measures, excluding data on the generalization and unsolvable items, are presented for each experimental group in Table 6. A preliminary multivariate analysis of variance on total pretest accuracy, self-efficacy, correct rate and log-transformed response latencies revealed no significant pretest differences among the five experimental groups ($\underline{F} = 1.19, p > .05$).

In order to examine group differences on the posttest measures, a multivariate analysis of covariance, with pretest measures (i.e., accuracy, rate, latency and self-efficacy) as the covariates was conducted on total posttest accuracy, self-efficacy, correct rate and log-transformed response latencies. The use of a covariate analysis provides a statistically powerful test of the hypotheses examined here. Such an analytic strategy requires the demonstration of the homogeneity of the regression slopes across treatment groups (Tabachnick & Fidell, 1983). A test of treatment by covariates interaction yielded a nonsignificant F and as such, the assumption of slope homogeneity was met. This test was conducted on the covariates as a set.

Since the experiment contained four treatment groups and a truncated control group, and since many comparisons of interest concerned this latter group, the MANCOVA was computed on all five groups. Orthogonal contrasts were used to decompose treatment main effects and interactions and to contrast all treatment groups as a set with the control group. Such a strategy provides both a parsimonious and statistically powerful model for detecting group differences without raising testwise error (Dayton, 1971).

An examination of the orthogonal contrasts on all adjusted posttest variables yielded no significant main effect due to prompt position ($F = 1.2, p > .05$) or to whether the prompt was learner or computer controlled ($F = 1.2, p > .05$). Nor was a statistically reliable interaction present on any of the

Table 6

Pretest and Posttest Means and Standard Deviation

Measures	Experimental Condition											
	CCP-Q ^a		CCP-E ^b		LCP-Q ^c		LCP-E ^d		No Prompt			
	M	SD	M	SD	M	SD	M	SD	M	SD		
Accuracy^e												
Pretest	8.7	1.8	8.8	1.4	9.2	1.5	8.7	1.4	8.5	1.9		
Posttest	9.3	1.4	9.2	1.3	9.6	1.6	8.8	1.6	9.0	2.1		
Latency^f												
Pretest	4.9	.4	5.2	.5	5.0	.5	5.1	.5	5.1	.4		
	(144.5)	(57.8)	(201.2)	(94.2)	(168.4)	(73.6)	(188.8)	(122.9)	(183.7)	(92.3)		
Posttest	4.3	.4	4.4	.4	4.4	.4	4.4	.4	4.5	.5		
	(82.0)	(31.2)	(89.2)	(33.4)	(88.8)	(36.9)	(89.3)	(33.7)	(104.7)	(58.7)		
Correct Rate^g												
Pretest	4.2	1.8	3.3	1.7	4.1	2.3	3.5	1.9	3.2	1.2		
Posttest	7.8	3.2	7.3	3.5	7.9	4.1	7.0	3.6	6.7	3.5		
Self-efficacy^h												
Pretest	88.6	11.7	85.2	12.0	89.3	10.5	83.4	13.4	89.4	15.6		
Posttest	100.3	11.4	100.9	9.6	98.8	13.2	95.8	13.5	96.6	16.2		

Note. N = 30 per group

Table 6 (cont'd)

- ^aCCP-Q is the computer controlled prompt with question group
- ^bCCP-E is the computer controlled prompt upon error group
- ^cLCP-Q is the learner controlled prompt with question group
- ^dLCP-E is the learner controlled prompt upon error group
- ^enumber of correct items on 12 problems (excluding generalization and unsolvable items).
- ^fnatural log transformed latencies summed across items (with total seconds in brackets)
- ^gnumber of analogies solved correctly per minute
- ^htotal self-efficacy across items: Scale range 12 (low) - 120.

posttest measures ($F = 0.32, p > .05$). Moreover, no reliable differences were found between the set of treatment groups ($n = 120$) and the no-prompt control ($F = 1.3, p > .05$).

A similar set of analyses was conducted on the generalization items. Means and standard deviations for each group on all pretest and posttest measures are found in Table 7. As was the case with the instructed analogy questions, no pretest differences were present on total problem-solving accuracy, rate, log latency and self-efficacy ($F = 0.9, p > .05$). Similarly, no reliable main effects, interactions, or treatment group with control contrasts were significant on the posttest MANCOVA.

Complete MANCOVA Tables for the between group analysis of treatment effects on practice and generalization items is contained in Appendix I.

There is of course the possibility that the failure to confirm Bandura's hypothesis about the effects of prompts on self-efficacy resulted from learners not attributing any of their performance successes to the prompts provided during instruction. To examine this possibility subjects were asked to estimate at the end of each practice trial the percentage of their success which they believed was due to the prompts provided by the computer program. These data are contained in Table 8. As noted there, learners did generally attribute some of their performance success to the instructional aids. On average across trials, subjects attributed slightly less than 20% of their success to the prompts.

Table 7

Pretest and Posttest Means and Standard Deviations on Generalization Items

Measures	Experimental Condition									
	CCP-Q ^a		CCP-E ^b		LCP-Q ^c		LCP-E ^d		No Prompt	
	M	SD	M	SD	M	SD	M	SD	M	SD
Accuracy^e										
Pretest	5.0	1.4	5.2	1.3	5.2	1.4	5.1	1.4	5.1	1.7
Posttest	5.4	1.5	5.5	1.4	5.2	1.4	5.1	1.4	5.7	1.4
Latency^f										
Pretest	4.9	.6	5.3	.5	5.1	.5	5.2	.5	5.2	.5
	(159.7)	(91.2)	(226.7)	(116.2)	(176.3)	(80.2)	(204.7)	(114.5)	(204.1)	(124.3)
Posttest	4.2	.5	4.4	.5	4.2	.6	4.2	.5	4.3	.6
	(77.0)	(40.0)	(93.1)	(48.1)	(76.7)	(41.0)	(76.8)	(37.3)	(91.0)	(60.4)
Correct Rate^g										
Pretest	2.4	1.4	1.6	.7	2.2	1.3	1.9	1.2	1.8	1.0
Posttest	5.1	2.7	4.5	2.8	5.3	3.1	4.9	2.5	5.1	2.8
Self-efficacy^h										
Pretest	55.5	8.7	55.0	9.0	54.4	10.0	52.7	8.6	54.1	10.9
Posttest	60.9	10.6	63.6	9.8	59.3	10.1	58.2	10.1	59.7	10.6

Note. n = 30 per group

Table 7 (cont'd)

^aCCP-Q is the computer controlled prompt with question group

^bCCP-E is the computer controlled prompt upon error group

^cLCP-Q is the learner controlled prompt with question group

^dLCP-E is the learner controlled prompt upon error group

^enumber of correct items on 8 problems

^fnatural log transformed latencies summed across items (with total seconds in brackets)

^gnumber of analogies solved correctly per minute

^htotal self-efficacy across items: Scale range 9 (low) - 80.

Table 8

Means and Standard Deviations for Performance Attributions across Trials

Trial	Experiment Conditions							
	CCP-Q ^a		CCP-E ^b		LCP-Q ^c		LCP-E ^d	
	M	SD	M	SD	M	SD	M	SD
1	25.3	18.0	28.0	24.3	21.3	18.5	18.6	22.7
2	19.0	16.7	17.0	22.5	19.7	17.3	19.3	22.7
3	20.0	19.5	19.7	18.1	19.3	17.2	16.3	15.2
4	18.3	20.0	20.3	17.9	17.7	18.5	18.7	14.1

Note. n = 30 per group.

^aCCP-Q is the computer controlled prompt with question group

^bCCP-E is the computer controlled prompt upon error group

^cLCP-Q is the learner controlled prompt with question group

^dLCP-E is the learner controlled prompt upon error group

Thus far, the evaluation of the effects of prompts on self-efficacy has been confined to analyzing between-group differences on total posttest self-efficacy. Another source of evidence bearing on this issue is found in the relationship between the rate of prompt usage present in learner-controlled prompt groups and individuals' subsequent self-efficacy across the practice trials. Presumably, individuals in these groups who chose to make substantial use of prompts during the practice trials would experience lower self-efficacy than those who used prompts less frequently. In this way, it would be expected that there would be an inverse relationship between prompt usage on a given trial and total self-efficacy estimates on the trial immediately following. Moreover, a similar relationship would be expected between the total use of prompts across the four practice trials and posttest self-efficacy.

An analysis of prompt usage and subsequent self-efficacy for learner-controlled prompt groups ($n = 60$) yielded somewhat mixed results. The correlation between trial 1 prompt usage and trial 2 self-efficacy was moderate and as expected, inverse ($r = -.32, p < .01$). A similar comparison between trial 2 prompt usage and subsequent efficacy on trial 3 produced almost identical results ($r = -.31, p < .05$). The correlation between prompt usage at trial 3 and efficacy at trial 4 was, however, not significantly different from zero ($r = .09, p > .05$). Moreover, the total use of prompts across the practice trials was not reliably related to posttest self-efficacy ($r = -.20, p > .05$).

