THE INFLUENCE OF COPING STRATEGIES,

PERFORMANCE AND ATTRIBUTIONAL

FEEDBACK ON SKILL, ATTRIBUTIONS AND

SELF-EFFICACY

by

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THE INFLUENCE OF COPING STRATEGIES, PERFORMANCE AND ATTRIBUTIONAL FEEDBACK

ON SKILL, ATTRIBUTIONS AND SELF-EFFICACY

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ABSTRACT

The present study examined the influence of the training of appropriate coping strategies and performance and attributional feedback on the self-efficacy, skill, and attributions of 60 female college students for elementary statistics. A combination feedback condition consisted of a training program that provided appropriate coping strategies, performance, and attributional feedback (i.e., ability and effort) during task engagement. The performance feedback condition consisted of the same training program and performance feedback only. The control group received training in a well known study method and performance feedback only.

Students' attributions for statistical successes and failures and judgements of self-efficacy for learning elementary statistics were assessed by following similar procedures of previous research on attributions and self-efficacy. Students then individually completed a written packet that provided instruction on elementary statistics while employing either the coping strategies approach or the alternate study method. All students received performance feedback by checking answers to problems provided in the packet. Students in the combined feedback condition received a combination of ability and effort attributional feedback for their progress. Following training, attributions, skill, and self-efficacy for solving elementary statistics problems were assessed.

Results indicate that students entered the study with high levels of self-efficacy and adaptive attributions. Students placed significantly greater emphasis on low task difficulty as a cause of problem-solving success at pretest than at posttest and placed significantly greater emphasis on effort at

posttest than at pretest. Overall, students placed significantly greater emphasis on the unknown as a cause of problem-solving failure at posttest than at pretest. Regardless of condition, students improved their skill at statistics from pretest to posttest.

The results of this study underscore the complex relationship between perceived effort and self-efficacy. The data do not support the claim that combining ability and effort attributional feedback leaves students wondering how much ability they have if they have to work hard to succeed, nor do these results support previous research findings of sex differences in students' performance expectancies and attributions. The findings warrant further investigation into the roles of attributions and percepts of efficacy in achievement across educational levels.

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CHAPTER I

Overview

This study embodies four premises which are derived from two areas of research: attribution theory and social learning theory. The first premise is that attributions and self-efficacy judgements are important constructs in the understanding of achievement behavior. The second premise is that in regard to elementary statistics, the achievement-related behaviors of many female college students resemble the maladaptive achievement-related behaviors of learning-disabled (LD) individuals. The third premise is that one must directly alter maladaptive beliefs regarding academic achievement. The fourth premise is that the literature in attribution retraining (AR), self-efficacy, and cognitive behavior modification provides a theoretical framework for a training program teaching appropriate coping strategies and providing effective feedback to improve achievement expectations. The respective rationales for each of the four premises are discussed below.

A review of the literature on attributions and self-efficacy reveals that there is increasing evidence that cognitions about personal qualities influence achievement behavior (Bandura, 1982; DeCharms, 1968; Harter, 1978; Rotter, 1966; Weiner, 1979). Although these theories differ, each emphasizes the important effect of students' achievement expectancies on behavior. Schunk (1983a, p. 848) states that, "attributional variables constitute an important source of efficacy information and influence performance primarily through their intervening effects on efficacy expectations." According to Schunk (1982a), efficacy appraisals involve weighting ability and nonability factors

(effort) in deriving expectancies for future successes or failures, and attributions given for past performances. Thus, the position taken in this study is that both attributions and self-efficacy are important variables in the understanding of achievement behavior.

The second premise taken in this study is that in regard to mathematics, many female college students hold maladaptive achievement-related behaviors that resemble those of LD individuals. The rationale for this position stems from the relevant research on the attributions and self-efficacy of learning disabled (LD) and nondisabled (NLD) individuals. Licht (1983) provides an analysis of the cognitive-motivational factors that contribute to the achievement of LD children. When confronted with difficulty, LD children are more likely than their NLD peers to attribute their difficulty to insufficient ability (Butkowsky & Willows, 1980) and less likely to attribute it to insufficient effort (Butkowsky & Willows, 1980; Pearl, 1982; Pearl, Bryan & Donahue, 1980). When LD children do experience success, they are not as likely as their NLD peers to view their success as a result of their ability (Butkowsky & Willows, 1980; Pearl, 1982; Pearl, Bryan & Herzog, 1983). Research focusing on NLD students' performance expectancies indicates that on masculine-type tasks (e.g., mathematics), girls hold lower expectancies for success and are less likely to attribute success to ability. They also lower their expectancies for future successes (e.g., elementary statistics) as do LD individuals.

The third premise in this study is that one must directly alter maladaptive beliefs. Support for this position is drawn from research on attributions and LD individuals. According to Dweck (1975), it may be possible

to foster more adaptive attributions by suggesting that the individual can overcome failure by persisting and then by ensuring that effort pays off. Research suggests that successful interventions may need to teach subjects strategies for dealing with failure. The claim that one must directly alter maladaptive beliefs regarding academic achievement is supported by Licht's (1983) analysis of cognitive motivational factors contributing to the achievement of learning-disabled (LD) children.

The rationale for the fourth premise is drawn from literature in the areas of attribution retraining (AR) (Licht, 1983), self-efficacy (Schunk, 1982b, 1983b, 1984a, 1984b; Schunk & Lilly, 1984; Schunk & Rice, 1984) and cognitive behavior modification (Meichenbaum, 1977). The literature in these areas provides the theoretical framework for a training program designed to teach appropriate coping strategies and to provide effective feedback to improve achievement behavior.

There are three components considered to be essential to AR programs (Licht, 1983). The first is intermittently exposing the individual to failure (Chapin & Dyck, 1976; Dweck, 1975; Fowler & Peterson, 1981) and second, teaching the individual to attribute failure to "insufficient effort and/or ineffective strategies" (Licht, 1983, p. 485). The third component involves "providing the individual with evidence of the validity of the attribution by clearly conveying that s/he is becoming more capable" (Licht, 1983, p. 485).

Recent research suggests that self-efficacy is aided when students receive verbal attributional feedback that links progress with ability (Schunk, 1983b). Schunk claims that combining effort and ability feedback may result in students

wondering how much ability they have if they have to work hard to succeed. However, in the context of teaching students with low performance expectations appropriate coping strategies and inducing attributions of failure to insufficient effort and/or ineffective strategies, a combination of ability and effort attributional feedback may strengthen self-efficacy. Although Schunk and Lilly (1984) suggest that explicit performance feedback moderates sex differences in self-efficacy and attributions, further research is needed that assesses students' attributions for successes and failures prior to training and that attempts to alter maladaptive attributions directly. Thus, within this context, research is needed to determine whether attributional feedback delivered along with performance feedback will enhance students' sense of efficacy, skill, and encourage adaptive attributions.

Finally, research in the area of cognitive behavior modification is drawn upon to develop an element of the training program aimed at teaching appropriate coping strategies. A coping-skills approach that is based on guidelines presented by Meichenbaum, Turk, and Burstein (1975) is utilized in this study. The four phases of the coping process (ie., task preparation, task engagement, coping with obstacles, task completion) are adapted from Meichenbaum (1974a). Coping skills approaches have been successfully applied in numerous problem areas. Some of these problem areas include speech anxiety (Meichenbaum, Gilmore, & Fedoravicius, 1971), test anxiety (Sarason, 1973), and phobias (Meichenbaum & Cameron, 1972). Effective treatments should consider all aspects of the problem (Meichenbaum & Butler, 1980). Further, Meichenbaum and Butler claim that multifaceted approaches will be most effective if they influence the individual's meaning system, internal dialogue, behavioral acts, and interpretations of behavioral outcomes. Thus, in this study, mental

imagery, self-verbalization, and a problem-solving technique are used to meet the challenges at each phase of the coping process.

Statement of the Problem

The overall purpose of this study is to determine the influence of the training of appropriate coping strategies and the provision of performance and attributional feedback on self-efficacy, skill development, and attributions. A training program designed to teach appropriate coping strategies and provide a combination of performance and attributional feedback during task engagement is expected to promote higher percepts of efficacy, skill development, and adaptive attributions of female college students with low performance expectations for elementary statistics. Specifically, it is hypothesized that a combination of performance and attributional (i.e. effort and ability) feedback during task engagement will more effectively promote higher percepts of efficacy, skill development, and adaptive attributions than performance feedback alone.

CHAPTER II

REVIEW OF THE LITERATURE

Attribution Theory and Self-Efficacy Theory

The first premise in this study is that attributions and self-efficacy are important variables in the understanding of achievement behavior. To explore the influence of attributions on achievement behavior, the development of attribution theory is discussed. Just as importantly, to examine the influence of self-efficacy on achievement behavior, the theory of self-efficacy is addressed.

Attribution Theory

Attribution theory is first discussed by describing its development by Heider (1958). Specifically, the major postulates of attribution theory, and the factors affecting action and outcomes are presented. Second, adaptations of attribution theory by Weiner (1972; 1980) are discussed and the causal dimensions of attributions are depicted. The relationship between attributions, expectancies, and achievement-related behavior is outlined.

Fritz Heider (1958) was responsible for developing attribution theory. Heider postulates that humans seek the construction of a predictable and controllable framework of life. By connecting outcomes to either relatively unchanging dispositional conditions or to more changeable situational factors the individual constructs a framework of life. A personal attribution refers

to the inference an individual makes about the causes of his/her behavior (Bar-Tal, 1978). Heider proposes that attributions support the constancy of the individual's framework of life.

Heider suggests that outcomes are a function of an "effective personal force" and an "effective environmental force". The effective personal force refers to within-person factors which include a power factor (ability) and a motivational factor (trying). According to Heider, ability is a stable factor and effort an unstable factor. The effective environmental force refers to environmental factors and includes task difficulty and luck. Task difficulty is considered to be a stable environmental factor and luck an unstable environmental factor. No action outcome could occur if either element of "Trying" or "Can" were completely absent. Each element is considered a necessary, but not sufficient condition to produce an outcome.

Weiner (1972) combines Fritz Heider's concept of stable and unstable factors and Julian Rotter's (1954) concept of locus of control. In Weiner's model of achievement motivation (Weiner 1974, 1977, 1979) causal attributions for prior outcomes (e.g., ability, effort, task difficulty, luck, and others) constitute the central influence on future expectancies of success and failure. Attributions may be categorized along three dimensions (locus of causality, stability, controllability) with some degree of certainty (Weiner, 1980). This theory rests on the assumption that individuals search for causal understanding, seeking answers to questions such as: "Why did I get a poor mark on the math test?" or "Why did I fail this course?".

The three causal dimensions are depicted in Table 1. Locus refers to the location of a cause as internal or external to the person. For example, if the "poor mark on the math test" is ascribed to low ability or to lack of effort, then attributions appear to have been made to factors internal to the individual. If, however, the poor mark is ascribed to an unfair exam then an external attribution has been made. Stability refers to the temporal nature of a cause. Causes may be enduring or change from moment to moment or situation to situation. Finally, controllability refers to the degree of volitional influence that can be exerted over a cause. Causes such as aptitude or luck are usually not perceived as subject to volitional influence, however, effort expenditure or performance strategy are generally perceived as controllable.

Table 1

Locus of Causality, Stability, and Controllability in Attribution Theory

Stability	Locus of Causality		
	Internal		External
unstable	effort	+	luck −
stable	ability	−	task difficulty +

Note:
    + denotes controllability; − denotes uncontrollability.

Performance expectations (i.e., self-efficacy) are influenced by attributional judgements concerning the contributions of ability, effort, task difficulty, chance, and other causes of one's successes and failures.

expectancies then influence achievement-related behavior such as choice and persistence. Thus variations in achievement expectancies and behaviors appear to depend upon causal attributions. While attribution retraining (AR) approaches have found support for this idea (Andrews & Debus, 1978; Dweck, 1978; Dweck, 1975), there is some evidence that causal attributions have little influence on achievement expectancies and behaviors (Covington & Omelich, 1979; Medway & Venino, 1982). Further research is needed to determine how antecedent influences on expectancies and behaviors are weighted and combined.

Self-Efficacy Theory

Like attribution theory, the theory of self-efficacy provides a theoretical framework to explain and predict psychological change. Self-efficacy is posited by Bandura (1977) as playing a major role in unifying a theory of behavioral change. An efficacy expectation is the conviction that one can successfully execute the behavior required to produce outcomes. It is hypothesized that expectations of personal efficacy determine whether coping behavior will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles. This theory also states that persistence in activities, through mastery experiences, enhances self-efficacy and reduces maladaptive behavior.

Expectations of personal efficacy are derived from four principle sources of information: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. Once performance accomplishments are achieved via participant modeling, desensitization, exposure and/or self-instruction, self-efficacy tends to improve. As a result, improvements in

behavioral functioning transfer to similar situations and activities. Regardless of the methods involved, results of comparative studies confirm the superiority of performance-based treatments (Bandura, 1977).

A second source of information for expectations of personal efficacy is vicarious experience. Live modeling and symbolic modeling are the modes of induction for this source. Vicarious experience, which relies on inferences from social comparison is a less dependable source of information about one's capabilities than is direct evidence of personal accomplishments. As a result the efficacy expectations induced by modeling alone are likely to be weaker and more vulnerable to change. However, if an individual observes people of widely differing characteristics succeeding, then the observer has a reasonable basis for increasing his/her sense of self-efficacy. Also, similarity to the model in various characteristics may increase the personal relevance of the vicariously derived information thus enhancing overall effectiveness (Kazdin, 1974).

Verbal persuasion is a third source of information for the expectations of personal efficacy. Efficacy induced in this manner is likely to be weaker than that arising from performance accomplishments. Simply informing people that they will or will not benefit from a treatment does not mean that they will necessarily believe what they are told or their self-verbalizations. This is especially true when the information contradicts past experiences. Verbal influence is aimed at mainly raising outcome expectations rather than at enhancing self-efficacy. While social persuasion may contribute to success through corrective performance, used alone it may have limitations as a means of creating an enduring sense of personal efficacy.

A final source of efficacy information is emotional arousal. The level and direction of motivation are greatly determined by cognitive appraisals of emotional arousal. Certain cognitive appraisals of emotional arousal might encourage motivation whereas other appraisals of the same state might not.

The impact of information on efficacy expectations depends on how it is cognitively appraised. Such appraisals depend on a number of contextual factors including situational and temporal circumstances of the events. Successes are more likely to enhance self-efficacy if performances are perceived as resulting from skill rather than fortitude. Failures are expected to produce greater reductions in self-efficacy when attributed to ability rather than to situational factors. A strong sense of self-efficacy is reinforced by ability ascriptions fostered by success with minimal effort. Successes achieved through great effort connote less ability and are therefore likely to have a weaker effect on perceived self-efficacy. The impact of performance accomplishments on perceived self-efficacy is affected by cognitive appraisals of the difficulty of tasks. No new information for altering one's sense of self-efficacy is provided by succeeding at easy tasks. One's sense of self-efficacy is enhanced, however, by the mastery of challenging tasks.

There appears to be increasing evidence that personal cognitions influence achievement behavior (Bandura, 1982; DeCharms, 1968; Harter, 1978; Rotter, 1966; Weiner, 1979). Recently, Schunk (1981, 1982a, 1983a) has explored the links between Weiner's attribution theory and Bandura's self-efficacy theory, and in the process has extended our understanding of the role attributions play in the development of self-efficacy. To explain the

link between the two theories, Schunk (1983a, p. 848) states," attributional variables constitute an important source of efficacy information and influence performance primarily through their intervening effects on efficacy expectations." In addition, Schunk (1982a, p. 549) explains that, "in the self-efficacy analysis, attributional variables are viewed as conveyors of efficacy information. They influence performance mainly through their intervening effects on perceived efficacy, such as when persons infer their efficacy from effort expended and perceived task difficulty." According to Schunk (1982a), efficacy appraisals involve weighting ability and nonability factors (e.g., effort) in deriving expectancies for future successes or failures, and attributions given for past performances. The point is not that one theory has more to offer than the other, but clearly that each has something to contribute to an understanding of achievement behavior.

Achievement-Related Behavior Patterns

The second premise in this study is that in regard to mathematics (e.g., elementary statistics), many female college students hold a maladaptive-achievement related pattern of behavior which resembles that of LD individuals. To explore this position the relevant research on the attributions and self-efficacy of LD and NLD individuals is discussed. First, a conceptualization of the cognitive-motivational factors that contribute to the achievement of LD children as described by Licht (1983) is outlined. Second, it will be shown that in the area of mathematics the attributions and self-efficacy of NLD females resemble those of LD individuals.

There are three components to the conceptualization of cognitive-motivational factors that contribute to the achievement of LD individuals proposed by Licht (1983). The first component of this conceptualization is that children who experience a substantial amount of failure come to believe that they are not capable of overcoming their difficulties. Success and failure have been manipulated in a number of studies in a variety of achievement situations. Such studies demonstrate that repeated failure can lead children to view themselves as lacking in ability and to lower their expectancies for future success (Nicholls, 1975; Parsons & Ruble, 1977; Rhodes, Blackwell, Jordan & Walters, 1980; Ruble, Parsons & Ross 1976; Stipek & Hoffman, 1980; Weiner, 1972, 1974, 1979, cited in Licht 1983).

The second component detected by Licht (1983) states that, "children's beliefs about their abilities can affect their achievement efforts and accomplishments" (p. 483). Both attributional and self-efficacy research address the issue that achievement-related beliefs can affect achievement-related behavior. The attributional and self-efficacy viewpoints claim that certain beliefs imply that in difficult situations effort will pay off, while other beliefs imply that it will not. Licht states that adaptive achievement-oriented behaviors are more likely to result if the individual believes that continued effort will pay off in difficult situations.