A more precise test of the effects of prompt usage and self-efficacy is yielded by an examination of learners' performance attributions. Learners may well have used the various prompts, but it is only under conditions where prompt usage gives rise to attributions of success due to the prompt that attenuating effects on self-efficacy are predicted by Bandura. In the present study, performance attributions on a given trial would be expected to have an inverse relationship with efficacy judgements on the subsequent trial. An analysis of the data revealed that this was consistently the case across trials. Learners who tended to attribute their performance success on trial 1 to the instructional hints, felt somewhat less efficacious on trial 2 analogy problems ($r = -.22, p < .05$). A similar relationship held between trial 2 performance attributions and trial 3 self-efficacy ($r = -.17, p < .05$), and between trial 3 attributions and trial 4 self-efficacy ($r = -.16, p < .05$). There was, however, no reliable relationship between learners' aggregate performance attributions across trials and their subsequent total self-efficacy on posttest items.

Closely related to the notion of self-efficacy are expectations concerning overall achievement. As mentioned some time ago, subjects' predictions of their achievement on the pretest and posttest were gathered prior to completing each test. The following analysis explores the effects of prompting conditions on these expectations.

A preliminary ANOVA on pretest achievement expectations suggested that there were no reliable differences between groups on this variable ($F = 1.35, p > .05$). Since a test of the homogeneity of slope assumption required for ANCOVA indicated regression coefficient heterogeneity, ($F = 2.7, p < .05$) posttest achievement expectations were analyzed by an ANOVA with a priori orthogonal contrasts. An examination of these contrasts indicated that there were no main effects due to prompt position ($F = .44, p > .05$) or to whether the prompt was learner controlled or computer controlled ($F = .90, p > .05$). Further, no statistically reliable interaction was present ($F = 1.19, p > .05$). There was, however, a reliable difference between the control group and the treatment groups considered as a set ($F = 4.4, p < .05$). Subjects receiving prompted instruction had higher achievement expectations ($M = 17.9, SD = 2.8$) than individuals in the control group ($M = 16.5, SD = 4.4$). The use of prompts during instruction tended to increase, rather than to decrease, learners' estimates of what they would achieve on the posttest.

Pretest-posttest differences. Since no reliable differences were present between groups on any of the pretest or posttest measures, these scores were pooled across all groups to examine overall within group pretest-posttest change ($N = 150$). Table 9 contains the pooled pretest and posttest means and standard deviations for performance and self-efficacy variables.

A one-sample Hotelling's T-square calculated on subjects' total problem-solving accuracy, correct rate, latency and

Table 9

Overall Pretest and Posttest Means and Standard Deviations

Measures	Instructed Items		Generalization Items	
	M	SD	M	SD
Accuracy^a				
Pretest	8.8	1.6	5.1	1.4
Posttest	9.2	1.6	5.4	1.4
Latency^b				
Pretest	5.1 (177.3)	.5 (91.7)	5.1 (192.3)	.6 (107.8)
Posttest	4.4 (90.8)	.4 (40.2)	4.3 (82.9)	.5 (46.1)
Correct Rate				
Pretest	3.6	1.8	2.0	1.2
Posttest	7.3	3.6	5.0	2.8
Self-efficacy^c				
Pretest	87.2	12.8	54.1	9.4
Posttest	98.5	13.0	60.3	10.3

^anumber of correct items - out of 12 for instructed items and 8 for generalization items.

^bnatural log transformed latencies summed across items (with total seconds in brackets)

^ctotal self-efficacy across items: scale range 12 (low) - 120 for instructed items and 8 (low) - 80 for generalization items.

self-efficacy indicated statistically reliable pretest-posttest differences on this set of variables ($T = 15.4, p < .001$). The finding of an overall multivariate T does not, of course, guarantee that pretest-posttest changes for all variables were statistically reliable. In order to investigate further the specific source of these differences, a series of univariate matched t -tests were computed. The results of this set of follow-up analyses revealed that all pretest-posttest differences were reliable: $\underline{t} = 3.9, p < .001$, for accuracy of problems solving; $\underline{t} = -18.8, p < .001$, for problem-solving latency; $\underline{t} = 15.9, p < .001$, for correct rate of problem solving; and $\underline{t} = 11.4, p < .001$, for self-efficacy.

An analysis of pretest-posttest changes on the generalization items was also of interest in the study (see Table 9). Using identical statistical procedures to those just described, a significant Hotelling's T -square was obtained for total problem-solving accuracy, latency, self-efficacy and the correct rate of problem solving on the generalization analogies ($T = 12.76, p < .001$). Subsequent t -test indicated that pretest-posttest change was significantly reliable for each variable ($\underline{t} = 3.6, p < .001$, for problem-solving accuracy; $\underline{t} = -17.0, p < .001$, for problem-solving latency; $\underline{t} = 14.0, p < .001$, for rate of correct problem-solving; and $\underline{t} = 7.39, p < .001$, for learners' self-efficacy).

Mediational Effects of Self-efficacy

Resting at the very heart of self-efficacy theory is the claim that self-efficacy mediates performance. In order to address this issue two path analyses were conducted on subjects' performance and self-efficacy across the four practice trials present in the study ($N = 150$). In the first path model, a series of regression equations was computed in accordance with Bandura's specification of the causal role of self-efficacy (see Figure 1). In the second, a more parsimonious model was specified; one in which self-efficacy was not included (see Figure 2).

Table 10 contains the means and standard deviations of learners' total self-efficacy and rate of problems solved correctly per minute across the four practice trials.

If Bandura's contention is correct, it would be expected that the path model specifying a mediational role for self-efficacy would yield significant path coefficients. As displayed in Figure 1, however, the only standardized path coefficient that was reliably different from zero was found between learners' efficacy expectations on trial 1 and their subsequent performance on that trial ($t = 4.25, p < .01$). All other path coefficients were not statistically significant. Parenthetically, very similar path coefficients were obtained using accuracy, rather than correct rate, as the performance measure (See Figure 3).

Table 10

Mean Self-efficacy and Correct Rate of Problem-solving

Trial	Correct Rate		Self-efficacy	
	M	SD	M	SD
1	4.50	2.8	101.9	19.1
2	5.27	2.8	103.9	17.2
3	5.80	2.8	111.6	16.4
4	4.65	2.2	111.2	16.0
Pretest	3.65	1.8	87.2	12.8
Posttest	7.33	3.6	95.5	13.0