A review of the literature points to sufficient evidence to suggest that maladaptive patterns of achievement-related behavior are displayed by individuals who are less able to view difficult situations as surmountable with effort (Diener & Dweck, 1978, 1980; Dweck, 1975; Dweck & Bush, 1976; Dweck & Repucci, 1973; Weiner, 1972, 1974, 1979). For example, Dweck and Repucci

(1973) demonstrate that following failure, a certain group of children do not perform the response required to succeed even though motivated and fully capable. Their analysis reveals that children most likely to give up in the face of failure believe that their difficulties are due to stable, internal factors (e.g., insufficient ability). In their tendency to attribute failure to stable, internal factors and ignore the role of effort, these children are operating under a belief of powerlessness to control the outcomes of particular events. In essence they are saying to themselves that regardless of how hard they try the consequences will be the same. Thus when confronted with difficulty these children are less likely to display effort and problem-solving strategies, and may continue to avoid tasks on which they have previously experienced difficutly. As a result, such children obtain a level of performance that is below their capabilities.

Attribution retraining (AR) studies provide further evidence that beliefs about efforts and accomplishments can affect achievement-related behaviors (e.g., Andrews & Debus, 1978; Chapin & Dyck, 1976; Dweck, 1975; Fowler & Peterson, 1981; Rhodes, 1977; Thomas & Pashley, 1982). These experimental studies show that altering children's causal attributions for failure results in more adaptive achievement-related patterns of behavior. For example, in the study by Thomas and Pashley (1982), children who were taught to attribute their failures to insufficient effort were observed to increase their persistence behaviors and improve their performance when confronted with difficulty. A "success only" group also showed improved persistence behaviors, however it was suggested that this was due to teachers altering the tasks to be more challenging to the students. In the studies by Chapin and Dyck (1976) and Dweck (1975) children in comparison groups receiving an equivalent amount of

practice involving consistent success experiences and no attribution retraining, did not show improved responses to failure. In accordance with Dweck (1975) and Licht (1983), altering a maladaptive pattern of causal attributions is not simply a matter of ensuring successful experiences.

The third cognitive-motivational component that contributes to the achievement of LD children is that "LD children hold the beliefs that are likely to foster a maladaptive pattern of achievement-related behaviors" (Licht, 1983 p. 484). Generally, the research supports this claim. On measures of self-esteem and perceptions of their abilities, the LD score lower than NLD individuals (Boersma & Chapman, 1981; Winne, Woodlands, & Wong, 1982). The type of messages the LD communicate to themselves regarding their performance on unmastered tasks may be the reason behind a maladaptive pattern of achievement-related behaviors. For example, LD individuals are more likely than NLD individuals to attribute their difficulty to insufficient ability when confronted with failure (Butkowsky & Willows, 1980). In addition, LD individuals are less likely than NLD indivudals to attribute their difficulty to insufficient effort (Butkowsky & Willows, 1980; Pearl, 1982; Pearl, Bryan & Donahue, 1980). Finally, LD are less likely than NLD individuals to attribute their success to ability (Butkowsky & Willows, 1980; Pearl, 1982; Pearl, Bryan & Herzog, 1983).

To recap, the second premise in this study is that in the area of mathematics, many female college students hold a maladaptive-achievement related pattern of behavior which resemembles that of LD individuals. An analysis of the cognitive-motivational factors that contribute to such a pattern of behavior as evident in LD individuals has been presented. Next,

research is presented that points to a sex difference among NLD individuals such that in the area of mathematics the attributions and self-efficacy of NLD females resemble those of LD individuals (specifically LD females). First, however, I turn to recent research that suggests that LD females more than LD males fit the maladaptive pattern of achievement-related behaviors.

Recent research by Licht, Kistner, Ozkaragoz, Shapiro and Clausen (1985) provides evidence that while LD females are generally more likely than NLD females to attribute their difficulties to insufficient ability, the two groups do not differ in their tendency to attribute their difficulties to external factors. This is in contrast to LD males who are more likely than NLD males to attribute their difficulties to external factors, however these two groups do not differ in their tendency to attribute their difficulties to insufficient ability. Apparently, the tendency to blame one's ability is negatively related to persistence but the tendency to attribute one's difficulties to external factors is not associated with less persistence (Licht et al., 1985). Thus, LD females, but not LD males were less persistent than their NLD peers. The finding that LD females, more than LD males fit the maladaptive pattern of achievement-related behaviors is consistent with research on sex differences which depicts females as more vulnerable than males to the debilitating effects of experiencing failure (see Licht & Dweck, 1983, for a review).

Research focusing on students' performance expectancies and attributions typically indicates that on masculine-type tasks (e.g., mathematics) females hold lower expectancies for success and are less likely to attribute success to ability than males (Maccoby & Jacklin, 1974; Parsons & Ruble, 1977). One explanation for these findings offered by Schunk and Lilly (1984) is, given

that females view themselves as less competent than males on a masculine-type task, females' successes should be expected with less certainty. Unexpected successes are less likely to be attributed to high ability (Deaux, 1976). Finally, less emphasis on ability as a cause of success will not promote expectations for future success, that is, self-efficacy (Bandura, 1981, 1982). In conclusion, in as much as some female college students 1) view their difficulties in mathematics as the result of insufficient ability, 2) are less likely to view their difficulty as the result of insufficient effort, 3) are less likely to attribute their success to ability, and 4) lower their expectations for future success in elementary statistics, a maladaptive pattern of achievement-related behavior has been fostered resembling that of LD females.

The third premise taken in this study is that one must directly alter maladaptive beliefs regarding academic achievement. Support for this position is drawn from research on attributions and the LD. Research by Dweck (1975) has shown that simply providing more success opportunities is not enough to remove the debilitating effect of failure for individuals who do not recognize the role of effort. According to Dweck, a more successful procedure involves directly inducing the individuals to change their attributions for failure when they do possess the skills required for success. Thus, it may be possible to foster more adaptive attributions by suggesting that the individual could overcome a failure by persisting and then ensuring that effort pays off. In addition, Pearl, Bryan & Donahue (1980) suggest that successful interventions may need to include a component which teaches strategies for dealing with failure.

The claim that one must directly alter maladaptive beliefs regarding academic achievement is also supported by Licht (1983). Licht outlines a general sequence of motivational problems of LD individuals. Due to a variety of factors, LD individuals experience many academic failures. These academic failures are experienced early in the school years. Inevitably the failure experiences leave LD children doubting their intellectual abilities and their capability to overcome difficulties. As a result they soon lessen their achievement efforts when confronted with difficult tasks. Thus, LD children experience increased and continued failure which reinforces their belief that they lack the ability to overcome their difficulties. It is explicitly stated by Licht that, aside from remediating academic deficits and providing success experiences, maladaptive beliefs must be altered.

Theoretical Framework for Training Program

The fourth premise in this study is that literature in the areas of attribution retraining (AR), self-efficacy, and cognitive behavior modification provide a theoretical framework for a training program aimed at teaching appropriate coping strategies and providing effective feedback to improve achievement expectations. The development of AR programs and methodological issues related to this study are discussed. Attention is focused on recent research on self-efficacy that addresses the importance of effective feedback to improve achievement expectations. Finally, research on cognitive behavior modification that relates to the instruction of the appropriate coping strategies included in this study is discussed.

Development of AR Programs and Methodological Issues

A review of the relevant literature reveals that three components are essential for a training program aimed at teaching appropriate coping strategies and providing effective feedback to improve achievement expectations. Each component and the related research is outlined. In addition, a number of methodological issues in the area of attribution retraining which influence this study are discussed.

The first component considered essential for an AR program is to "intermittently expose the individual to failure" (Chapin & Dyck, 1976; Dweck, 1975; Fowler & Peterson, 1981; Rhodes, 1977; Thomas & Pashley, 1982). One of the first studies to demonstrate that attribution retraining can be used to alter the way that "helpless" children respond to their failures was undertaken by Dweck (1975). An "attribution retraining" group of children was irregularly exposed to failure while the "success group" was not. The purpose of Dweck's study was to determine whether altering attributions for failure would enable the identified "helpless" children to deal more effectively with failure in an experimental problem-solving situation. The results show that the attribution retraining students, who were induced to attribute their failure to insufficient effort, maintained or improved their performance. However, the success only students deteriorated in the face of failure, thus implying that counteracting "helplessness" is not just a simple matter of ensuring success.

Subsequent studies generally support the effectiveness of the AR approach. Rhodes (1977) replicated and extended Dweck's (1975) results by showing that the positive effects of AR may generalize to tasks not used in training.

However, both Dweck (1975) and Rhodes (1977) fail to separate the variables of AR and partial reinforcement. Chapin and Dyck (1976) separate these variables and conclude that the impact of AR on persistence is somewhat dependent on the manner in which success and failure trials are scheduled. When the schedule contains only single failure experiences, persistence increases in the presence but not in the absence of AR. When the schedule contains multiple failure experiences, persistence increases in the presence or absence of AR.

The purpose of the Fowler and Peterson (1981) study was to replicate and extend the results of the Chapin and Dyck (1976) study to determine whether a "direct" method of AR might be more effective than the "indirect" method used by Dweck (1975). The direct method involved prompting and reinforcing children for verbalizing the appropriate effort attributions whereas the indirect method involved simply telling children that they needed to try harder when they failed. "Helpless" children aged 9-13 years were randomly assigned to one of four treatments: (a) partial reinforcement with single failure experiences, (b) partial reinforcement with multiple failure experiences, (c) partial reinforcement with multiple failure experiences and "indirect" AR, and (d) partial reinforcement with multiple failure experiences and "direct" AR. Fowler and Peterson indicated significant increases in reading persistence for children who had received AR compared to single failure experience controls. Direct AR was signficantly more effective than no AR in increasing children's attribution to effort on the Intellectual Achievement Responsibility (IAR) Scale (Crandall, Katkovsky, & Crandall, 1965). It appears however, that failure length (i.e., the number of failure experiences prior to a success) may be as important a variable as AR in increasing persistence as multiple failure experience led to increased reading persistence even without AR.

Contrary to the previous studies, Palmer, Drummond, Tollison, and zinkgraft (1982) found that children with a history of failure judged lack of effort as important in their failures as did normal children. These differences appeared to be due to the fact that different instruments were used. The IAR scale is a general measure whereas the Task Attribution Questionnaire used by Palmer and his associates is a task specific measure of attribution.

A study by Thomas and Pashley (1982) represents perhaps the first attempt to apply the AR approach in a school setting. Teachers in the AR condition participated in sessions in which they learned how to model self-instruction, make effort attribution statements and to reinforce students' self-instruction and effort attribution statements. Following the teacher training, teachers applied these strategies over a five-week period. Thomas and Pashley were unsuccessful in changing LD students' attributions but were successful in changing their persistence behaviors. The "success only" group also showed improved persistence behaviors. However, it was suggested that this was due to teachers altering the tasks to be more challenging to the students.

In summary, "intermittently exposing the individual to failure" is one component considered essential to an AR program. In support of this conception, Dweck (1975) states that counteracting "helplessness" is not simply a matter of ensuring successful experiences. Chapin and Dyck (1976) conclude that the impact of AR on persistence is dependent on the way in which success and failure trials are scheduled. Further, Fowler and Peterson (1981) reveal

significant increases in reading persistence for children who receive AR compared to single failure experience controls. Finally, Thomas and Pashley (1982) claim that the "success only" group in their study showed improved persistence behaviors like the AR group because teachers altered the tasks to be more challenging to the students.

In analysing methodological problems in attributional research, Weiner (1983) suggests that the manipulation of causal ascriptions by experimental instructions and/or feedback may be negated by the life experience or experimental experience of the subject. Subjects may have deeply ingrained perceptions of their abilities which are inconsistent with the experimental instructions and/or feedback. During the experiment it may be difficult to induce subjects to believe that their failure is due to lack of effort—as opposed to poor work strategy—because subjects generally are fully engaged in the task. Although Dweck (1975) apparently induced effort attributions for failure, there may be experimental factors such as the wording of the effort feedback or nature of the task which are necessary for this manipulation.

A number of suggestions can be made regarding the manipulation of causal ascriptions. First, attempts should be made to ensure that the characteristics of the task and the task instructions and/or feedback are congruent. Second, the failure of experimental manipulation due to prior experience can be minimized by using unfamiliar tasks that require unfamiliar skills. Third, pilot research should be carried out to ascertain the most salient causes within a particular domain. These methodological problems are not formidable and may be corrected.

A number of methodological problems may also be responsbile for the failure of AR studies to achieve significant results. First, the dependent measure (i.e., IAR scale) may be too general a measure to detect any changes in attribution that may be occurring. That is, treatment effects may be obscured by the failure to assess changes in the attribution specific to the task targetted in the intervention. Second, the IAR scale may be eliciting socially desirable responses. Third, the interventions are short-term rather than long-term.

The second component considered essential for an AR program is to teach the individual to attribute his/her failures to insufficient effort and/or ineffective strategies (Licht, 1983). The rationale for the second training component developed out of Licht's awareness that there are particular risks in conveying that the only requirement for success is effort. Clearly, effort may be necessary in some instances, but it may not always be sufficient. In AR approaches that stress only effort, the individual may become discouraged when faced with a task where increased effort is not all that is required for success. When increased effort is met with failure, the individual may readopt maladaptive attitudes (Licht, 1983).

Anderson and Jennings (1980) examine the effects of attributing one's failure to "ineffective strategies" or to insufficient ability. College students were induced to attribute their failure at soliciting volunteers for a blood donation drive either to strategy or ability. Strategy subjects appeared to react more adaptively to failure (i.e., they made higher predictions of subsequent success and expected to improve with practice). Unfortunately, data were not collected on the subjects' actual subsequent performances. Licht

(1983) suggests that it is possible that attributing failure to ineffective strategies will convey that a search for more effective strategies is necessary. Further, the individual could be directly taught to analyse the difficult task and to determine whether increased effort alone or increased effort plus an alternative strategy is necessary.

Implications for the treatment of maladaptive achievement-related behaviors may be drawn from the research performed by Anderson and Jennings (1980). Some individuals may fail to generate and implement effective strategies due to a maladaptive belief that their efforts will not be worthwhile (Torgesen & Licht, 1983). It may be that when failure is attributed both to ineffective strategies and insufficient effort, the individual will be prompted to increase effort then if unsuccessful, generate new strategies. Future research is needed to determine how best to combine attributions of failure to ineffective strategies and insufficient effort. Further research is also needed to determine the best way to combine AR with the instruction of specific strategies (Licht, 1983).

The third component that is central to an AR program originates with Dweck (1977) who suggested that in order to "effectively teach a new attribution, the individual should be presented with evidence of its validity" (cited in Licht, 1983 p. 485). That is, the individual's increased efforts should result in improved task performance. Recent research in the area of self-efficacy (Schunk, 1982b, 1983b, 1984a, 1984b; Schunk & Lilly, 1984; Schunk & Rice, 1984) represents an effective means of meeting this component. Schunk (1984b) points out that particular educational practices "validate" a sense of efficacy by clearly conveying that the individual is becoming more capable. Verbalizations

and progress monitoring are two practices that warrant further discussion on this topic.

Schunk (1982b) hypothesizes that combining operational strategies with free verbalization will lead to greater competency in math, higher percepts of self-efficacy, and greater interest. His results show that operational strategies combined with free verbalization does lead to greater skill, higher percepts of efficacy and greater interest. However, free verbalization alone led to equally high skill development. In explaining the results, Schunk suggests that clear evidence of progress improves subjects' self-percepts (Bandura, 1981 in Schunk 1982b). According to Schunk, verbalizing focuses attention on problem-solving strategies thus increasing the understanding of task demands that are necessary for the development of self-efficacy. It may be that when strategies are supplemented with self-generated verbalizations that match strategies to specific problems, students will be more likely to perceive the progress that they are making. However, Schunk (1982b) did not verify this. Other treatments besides combining operational strategies and free verbalization may be as effective, provided they accurately convey task demands and promote the perception of progress.

Schunk and Rice (1984) explore the effects of verbalizing comprehension strategies on reading achievement, self-efficacy and attributions across grades four and five. Half of the students were required to verbalize strategies before applying them and the other half were not. Verbalization was expected to convey greater personal control over outcomes as it is a means of regulating one's performance (Bandura, 1982). Results show that strategy verbalization

leads to higher reading comprehension, self-efficacy, and ability attributions. Contrary to prediction, strategy verbalization did not promote effort attributions. However, it appears that while young children believe that effort can enhance ability, there is increasing devaluation of effort with development (Nicholls, 1978).

An implication of the study by Schunk and Rice (1984) might be outlined as follows. Verbalizing strategies prior to applying them may create a sense of personal control over outcomes. In turn, this may raise self-efficacy and promote internal attributions for success. As students successfully apply strategies their initial sense of efficacy is validated. Within this context attributional feedback could be combined with performance feedback and may possibly enhance the benefits of instructional procedures (Schunk & Rice, 1984).

Schunk and Lilly (1984) have shown that explicit performance feedback appears to moderate sex differences in performance expectations and attributions. However, students' attributions were not assessed prior to training and no attempt was made to alter maladaptive attributions directly. Performance feedback was delivered on a math task by placing the answer to every other problem in the right-hand margin opposite the next problem. Schunk and Lilly contend that students feel more competent as they are engaged in a task and receive explicit performance feedback indicating some success. According to Schunk and Lilly, research is needed to determine whether attributional feedback delivered along with performance feedback will enhance students' skill and sense of efficacy. Research suggests that self-efficacy is aided when students receive verbal attributional feedback that links progress

with ability (Schunk 1983b). Schunk claims that combining effort and ability feedback may result in students wondering how much ability they have if they have to work hard to succeed. However, in the context of teaching students with low performance expectations appropriate coping strategies and inducing attributions of failure to insufficient effort and/or ineffective strategies, skill and self-efficacy may be enhanced by a combination of ability and effort attributional feedback.