Note. N = 150

Figure 1

Bandura's Causal Model

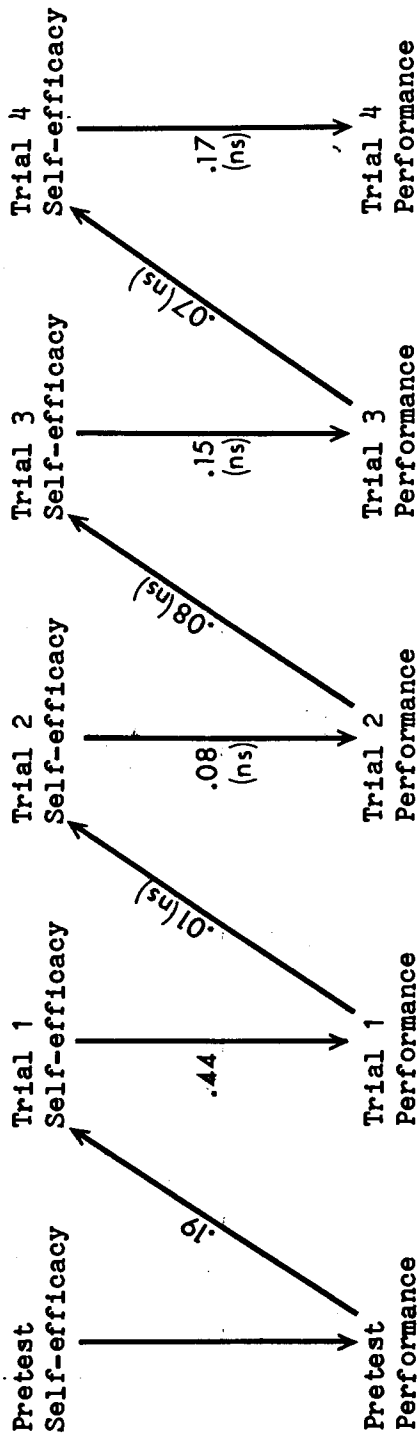


Figure 2

Respecified Path Model

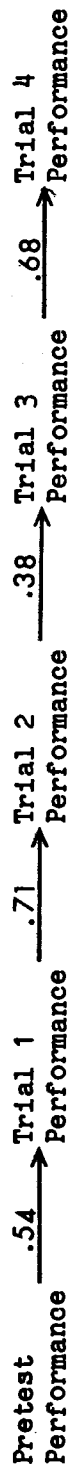
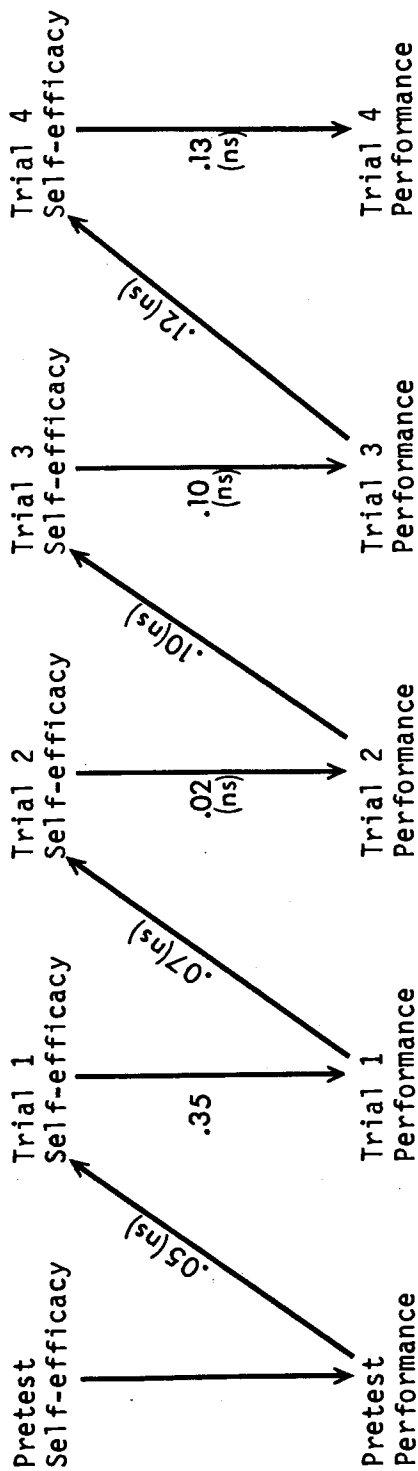


Figure 3

Bandura's Causal Model on Problem-solving Accuracy



In general, and with the exception of trial 1, these data indicate that changes in self-efficacy were not met with direct changes in performance. Given this, the results do not indicate that self-efficacy mediated performance, at least in the way specified by Bandura.

The path coefficients found in Figure 1 speak to the specific question of whether self-efficacy mediates performance under the confines of a specific model. A slightly different approach to assessing the mediating effects of self-efficacy is to contrast directly Bandura's causal model with one which does not contain self-efficacy as a variable. This latter path model is illustrated in Figure 2, along with its associated standardized path coefficients. If Bandura's model has more explanatory power, it should yield larger multiple R's with performance at each trial than the more parsimonious model.

The multiple correlation with trial performance for each of the path models is displayed in Table 11. As detailed in this table, Bandura's model did generally yield larger multiple correlations with performance at each trial. This increase in prediction was, however, reasonably small. Bandura's model accounted for an average of only 3.9 percent more trial performance variance when contrasted to the respecified path model which did not include self-efficacy as a variable.

One last source of evidence bearing on the mediating effects of self-efficacy is found in the intercorrelations between self-efficacy and performance measured at pretest and posttest. Assuming that self-efficacy mediates performance, it would be

Table 11

Comparison of Multiple Correlations with Performance under Bandura's Model and a Respecified Model

Trial	Bandura's Model	Respecified Model	R ² Difference
1	.614	.546	.079
2	.816	.809	.011
3	.822	.797	.040
4	.812	.794	.029

Note. N = 150

expected that posttest self-efficacy would be a better predictor of posttest performance, than previous performance on the pretest. An examination of the data on this point showed that quite the opposite was true. The correlation between the correct rate of problem solving at pretest and posttest was .67, while the correlation between posttest efficacy and posttest correct rate was only .42. The difference between these correlations was statistically reliable ($t = 3.40$, $p < .05$). A similar comparison using problem solving accuracy yielded identical results. The correlation between pretest and posttest accuracy was .734. This was significantly higher than the .38 correlation obtained between posttest self-efficacy and posttest problem solving accuracy. ($t = 5.68$, $p < .05$).

Summary of Results

In this, the closing section of the chapter, the questions posed at the end of chapter 3 are brought forward once again. As each question is reiterated, a summary of the substantive findings of the study is provided.

1. *What is the relationship between learners' efficacy expectations, and their speed, accuracy and correct rate of analogical problem-solving prior to, during, and following computer-assisted instruction?*

As reported in Table 5, subjects' efficacy expectations were generally found to be positively correlated with problem-solving performance measures. These correlations were, however,

reasonably small. When averaged across pretest, posttest and the four practice trials, self-efficacy accounted for approximately 8% of the variance in learners' problem-solving accuracy, and about 13% of the variance in learners' correct rate of problem solving. Self-efficacy was also found to be inversely related to problem-solving speed, with an average correlation of $-.28$ across pretest, posttest and practice trials.

Generally then, these data support Bandura's prediction about the relationship between self-efficacy and performance. The magnitude of the relationship gleaned from this investigation is, however, considerably less than previous research has indicated.

2. What is the relationship between learners' self-efficacy and their persistence on a set of unsolvable analogy problems?

Running contrary to self-efficacy theory, no statistically reliable correlations were found between subjects' self-efficacy at pretest and posttest and their subsequent persistence on the unsolvable analogy items.

3. Does the computer-assisted instructional treatment produce increases in learners' analogical reasoning performance and perceived self-efficacy?

An analysis of pretest-posttest differences revealed that there was a statistically significant overall increase in problem-solving accuracy, rate of correct problem solving and self-efficacy. In addition, subjects' tended to decrease their

problem-solving latencies from pretest to posttest.

The magnitude of pretest-posttest change in these variables varied considerably. Learners' evidenced reasonably small gains in accuracy. Such increases were in the order of .25 of a standard deviation. Decreases in response latencies were more substantial and represented about a 1.4 standard deviation decrease in magnitude. Overall, learners' increased their correct rate of problem-solving by about 2 standard deviations. Close to a full standard deviation change in self-efficacy was also noted from pretest to posttest.

4. *To what extent do any increases in self-efficacy occurring during instruction generalize to types of analogy problems which were not the subject of instruction?*

An examination of learners' pretest and posttest self-efficacy on the generalization items revealed a reliable increase. Predictably, the size of this increase, which was approximately .66 of a standard deviation, was less than found on the instructed items. Reliable gains in analogical reasoning were also found on the generalization items.

5. *What are the relative effects on analogical problem-solving performance of the different prompt delivery systems used during computer-assisted instruction?*

An analysis of problem-solving performance measures (latency, accuracy and correct rate) indicated no reliable differences were present between the various prompted groups, and between all prompted groups and the no-prompt control group. This finding held for both instructed analogy items and for the

generalization items. Contrary to expectations then, there was no instructional benefit to providing learners with prompts which informed them about the mapping relationship between analogy pairs.

6. Are there differential effects on self-efficacy arising from the system of prompt delivery found during instruction? To what extent do learners' prompt usage and performance attributions attenuate self-efficacy?

Despite the fact that subjects attributed about 20% of their performance successes to the hints provided by the computer program, there was no significant difference between treatment and control groups in posttest self-efficacy. There was a slight tendency for subjects in prompted groups who attributed more of their performance successes to the prompts, to exhibit somewhat lower self-efficacy. While this effect was consistent across trials, it was reasonably small in magnitude, with correlations ranging from $-.16$ to $-.22$. Further, there was no relationship between total prompt attribution across trials and self-efficacy on the posttest.

An examination of prompt usage in the two learner-controlled prompt groups indicated that there was some tendency for high-prompt users to exhibit lower self-efficacy on some of the subsequent trials. This tendency was not consistent across all trials, nor did total prompt usage have the predicted inverse relationship with posttest self-efficacy.

In summary, while it does appear that there may be some attenuating effects on self-efficacy of using prompts during

instruction, such effects appear to be very small when present in the data. Bandura's remarks about the attenuating effects of performance prompts on self-efficacy do not find widespread support in this study.

7. Is the path model generated by examining changes in self-efficacy and problem-solving performance during instruction consistent with the contention that self-efficacy mediates performance?

The study presents three sources of evidence bearing on the question of the mediational role of self-efficacy. First, results of the path analysis conducted on subjects' self-efficacy and performance across the practice trials indicated that only one path coefficient was reliably different from zero. Second, when Bandura's path model was compared to a respecified model that did not include self-efficacy, only a marginal improvement in the prediction of trial performance was found (see Table 11). Third, an analysis of pretest and posttest achievement revealed that prior achievement was a substantially better predictor of posttest performance, than was posttest self-efficacy. Taken together, these data suggest that self-efficacy did not mediate learners' analogical problem solving during the study.

CHAPTER VI

DISCUSSION

This chapter discusses the results of the experiment in relation to other findings in the self-efficacy research. In doing this, a narrative summary of the current findings is coupled with a discussion of some of the possible limits of self-efficacy theory, as well as a description of some of the possible limitations of this investigation. The chapter concludes with a number of recommendations for future research in this area.