In summary, the second component that may be considered essential to an AR program is to teach the individual to attribute his/her failures to insufficient effort and/or ineffective strategies (Licht, 1983). Clearly in some instances, success requires more than effort alone. While research on this issue is scanty, Anderson and Jennings (1980) claim that attributing failure to ineffective strategies as opposed to insufficient ability results in strategy subjects reacting more adaptively to failure. Licht (1983) suggests that attributing failure to ineffective strategies may convey to the student that a search for more effective strategies is necessary. Further, the individual could be directly taught to analyse the difficult task and to determine whether increased effort alone or increased effort plus an alternative strategy is necessary. In this context the second component seems especially appropriate.

The third component central to an AR program proposed by Licht (1983, p. 485) is the consideration that to "effectively teach a new attribution, the individual should be presented with evidence of its validity". In other words, the individual's efforts should result in improved task performance. Verbalizations and progress monitoring are two educational practices that "validate" a sense of efficacy by clearly conveying that the individual is

becoming more capable. Although Schunk and Lilly (1984) claim that explicit performance feedback moderates sex differences in performance expectations and attributions, they did not assess students' attributions prior to training nor attempt to directly alter maladapative attributions. Schunk (1983b) contends that a combination of effort and ability feedback may not be advisable. However, in the context of teaching students with low performance expectations appropriate coping strategies and inducing attributions of failure to insufficient effort and/or ineffective strategies, a combination of effort and ability feedback may enhance self-efficacy, skill and adaptive attributions.

The Relevant Literature from Cognitive Behavior Modification

Finally, literature in the area of cognitive behavior modification, in part, provides a theoretical framework for the training program utilized in this study. Research that relates to the instruction of the appropriate coping skills used in this study is discussed. A coping-skills approach that is based on previous research and guidelines by Meichenbaum, Turk, and Burstein (1975) is outlined. Four phases of the coping process that are adapted from Meichenbaum (1974) are described. Lastly, the three coping strategies (i.e., mental imagery, self-verbalization, problem-solving) used in this study are discussed.

Coping-skills approaches have been successfully applied in numerous areas. These include speech anxiety, test anxiety, phobias, anger, social incompetence, alcoholism, social withdrawal, and laboratory and clinical pain (see Meichenbaum, 1977). These coping-skills programs contain a number of common treatment components. Certain of these components underlie the

coping-skills program utilized in this study. These include: (1) teaching the individual the role of cognitions in contributing to a problem; (2) training in the use of positive self-statements and images, and in the self-monitoring of maladaptive behaviors; (3) training in the fundamentals of problem-solving; (4) modeling of the self-statements and images associated with both overt and cognitive skills; (5) modeling, rehearsal, and encouragement of positive self-evaluation and of coping and attentional focusing skills; and (6) the use of various behavior therapy procedures, such as relaxation and mental imagery, and behavioral rehearsal; and (7) in vivo behavioral assignments (adapted from Meichenbaum, 1977).

A multifaceted approach is considered to be most effective if it influences the individual's meaning system, internal dialogue, behavioral acts, and interpretations of behavioral outcomes (Meichenbaum & Butler, 1980). Thus, effective treatments consider all aspects of the problem. Meichenbaum, Turk, and Burstein (1975) note the complexity of the coping process and suggest particular guidelines for training coping skills. Two guidelines taken into consideration in this study are (1) that coping devices are complex and need to be flexible, employing a variety of cognitive and behavioral strategies and (2) that training techniques need to be sensitive to individual differences.

The four phases of the coping process utilized in this study are adapted from Meichenbaum (1974a). The phases are designated as task preparation, task engagement, coping with obstacles, and task completion. Appropriate coping strategies are provided to be employed at each successive stage of the coping process. The coping strategies include mental imagery, self-verbalization, and a problem-solving technique.

A review of the mental imagery literature (Richardson, 1967a,b) indicates that subjects can improve their performance through the use of this technique. Mental imagery simply involves "thinking about" or imagining oneself performing a particular act. Steffy, Meichenbaum, and Best (1970) suggest that mental imagery (1) leads to a better representation of the stimuli that contribute to the maladaptive behavior; (2) involves many different situational cues in the training; and (3) results in greater emotional involvement.

The use of self-verbalizations in this study is modeled after examples of coping self-statements and procedures used by Meichenbaum (1974b). Meichenbaum introduces cognitive coping by pointing out that both maladaptive and adaptive responses are mediated by statements that one says to oneself. Internal dialogue is modified by becoming aware of, and monitoring negative self-statements. The individual is encouraged to develop constructive self-statements appropriate to each phase of the coping process. Self-statements help the individual to (1) assess the situation; (2) control negative thoughts and images; (3) cope with obstacles constructively and in an organized manner; and (4) reflect on performance and reinforce efforts.

Lastly, problem-solving approaches are regarded as having therapeutic value by a number of investigators (Hanel, 1974, cited in Meichenbaum, 1977; Meichenbaum, 1974a; Scheider & Robin, 1975; Spivak & Shure, 1974, cited in Meichenbaum, 1977). Problem-solving training approaches may be employed with varied populations. For example, problem-solving training approaches have been applied in crisis clinics (McGuire & Sifneos, 1970), to teach adolescents to handle conflicts (Kifer, Lewis, Green, & Phillips, 1973), and to teach high

school and college students to deal with interpersonal anxiety (Christensen, 1974). A number of common components to these approaches that influenced the problem-solving technique used in this study are (1) problem identification; (2) generating solutions; (3) selecting a solution; (4) testing a solution; and (5) verifying the effectiveness of a solution.

In summary, attribution theory and self-efficacy theory have been discussed and it has been concluded that attributions and self-efficacy are important variables in the understanding of achievement behavior. Licht's(1983) conceptualization of the cognitive-motivational factors that contribute to the achievement of LD children has been outlined. As well, recent research that suggests that on masculine-type tasks (eg., statistics) the attributions and self-efficacy of NLD females resemble those of LD individuals has been discussed. Support has been provided for the claim that one must directly alter maladaptive beliefs regarding academic achievement.

A review of the relevant literature has revealed that there are at least three essential components to consider in developing a training program that teaches appropriate coping strategies and provides effective feedback to improve achievement expectations. Specific methodological issues in the area of attribution retraining that influenced this study have been examined. The literature on cognitive behaviour modification influencing the instruction of appropriate coping strategies utilized in this study was addressed. Guidelines and phases for the coping-skills approach were outlined. Lastly, the coping strategies including mental imagery, self-verbalization, and problem-solving were discussed.

Summary

The four premises discussed in this paper determine the context and design of this project. The following experimental design utilized the three components considered to be essential to an AR program, and a coping skills approach. The study involved female college students and the academic subject area was statistics. The independent variable in this study was type of feedback (i.e, attributional and performance feedback, or performance feedback). Schunk (1983b) has contended that combining effort and ability feedback may not be advisable. However, such a combination of attributional feedback appears appropriate when teaching students with low performance expectations appropriate coping strategies and inducing attributions of failure to insufficient effort and/or effective strategies. Thus, it was hypothesized that a combination of performance and attributional (ie. effort and ability) feedback during task engagement would more effectively promote higher percepts of efficacy, skill development, and adaptive attributions than performance feedback alone.

CHAPTER III

METHOD

Subjects

Sixty subjects were involved in this study. The subjects were students in two average, heterogeneous sections of an introductory psychology course offered for nurses at the College of New Caledonia, in Prince George, British Columbia. The sections were established prior to this experiment and without regard to it. Both sections were assigned to the experimenter. Each section enrolled 30 students, all of whom participated in the study. A variety of socio-economic backgrounds were represented, however, the majority of subjects were middle class. All subjects had successfully completed a minimum of grade 11 algebra.

Experimental Design

There were three phases to this study. The phases (pre-training, training, and testing) and corresponding dependent measures for the instructional unit on elementary statistics are displayed in Table 2.

This study utilized a 3 (combination feedback, performance feedback, control) x 2 (pretest, posttest) factorial design. MANOVAS and ANOVAS with repeated measures effects were used to analyze the data. The combination feedback condition consisted of a training program that provided appropriate coping strategies, and a combination of performance and attributional feedback (ie., ability and effort) during task engagement. The performance feedback condition consisted of the same training program for coping strategies but provided subjects with performance feedback only during task engagement. The

control group received training in the PQ4R (Preview, Question, Read, Reflect, Recite, Review) study method by Thomas and Robinson (1972) and performance feedback only during task engagement. At the completion of the experiment the control subjects were offered the treatment consisting of appropriate coping strategies.

Instruments and Materials

Pre-Assessment questionnaire. All of the subjects who were entering the second semester of an introductory psychology course for nurses answered a Pre-Assessment Questionnarie (Appendix 1) during the pretraining phase of the experiment. The questionnaire was comprised of four parts:

a. Attributions for Mathematical Successes and Failures in Algebra 11 (General);

b. Self-Efficacy for Prerequisite Algebraic Skills;

c. Attributions for Successes and Failures on Prerequisite Algebraic Skills (Specific);

d. Self-Efficacy for Central Tendency, Variability, and Correlation.

To obtain a measure of students' attributions and self-efficacy prior to the training phase students' attributions for mathematical successes and failures in algebra 11 and on the pretest were assessed by following similar procedures of previous research on self-efficacy (Bandura & Schunk, 1981; Schunk, 1981; Schunk & Lilly, 1984) and attributions (Crandall, Katkovsky & Crandall, 1965; Licht, Kistner, Ozkaragoz, Shapiro & Clausen, 1985). For the attribution measure five scales were displayed on paper for the success situation and five scales for the failure situation (see Appendix 1). Each

Table 2

Experimental Phases and Dependent Measures

EXPERIMENTAL PHASES		
Pretraining Phase	Training Phase	Testing Phase
Pre-assessment Questionnaire:	Self-Tests:	Posttests:
Attributions (General)	Central Tendency	Self-Efficacy for Central Tendency,
Self-Efficacy for Prerequisite Algebraic Skills	Variability	Variability, Correlation
	Correlation	Elementary Statistics, Research Methods and Major Theories
Attributions (Specific)		
Self-Efficacy for Central Tendency, Variability, Correlation		Attributions (Specific)
Pre-Test for Elementary Statistics		
Prerequisite Algebraic Skills		
Central Tendency, Variability and Correlation		

scale ranged from 10 to 100 in intervals of 10 from 10-- HIGHLY UNLIKELY, through to 100-- HIGHLY LIKELY. The scales were labeled "WORKED HARD" (effort), "GOOD AT" (ability), "GOOD LUCK" (chance), "PROBLEM WAS TOO EASY" (task) and "DON'T KNOW" (unknown) for the success situation. For the failure situation the scales were labeled "DID NOT WORK HARD" (effort), "NOT GOOD AT" (ability), "UNLUCKY" (chance), "PROBLEM WAS

TOO DIFFICULT" (task) and "DON'T KNOW" (unknown). Situation and label order were counterbalanced across subjects.

Subjects' self-efficacy for performing algebraic problems correctly and for learning how to perform statistics problems correctly were assessed by following similar procedures of previous research on self-efficacy (Bandura & Schunk, 1981; Schunk, 1981; Schunk & Lilly, 1984). Students' self-efficacy for prerequisite algebraic skills were assessed by examining four areas (adding and subtracting integers, multiplying and dividing integers, powers and square root of integers, cartesian planes — reading and plotting points). Students' self-efficacy for elementary statistics was measured by including three areas of descriptive statistics (central tendency, variability and correlation). The efficacy scale ranged from 10 to 100 in 10-unit intervals from HIGH UNCERTAINTY -- 10, through intermediate values --50/60, to HIGH CERTAINTY -- 100.

Pretest for Elementary Statistics. During the pretraining phase of the experiment all subjects completed the Pretest for Elementary Statistics (Appendix 2). The pretest consisted of two parts entitled :

a.   Prerequisite Algebraic Skills, and

b.   Elementary Statistics.

The first part included twenty fill in the blank and short answer questions on adding and subtracting integers, mulitiplying and dividing integers, power and square root of integers, and cartesian planes -- reading and plotting points. The second part included thirty multiple choice items on the measures of central tendency, measures of variability, and correlational method. The questions for the first part of the pretest were drawn from Freedman, Pisani and Purves (1974) a text for university introductory statistics. The multiple-choice items of the pretest were drawn from several sources (e.g., Ferguson, 1981; Hardyck & Petrinovich, 1965; Robinson, 1976). The second part of the pretest met the specifications outlined in Table 3.

As evident in Table 3, the Elementary Statistics Pretest included ten test items on each of the three topics: central tendency, variability, and correlation. On the pretest the number of items that involve definitions, procedures, applications or interpretation is designated for each topic in parentheses. For example, of the ten items referring to central tendency, six are definition items, two are procedure items, and two are application items. The test items were also selected on the basis of the first three levels of Bloom's (1965) Taxonomy of Educational Objectives: Cognitive Domain (i.e., knowledge, comprehension, application). For example, of the ten items referring to central tendency, four require knowledge, three require comprehension, and three require application.

Elementary Statistics Program. During the training phase of the experiment all subjects received three booklets entitled -- Elementary Statistics Program -- (Appendix 3). The first booklet was divided into three major sections. The first section described either the coping strategies

Table 3

Table of Specifications for Elementary Statistics Pretest and Elementary Statistics, Research Methods, and Major Theories Posttest

Topic	Knowledge 40%	Comprehension 40%	Application 20%	Items/ Topic
Objectives				
Pretest and Posttest:				
Central Tendency 20%				
Definitions (6)	8%	8%	4%	(10)
Procedures (2)	(4)	(3)	(3)	
Applications (2)				
Variability 20%				
Defintions (2)	8%	8%	4%	(10)
Procedures (2)	(4)	(4)	(2)	
Applications (6)				
Correlation 20%				
Defintions (3)	8%	8%	4%	(10)
Procedures (2)	(4)	(4)	(2)	
Interpretations (5)				
Posttest Only:				
Research Methods 20%				
Research Techniques (5)	8%	8%	4%	(10)
Develop. Approaches (5)	(4)	(3)	(3)	
Major Theories 20%				
Stage Theories (5)	8%	8%	4%	(10)
Nonstage Theories (5)	(4)	(3)	(3)	
Items/Objective	(20)	(20)	(10)	(50) Total Items

Note: Number in parenthesis indicates the number of items.

(mental imagery, self-verbalization, problem-solving approach) or the PQ4R study method. The second section included a practice exercise and content material on the measures of central tendency. The content material was divided into three topics (a) Definitions for Measures of Central Tendency, (b) Procedures for Measures of Central Tendency and (c) Applications of Measures of Central Tendency. After each topic there were an average of ten review questions relating to the content material. The third section of the first booklet consisted of a ten item multiple-choice self-test. The answers to review questions and the self-test were placed on the opposite side of the review and self-test. The second booklet consisted of the content material for measures of variability. It was divided into three topics (a) Definitions for Measures of Variability, (b) Procedures for Measures of Variability and (c) Applications of Measures of Variabiltiy. A short review followed each topic and answers to review questions were placed on the opposite pages to the review question. The second booklet also included a ten item multiple-choice self-test and answers were placed opposite the last page of the self-test. The third booklet consisted of content material on correlation. It was divided into (a) Definitions for Correlation, (b) Procedures for the Correlation Coefficient and (c) Interpretations of Correlation Coefficients. A short review and a ten item multiple-choice self-test following the format described for the first and second booklets was also provided. The content material and self-test items for each booklet were adapted from Blank (1968) and the booklet, Guide to Elementary Statistics, 2nd Edition, Rubadeau (1979).

Self-Efficacy Posttest. The Self-Efficacy Posttest (Appendix 4) was administered during the testing phase which followed the completion of the third booklet by each subject. The scale and procedure for assessing

self-efficacy were similar to those used on the Pre-Assessment Questionnaire.
However, rather than judging their capability for learning how to solve
statistical problems correctly, students judged their capability for being able
to solve statistical problems correctly.

Posttest for Elementary Statistics, Research Methods and Major Theories.
The Posttest for Elementary Statistics, Research Methods and Major Theories
(Appendix 5) was administered to all subjects during the testing phase. The
posttest consisted of fifty multiple-choice items (each item was worth two
percent) and the specifications are described in Table 3. Like the Pretest for
Elementary Statistics, the posttest included thirty items on elementary
statistics (i.e., ten items per topic) thus, sixty percent of the posttest was
comprised of elementary statistics. The topics were measures of central
tendency, measures of variability, and the correlation approach. Test items
were again selected according to the first three levels of Bloom's (1965)
Taxonomy of Educational Objectives and were drawn from the same sources as
those for the pretest. Forty percent of the questions were knowledge items,
forty percent were comprehension items, and twenty percent were application
items. In addition, the posttest included twenty test items on review material
(i.e., research methods, major theories) from the first semester of the
introductory psychology course. These items (ten per topic) were drawn from
the test bank for LeFrancois (1984).

Attribution Posttest. The Attribution Posttest (Appendix 6) was
administered during the testing phase of the experiment after all subjects had
received their results of the Posttest for Elementary Statistics, Research
Methods and Major Theories. Students' attributions for their successes and

failures on the posttest were assessed following the description outlined for parts 1 and 3 of the Pre-Assessment Questionnaire. However, students indicated the likelihood that each factor influenced their successes and failures on the posttest for Elementary Statistics, Research Methods, and Major Theories.

PROCEDURE

The following procedures were conducted by, myself, an adult female experimenter and one adult male assistant. I was the instructor for an introductory psychology course for nurses and the assistant an undergraduate student who had completed Psychology 210 (Data Analysis in Psychology) at Simon Fraser University. The assistant aided the experimenter during the training phase of the experiment. Following the initial introductory session of the training phase the assistant accompanied the experimenter to each group meeting. The subjects were requested to alternate between the experimenter and assistant to have their reviews and self-tests recorded.

Pretraining Phase. Prior to the beginning of an introductory psychology course for nurses, students met to discuss the course outline and objectives related to the upcoming semester. The experimenter informed the students that their overall course grade for the second semester would be based upon their performance on four multiple-choice exams each relating to one of four units over a sixteen week period. Students were told that each exam would account for one-fourth of their total grade for the semester. All students were given a course outline and list of course objectives for the second semester and asked to refer only to information relating to the first unit on elementary statistics, research methods, and major theories.

It was explained that exam one would consist of fifty multiple-choice items (i.e., thirty referring to statistics; ten to research methods; ten to major theories). Students were told that they would spend a total of three hours in class during the second semester reviewing material on research methods and major theories. It was pointed out that a total of ten hours in class would be devoted to elementary statistics. Students were informed that the program for elementary statistics would be used to determine the effectiveness of different study methods for learning elementary statistics. The experimenter emphasized that all students would have the opportunity to experience what is determined as the most effective method.

A summary of the three phases of the elementary statistics program and a consent form were distributed to all students. The students were advised to read the forms carefully, ask any questions and decide whether or not they would like to be involved in the experimental study, then return the signed consent forms. All students returned their signed consent forms. It was explained that the pretraining phase of the experiment would begin two weeks prior to the end of the first semester and required that all students complete the Pre-assessment Questionnaire and the Pretest for Elementary Statistics. The administration of the questionnaire and pretest was completed during three separate one-half hour sessions over a two week period.

During the first session of the pretraining phase the experimenter distributed the first two parts (ie. Attributions for Mathematical Successes and Failures in Algebra 11; Self-Efficacy for the Prestest for Elementary Statistics) of the questionnaire and the first part of the pretest (ie., Prerequisite Algebraic Skills) to each subject. The title for the first part

of the questionnaire was read aloud by the experimenter, subjects were directed
to page two of the questionnaire and asked to fill in their student number,
age, and indicate whether or not they had successfuly completed algebra 11.
The written instructions were read aloud. During the warmup exercise the
experimenter described a hypothetical situation to the subjects while
displaying an overhead transparency of the five scales. The experimenter
explained the scale, the success and failure situations, then provided examples
of how the scales might be marked. As a practise exercise, printed copies of
the overhead transparency were distributed to all subjects and they were
instructed to indicate on their copy the likelihood that each factor influenced
their performance during the most recent psychology examination. For the first
part of the questionnaire, subjects were advised to be honest, to think about
their previous experience in algebra 11 and indicate the likelihood that each
factor influenced their successes and failures. The subjects were told that
their judgements did not have to add to a particular number (e.g., 100). The
subjects recorded their ratings privately.

Following the completion of the first part of the questionnaire subjects
were directed to the second part. The title for the second part of the
questionnaire was read aloud by the experimenter. As a warm up exercise, the
experimenter described a hypothetical situation to the subjects while referring
to an overhead transparency of the efficacy scale. The experimenter explained
the scale and provided examples of how the scale might be used. As a practise
exercise, printed copies of the overhead transparency were distributed to all
subjects and they were instructed to indicate on their copy how confident they
were that they were able to meet previous objectives for the most recent
psychology exam. For the second part of the questionnaire, subjects were again

advised to be honest, not to perform any calculations, and to circle the numerical value referring to how confident they were that they were able to perform the algebraic problem correctly. The algebraic problems were displayed on overhead tranparencies. The subjects were told that the judgements did not have to add to a particular number (e.g., 100). All subjects recorded their ratings privately.

After completing and returning the first two parts of the questionnaire subjects were asked to pick up the first part of the pretest. Subjects completed the pretest privately. Upon completion of the pretest subjects returned all papers to the experimenter.

During the second session of the pretraining phase all subjects received their individual scores from the first part of the pretest. Following this the experimenter distributed the last two parts (i.e., Attributions for Successes and Failures on the Pretest for Elementary Statistics; Self-Efficacy for the Pretest for Elementary Statistics) of the questionnaire. The experimenter read aloud the title and written instructions for the third part of the questionnaire then subjects were reminded to fill in their student number and age. For this part of the questionnaire subjects were advised to be honest, to think about their experience on the first part of the pretest, and to indicate the likelihood that each factor influenced their successes and failures.

Following the completion of part three of the questionnaire, part four was addressed. Subjects were reminded to be honest, not to perform any calculations, and to circle the numerical value referring to how confident they

are that they are able to learn to perform statistical problems correctly. The statistics problems were displayed on overhead transparencies. For the last two parts of the questionnaire subjects were told that neither set of judgements had to add to a particular number and all subjects recorded their ratings privately.

During the final session of the pretraining phase all subjects received part two of the pretest (ie. Central Tendency, Variability and Correlation). The title and instructions were read aloud by the experimenter. Subjects completed the pretest independently and returned their papers to the experimenter.

All subjects were found to possess the necessary prerequisite algebraic skills as determined by the Pretest for Elementary Statistics. Sixty subjects (30 from each section) were randomly selected and assigned to one of three groups (i.e., combination feedback, performance feedback, control) within each section.

Training Phase. Each experimental group (combination feedback, performance feedback) and the control group met on separate occasions during the training phase of the experiment. Subjects were instructed to keep the content and format of these meetings private from those outside their group. Each group met for two, one and one-half hour scheduled class periods over a three week span and an additional one hour outside of class period for an initial introductory meeting.

On the first meeting with each group the experimenter distributed the first booklet entitled "Elementary Statistics Program". The experimenter

pointed out that there were three sections to the booklet (i.e., coping strategies or PQ4R, content material and reviews, self-test). Students were advised to read carefully through section one.

The experimental subjects received written instructions for appropriate coping strategies (i.e., mental imagery, self-verbalization, problem-solving approach). The control subjects received written instructions for the PQ4R study method. Time was set aside to discuss the coping strategies and study method and to answer students' questions. The subjects in each group were instructed to summarize the first section of the booklet on a 5 by 8 card. The experimenter checked all cards to ensure that each step for appropriate coping strategies or the PQ4R study method was outlined on the summary card.

Experimental subjects were encouraged to refer to their summary cards while viewing a video presentation of the coping strategies. The model on the video was a student who role played having difficulty in statistics prior to using the strategies described in the Elementary Statistics Program. The model had been asked to share her thoughts or think aloud as she worked through the first booklet. Questions and discussion followed the video presentation. Subjects in the control group did not view a video presentation of the PQ4R study method. All subjects had been introduced to the PQ4R method for three hours over a one week period at the beginning of their first semester at the College of New Caledonia. During this time subjects were introduced to, applied, and discussed the PQ4R study method.

All subjects were instructed to complete the practise exercise at the beginning of section two of the first booklet. Subjects were reminded to refer to their summary cards while completing the practise exercise. The subjects were instructed to complete the review for the practise exercise, check their answers and request that the experimenter record their performance on a record sheet. Subjects were told to follow this procedure for each topic in section two and for the self-test in section three.

As subjects individually reported their performance on each review and self-test the experimenter or assistant enquired as to whether they were using the coping strategies or PQ4R method. When subjects reported an error on a review the experimenter or assistant asked them what they would do to meet the objective they had failed to meet. Subjects in treatment 1 received a combination of performance and attributional feedback. The experimenter or assistant pointed out to subjects in treatment 1 that "you have been working hard and you are good at this" after each review and self-test. Thus, all subjects received performance feedback on twelve separate occasions and in addition, treatment 1 subjects received verbal attributional feedback linked to their performance feedback on each of the twelve occasions.

Testing Phase. Following the completion of the third booklet on elementary statistics all subjects completed the Self-Efficacy Posttest, then the Posttest for Elementary Statistics, Research Methods and Major Theories and finally the Posttest for Attributions over a two week period. The scale and procedure for assessing self-efficacy were similar to those used on the Pre-Assessment Questionnaire. However, on the posttest students judged their capability for being able to solve statistical problems correctly. The subjects were told that their judgements did not have to add to a particular number (e.g., 100) and all subjects recorded their ratings privately.

One week following the Self-Efficacy Posttest all subjects were administered the Posttest for Elementary Statistics, Research Methods and Major Theories. This posttest was completed during regular classtime for sections one and two of the psychology course. The subjects were seated at sufficient distances from one another to preclude viewing of each other's work during test administration. The experimenter read the test instructions aloud and answered students' questions. Upon completing the test students returned their test papers to the experimenter. The graded answer sheets were returned to all subjects within one week. A total percentage and letter grade were placed at the top of each answer sheet for all subjects. In addition the subjects in treatment 1 received written attribution feedback (i.e., "You have worked hard and are good at elementary statistics"). Subjects were asked to keep their answer sheets private until they had completed the Posttest for Attributions.

Immediately following the return of answer sheets the attribution posttest was administered. The scale and procedure for assessing attributions were similar to those described for the Pre-Assessment Questionnaire. However, subjects indicated the likelihood that each factor influenced their successes and failures on the Posttest for Elementary Statistics, Research Methods and Major Theories. It was emphasized that subjects were only to recall the test items referring to elementary statistics (i.e., numbered 1-30) while completing the posttest. Subjects were advised to be honest and were told that their ratings did not have to add to a particular number (e.g., 100). The subjects recorded their ratings privately and returned their papers to the experimenter. Finally, a summary and discussion of the experiment ensued.

CHAPTER IV

RESULTS AND DISCUSSION

Overall, the findings of this study were both positive and negative. Specifically, the results do not support the hypothesis that a combination of performance and attributional feedback (i.e., effort and ability) during task engagement promotes higher percepts of efficacy, skill development, and more adaptive attributions than performance feedback alone. Moreover, the results of this study do not support the typical findings of research on sex differences in students' self-efficacy and attributions. However, these data warrant further investigation into the roles of attributions and percepts of efficacy in achievement across age, achievement motivation, and educational levels. Female post-secondary students entered this study with relatively high levels of self-efficacy for learning how to solve statistics problems and displayed adaptive patterns of attributions for success and failure/difficulty at statistics. These data also provide support for the overall effectiveness of a coping strategies approach at enhancing skill in the area of statistics.

This study was designed to determine the influence of appropriate coping strategies, performance and attributional feedback on self-efficacy, skill development, and attributions. Results pertaining to the overall purpose of the study are now reported and discussed. This discussion contains three parts, each corresponding to one of the three dependent measures (attributions, skill at statistics, self-efficacy). First, the analyses of the attribution measure are presented. Here, the results for attributions for success and attributions for failure/difficulty are examined separately. Second, the findings for the measure of skill at statistics are

reported and discussed. Third, the results of the self-efficacy measure are addressed. To facilitate reading of the results, the statistically significant effects are highlighted and discussed in this chapter. For further reference the means and standard deviations by condition(combined feedback, performance feedback, control) for the dependent measures (attribution, self-efficacy) are provided in Appendix 7. In addition, Pearson Correlation Coefficients between time 1 (pretest) and time 2 (posttest) for each of the three dependent measures are located in Appendix 8.

Attributions for Success

Students' attributions for their problem-solving successes were analyzed according to a 3 (Condition) x 5 (Attribution) X 2 (Pretest, Posttest) analysis of variance (ANOVA) with repeated measures over the last two factors. The ANOVA yielded a significant main effect due to attribution ($F_{[4,52]}$= 26.26, p < .001), and a significant interaction of attribution by time ($F_{[4,52]}$= 26.45, p < .01). To further explore the main effect for attribution, post hoc comparisons were conducted using the Scheffe (Ferguson, 1959) method. These contrasts are presented in Table 4 below. A total of ten comparisons were tested after aggregating means across conditions and time. The Scheffe F tests conducted for each attribution (don't know, task difficulty, chance, ability, effort) revealed significant differences for seven contrasts.

Several conclusions were drawn based on the results of the significant F tests. Students placed significantly greater emphasis on effort, ability, and task difficulty as causes of problem-solving success than the unknown and chance factors. Although there was not a significant difference between the

emphasis placed on effort and ability, students did place significantly greater emphasis on effort as a cause of problem-solving success than on low task difficulty. However, they did not place significantly greater emphasis on ability compared to task difficulty. Students placed the least emphasis on the unknown and chance factors as causes of problem-solving success and the difference between these two factors was not statistically significant.

The significant attribution by time interaction was further investigated using the Bonferroni t Statistic (Myers, 1972) to maintain a conservative one-sided experiment-wise .05 error rate. A total sample mean was calculated for each of the five types of attributions for pretest and for posttest. Thus, a total of five contrasts were tested, one between the means of each type of attribution at pretest and posttest. The means for each of the five attributions for the entire sample (N=57) comparing pretest levels to posttest levels are depicted in Figure 1. Bonferroni's t yielded a significant difference between pretest and posttest for the attribution of task difficulty $(t_{[211]} = 4.70, p < .05)$ and for effort $(t_{[211]} = 2.94, p < .05)$. Students placed significantly greater emphasis on low task difficulty as a cause of problem-solving success at pretest than at posttest and placed significantly greater emphasis on effort at posttest than at pretest.

Attributions for Failure/Difficulty

Students' attributions for their problem-solving·failures/difficulty were also analyzed according to a 3 (Condition) x 5 (Attribution) X 2 (Pretest, Posttest) analysis of variance (ANOVA) with repeated measures over the last two factors. The ANOVA yielded a significant main effect due to attribution $(F_{[4,52]} = 6.99, p < .001)$ and a significant interaction of attribution by time $(F_{[4,52]} = 7.76, p. < .001)$.

Table 4

Multiple Comparisons of Attributions for Success: Main Effect Using Scheffe

(Means Aggregated over Condition and Time)

Contrast	Mean	F	Significance of F
Don't know– Task Difficulty	28.95 47.02	17.5	p < .01
Don't know– Chance	28.95 28.68	<1.0	not significant
Don't know– Ability	28.95 59.65	50.3	p < .01
Don't know– Effort	28.95 62.27	59.4	p < .01
Effort – Task Difficulty	62.27 47.02	12.5	p < .05
Effort– Chance	62.27 28.68	60.4	p < .01
Effort– Ability	62.29 59.65	<1.0	Not significant
Task Difficulty Chance	47.02 28.68	17.9	p < .01
Task Difficulty Ability	47.02 59.65	8.5	Not significant
Chance– Ability	28.68 59.65	51.3	p < .01

Note: N = 57 df_1 = 4, df_2 = 52

Range of scale: 10 (Highly unlikely) – 100(Highly likely)
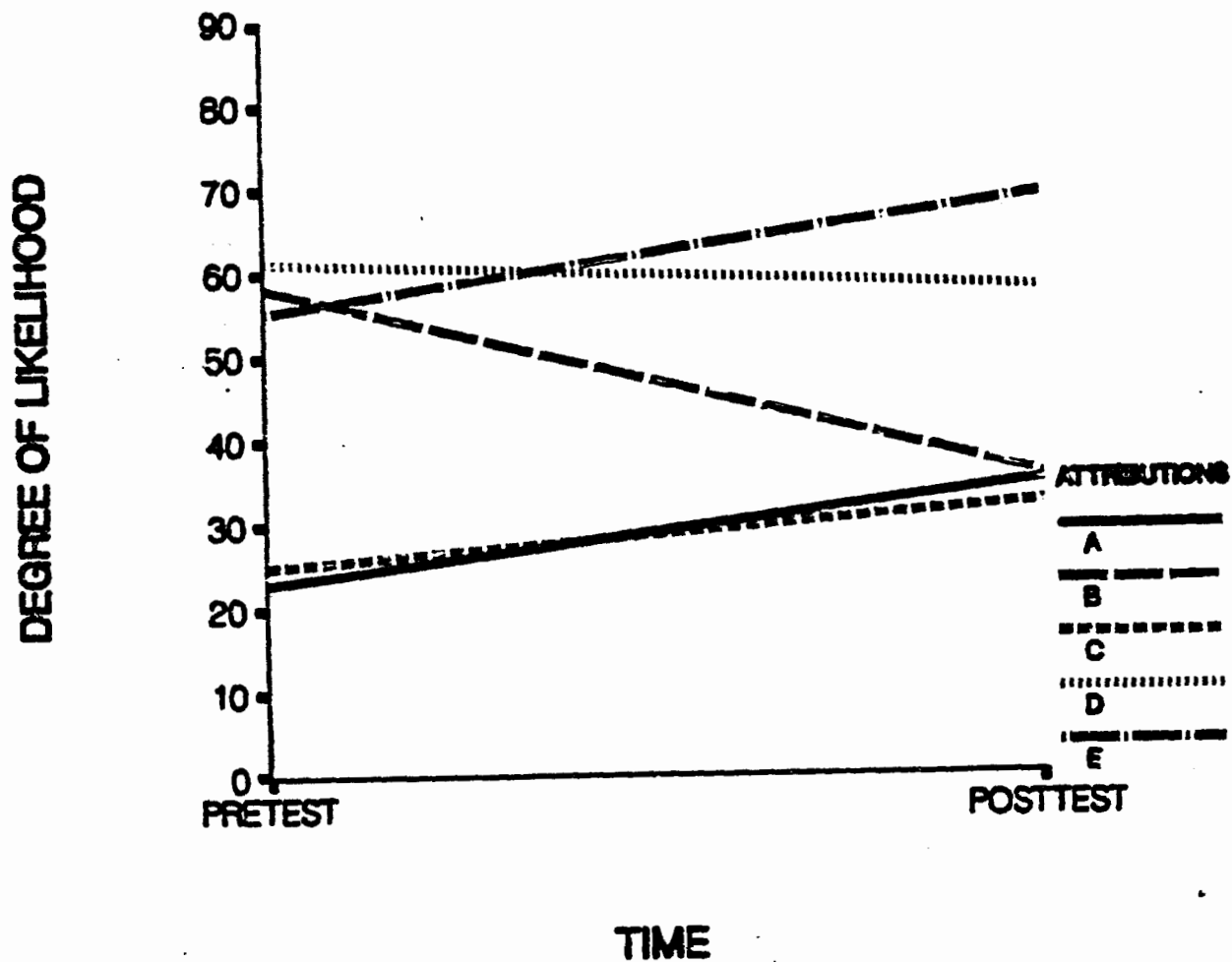
Figure 1. Success Attributions Compared at Pretest & Posttest

Note. Scale Range: 10 (Highly Unlikely) 100 (Highly Likely)

    A - don't know
    B - task difficulty
    C - chance
    D - ability
    E - effort

Again, to further explore the main effect for attribution post hoc comparisons were conducted using the Scheffe method. These contrasts are presented in Table 5 below. A total of ten comparisons were tested for significant differences after aggregating means across conditions and time.