The general finding that self-efficacy is correlated with problem-solving performance is, of course, predicted by self-efficacy theory and is consistent with a large number of other studies (see Tables 1 & 2). Unlike previous research, however, the magnitude of the correlation found between self-efficacy and performance in the present study is quite small. In this study, approximately 8 to 13 percent of performance variance was accounted for by learners' efficacy expectations. In contrast, previous investigations have, on average, found that self-efficacy accounts for about 36% of the variability in performance.

There are several possible reasons for the relatively small correlations observed in this study. First, the Guttman lower-bound reliability estimates for pretest and posttest achievement tests are only moderate (.65 and .70), and likely the result of range restrictions present on self-efficacy and achievement

variables in the sample. Given this, the correlations between self-efficacy and performance might be attenuated to some degree. Even when corrected for attenuation due to unreliability, however, the correlations between self-efficacy and performance do not approach those typically found in the literature. This is despite the fact that corrections to correlations using lower-reliability estimates tend to overestimate correlation coefficients. This fact, coupled with the observation that none of the correlations in the self-efficacy literature, which are used as a comparison here, have been corrected for unreliability, suggests that measurement error alone cannot account for the relatively low efficacy-performance correlations.

One of the merits of this study is that it examined self-efficacy and performance in a manner that was not highly influenced by experimenter demand. Little of the experimenter surveillance that was discussed in Chapter 2 as a confounding source efficacy-performance agreement was present in the current study. Since the entire study was conducted by a computer, subjects' completed their efficacy judgements and achievement tasks in relative isolation from the experimenter. Ironically, this lack of experimenter demand may have reduced the size of the correlations between self-efficacy and problem-solving performance. While the extent of the possible influence of demand on self-efficacy and performance awaits explicit empirical investigation, it does seem reasonable that subjects would have a greater tendency to match their predictions of

their behaviour with commensurate performance under conditions of high experimenter surveillance, rather than low surveillance conditions. Given this, it may be that correlations found in this study are lower because of closer experimental attention to the influences of social demand.

Yet a third reason for the relatively small efficacy-performance correlations may rest with the nature of the tasks used in the study. As indicated in Chapter 2, there are relatively large differences in the observed relationship between efficacy expectations and performance in clinical, educational and sports studies. It was argued in that chapter that such differences arise because the efficacy judgements on well-defined behavioural tasks, like those found in clinical studies of phobias, are apt to be more accurate estimates. In contrast, efficacy judgements made on cognitive tasks whose demands are not as easily ascertained, such as those employed by Schunk, are apt to be less accurate. In a similar way, the analogy problems in this study can be viewed as reasonably ill-defined tasks, at least in the sense that a cursory evaluation of the task may not always reveal its full demands.

The speculation that cognitive tasks are somewhat less well defined than behavioural tasks deserves some elaboration. Both behavioural and cognitive tasks can be viewed as possessing initial conditions that are subject to activities that give rise to the fulfillment of a goal (Newell & Simon, 1972). While both classes of tasks share these features in common, that is, both have initial conditions, goal states and are subject to

activity, the precise nature of these aspects differs considerably.

Consider first the initial conditions and goals of behavioural and cognitive tasks used in self-efficacy research. The initial conditions of behavioural tasks are quite explicit inasmuch as there is little room to misinterpret the demands of such tasks. For example, if one is asked to hold a snake, the task goal and conditions require little interpretation. On the other hand, solving cognitive problems such as analogies may require considerable cognitive representation to fully understand the demands of the task. On a surface level, all analogy problems are roughly of the same form. Before their full demands are apprehended, they must be represented in the problem space.

Recent work in the area of problem representation suggests problems may be represented in a number of different ways (Chi, et al. 1981). Although this research has focussed upon physics problems, the general finding that some problem solvers represent tasks in terms of surface features, while others represent tasks in terms of the problem solving procedure is of importance here. In a parallel way, analogies may be subject to different representations. As learners judge their efficacy on analogy problems, their representation of the problem may be rudimentary, such as, "I know all of the words in the analogy and hence should be able to solve it". Alternatively, learners may represent the problems in a more sophisticated way, for example, "I know the rule, and hence can solve the problem".

The importance of the preceding for self-efficacy research is that since cognitive tasks require representation in the problem space and since it is likely that such representations may differ, it is also likely that representational errors may occur as learners judge their efficacy. This is to say, that surface representation of the problem at the time learners make their efficacy judgements may not match the deeper representation necessary to solve the problem. As this represents a source of error not present in behavioural tasks, which require little representation, some lessening of the relationship between self-efficacy and performance on cognitive tasks may be expected.

The notion that the salience of the cognitive demands present in a given task may interact with efficacy judgements has been neglected in both self-efficacy theory and research, despite its importance. If, as Bandura suggests, self-efficacy is a central mediator of all human performance, then it must operate to a large extent independently of features of tasks. This is to say that self-efficacy theory must account for performance on a myriad of tasks, both well-defined and ill-defined, which regularly confront individuals. Already, however, we have hints from the meta-analysis of previous studies and the results of this study, that the relationship between self-efficacy and performance may be dependent upon the nature of the performance task. If this is the case, then the generalizability of self-efficacy theory may be severely limited.

Speculation on the relationship between task parameters, self-efficacy and performance also underscores the need for self-efficacy researchers to examine more closely the cognitive judgements which give rise to efficacy expectations. As was argued at the end of Chapter 2, self-efficacy theorists have been remiss in not providing an adequate account of the self-appraisal mechanisms which presumably produce efficacy expectations. Focus on self-evaluative cognitions may lead to a better understanding of the kind of task information which learners utilize in making self-efficacy judgements and perhaps provide a better understanding of the general relationship between task parameters and self-efficacy.

The finding of an inverse relationship between learners' self-efficacy and persistence on both the instructed and generalization analogy problems is not too surprising. Subjects who tended to feel efficacious would not be expected to linger over their responses. Notice, however, that the finding of an inverse relationship between self-efficacy and persistence is at variance with most of the previous research. The reason for this likely lies once again in task differences. In the behavioural tasks found in previous investigations, such as approaching fear-evoking objects, persistence is a required part of achieving the task. Persistence becomes an integral part of task performance. On the other hand, in problem-solving tasks, lingering over the solution is likely to denote to the learner a sense of diminished competence.

The additional finding that self-efficacy and persistence on the unsolvable analogy items were unrelated is more difficult to explain. Whatever the explanation, it is not because learners resigned their efforts quickly. Indeed, response latencies on these items were generally three times greater than latencies on the solvable pretest and posttest items.

There is of course the possibility that there were too few unsolvable items to yield a scale with high reliability. This may be the most parsimonious explanation of the nonsignificant correlations, since scales cannot correlate higher than the square root of the product of the reliability of each scale (Ghiselli, Campbell & Zedeck, 1981).

A major focus of this investigation was upon the effects of prompts on self-efficacy. Despite the fact that learners did tend to attribute some of their performance successes to the aids provided during instruction, there were only small and scattered attenuating effects on self-efficacy. Such effects were not present in comparisons of the posttest self-efficacy of groups receiving prompted instruction and the no-prompt control group. Rather, the only attenuating effects of prompts were observed over the practice trials, with learners who attributed more of their performance success to the prompts experiencing slightly reduced self-efficacy. As mentioned, this inverse relationship was small, in the order of $-.17$ to $-.22$, and tended to wane over the practice trials.

In light of these data, it appears that Bandura's claim regarding the attenuating effects of prompts on self-efficacy is

not supported. Admittedly, it may be that learners in prompted groups did not attribute enough of their performance success to the prompts, and consequently, performance attributions did not produce a robust effect on self-efficacy. Nevertheless, under conditions where learners attribute about 20 percent of their success to performance aids, self-efficacy remains largely unaffected.

The lack of discernible effects of the prompts on achievement is surprising. According to Sternberg's account of analogical reasoning, the prompted groups should have performed better than the noprompt control because less inferencing would be required by learners in prompted groups. It is possible that the lack of prompt effects was present because subjects were not adept at utilizing the knowledge present in the prompt during inferencing. Alternatively, it may be that the inferencing demands of the analogy problems were minor because of the nature of the sample used in the study. This is to say, that the university students in the study may have been very skilled at making such inferences and did not benefit from the prompts because of a high level of preexisting problem-solving strategies. Errors committed by the students may have arisen from entirely different sources, such as not knowing the meanings of the words present in the analogy.

The last major set of findings for discussion pertain to the mediational role of self-efficacy. Generally speaking, there is only scant evidence that self-efficacy mediated learners' performance over the practice trials present in this study.

Only on trial 1 were changes in self-efficacy met with direct changes in performance. Moreover, when Bandura's causal model was contrasted to one which did not contain self-efficacy, only a modest decrease in prediction of trial performance for the reduced model was evident.