The Scheffe F tests conducted for each type of attribution revealed significant differences for two contrasts. Students placed significantly greater emphasis on insufficient effort as a cause of problem-solving failure/difficulty than on chance (bad luck). In addition, students placed significantly greater emphasis on high task difficulty as a cause of problem-solving failure/difficulty than on chance.

The significant interaction of attribution by time was investigated using Bonferroni's t. A total sample mean was calculated for each of the five types of attributions for failure for pretest and posttest in time. Thus five contrasts were tested. The means for each of the five attributions for the entire sample (N= 57) comparing pretest levels to posttest levels are depicted in Figure 2. The Bonferroni's t yielded a significant difference between the pretest and posttest means for the attribution of don't know ($t_{[211]}$ = 4.04, p < .05). Overall, students placed significantly greater emphasis on the unknown factor as a cause of problem-solving failure/difficulty at posttest than at pretest. Examination of group means (appendix 7) suggests that treatement 2 (performance feedback) contributed most to this significant interaction.

In summary, to determine the influence on attributions of appropriate coping strategies and a combination of performance and attributional feedback during task engagement the data for the success and failure/difficulty

Table 5

Multiple Comparisons of Attributions for Failure/Difficulty Main Effect Using
Scheffe (Means Aggregated over Condition and Time)

Contrast	Mean	F	Significance of F
Don't know–	36.93		
Task Difficulty	40.26	<1.0	not significant
Don't know–	36.93		
Chance	24.91	7.50	not significant
Don't know–	36.93		
Ability	38.16	<1.0	not significant
Don't know–	36.93		
Effort	44.82	3.24	not significant
Effort–	44.82		
Task Difficulty	40.26	1.08	not significant
Effort–	44.82		
Chance	24.91	20.59	p < .01
Effort–	44.82		
Ability	38.16	2.31	not significant
Task Difficulty	40.26		
Chance	24.91	12.24	p < .05
Task Difficutly–	40.26		
Ability	38.16	<1.0	not significant
Chance–	24.91		
Ability	38.16	9.11	not significant

Note: N = 57 df_1 = 4, df_2 = 52
     Range of Scale: 10 (Highly Unlikely) – 100 (Highly Likely)
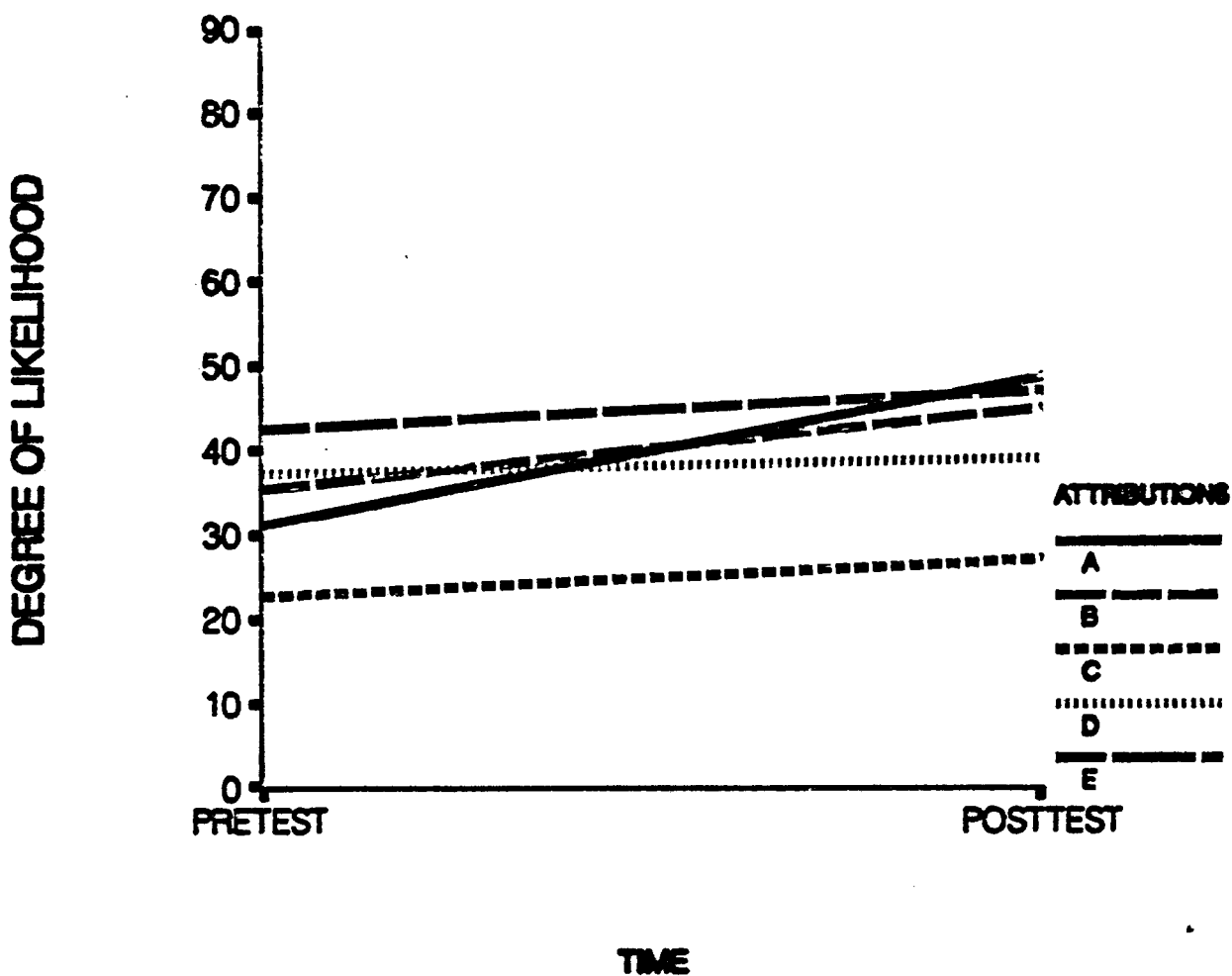
Figure 2. Failure Attributions Compared at Pretest & Posttest

Note: Scale Range: 10 (Highly Unlikely) 100 (Highly Likely)

- A – don't know
- B – task difficulty
- C – chance
- D – ability
- E – effort

situations were analysed using separate 3 x 5 X 2 analyses of variance with repeated measures. The analyses did not substantiate the hypothesis that students who received a training program in which they were taught appropriate coping strategies and were provided a combination of performance and attributional feedback during task engagement, display more adaptive attributions than students receiving training in coping strategies or PQ4R and performance feedback alone. Students in each of the three conditions did not differ significantly in the degree to which they made different types of attributions for their successes or failures/difficulty. However, some significant main effects and interactions were found. These data point to an adaptive pattern of attributions for success and failure/difficulty at statistics held by female college students over the course of the study. The second hypothesis that the achievement-related behaviors regarding elementary statistics of many female college students resemble the maladaptive achievement-related behaviors of LD individuals is discussed in light of the results.

On the basis of the current literature it was proposed that to the extent that female college students view their difficulties in mathematics as the result of insufficient ability, are less likely to attribute their difficulties to insufficient effort, and are less likely to attribute their success to ability, they may lower their percepts of efficacy for elementary statistics, thus displaying a maladaptive pattern of achievement-related behavior resembling that of LD females. In regard to attributions for success the students in this study placed significantly greater emphasis on effort, ability, and low task difficulty as causes of success than on the unknown and chance factors. Students did not place significantly more or less emphasis on

ability as a cause of success than on effort or low task difficulty. Students placed significantly greater importance on effort as opposed to low task difficulty as a cause of success. They appear to have minimized the influence of low task difficulty as a cause of success over time and maximized the importance of their effort as a cause of success over time. In otherwords, from the pretest to posttest phase of the experiment, students placed significantly less emphasis on low task difficulty and significantly more emphasis on effort as causes of their problem-solving success. Thus, overall these students displayed an adaptive pattern of attributions for success which does not resemble that of LD individuals who are reported to be less likely than NLD individuals to attribute their success to ability (Butkowsky & Willows, 1980: Pearl, 1982; Pearl, Bryan & Herzog, 1983) and more likely to attribute their success to external factors (Licht, 1983; Licht, Kistner, Ozkaragoz, Shapiro, & Clausen, 1985).

That students in this study did not differentiate significantly between the influence of effort and ability as causal ascriptions for success is interesting. It should be recognized that according to some researchers (e.g., Harari & Covington, 1981; Nicholls, 1978, 1979) an emphasis on ability as a cause of success becomes increasingly important with development. While young children emphasize effort as much as ability in determining outcomes, older children (by nine years of age) begin to differentiate ability from effort (Nicholls, 1978, 1979). Previous research has pointed out that generally with development, emphasis on effort as a causal factor becomes less important (e.g., Harari & Covington, 1981; Nicholls, 1978, 1979). Given that the female college students in this study place as much emphasis on effort as ability in determining their successes at statistics it appears that they may recognize

the important role of effort in influencing success at the post secondary educational level. Future research should investigate possible differences in the pattern of attributions for success across educational levels. Further, as students in this study may represent a more restricted range of ability than is likely to be found with younger children in classrooms, research is needed to examine how individuals of different achievement/ability levels use the causal factor of effort with development.

The students in this study placed significantly greater emphasis on insufficient effort and on high task difficulty as causes of problem-solving failure/difficulty for statistics than on the chance factor. Again, these students do not appear to hold the beliefs that foster a maladaptive pattern of achievement-related behaviors. More specifically, these students do not appear to resemble LD individuals who are more likely than NLD individuals to attribute their difficulty to insufficient ability (Butkowsky & Willows, 1980) and are less likely than NLD individuals to attribute their difficulty to insufficient effort (Butkowsky & Willows, 1980; Pearl, 1982; Pearl, Bryan & Donahue, 1980).

Surprisingly, from the pretest to posttest phase, students placed significantly greater emphasis on the unknown factor as a cause of problem-solving failure/difficulty at statistics (see Figure 2). According to Connell (1980), the higher the unknown score the less the individual claims to understand about the reasons for the outcome. This result was unexpected as students in the treatment conditions received as part of their training in appropriate coping strategies, instruction at analysing their failures/difficulties to determine whether insufficient effort, an inadequate strategy, or a combination of insufficient effort and inadequate strategy were

responsible for their failure/difficulty. In explanation of this result, it is possible that students in the treatment conditions more than the control condition would have emphasized inadequate coping strategy as a causal factor in determining their failure/difficulty at statistics had this attribution been made available. It is also possible, however, that students in the treatment conditions were not provided with the training they needed in order to effectively analyse their failures/difficulties. Further research should utilize training programs which provide students with ample opportunity to analyse their failures/difficulties. In addition, empirical research is needed to investigate the reasons for the endorsement or denial of the unknown factor under success and failure situations.

Skill at Statistics

Students' skill at statistics was analysed with a 3 (Condition) x 2 (Pretest, Posttest) multivariate analysis of variance (MANOVA) with repeated measures over time. The three dependent variables in this analysis were the three statistics skills (central tendency, variability and correlation). The analyses did not confirm the hypothesis that students receiving training in coping strategies and a combination of performance and attributional feedback perform at a higher level of skill than students receiving training in coping strategies or PQ4R and performance feedback alone. The MANOVA did reveal a significant main effect for time ($F_{[3,52]}$ = 158.33, p < .001). The univariate F tests conducted on each skill area (central tendency, variability, and correlation) over time were all significant. Specifically, the univariate F tests revealed a significant difference for students from pretest to posttest for central tendency. ($F_{[1,54]}$ = 122.81, p < .001), variability ($F_{[1,54]}$ = 232.32, p. < .001), and correlation ($F_{[1,54]}$ = 269.39, p. < .001).

The MANOVA also revealed a significant condition by time interaction ($F_{[3,52]}$ = 2.27, p < .05). However, the univariate F tests conducted on each condition by time did not reveal any significant effects. Students' skill at statistics (i.e., central tendency, variability, correlation) for time 1 (pretest) and time 2 (posttest) are depicted in Figures 3, 4, and 5 below. The overall trends are positive, that is the group means for each condition in each area of statistics increased from time 1 to time 2. These results indicate that over the course of the study all students learned more about statistics. Specifically they correctly solved more problems on central tendency, variability, and correlation at posttest than at pretest.

To further explore the significant condition by time effect, a combined treatment group was created by adding the means for the performance feedback and combined feedback conditions for each level of skill (central tendency, variability, and correlation) and dividing by two. The means and standard deviations for the combined treatment group and the control group are available in Table 6. The MANOVA yielded a significant condition by time interaction ($F_{[3,54]}$ = 4.05, p < .01). Univariate F tests revealed a significant difference for the control group from pretest to posttest for central tendency ($F_{[1,54]}$ = 4.53, p < .05) and a significant difference for the combined treatment group from pretest to posttest for correlation ($F_{[1,54]}$ = 5.44, p < .05). Table 6 indicates that for central tendency, students in the control group improved significantly whereas, for correlation the students in the combined treatment improved significantly from pretest to posttest. The MANOVA also yielded a significant main effect for condition. This main effect for condition is reported in Appendix 9.
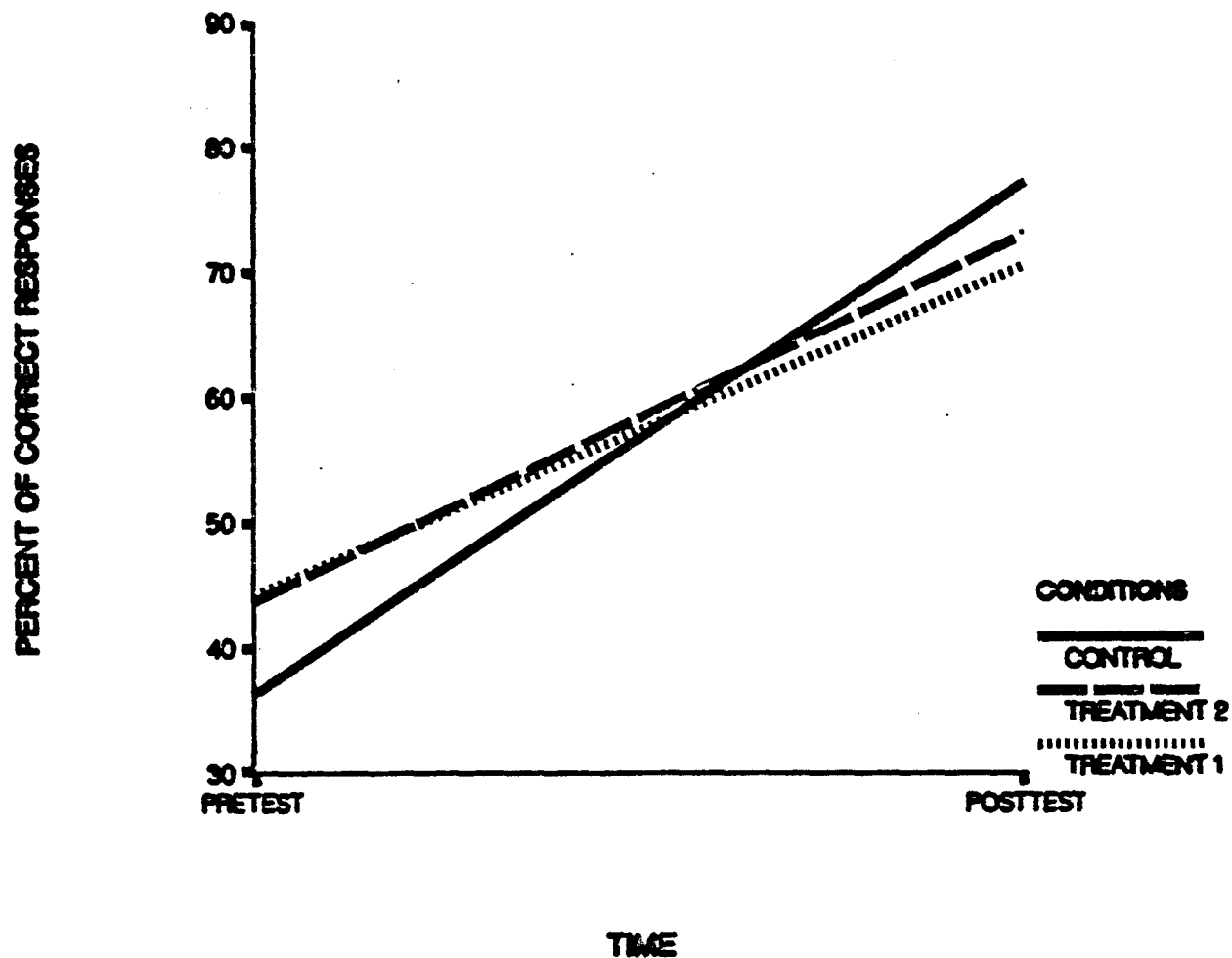
Figure 3. Skill at Statistics: Central Tendency