One possible conclusion from these data is that self-efficacy is simply a co-effect of performance and not a mediating variable. Such a conclusion would, however, fail to account for the initial mediating effects on self-efficacy observed at trial 1. An intriguing rival hypothesis is that self-efficacy's relationship with performance is more characteristic of a step function, than an incremental linear function. In this way, learners may harbour initial expectations which are changed only in the face of substantial performance changes. Not only is this view consistent with the results of this study, but it is also consistent with data reported by Feltz and her colleagues, who found that self-efficacy's influence on performance tended to wane over performance trials (Feltz, 1982; Feltz & Mungo, 1983).

Before turning to other matters, it should be noted that the path-analytic findings may be the result of the conditions under which learners practiced problem solving. In contrast to previous studies which have explored self-efficacy changes as learners practiced on tasks of increasing difficulty, subjects in this study practiced on tasks which were randomized in terms of their difficulty. It may well be that practice on graduated tasks may have shown more mediating effects of self-efficacy,

inasmuch as such a task condition might have provided learners with an opportunity to evaluate their progress more clearly. It should be noted that if this is the case, some modification of self-efficacy theory is still required. More precisely, the mediating effects of self-efficacy would be limited to enactive success garnered from graduated practice, not practice writ large.

It is difficult to speculate on the direct implications which arise from this study and bear on a cognitive analysis of student motivation. Nevertheless, a number of remarks might be made, bearing in mind that the study was conducted in a setting reasonably unlike typical classrooms. First, the bulk of self-efficacy studies have been conducted using well-defined tasks. This presents little problem when self-efficacy theory is applied to clinical or sports settings. It does, however, present difficulties when applied to classroom settings, inasmuch as a large number of classroom tasks are somewhat ill-defined. Since efficacy judgements are task judgements to some degree, it is crucial to examine self-efficacy on a range of classroom tasks. Schunk's examination of self-efficacy on arithmetic problems exclusively seems extraordinarily limited, if self-efficacy is going to take its place as an important variable in the analysis of student motivation. What is needed here, of course, is a much more extensive analysis of self-efficacy, task and performance relationships.

Second, no study has ever examined whether self-efficacy judgements are naturally occurring cognitive phenomena. To be

sure, if researchers ask individuals to rate their self-efficacy, they do so. But without evidence that self-efficacy judgements are regularly made by individuals when confronted with tasks, there is little reason to believe that self-efficacy is not simply an interesting proxy for some other sort of motivational variable.

Lastly, much more empirical work needs to be done on examining how efficacy expectations are acquired before self-efficacy theory can yield important prescriptions for instruction. For example, while it is clear that efficacy determining information may arise from a number of sources, it is unclear how learners might integrate information from a number of these sources. Similarly, while it is clear that enactive successes increase self-efficacy, it is not clear how the pattern of such successes might influence self-efficacy. In general, what is needed is a much more particular accounting of the variables which affect the transmission of self-efficacy. It is only when research of this sort is forthcoming, that it is reasonable to suppose that self-efficacy research will inform the planning and delivery of instruction in classrooms.

APPENDIX A

Program Documentation

Overview of the Programs

Six disks accompany the dissertation. In the event that the disks are not contained in this particular copy of the dissertation, they may be obtained from the Graduate Programs office in the Faculty of Education. The first five disks, which are labelled conditions 1 through 5, contain the analogical reasoning programs for each of the five experimental conditions. In addition, the user will find various support programs and data files. The specific function of these latter two types of programs will be explained shortly. The last disk contains additional utility programs which were used to merge subjects responses into larger data sets.

There are three general types of programs found on the appended disks: 1. tutorial programs, 2. utility programs and 3. response and text files. The discussion now turns to a description of the nature and function of each of these type of programs.

Tutorial Programs

Each of the five conditions present in the study is found on separate disks labelled conditions 1 through 5. These programs are written in Applesoft Basic. All programs boot automatically

from the disk and function as described in the methods section of dissertation.

Utility Programs

A number of utility programs support the tutorial programs. Some of these programs are found on the tutorial disks, while others are found on a separate disk labelled System Master. The discussion in this section of the documentation begins with those programs found on the tutorial disks.

Setup. The purpose of program SETUP is to gather and store the subject's identification number, condition number and sex. The program is menu driven and permits the user to enter subject information, read the existing subject information, print the existing subject information or exit the program. This program can be run by: 1. booting one of the tutorial disks, 2. pressing the control and reset keys simultaneously and 3. typing RUN SETUP. The subject's id, condition number and sex are stored in a text file called PERSONAL.

Readres. The purpose of program READRES is to read or print the responses of a subject to the various analogies presented during instruction. All of the response data is contained in a text file called RESPONSE. The organization of the data in this file will be described later in the documentation.

The program READRES is menu driven and easy to use. It can be run by: 1. booting one of the tutorial disks, 2. pressing the control and reset keys simultaneously and 3. typing RUN READRES.

The following utility programs are found on the disk labelled SYSTEM MASTER. In general, there are two basic types of utility programs. The first type are used to merge the response file contained on separate tutorial disks. The second type of utility programs may be used to modify the items found in the tutorial disks.

Merge. The purpose of the MERGE program is twofold. First, since each subjects responses are contained on a separate disk, it becomes necessary at some point to merge several subjects responses into a larger data file. This should be done by condition. This is to say, that the user should merge subjects' responses from one condition on a separate disk. In the present study, this resulted in five disks of merged subject data.

The second purpose of MERGE is to change the way the data are organized. The organization of data found on file RESPONSE is transformed by the merge file to facilitate data analysis. The specific organization of this new response file, called MDATA, will be discussed later.

Before attempting to merge any data, the user should copy the following programs from the SYSTEM MASTER disk to a new disk: 1. CREATE MDATA, 2. MERGE and 3. READMDATA. This will permit enough space for file MDATA and again, should be done for each of conditions.

Before the MERGE program can be run, the text file MDATA must be created. This is a rather simple procedure and needs to be done only once, when a new disk of merged data is being created. (Creating MDATA when it already exists on the disk,

will result in a loss of all responses contained in MDATA.) To create MDATA, place the disk containing READMDATA, MERGE and CREATE MDATA in disk drive 1 and boot. After the disk is booted, type RUN CREATE MDATA. This will create MDADA, but more importantly, it will initialize the file with a file pointer. The file pointer permits response files which are being merged to be concatenated. Without the file pointer, the response data would simply be overwritten on the previously merged data.

The merging of data requires two disk drives. Place the disk with MERGE in drive 1 and run MERGE. The MERGE program is menu driven and self-explanatory. It will instruct the user to place the disk containing the data to be merged in the second drive. Once this is done, simply press return to begin the merging of the data.

Readmdata. The function of READMDATA is similar to the program READRES. It permits the user to read or print the file MDATA. This program is also menu driven and self-explanatory. It can be run by typing RUN READMDATA.

This completes the description of the utility programs found on the SYSTEM MASTER disk which are devoted to merging tasks. The next set of utility programs are used to modify items found on the tutorial disk.

Item editor. All of the analogy items used in the tutorial programs are found in a text file called ITEMS. The purpose of the ITEM EDITOR program is to update, modify, delete, or print the analogy questions contained in text file ITEMS. Again, this program is menu driven, so the user needs only to select the

appropriate menu option. The organization of the ITEM text file is discussed later.

Create items. If a completely new set of items is being generated on a new tutorial disk, the file ITEMS will not exist. It must be created before any items can be inserted. The program CREATE ITEMS serves this purpose. CREATE ITEMS can be run in exactly the same way that CREATE MDATA is run.

Text and Response Files

Although mention has already been made of the various text and response files used in this study, little discussion has been offered on how the files are organized. This section lists all of the text files found on the appended disks, and describes the general format of these files. All of the files described here are located on the tutorial disks.

Intend2, pretest and practice. These three files contain the instructions offered to learners as they completed the analogies program. These instructions can be modified by APPLEWRITER.

It is important to note that there are a series of screen print control commands in the first two columns of each text line. These commands and their associated function are as follows:

1. /# -Clear current screen and begin next line
on the top of the new screen.
2. /& -Clear screen and call up the Self-efficacy

scale.

3. /* -End of file

There are a number of restrictions on the contents of these text files. First, commas cannot be used in the file. Second, the automatic carriage return feature of appewriter cannot be used. The carriage return must occur in column 35.

Items. As mentioned previously, this file contains all of the analogy items used during the course of instruction. Each item consists of a sequence number, an item stem, the correct response choice, three distractors, the type of analogy item and explanations which served as descriptive feedback. The sequence number is used to identify items during editing. Analogy item type is identified by the following code: 1 -part whole, 2 - synonym and 3 -similar function.