Control   PQ4R and Performance Feedback

Treatment 2   Strategies & Performance Feedback

Treatment 1   Strategies, Performance & Attribution Feedback
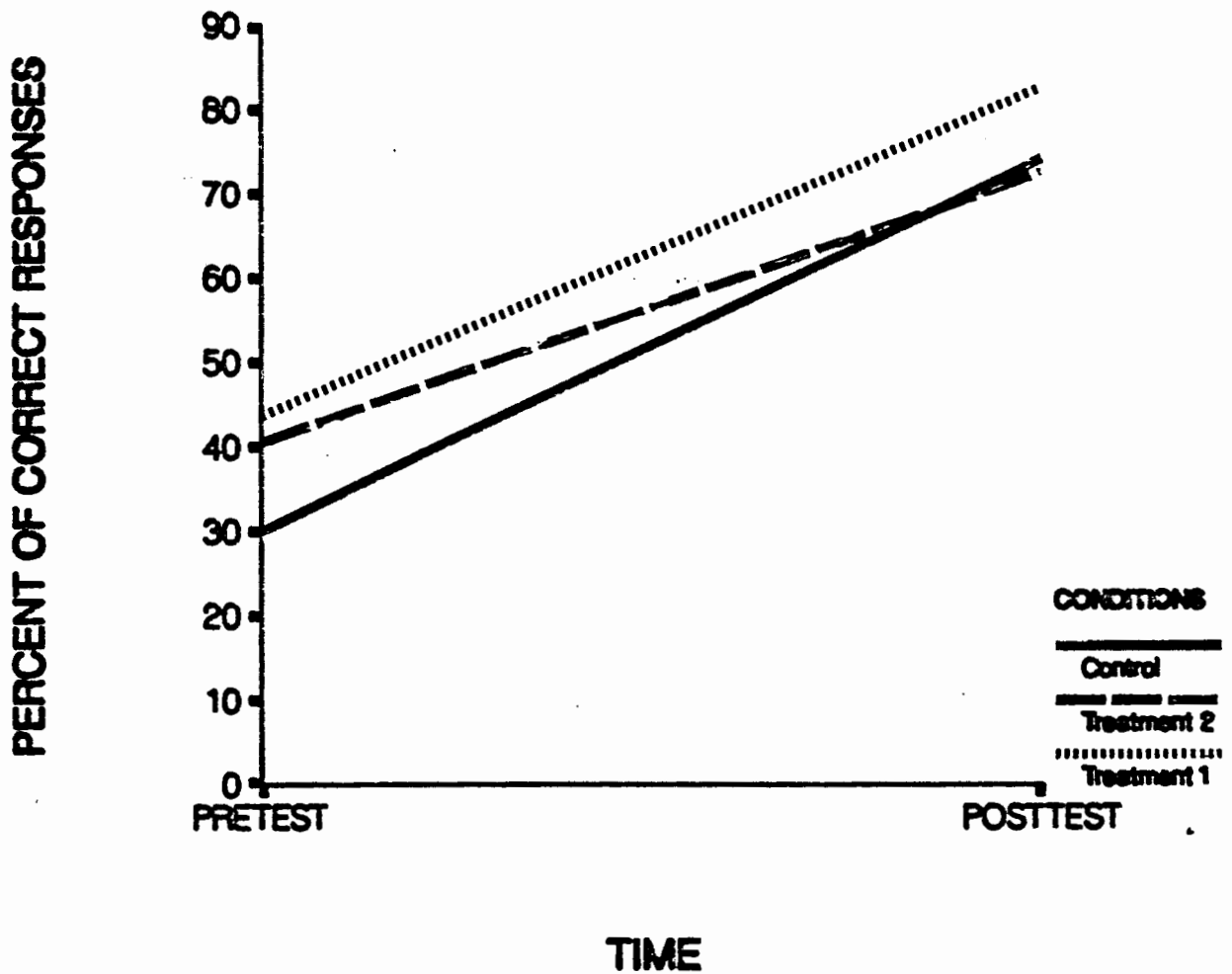
Figure 4. Skill at Statistics: Variability

Control   – PQ4R & Performance Feedback

Treatment 2   – Strategies & Performance Feedback

Treatment 1   – Strategies, Performance & Attribution Feedback
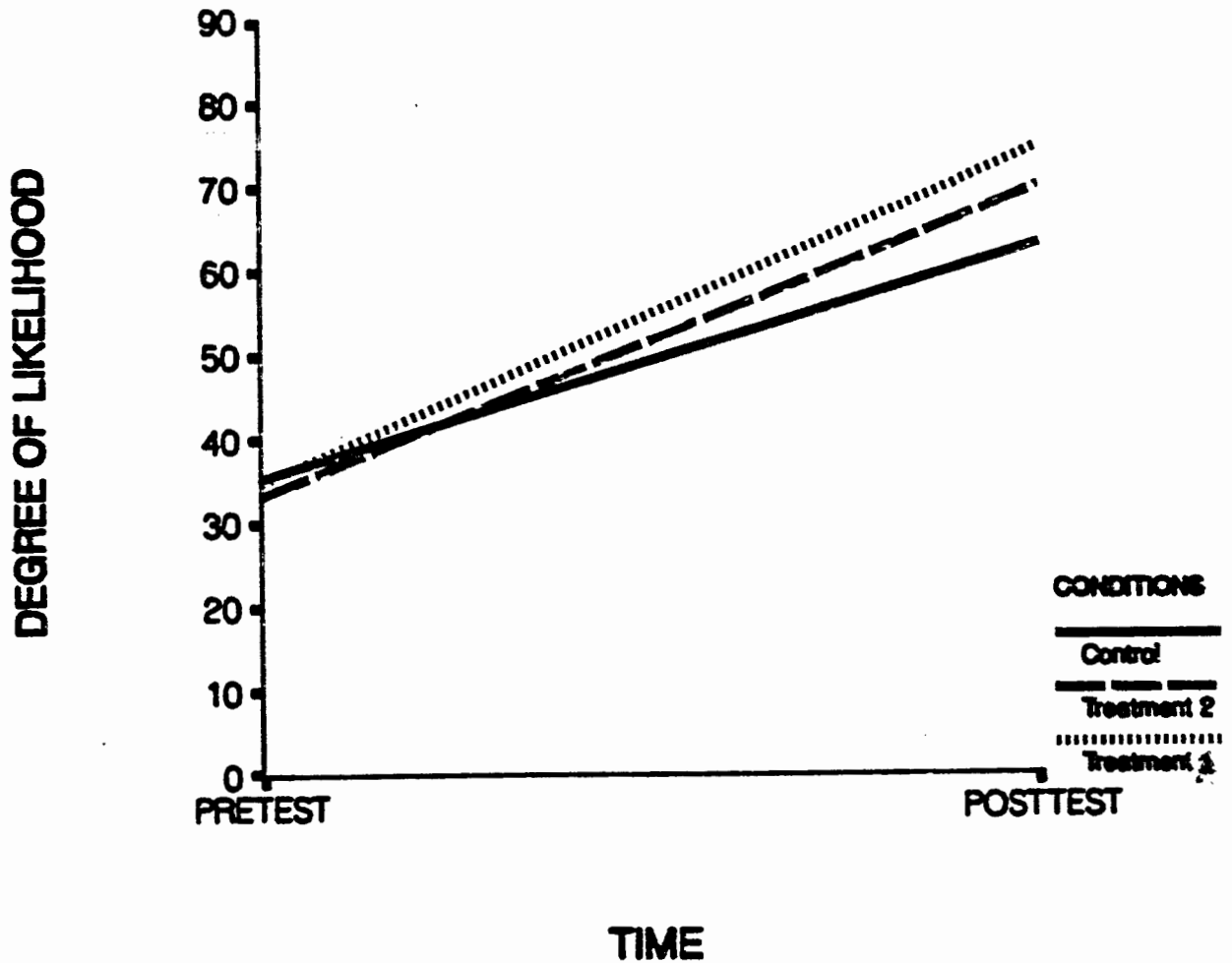
Figure 5. Skill at Statistics: Correlation

Control   – PQ4R & Performance Feedback

Treatment 2   – Strategies & Performance Feedback

Treatment 1   – Strategies, Performance & Attribution Feedback

Students' transfer skill was analysed with a 3 (Condition) x 2 (Transfer Skill) multivariate analysis of variance. The transfer skills were knowledge of research methods and knowledge of major theories. The transfer skills were tested at posttest only. The MANOVA did not yield any significant main effects or interactions.

In sum, the analyses did not substantiate the hypothesis that students receiving a coping strategies program and a combination of performance and attributional feedback would develop a higher skill level for statistics than students receiving a coping strategies program or PQ4R and performance feedback. The group means displayed in figures 3, 4 and 5 indicate that students in each condition did learn more from pretest to posttest in each of the three areas of statistics. This may be attributable to the potency of the written instructional package. Thus, regardless of condition, students improved their skill at statistics. Further, the results indicate that although the control group improved significantly on central tendency from pretest to posttest, the combined treatment group improved significantly on correlation from pretest to posttest.

Self-Efficacy

Students' self-efficacy was analysed according to a 3 (Condition) x 2 (Pretest, Posttest) multivariate analysis of variance with repeated measures over time. The dependent variables were the three skill areas in statistics. The main effects and interactions were nonsignificant. Inconsistent with expectation these female college students entered the experiment with a relatively high sense of self-efficacy for learning how to solve statistics problems. The means (and standard deviations) for self-efficacy at pretest

Table 6

Means (and Standard Deviations) for Skill: Combined Treatment
Group and Control Group Over Time

	Experimental Condition	
	Control (n=19)	Combined Treatment Group (n=38)
Skill		
Pretest		
Central Tendency	36.32 (16.40)	43.95 (18.71)
Variability	30.00 (11.06)	42.11 (22.06)
Correlation	35.26 (11.72)	33.95 (12.93)
Posttest		
Central Tendency	77.37 (11.95)	71.84 (15.18)
Variability	74.21 (15.39)	77.63 (15.39)
Correlation	63.16 (15.29)	72.74 (14.76)

Note:

Combined Treatment Group: an average of (combination feedback and
performance feedback)

Range of scale: 0 percent correct to 100 percent correct.

and posttest for the entire sample (N = 57) are provided in Table 7.

An evident in Table 7 there was a considerable reduction in variance from prestest to posttest. A plausible explanation is that students using the low end of the self-efficacy scale at pretest moved towards the high end of the scale at posttest. This would account for the overall increase in the mean scores from pretest to posttest. Thus, there appears to have been a ceiling effect.

To put the data reported in Table 7 in perspective, the means (and standard deviations) for self-efficacy at pretest for grade 6 and grade 8 females reported by Schunk and Lilly (1984) were 45.3 (22.3) and 49.3 (18.7) respectively. Age and achievement motivation (low, high) are obvious factors that could explain the difference in the way that students in this study and the female students in the Schunk and Lilly study used the self-efficacy rating scale. Thus, further research is needed to explore the possible changes in percepts of efficacy that may occur across age, educational and achievement motivation levels.

Table 7

Means (and standard deviations) for Self-Efficacy

	Mean	Standard Deviation
Self-efficacy		
Pretest		
Central Tendency	72.49	(22.18)
Variability	68.82	(23.05)
Correlation	68.63	(21.72)
Posttest		
Central Tendency	85.82	(11.51)
Variability	82.70	(12.83)
Correlation	82.96	(13.40)

Note: N = 57

Range of Scale: 10 (highly uncertain) – 100 (highly certain)

CHAPTER V

CONCLUSIONS

A number of theoretical and instructional implications may be drawn as a result of this study. The findings of this study point to and shed light on the complex relationship between perceived effort and self-efficacy. The data do not support the claim by Schunk (1983b) that combining ability and effort attributional feedback, leaves students wondering how much ability they have if they have to work hard to succeed. Nor do the results of this study support previous research findings of sex differences in students' performance expectancies and attributions (eg., Crandall, 1969; Deaux, 1976; Maccoby & Jacklin, 1974; Parsons & Ruble, 1977). Before drawing implications as a result of this study, the influence of attributional variables on self-efficacy is summarized.

Bandura's theory of self-efficacy claims that different treatments change behavior partly by developing a sense of self-efficacy (Bandura, 1977, 1981, 1982). According to Schunk (1983a), attributional variables are a major influence on self-efficacy. People often attribute the outcomes of their actions to ability, effort, task difficulty, and luck (Frieze, 1980; Weiner, 1979). Such categories may be insufficinet and Weiner (1986) has expanded upon these (eg., strategy). Weiner (1979) claims that such attributions influence future expectancies of success and failure. More specifically, attributing one's success to fairly stable causes such as high ability or low task difficulty tends to produce high expectancies of future success (McMahan, 1973; Weiner, 1979). On the otherhand, attributing one's success to fairly unstable causes, such as great effort or good luck should result in relatively lower expectancies of future success (McMahan, 1973; Weiner, 1979).

Interestingly, over the course of the study, the students in the present study placed significantly less emphasis on low task difficulty (stable factor) and significantly more emphasis on effort (unstable factor) as causes of success. Although the analyses of self-efficacy judgements did not reveal any significant effects, for each condition percepts of efficacy were higher at posttest than at pretest (see Appendix 7). Similary, Schunk and Lilly (1984) reported that sixth grade students placed greater emphasis on effort than eighth grade students as a cause of probelm-solving progress but did not judge posttest self-efficacy lower. These findings are inconsistent with Bandura (1981) who claims that given a task is perceived as intermediate in difficulty success achieved with more perceived effort should raise self-efficacy less than when minimal effort is required. The results of this study and Schunk and Lilly (1984) highlight the complexity of the relationship between perceived effort and self-efficacy. One implication of this study is that for some students, success achieved with more perceived effort does not necessarily raise self-efficacy less than when minimal effort is expended. Thus, future research should, examine how variables such as achievement motivation, age, sex, and educational level interact with the interpretation of attributional feedback in influencing self efficacy.

Schunk (1983b) has cautioned that combining effort and ability attributional feedback may result in students wondering how much ability they have if they have to work hard to succeed. Although students in this study placed significantly greater emphasis on effort at posttest than at pretest as influencing their success, they did not place significantly more or less emphasis on ability at posttest than at pretest. More specifically an implication of the present study is outlined as follows. It appears that some

students rate initial self-efficacy for learning a task as high and recognize the important role of effort in success. As a result they do not place significantly more or less emphasis on ability as opposed to effort as a cause of success and self-efficacy continues to rise. Given this scenario, it is unlikely that a combination of ability and effort attributional feedback will leave such students wondering how much ability they have even though they have to work hard to succeed. Thus an instructional implication is that teachers need to carefully consider the students and the context when they are delivering attributional feedback.

Finally, the results of this study tend not to support the typical findings of research on sex differences in students' performance expectancies and attributions. Much of the research in this area indicates that on masculine-type tasks (e.g., mathematics) girls hold lower expectancies for success and are less likely to attribute success to ability than boys (Crandall, 1969; Deaux, 1976; Maccoby & Jacklin, 1974; Parsons & Ruble, 1977). In contrast, this study provides evidence that some womens' successful performances on masculine-type tasks (e.g., statistics) may be as likely to be attributed to effort as ability and that even when great effort is expended, percepts of efficacy continue to develop.

The difference between the results of this study and the previous research exploring sex differences in students' performance expectancies and attributions may be due, in part, to the general versus specific nature of the dependent measures. For example, research on sex role stereotypes shows that men are generally perceived as more compentent than women on masculine-type tasks (Broverman, Vogel, Broverman, Clarkson, & Rosenkrantz, 1972; Deaux,

1976). Such a general measure may be more likely to exaggerate sex differences particularly if women tend to view "other" women more negatively than "themselves" (Neugarten, 1980). In addition, although "girls" may hold lower expectancies for success and may be less likely to attribute success to ability than "boys" on masculine-type tasks, it does not necessarily follow that this same pattern continues at the college level. Thus a third implication of this study is that Bandura's theory of self-efficacy and recent research on sex differences and attributions may more aptly explain the achievement cognitions of "girls" and "boys" and those who display relatively low levels of self-efficacy than the achievement cognitions of at least some female college students.

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APPENDIX 1

PRE-ASSESSMENT QUESTIONNAIRE

Instructions:

Page two and three are warm up exercises only. Please take a moment to recall
your experience in psychology 161. Then answer each of the following items by
circling a numerical value located on each scale that corresponds to the
likelihood the factor in quotations influenced your success or failure.

Practice Situation

When you were faced with a difficult question on a psychology 161 exam that you
COULD answer, this was because

(a) well ... you really "DON'T KNOW" why you could answer it.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(b) the "PROBLEM WAS TOO EASY" for psychology 161 students.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(c) you were "LUCKY".

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(d) you are "GOOD AT" psychology.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(e) you "WORKED HARD".

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

Practice Situation

When you were faced with a difficult question on a psychology 161 exam that
you **COULD NOT** answer, this was because

(a) well ... you really **"DON'T KNOW"** why you could not answer it.

```
Highly                                                          Highly
Unlikely                                                        Likely
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```

(b) the **"PROBLEM WAS TOO DIFFICULT"** for psychology 161 students.

```
Highly                                                          Highly
Unlikely                                                        Likely
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```

(c) you were **"UNLUCKY"**.

```
Highly                                                          Highly
Unlikely                                                        Likely
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```

(d) you are **"NOT GOOD "** at psychology.