Response. The file RESPONSE contains subject's responses. The format for these data is as follows:

Line	Format	Variable Description
1	23(f2.0)	Pretest Self-efficacy
2	12(f4.1)	Pretest Latencies
3	11(f4.1)	Pretest Latencies
4	23(f1.0)	Pretest Responses
	f2.0	Pretest Items Correct
5	15(f2.0)	Trial 1 -Self-efficacy
6	15(f4.1)	Trial 1 -Latencies
7	15(f1.0)	Trial 1 -Responses
	f2.0	Trial 1 -Items Correct
8	15(f2.0)	Trial 2 -Self-efficacy

9	15(f4.1)	Trial 2 -Latencies
10	15(f1.0)	Trial 2 -Responses
	f2.0	Trial 2 -Items Correct
11	15(f2.0)	Trial 3 -Self-efficacy
12	15(f4.1)	Trial 3 -Latencies
13	15(f1.0)	Trial 3 -Responses
	f2.0	Trial 3 -Items Correct
14	15(f2.0)	Trial 4 -Self-efficacy
15	15(f4.1)	Trial 4 -Latencies
16	15(f1.0)	Trial 4 -Responses
	f2.0	Trial 4 -Items Correct
17	23(f2.0)	Posttest -Self-efficacy
18	12(f4.1)	Posttest -Latencies
19	11(f4.1)	Posttest -Latencies
20	23(f1.0)	Posttest -Responses
	f2.0	Posttest -Items Correct
21	16(f3.0 X)	Attribution Questions: to hint, to effort, to ability, and to luck (arranged by trial)
22	4(f2.0)	Number of times hints used in each trial
23	2(f2.0)	Pre and post achievement expectations

Mdata. As mentioned earlier, this response file contains the merged data file. Its format is as follows:

Line	Format	Variable Description
------	--------	----------------------

1	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	23(f1.0)	Pretest Responses
	f2.0	Pretest Total
	15(f1.0)	Trial 1 Responses
	f2.0	Trial 1 Total
	15(f1.0)	Trial 2 Responses
	f2.0	Trial 2 Total
2	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f1.0)	Trial 3 Responses
	f2.0	Trial 3 Total
	15(f1.0)	Trial 4 Responses
	f2.0	Trial 4 Total
	23(f1.0)	Posttest Responses
	f2.0	Posttest Total
3	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	12(f4.1)	Pretest Latencies
4	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	11(f4.1)	Pretest Latencies
5	f3.0	Id Number

	f1.0	Sex
	f1.0	Condition
	15(f4.1)	Trial 1 Latencies
6	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f4.1)	Trial 2 Latencies
7	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f4.1)	Trial 3 Latencies
8	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f4.1)	Trial 4 Latencies
9	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	12(f4.1)	Posttest Latencies
10	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	11(f4.1)	Posttest Latencies
11	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	23(f2.0)	Pretest Self-efficacy

	15(f2.0)	Trial 1 Self-efficacy
12	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f2.0)	Trial 2 Self-efficacy
	15(f2.0)	Trial 3 Self-efficacy
13	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	15(f2.0)	Trial 4 Self-efficacy
	23(f2.0)	Posttest Self-efficacy
14	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	16(f3.0 X)	Attribution Questions: to hint, to effort, to ability, to luck; arranged within trial.
15	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	4(f2.0)	Prompt or hint useage for trials 1 to 4.
16	f3.0	Id Number
	f1.0	Sex
	f1.0	Condition
	2(f2.0)	Achievement

expectations for
pretest and posttest

Closing Comments

All of the appended programs will work very well without modification. If you intend to modify the programs, however, you will soon discover that the source programs will exceed the memory limits of the Apple. This fact, coupled with the large number of utility programs required to support the main programs, suggests that better results might be obtained by writing the program in a different language and using a different computer. The main tutorial programs could be re-written quite easily in DBASE III and would run much better on a CPM or MSDOS machine.

APPENDIX B

Pretest Posttest and Practice Analogy Items

Part-whole Analogies

COAL IS TO CARBON AS

WATER IS TO

1. HYDROGEN*
2. IMPURITY
3. DROP
4. ICE

BAR IS TO NOTE AS

SENTENCE IS TO

1. LETTER
2. PHRASE
3. WORD*
4. COMMA

CODICIL IS TO WILL AS

CLAUSE IS TO

1. DISAGREEMENT
2. SCHEDULE
3. PROVISION
4. CONTRACT*

PIECE IS TO JIGSAW PUZZLE AS

TILE IS TO

1. CANVAS
2. TIME
3. PICTURE
4. MOSAIC*

FABRIC IS TO THREAD AS

ORGANISM IS TO

1. CELL*
2. MOLECULE
3. SKIN
4. LIFE

OXYGEN IS TO WATER AS

SODIUM IS TO

1. STEEL
2. COPPER
3. SALT*
4. NITROGLYCERINE

BUILDING IS TO WING AS

FOOTNOTE IS TO

1. BIRD
2. BODY
3. BINDING
4. PAGE*

SEDIMENT IS TO DELTA AS

CORAL IS TO

1. POLYP
2. ISTHMUS
3. CANYON
4. REEF*

TABLE IS TO VENEER AS

BUILDING IS TO

1. CHRYSLER
2. ARCHITECTURE
3. CONSTRUCTION
4. FACADE*

MERMAID IS TO FISH AS

CENTAUR IS TO

1. DOLLAR
2. MILKMAID
3. TOREADOR
4. HORSE*

MLA IS TO LEGISLATURE AS

VIOLINIST IS TO

1. ORCHESTRA*
2. MUSICIAN
3. CONDUCTOR
4. STRINGS

MOSAIC IS TO TILE AS

MELODY IS TO

1. SONG
2. PIANO
3. NOTE*
4. SINGER

BOWLING IS TO FRAME AS

TENNIS IS TO

1. RISE
2. RACKET
3. NET
4. SET*

STAR IS TO CONSTELLATION AS

ISLAND IS TO

1. VAPOUR
2. ARCHIPELAGO*
3. VIRAGO
4. ISTHMUS

APE IS TO MENAGERIE AS

SOLDIER IS TO

1. ARMY*
2. UNIFORM
3. COUNTRY
4. CANTEEN

SOAP IS TO FAT AS

CONCRETE IS TO

1. SAND*
2. BRICK
3. IVORY
4. SOLIDITY

TREE IS TO STUMP AS

WHEAT IS TO

1. GRAIN
2. STALK
3. BREAD
4. CHAFF*

LAWYER IS TO BAR AS

ARISTOCRAT IS TO

1. PARLIAMENT
2. ELITE*
3. LINEAGE
4. CLASS

CAP IS TO MUSHROOM AS

TIP IS TO

1. VEGETABLE
2. FUNGUS
3. ASPARAGUS*
4. CIGARETTE

ELBOW IS TO ARM AS

KNEE IS TO

1. REFLEX

2. LEG*

3. THIGH

4. CALF

BRONZE IS TO TIN AS

BRASS IS TO

1. ARGON

2. ZINC*

3. IRON

4. LEAD

WHALE IS TO POD AS

GOOSE IS TO

1. GAGGLE*

2. PEA

3. JONAH

4. WING

BOOK IS TO CHAPTER AS

COURSE IS TO

1. LESSON*

2. SUMMARY

3. PAGE

4. SYNOPSIS

Synonym Type Analogies

ERUDITE IS TO LEARNED AS

HAGGARD IS TO

1. GAUNT*
2. SLENDER
3. HUSKY
4. ROBUST

INCARCERATE IS TO IMPRISON AS

INEBRIATE IS TO

1. INCINERATE
2. INOCULATE
3. INTOXICATE*
4. IMBIBE

AWKWARD IS TO GAUCHE AS

ADROIT IS TO

1. SKILLFUL*
2. DULL
3. SPEEDY
4. SLY

GERMANE IS TO PERTINENT AS

IMPERTINENT IS TO

1. UNKIND
2. PRESUMPTUOUS*
3. VULGAR
4. PROPER

REBELLION IS TO INSURRECTION AS

CACOPHONY IS TO

1. HARMONY
2. DISSONANCE*
3. CONSONANCE
4. UPROAR

AMMUNITIONS IS TO MUNITIONS AS

EFFULGENCE IS TO

1. MUNIFICENCE
2. RADIANCE*
3. ARMAMENT
4. OPALESCENCE

EVANESCENT IS TO TRANSITORY AS

EVERLASTING IS TO

1. FADING
2. ETERNAL*
3. DUTIFUL
4. OLD

LOQUACIOUS IS TO GARRULOUS AS

RETICENT IS TO

1. DEROGATORY
2. TACITURN*
3. MAUDLIN
4. PROLIX

EMACIATED IS TO GAUNT AS

ROTUND IS TO

1. CORPULENT*

2. HANDSOME

3. WAN

4. ROTTEN

PERSPICUOUS IS TO CLEAR AS

PERSPICACIOUS IS TO

1. LUCID

2. OBVIOUS

3. SHREWD*

4. OPAQUE

WHIP IS TO FLOG AS

BERATE IS TO

1. SCOLD*

2. PUNCH

3. BEAT

4. PRORATE

REMARKABLE IS TO PHENOMENAL AS

COMMONPLACE IS TO

1. CHEMICAL

2. MEDIOCRE*

3. GHOSTLY

4. MARKETABLE

BUCOLIC IS TO RUSTIC AS

SACCHARINE IS TO

1. CLOYING*

2. PICTURESQUE

3. TABLET

4. PUNGENT

OSTENTATIOUS IS TO GAUDY AS

SUPERCILIOUS IS TO

1. BAWDY

2. SLIPPERY

3. ARROGANT*

4. MEAN

VORACIOUS IS TO RAVINOUS AS

VERACIOUS IS TO

1. TRUTHFUL*

2. EAGER

3. DISTRUSTFUL

4. DISHONEST

UNREMITTING IS TO INCESSANT AS

RECURRENT IS TO

1. CONTINUOUS

2. REGULAR

3. INTERMITTENT*

4. INFREQUENT

ASCETIC IS TO AUSTERE AS

ROCOCO IS TO

1. MEDIEVAL
2. ORNATE*
3. MONASTIC
4. CUCKOO

TOCSIN IS TO ALARM AS

SENTINEL IS TO

1. MILITIA
2. ALERT
3. SENTRY*
4. CENTURY

ERUDITE IS TO LEARNED AS

JEJUNE IS TO

1. EXOTERIC
2. SCHOLARLY
3. AUGUST
4. INSIPID*

REVERE IS TO HONOUR AS

ABUSE IS TO

1. PERSEVERE
2. RIDE
3. REVILE*
4. DREAM

DEPRECATE IS TO DEPRECIATE AS

PLUNDER IS TO

1. DECIMATE
2. DESECRATE
3. DEPREDATE*
4. DETONATE

KEEPSAKE IS TO MEMENTO AS

SAFEKEEPING IS TO

1. MEMORY
2. SAFE
3. RETAINER
4. CUSTODY*

FATHOM IS TO GRASP AS

TETHER IS TO

1. TITHE
2. FASTEN*
3. KNOTTED
4. MEASURE

ARDUOUS IS TO LABORIOUS AS

SUPERFLUOUS IS TO

1. EXCESSIVE*
2. DIFFICULT
3. SUPERFICIAL
4. CALCULATING

Similar Function Type Analogies

PILLOW IS TO HEAD AS

OTTOMAN IS TO

1. ARMS
2. TURK
3. CHIN
4. FEET*

BUTTER IS TO MARGARINE AS

SUGAR IS TO

1. STRYCHNINE
2. SACCHARIN*
3. SPICE
4. FAT

CONSOLATION IS TO SORROW AS

ASPIRIN IS TO

1. TABLET
2. RELIEF
3. PAIN*
4. MEDICINE

STRAIN IS TO HEART AS

SMOKE IS TO

1. FIRE
2. LUNGS*
3. CIGARETTE
4. FAILURE

TAX IS TO GOVERNMENT AS

DUES IS TO

1. FAMILY
2. SCHOOL
3. CLUB*
4. TUITION

SWORD IS TO SCABBARD AS

GUN IS TO

1. PISTOL
2. SHOT
3. HOLSTER*
4. TARGET

RUG IS TO FLOOR AS

HOOD IS TO

1. RIDING
2. WINK
3. CAR
4. HEAD*

ARROW IS TO BOW AS

STONE IS TO

1. BLUNDERBUSS
2. SLINGSHOT*
3. CANNON
4. BULLET

KNEE IS TO LEG AS

KNUCKLE IS TO

1. DOWN
2. ANATOMY
3. BONE
4. FINGER*

SICKNESS IS TO HOSPITAL AS

MADNESS IS TO

1. INSANITY
2. FOLLY
3. ASYLUM*
4. PSYCHIATRIST

COPYWRITE IS TO LITERATURE AS

PATENT IS TO

1. WRITING
2. MEDICINE
3. OBJECT
4. INVENTION*

PLANTS IS TO GREENHOUSE AS

MERCHANDISE IS TO

1. WAREHOUSE*
2. ANIMALS
3. RAINBOW
4. SPINACH

CANDLE IS TO WICK AS

LIGHTBULB IS TO

1. BLAZE
2. CORD
3. CONDUIT
4. FILAMENT*

HAIR IS TO WIG AS

TEETH IS TO

1. DENTIST
2. DENTURE*
3. ENAMEL
4. TOOTHPASTE

NURSE IS TO DOCTOR AS

SQUIRE IS TO

1. HORSE
2. KNIGHT*
3. SADDLE
4. ARMOUR

STRETCHER IS TO PATIENT AS

TRAY IS TO

1. MEAL*
2. WAITRESS
3. X-RAY
4. TABLE

LOCOMOTIVE IS TO TRAIN AS

HUSKY IS TO

1. ROCKET
2. PASSENGER
3. TRACK
4. SLED*

AVIARY IS TO BIRD AS

APIARY IS TO

1. MONKEY
2. TREE
3. BEE*
4. LIBRARY

HEAD IS TO HELMET AS

FINGER IS TO

1. THIMBLE*
2. NECK
3. LAKE
4. NAIL

CAMERA IS TO TRIPOD AS

STATUE IS TO

1. PLAZA
2. PEDESTAL*
3. SCULPTURE
4. FOUNDATION

DISEASE IS TO VACCINATION AS

FIRE IS TO

1. INJECTION
2. SPARK
3. ASBESTOS*
4. GERM

CURFEW IS TO TIME AS

BOUNDARY IS TO

1. LINE
2. SPACE*
3. REGULATION
4. BINDERY

TOXIN IS TO POISONING AS

BACTERIA IS TO

1. GERM
2. MEDICINE
3. INFECTION*
4. FEVER

INSURANCE IS TO LOSS AS

VACCINATION IS TO

1. INOCULATION
2. DISEASE*
3. MEDICINE
4. DOCTOR

APPENDIX C

Generalization Items

Worker-Tool Analogies

DENTIST IS TO DRILL AS

SURGEON IS TO

1. ANESTHETIC
2. CLEANLINESS
3. SCALPEL*
4. DIAGNOSIS

CARPENTER IS TO SAW AS

MASON IS TO

1. TROWEL*
2. BOOKCASE
3. DIXON
4. SEEN

QUIVER IS TO ARCHER AS

TACKLE IS TO

1. FULLBACK
2. QUARTERBACK
3. HUNTER
4. ANGLER*

KILN IS TO POTTER AS

FORGE IS TO

1. IRON
2. FIRE
3. SMITH*
4. VALLEY

Numerical Analogies

6 IS TO 37 AS

8 IS TO

1. 64
2. 65*
3. 48
4. 56

6 IS TO 21 AS

24 IS TO

1. 13
2. 25
3. 35
4. 12*

567 IS TO 678 AS

345 IS TO

1. 234*
2. 457
3. 834
4. 512

25 IS TO 36 AS

49 IS TO

1. 53

2. 64*

3. 72

4. 78

APPENDIX D

Unsolvable Analogy Items for Persistence Test

LAST IS TO ENDURE AS

CHANCE IS TO

1. FIGURES
2. CONTAIN
3. PARTICULAR
4. CALENDAR

BOOK IS TO LIBRARY AS

KEY IS TO

1. HOUSES
2. CARPET
3. SOFA
4. PLANTS

POLICE IS TO CITY

ARMY IS TO

1. CAPTAIN
2. TANK
3. RIFLE
4. NAVY

APPENDIX E

Description of the Experiment

This experiment is constructed to discover the most efficient way of teaching analogical reasoning. You will be asked to work on the computer for approximately one hour. At various times during the experiment, you will be asked to solve analogies and to rate your confidence in solving these problems. A full theoretical rationale for the experiment will be offered to you following your participation in the experiment. In addition, you may obtain a copy of the results of this study, upon completion, by contacting John Walsh in the Faculty of Education.

APPENDIX F

Subject Consent Form

My signature on this document indicates that I have agreed to participate voluntarily in the experiment described on the previous page. I understand that my performance during the one-hour experiment will be strictly confidential, and that data from the experiment will not be identified with me in any way. In this regard, complete confidentiality is guaranteed by the experimenter. Further, I understand that I may withdraw my participation in the experiment at any time. I also understand that I may contact Dr. Ron Marx, Director of Graduate Programs, Faculty of Education, if I have any complaints regarding the experiment.

Date: _____ Signature _____

APPENDIX G

Listing of the Introductory Section of the Computer Program

Welcome to the Analogies Program

The purpose of this program is to teach you how to solve analogies. Make sure you read the screen very carefully and follow the directions closely as you work through the program.

PRESS RETURN TO CONTINUE

You may be wondering what analogies are. They are word problems which ask you to discover how words are related to one another. They usually consist of word pairs. Let's look at an example.

PRESS RETURN TO CONTINUE

Here is an analogy:

Leaf is to tree as petal is to

- (1) toad
- (2) flower
- (3) suite
- (4) tailor

SELECT THE BEST ANSWER BY ENTERING THE CORRESPONDING NUMBER.

Your answer is?

Your answer is incorrect.

PRESS RETURN TO CONTINUE

The correct answer to this analogy is flower. A leaf is part of a tree in exactly the same way that a petal is part of a flower.

PRESS RETURN TO CONTINUE

Before you solve any analogies we want to get an idea of how confident you feel about solving these kinds of problems. This section of the program will present a series of analogy problems and you will be asked to indicate how confident you are that you will be able to solve each problem correctly.