```
Highly                                                          Highly
Unlikely                                                        Likely
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```

(e) you **"DID NOT WORK HARD"**.

```
Highly                                                          Highly
Unlikely                                                        Likely
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```

Pre-Assessment Questionnaire

Part A: Attributions for Mathematical Successes and Failures in Algebra 11

AGE   _____

SEX   _____

ID   _____

INSTRUCTIONS:

Please take a moment a recall your experience in Algebra II. Then answer each questionnaire item by circling a numerical value located on each scale that corresponds to the likelihood the factor in quotations influenced your success or failure.

Situation

When you were faced with a difficult math problem in algebra 11 that you **COULD NOT** answer correctly, this was because

(a) well ... you really **"DON'T KNOW"** why you could not answer it.

Highly   Highly
Unlikely   Likely
|————|————|————|————|————|————|————|————|————|
10   20   30   40   50   60   70   80   90   100

(b) the **"PROBLEM WAS TOO DIFFICULT"** for algebra 11 students.

Highly   Highly
Unlikely   Likely
|————|————|————|————|————|————|————|————|————|
10   20   30   40   50   60   70   80   90   100

(c) you were **"UNLUCKY"**.

Highly   Highly
Unlikely   Likely
|————|————|————|————|————|————|————|————|————|
10   20   30   40   50   60   70   80   90   100

(d) you are **"NOT GOOD"** at algebra 11.

Highly   Highly
Unlikely   Likely
|————|————|————|————|————|————|————|————|————|
10   20   30   40   50   60   70   80   90   100

(e) you **"DID NOT WORK HARD"**.

Highly   Highly
Unlikely   Likely
|————|————|————|————|————|————|————|————|————|
10   20   30   40   50   60   70   80   90   100

Situation

When you were faced with a difficult math problem in algebra 11 that you COULD answer, this was because

(a) well ... you really **"DON'T KNOW"** why you could answer it.

```
Highly                                                                Highly
Unlikely                                                              Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90     100
```

(b) the **"PROBLEM WAS TOO EASY"** for algebra 11.

```
Highly                                                                Highly
Unlikely                                                              Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90     100
```

(c) you were **"LUCKY"**.

```
Highly                                                                Highly
Unlikely                                                              Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90     100
```

(d) you are **"GOOD AT"** algebra.

```
Highly                                                                Highly
Unlikely                                                              Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90     100
```

(e) you **"WORKED HARD"**.

```
Highly                                                                Highly
Unlikely                                                              Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90     100
```

Part B: Self-Efficacy for Pretest of **Elementary** Statistics

(Part A: Prerequisite Algebraic Skills)

AGE   _____

SEX   _____

ID   _____

INSTRUCTIONS

Each questionnaire item requires that you read specific questions on a overhead transparency that are identical to particular questions on the Pretest of Elementary Statistics—Part A: Prerequisite Algebraic Skills. Please do NOT perform any calculations. Simply refer to the scale below each item on this questionnaire and circle the numerical value corresponding to how confident you are that you are able to perform the algebraic problem correctly.

Adding and Subtracting Integers

1. Please read questions 1 and 2 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to:

a. add positive and negative integers correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|———————|————————|————————|————————|————————|————————|————————|———————|———————|
10      20       30       40       50       60       70       80      90     100
```
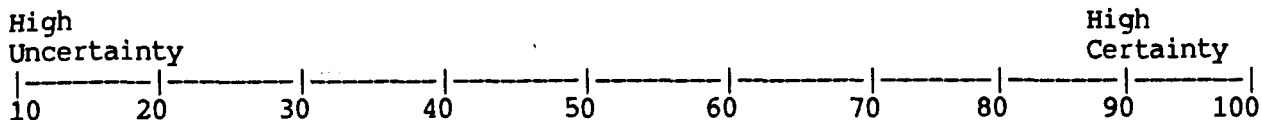
b. subtract positive and negative integers correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|———————|————————|————————|————————|————————|————————|————————|———————|———————|
10      20       30       40       50       60       70       80      90     100
```
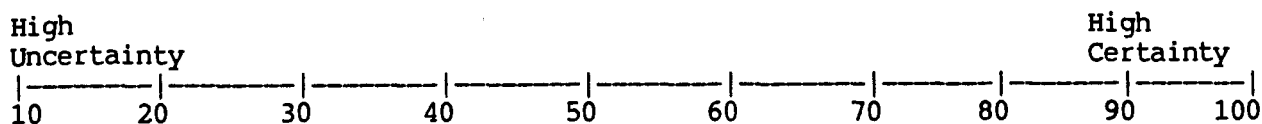
Multiplying and Dividing Integers

2. Please read questions 3 and 4 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to:

a. multiply positive and negative integers correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|———————|————————|————————|————————|————————|————————|————————|———————|———————|
10      20       30       40       50       60       70       80      90     100
```
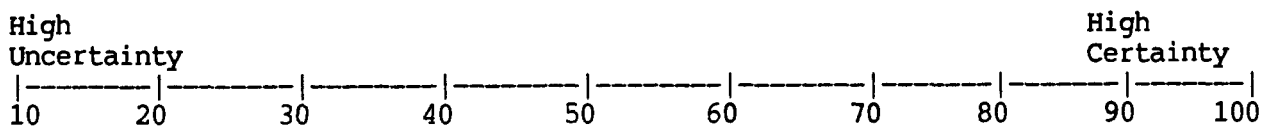
b. divide positive and negative integers correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|———————|————————|————————|————————|————————|————————|————————|———————|———————|
10      20       30       40       50       60       70       80      90     100
```
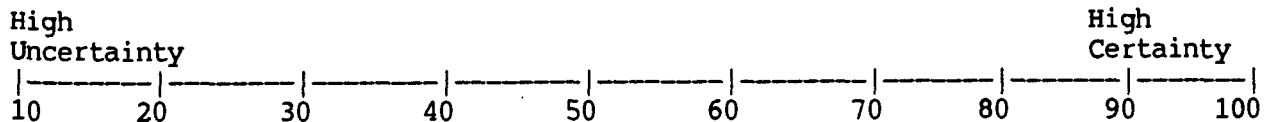
Powers and Square Roots of Integers

3. Please read questions 5, 6 and 7 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to

a. determine the square of a positive integer correctly.

```
High                                                      High
Uncertainty                                               Certainty
|——————|——————|——————|——————|——————|——————|——————|——————|——————|
10      20      30      40      50      60      70      80      90     100
```
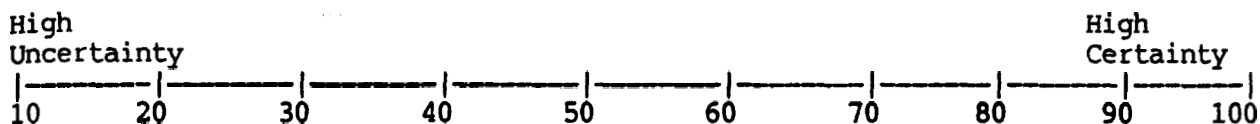
b. determine the square of a negative integer correctly.

```
High                                                      High
Uncertainty                                               Certainty
|——————|——————|——————|——————|——————|——————|——————|——————|——————|
10      20      30      40      50      60      70      80      90     100
```
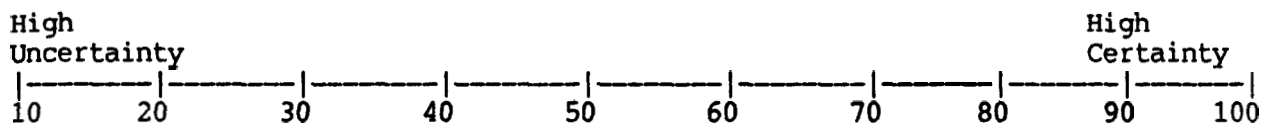
c. determine the square root of an integer correctly.

```
High                                                      High
Uncertainty                                               Certainty
|——————|——————|——————|——————|——————|——————|——————|——————|——————|
10      20      30      40      50      60      70      80      90     100
```
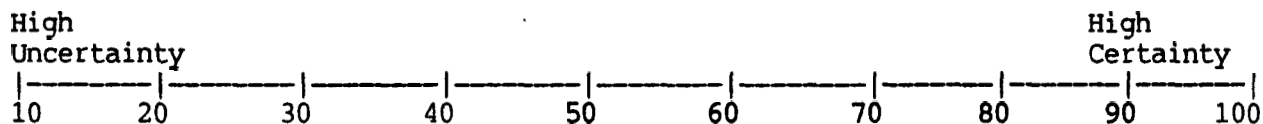
Cartesian Planes—Reading and Plotting Points

4. Please read questions 8 and 9 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to

(a) read points off of a graph correctly.

```
High                                                      High
Uncertainty                                               Certainty
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```
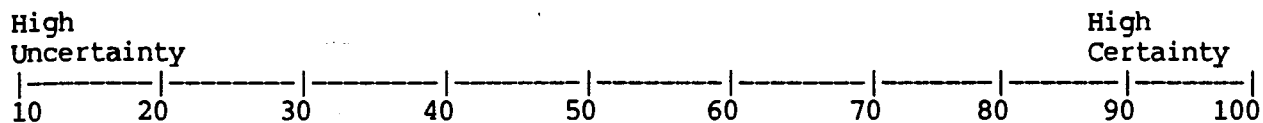
(b) plot points on to a graph correctly.

```
High                                                      High
Uncertainty                                               Certainty
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
10       20       30       40       50       60       70       80       90      100
```
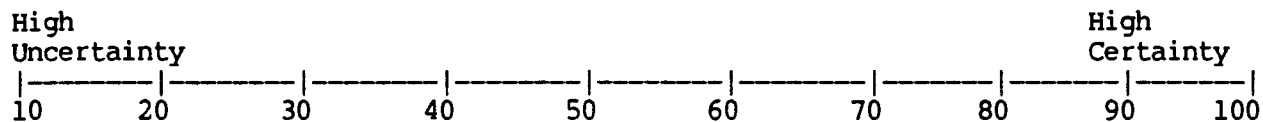
PRE–ASSESSMENT QUESTIONNAIRE

Pre-Assessment Questionnaire

Part C: Attributions for Successes and Failures on the Pretest for Elementary Statistics -- Part A

AGE _____

SEX _____

ID _____

INSTRUCTIONS:

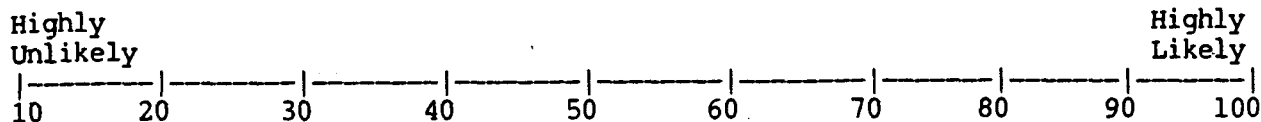The following questionnaire items refer only to your performance on the Pretest for Elementary Statistics—Part A. Please take a moment to recall your performance on the pretest. Then answer each questionnaire item by circling a numerical value located on the scale that corresponds to the likelihood the factor in quotations influenced your success or failure.
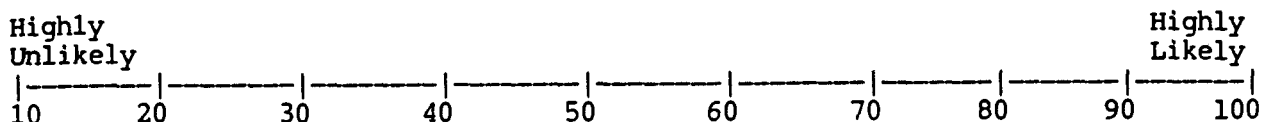
Situation

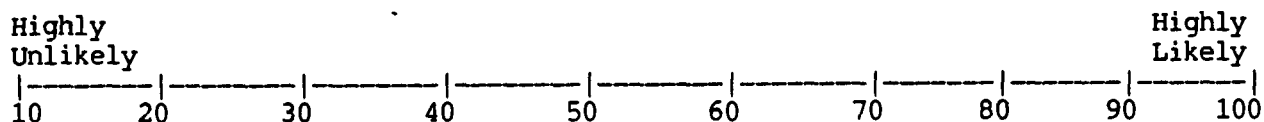When you were faced with a difficult math problem in Pretest: Part A that you **COULD** answer, this was because

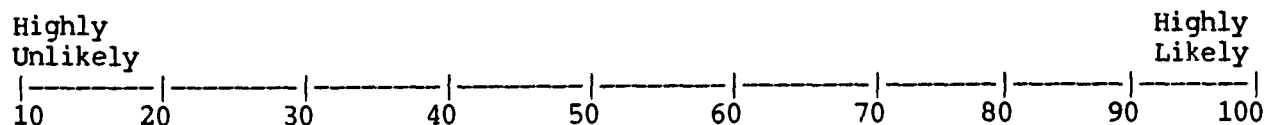(a) well ... you really **"DON'T KNOW"** why you could answer it.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10        20        30        40        50        60        70        80        90        100
```

(b) the **"PROBLEM WAS TOO EASY"** for algebra 11.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10        20        30        40        50        60        70        80        90        100
```

(c) you were **"LUCKY"**.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10        20        30        40        50        60        70        80        90        100
```

(d) you are **"GOOD AT"** algebra.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10        20        30        40        50        60        70        80        90        100
```

(e) you **"WORKED HARD"**.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10        20        30        40        50        60        70        80        90        100
```

Situation

When you were faced with a difficult math problem in Pretest: Part A that you
COULD NOT answer correctly, had difficulty with at this level or would have
difficulty with at a more advanced level this was because

(a) well ... you really **"DON'T KNOW"** why you could not answer it.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10       20       30       40       50       60       70       80       90      100
```

(b) the **"PROBLEM WAS TOO DIFFICULT"** for algebra 11 students.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10       20       30       40       50       60       70       80       90      100
```

(c) you were **"UNLUCKY"**.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10       20       30       40       50       60       70       80       90      100
```

(d) you are **"NOT GOOD"** at algebra 11.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10       20       30       40       50       60       70       80       90      100
```

(e) you **"DID NOT WORK HARD"**.

```
Highly                                                              Highly
Unlikely                                                           Likely
|————————|————————|————————|————————|————————|————————|————————|————————|————————|
10       20       30       40       50       60       70       80       90      100
```

Pre-Assessment Questionnaire

Part D: Self-Efficacy for Pretest of Elementary Statistics (Part B
         Central Tendency, Variability and Correlation

SEX _____

AGE _____

ID _____

INSTRUCTIONS:

Each questionnaire item requires that you read specific questions
on a overhead transparency that are identical to particular
questions on the Pretest of Elementary Statistics -- Part B:
Central Tendency, Variability and Correlation.   Please DO NOT
perform any calculations.   Simple refer to the scale below each
item on this questionnaire and circle the numerical value
corresponding to how confident you are that you are able to learn
how to perform the statistics problem correctly.

A. Central Tendency

1.   Please read questions 1 through 4 on the overhead transparency and circle
     the numerical value that corresponds to how certain you feel that you
     will be able to learn how to

a.   define the mean, median, and mode correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|--------|--------|--------|--------|--------|--------|--------|--------|-------|
10       20       30       40       50       60       70       80       90     100
```

b.   identify the procedures for the mean, median, and mode correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|--------|--------|--------|--------|--------|--------|--------|--------|-------|
10       20       30       40       50       60       70       80       90     100
```

c.   differentiate correctly between the mean, median and mode and their uses.

```
High                                                              High
Uncertainty                                                       Certainty
|--------|--------|--------|--------|--------|--------|--------|--------|-------|
10       20       30       40       50       60       70       80       90     100
```

d.   calculate the appropriate measure of central tendency correctly given a
     particular situation and draw conclusions.

```
High                                                              High
Uncertainty                                                       Certainty
|-------|--------|--------|--------|--------|--------|--------|--------|-------|
10      20       30       40       50       60       70       80       90     100
```
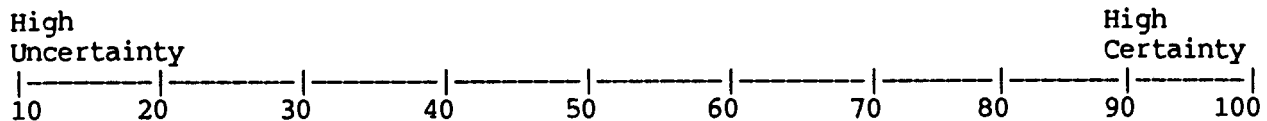
B. Variability

2. Please read questions 5 through 8 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you will be able to learn how to
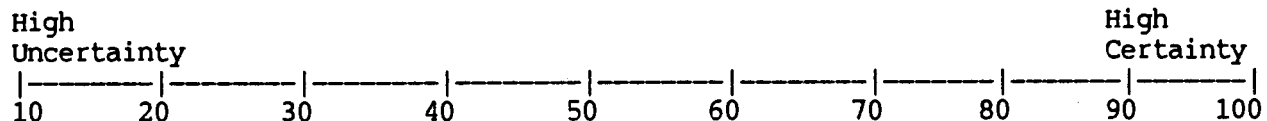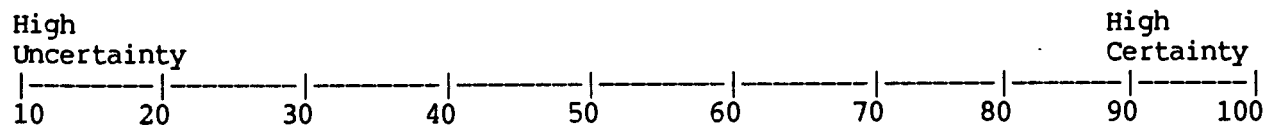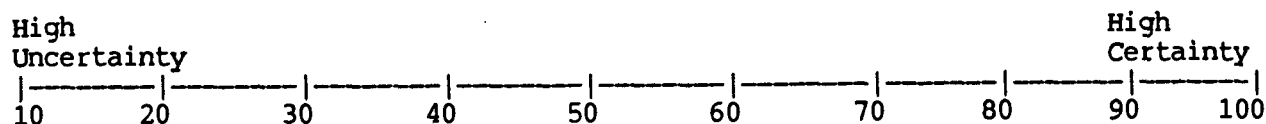
a. define the range and standard deviation correctly.

```
High                                                           High
Uncertainty                                                    Certainty
|-------|-------|-------|-------|-------|-------|-------|-------|-----|
10      20      30      40      50      60      70      80      90   100
```
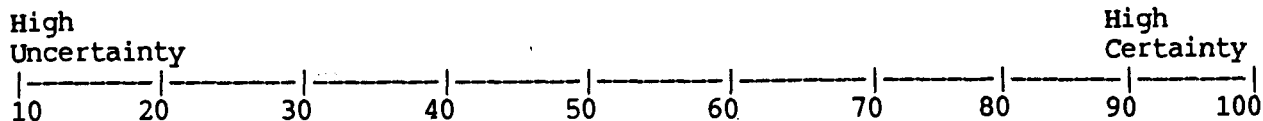
b. identify the procedures for the range and standard deviation correctly.