PRESS RETURN TO CONTINUE

Each problem will be presented for 8 seconds. You will then be asked to rate your confidence on a scale from 1 to 10. If you feel very sure that you can solve the problem then rate your confidence as 9 or 10.

PRESS RETURN TO CONTINUE

If you feel quite sure, then rate your confidence as 6 or 7 or 8.

If you feel you are quite unsure
then rate your confidence as 3 or
4 or 5. If you are very unsure
then you should rate your confidence
as 1 or 2.

PRESS RETURN TO CONTINUE

In general, the more confident
you feel the higher your rating
should be.

Let's go through an example.

PRESS RETURN TO CONTINUE

Look at the following analogy
carefully and quickly. You will
only have 8 seconds to decide
on your confidence to solve the
problem.

PRESS RETURN TO CONTINUE

Hard is to soft as fast is to

- (1) speed
- (2) quick
- (3) slow
- (4) faster

[following the 8 second display, this scale appeared]

Move the cursor by <-- or --> to
rate you confidence. Press return
to enter your rating.

CONFIDENCE SCALE

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

very

very

unsure

unsure

sure

sure

APPENDIX H

Correlation Matrix for Dependent Variables

Variable	1	2	3	4	5	6	7	8
Pretest								
1 Accuracy		.39	.03*	.30	.41	.19	-.08*	.28
2 Rate			-.85	.33	.24	.55	-.55	.41
3 Latency				-.23	-.07*	-.51	.60	-.32
4 SE					.11*	.21	-.21	.75
Trial 1								
5 Accuracy						.50	-.24	.26
6 Rate							-.89	.43
7 Latency								-.36
8 SE								
Trial 2								
9 Accuracy								
10 Rate								
11 Latency								
12 SE								
Trial 3								
13 Accuracy								
14 Rate								
15 Latency								
16 SE								
Trial 4								
17 Accuracy								
18 Rate								
19 Latency								
20 SE								
Posttest								
21 Accuracy								
22 Rate								
23 Latency								
24 SE								
Pretest								
25 Achievement Expectations								
Posttest								
26 Achievement Expectations								

* p > .05

Correlation Matrix for Dependent Variables Cont'd

Variable	9	10	11	12	13	14	15	16
Pretest								
1 Accuracy	.48	.25	-.06*	.32	.39	.23	-.08*	.29
2 Rate	.28	.54	-.50	.41	.23	.51	-.47	.39
3 Latency	-.06*	-.45	.53	-.31	-.04*	-.44	.50	-.31
4 SE	.20	.27	-.20	.74	.14	.17	-.12	.68
Trial 1								
5 Accuracy	.60	.40	-.15	.28	.64	.36	-.14	.29
6 Rate	.31	.80	-.75	.37	.30	.76	-.69	.38
7 Latency	-.18	-.75	.85	-.32	-.15	-.74	.81	-.35
8 SE	.27	.45	-.34	.85	.20	.26	-.19	.74
Trial 2								
9 Accuracy		.54	-.20	.29	.63	.30	-.10*	.34
10 Rate			-.86	.42	.39	.75	-.68	.43
11 Latency				-.30	-.17	-.77	.85	-.33
12 SE					.23	.21	-.12*	.80
Trial 3								
13 Accuracy						.49	-.17	.29
14 Rate							-.90	.31
15 Latency								-.25
16 SE								
Trial 4								
17 Accuracy								
18 Rate								
19 Latency								
20 SE								
Posttest								
21 Accuracy								
22 Rate								
23 Latency								
24 SE								
Pretest								
25 Achievement								
Expectations								
Posttest								
26 Achievement								
Expectations								

* p > .05

Correlation Matrix for Dependent Variables Cont'd

Variable	17	18	19	20	21	22	23	24
Pretest								
1 Accuracy	.23	.07*	.02	.22	.73	.50	-.30	.34
2 Rate	.06*	.39	-.42	.30	.34	.62	-.57	.44
3 Latency	.09*	-.41	.50	-.25	-.02*	-.46	.52	-.34
4 SE	.01*	.07*	-.04	.62	.28	.28	-.20	.56
Trial 1								
5 Accuracy	.48	.28	-.10*	.25	.37	.33	-.26	.33
6 Rate	.27	.66	-.62	.35	.24	.51	-.51	.33
7 Latency	-.15	-.70	.76	-.33	-.13*	-.48	.53	-.33
8 SE	.00*	.11*	-.11*	.75	.35	.40	-.30	.62
Trial 2								
9 Accuracy	.56	.19	-.01*	.28	.43	.23	-.15	.37
10 Rate	.35	.61	-.56	.41	.25	.48	-.48	.41
11 Latency	-.19	-.70	.76	-.31	-.11*	-.48	.56	-.29
12 SE	.07*	.09*	-.07	.79	.34	.30	-.20	.67
Trial 3								
13 Accuracy	.58	.28	-.08*	.28	.32	.24	-.19	.35
14 Rate	.35	.78	-.73	.27	.23	.55	-.58	.36
15 Latency	-.14	-.77	.86	-.21	-.14	-.53	.62	-.28
16 SE	.13*	.19	-.15	.83	.38	.34	-.23	.71
Trial 4								
17 Accuracy		.45	-.08*	.13*	.21	.16	-.12*	.15
18 Rate			-.88	.19	.08*	.49	-.57	.21
19 Latency				-.18	-.03*	-.49	.63	-.19
20 SE					.31	.29	-.22	.71
Posttest								
21 Accuracy						.55	-.29	.38
22 Rate							-.91	.42
23 Latency								-.33
24 SE								
Pretest								
25 Achievement Expectations								
Posttest								
26 Achievement Expectations								

* p > .05

Correlation Matrix for Dependent Variables Cont'd

Variable	25	26
Pretest		
1 Accuracy	.13*	.30
2 Rate	.20	.26
3 Latency	-.20	-.18
4 SE	.51	.33
Trial 1		
5 Accuracy	.19	.29
6 Rate	.29	.29
7 Latency	-.32	.24
8 SE	.58	.43
Trial 2		
9 Accuracy	.13*	.41
10 Rate	.29	.33
11 Latency	-.26	-.18
12 SE	.53	.48
Trial 3		
13 Accuracy	.15	.48
14 Rate	.23	.33
15 Latency	-.21	-.21
16 SE	.52	.56
Trial 4		
17 Accuracy	-.05*	.21
18 Rate	.13*	.18
19 Latency	-.17	-.14
20 SE	.52	.51
Posttest		
21 Accuracy	.19	.27
22 Rate	.23	.27
23 Latency	-.21	-.22
24 SE	.50	.66
Pretest		
25 Achievement		.55
Expectations		
Posttest		
26 Achievement		
Expectations		

* $p > .05$

APPENDIX I

MANCOVA Tables for Between Group Orthogonal Contrasts

Table 1 Mancova on Posttest Performance on Instructed Items

Contrast	Wilks Lambda	Df	F	Sig. of F
Prompt Position	.965	4,138	1.2	.292
Prompt Control	.966	4,138	1.2	.308
Interaction	.990	4,138	.3	.866
Treatment vs Control	.964	4,138	1.3	.269

Table 2 Mancova on Posttest Performance on Generalization Items

Contrast	Wilks Lambda	Df	F	Sig. of F
Prompt Position	.991	4,138	.3	.870
Prompt Control	.944	4,138	2.0	.090
Interaction	.988	4,138	.4	.804
Treatment vs Control	.948	4,138	1.9	.116

NOTES

¹The coefficient of reproducibility is 1 minus the proportion of responses which would have to be changed in order to obtain a perfect Guttman scale (i.e., a scale such that the passing of a given item implies the passing of all previous items).

²To be sure, there have been additional studies that have applied path-analytic techniques to explore the mediational effects of self-efficacy (e.g., Bandura & Schunk, 1981). Such analyses have, however, been limited to examining self-efficacy and performance changes at only two points in time (pretest, posttest). Moreover, these investigations have employed small sample sizes, and as such, have tended to yield path coefficients of dubitable stability. Only the Feltz (1982) and Feltz and Mungo (1983) studies have had, as their primary purpose, the evaluation of the mediational property of self-efficacy over a series of trials, and have incorporated samples of sufficient size to produce stable path-coefficient population estimates.

³There are a number of different ways that analogy items might be classified. Since the prompts used in the study are based on the mapping relationship between analogical word-pairs, the classification system for describing the analogies used in the study reflects this mapping relationship. Thus, when analogies are referred to as synonym, part-whole or similar-function types, it is meant that the mapping relationship

between the analogy pairs is that both are synonyms, or part of a whole, or perform a similar function, as the case may be. Examples of each kind of analogy, listed by type, can be found in Appendix B.

⁴Prior to transformation, the skew of latency variables ranged from 1.4 to 2.4. Following Napierian-log transformation, the skew of latency variables ranged from -.013 to .2.

⁵The general formula for correct rate was: $60 \times (\text{number correct} / \text{total latency in seconds})$.

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