```
High                                                           High
Uncertainty                                                    Certainty
|-------|-------|-------|-------|-------|-------|-------|-------|-----|
10      20      30      40      50      60      70      80      90   100
```

c. understand the characteristics of the standard deviation.

```
High                                                           High
Uncertainty                                                    Certainty
|-------|-------|-------|-------|-------|-------|-------|-------|-----|
10      20      30      40      50      60      70      80      90   100
```

d. calculate the standard deviation for a particular distribution correctly and draw conclusions.

```
High                                                           High
Uncertainty                                                    Certainty
|-------|-------|-------|-------|-------|-------|-------|-------|-----|
10      20      30      40      50      60      70      80      90   100
```

C.   Correlation

3.   Please read questions 9 through 12 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you will be able to learn how to
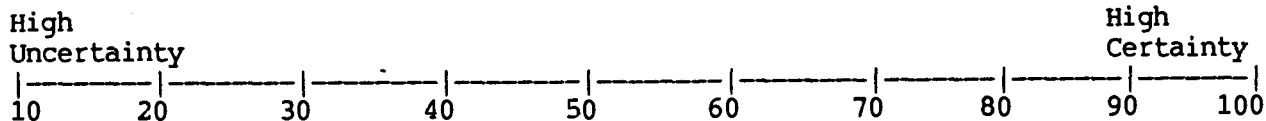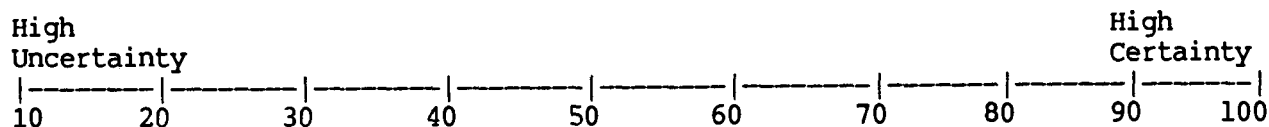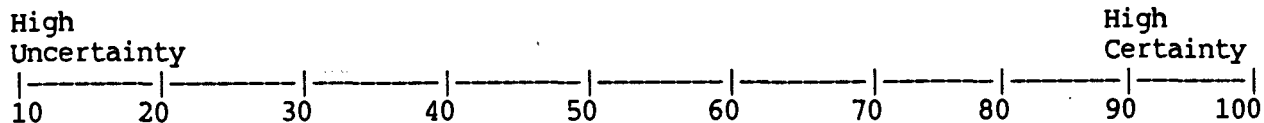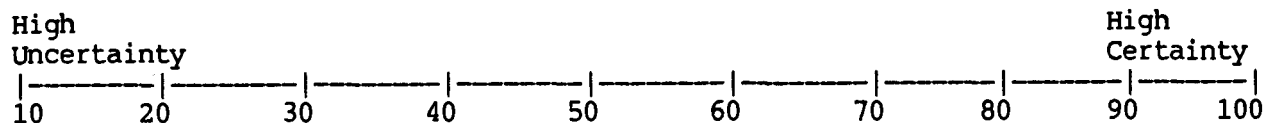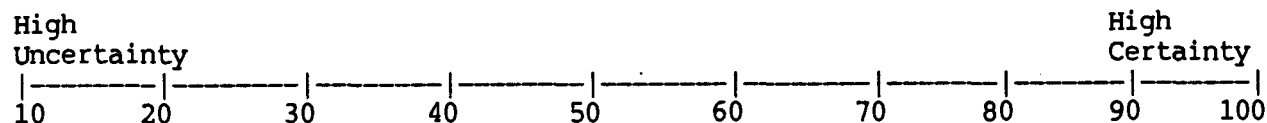
a.   define correlation and correlation coefficient.

```
High                                                      High
Uncertainty                                               Certainty
|———|———|———|———|———|———|———|———|———|———|
10      20      30      40      50      60      70      80      90      100
```

b.   understand the procedures for calculating the correlation coefficient.

```
High                                                      High
Uncertainty                                               Certainty
|———|———|———|———|———|———|———|———|———|———|
10      20      30      40      50      60      70      80      90      100
```

c.   understand types of correlations and correlation coefficients.

```
High                                                      High
Uncertainty                                               Certainty
|———|———|———|———|———|———|———|———|———|———|
10      20      30      40      50      60      70      80      90      100
```

d.   apply knowledge and understanding of the concept of correlation to draw conclusions in a variety of situations.

```
High                                                      High
Uncertainty                                               Certainty
|———|———|———|———|———|———|———|———|———|———|
10      20      30      40      50      60      70      80      90      100
```
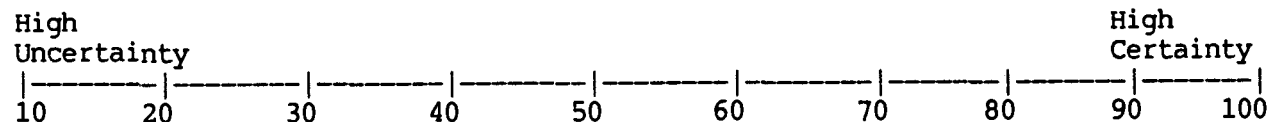
Pre-assessment Questionnaire

Overhead Transparency: Self-Efficacy for Pretest of Elementary Statistics (Part A)

Adding and Subtracting Integers

1. $(-2) + 4 + (-3) =$ -1

2. $(-3) - (-4) =$ +1

Multiplying and Dividing Integers

3. $(-2) \times (-3) =$ +6

4. $(-3) \times (-4) / (-2) \times 3 =$ -2

Power and Square Root of Integers

5. $0^2 =$ 0

6. $(-4)^2 =$ 16

7.   16 = -4, +4

Cartesian Planes – Reading and Plotting Points

8.   Figure 1 shows two points. Write down the x-coordinate and y-coordinate for each point:

9.   Plot each of the following points:

x	y
1	1
2	2
3	3
4	4

Pre-assessment Questionnaire

Overhead Transparency: Self-Efficacy for Pretest of Elementary Statistics (Part B)

Central Tendency

1. The mode is defined as:

    a. the lowest score in a distribution
    b. that which divides a group into two equal groups
    c. that which equals half of the number of test items
    d. the most frequently occurring score

2. Arranging a distribution of scores from highest to lowest and then counting to the middle score finds the:

    a. mean
    b. median
    c. mode
    d. average

3. In the distribution 10, 12, 12, 13, 14, 15, 85 the best measure of central tendency is the:

    a. mean
    b. median
    c. mode
    d. average

4. From the graph below the best measure of central tendency is calculated as _____, because _____.

    a. 5, it is positively skewed
    b. 6, of atypical scores
    c. 8, of the symmetrical curve
    d. 5, it is negatively skewed

Salary in Thousands (Semi-Annually) for Canadian Nurses

Variability

5.   The highest minus the lowest score defines the:

   a.   standard deviation
   b.   median
   c.   range
   d.   mean

6.   Which of the following is NOT a step required in determining a standard deviation?

   a.   determine the mean
   b.   sum the squared deviations from the mean
   c.   take the square root of the squared deviations from the mean
   d.   find the average squared deviation and take the square root

7.   In distributions where scores sprecid out, a good deal on both sides of the mean, the standard deviation will be:

   a.   large
   b.   small
   c.   the same as the mean
   d.   equal to the range

8.   Using the formula below yields the standard deviation for the distribution: 0, 2, 2, 8 to be _____, thus you may conclude that:

   a.   0, the scores are clustered
   b.   3, the scores are fairly spread out
   c.   8, the scores are extremely spread out
   d.   0, the scores are spread out

   Formula:

Correlation

9.   A correlation is a(n)

   a.   summary of the relationship between two or more sets of data.
   b.   indication of the dispersion of sets of data
   c.   summary of the frequency of sets of data
   d.   indication of the center of sets of data

10.   Which of the following is not necessary to find a correlation coefficient using the formula below?

   a.   determine means for x and y
   b.   determine standard deviations for x and y
   c.   determine the square root of the deviation scores squared.
   d.   obtain the sum of the cross-products

Formula:

11. Which correlation coefficient between x and y is she most efficient in predicting y from x

    a.   +.40
    b.   +.50
    c.   −.60
    d.   −.70

12. Many studies have found an association between cigarette smoking and heart disease. Recent research supports the notion of a correlation between coffee drinking and heart disease. Which of the following may we conclude?

    a.   drinking coffee causes heart disease
    b.   smoking causes heart disease
    c.   the correlation between coffee drinking and heart disease may be due to the association between coffee drinking and cigarette smoking
    d.   all of the above

Answer Key:
Overhead Transparency: Self-Efficacy for Pretest of Elementary Statistics
(Part A and B)

Part A

1.   −1
2.   +1
3.   +6
4.   −2
5.   0
6.   16
7.   −4, +4
8.   (1,2) (4,4) (5,3) (5,1) (3,))
9.   (1,1) (2,2) (3,3) (4,4) positive correlation, straight line from lower
     left to upper right.

Part B

1.   d
2.   b
3.   b
4.   a
5.   c
6.   c
7.   a
8.   b
9.   a
10. c
11. d
12. c

APPENDIX 2

PRETEST FOR ELEMENTARY STATISTICS

PART A: PREREQUISITE ALGEBRAIC SKILLS

Pretest for Elementary Statistics

Part A: Prerequisite Algebraic Skills

Age   _____

Sex   _____

ID   _____

Instructions

The following pretest assesses whether you have the prerequisite algebraic skills necessary for elementary statistics. Please take your time and answer each of the twenty questions in the spaces provided.

PRETEST FOR ELEMENTARY STATISTICS

PART A: PREREQUISITE ALGEBRAIC SKILLS

Adding and Subtracting Integers

1. $7 + (-3) =$ +4

2. $(-4) + (-1) =$ -5

3. $(-2) + 4 + (-3) =$ -1

4. $3 - 4 =$ -1

5. $(-5) - 1 =$ -6

6. $(-3) - (-4) =$ +1

Multiplying and Dividing Integers

7. $2 \times (-3) =$ -6

8. $(-2) \times (-3) =$ +6

9. $3 \times 4 / (-2) \times (-3) =$ +2

10. $(-3) \times (-4) / (-2) \times 3 =$ -2

Power and Square Root of Integers

11. $(-4)^2 =$ 16

12. $0^2 =$ 0

13. $1^2 =$ 1

14. $1 \quad =$ ±1

15. $16 \quad =$ ±4

Cartesian Planes -- Reading and Plotting Points

16. Figure 1 shows five points. Write down the X-coordinate and Y-coordinate for each point:

$$A =$$

$$B =$$

$$C =$$

$$D =$$

$$E =$$

17. As you move from point A to point B in Figure 1, your X-coordinate goes up by ____, and your Y-coordinate goes up by ____.

18. One point in Figure 1 has a Y-coordinate 1 bigger than the Y-coordinate of point E. Which point is that?

19. Plot each of the following points:

X	Y
1,	1
2,	2
3,	3
4,	4

What can you say about them?

20. Which of the following two points is in each of the shaded region: (1,2)
    or (2,1)?   Designate the point that is in the shaded area by circling your
    answer for a, b, and c.

    a.
       (1,2)
       (2,1)

    b.
       (1,2)
       (2,1)

    c.
       (1,2)
       (2,1)

Answer Key: Pretest for Elementary Statistics

Part A: Prerequisite Algebraic Skills

Adding and Subtracting Integers

1. +4
2. −5
3. −1
4. −1
5. −6
6. +1

Multiplying and Dividing Integers

7. −6
8. +6
9. +2
10. −2

Power and Square Root of Integers

11. 16

12. 0

13. 1

14. ± 1

15. ± 4

Cartesian Planes − Reading and Plotting Points

16. (1,2) (4,4) (5,3) (5,1) (3,0)

17. x by 3; y by 2

18. D

19. (1,1) (2,2) (3,3) (4,4) positive correlation; straight line

20. (a) (1,2)

    (b) (2,1)

    (c) (1,2)

PRETEST FOR ELEMENTARY STATISTICS

PART B: CENTRAL TENDENCY, VARIABILITY AND CORRELATION

Pretest for Elementary Statistics

Part B: Central Tendency, Variability and Correlation

Sex _____

Age _____

ID _____

Instructions:

The following pretest assesses your knowledge of elementary statistics. Please take your time and answer as many of the thirty questions as possible. Each item is worth two points and circle the best response.

Pretest for Elementary Statistics

Part B: Central Tendency, Variability and Correlation

Measures of Central Tendency

1. The median is defined as:

    a.   the middle score in a distribution
    b.   the average of a distribution
    ·c.   the most common score in a distribution
    d.   the highest score in a distribution

2. The mode is defined as

    a.   the lowest score in a distribution
    b.   **that which divides a group into two equal groups**
    c.   that which equals half of the number of test items
    d.   the most frequently occurring score

3. The mean is the

    a.   score that appears in the middle of a distribution after the scores
         have been arranged from highest to lowest
    b.   the sum of the scores minus the number of cases
    c.   the sum of the cases divided by the number of scores
    d.   the sum of the scores divided by the number of cases

4. Arranging a distribution of scores from highest to lowest and then
    counting to the middle score find the

    a.   mean
    b.   median
    c.   mode
    d.   average

5. In the distribution 10, 12, 12, 13, 14, 15, 85 the best measure of central
    tendency is the

    a.   mean
    b.   median
    c.   mode
    d.   average

6. After plotting the average yearly salary of nurses in Canada, we might have a negatively skewed curve and as a result the best measure of central tendency would be the

   a. mean
   b. median
   c. mode
   d. average

7. After plotting the average income for adults, in Canada we might have a positively skewed curve where the mode is the lowest figure, the median the middle figure and the mean the highest figure. The best measure of central tendency would be the

   a. mean
   b. median
   c. mode
   d. average

8. What is the mean of the following distribution: 100, 90, 80, 80, 60?

   a. 80
   b. 85
   c. 90
   d. 82

9. What is the median of the following distribution: 15, 10, 12, 13, 12, 85, 14?

   a. 12
   b. 13
   c. 14
   d. 15

10. What is the mode of the following distribution: 15, 10, 12, 13, 12, 85, 14

   a. 12
   b. 13
   c. 14
   d. 15

Measures of Variability

11. Measures of variability indicate the

   a. central tendency
   b. amount of spread
   c. amount of skewedness
   d. correlation

12. The highest minus the lowest score defines the

    a.   standard deviation
    b.   median
    c.   range
    d.   mean

13. Which of the following is NOT a step required in determining a standard deviation

    a.   determine the mean
    b.   sum the squared deviations from the mean
    c.   take the square root of the squared deviations form the mean
    d.   find the average squared deviation and take the square root

14. Inter-Individual Variability refers to

    a.   variability in performance between individuals
    b.   variability within an individual's performance
    c.   the spread from the lowest to the highest score in a distribution
    d.   the average score for an individual

15. In distributions where scores spread out a good deal on both sides of the mean, the standard deviation will be:

    a.   large
    b.   small
    c.   the same as the mean
    d.   equal to the range

16. In distributions where scores cluster quite closely around the mean, the standard deviation will be:

    a.   very large
    b.   small
    c.   the same as the mean
    d.   equal to the range

17. If individual differences increase, the standard deviation will:

    a.   change in an unpredictable direction
    b.   decrease
    c.   remain the same
    d.   increase

18. The sum of the deviations from the arithmetic mean is:

    a.   always more than 1
    b.   variable
    c.   0
    d.   1

19. Calculate the standard deviation for the distribution: 0,2,2,8 using the formula below

    a.   2
    b.   3   S.D. =
    c.   8
    d.   9

20. Calculate the standard deviation for the distribution: 1, 3, 4, 5, 7 using the formula below

    a.   2
    b.   3   S.D. =
    c.   4
    d.   9

Correlation

21. The sign (+ or -) of the correlation coefficient indicates:

    a.   neither the degree or direction of the relationship
    b.   the degree and the direction of the relationship
    c.   the degree of the relationship
    d.   the direction of the relationship

22. When plotting the relationship between two distributions on a graph, a perfect positive correlation will appear as:

    a.   a circle
    b.   a line from the lower left to the upper right of the graph
    c.   a line from the upper left to the lower right of the graph
    d.   none of these

23. The Pearson's Product-Moment Coefficient of Correlation may take all of these values except

    a.   +2.00
    b.   -1.00
    c.   0.00
    d.   +1.00

24. Which of the following is not necessary to find a correlation coefficient using the formula:

    a.   determines means for x and y
    b.   determine standard deviations for x and y
    c.   determine the square root of the deviation scores squared
    d.   obtain the sum of the cross-products

25. For a class of 26 fourth graders, you have computed the correlation coefficient between their height in inches and their height in centimeters to be

    a.   about +0.50
    b.   nearly −1.00
    c.   nearly +1.00
    d.   More information is needed to give a definite answer.

26. A negative correlation means that:

    a.   students who perform well on one test tend to perform poorly on another test.
    b.   there is no relationship between how students perform on two tests
    c.   there is a chance relationship between scores on two tests
    d.   students who perform poorly on one test also tend to perform poorly on another test.

27. Which correlation coefficient between X and Y is most efficient in predicting Y from X

    a.   +.40
    b.   +.50
    c.   −.60
    d.   −.70

28. If the correlation coefficient between X and Y is equal to zero, then we may say that:

    a.   x depends upon y
    b.   x is independent of y
    c.   x and y are the same numbers
    d.   y is a function of x

29. Many studies have found an association between cigarette smoking and heart disease. Recent research supports notion of a correlation between coffee drinking and heart disease. Which of the following may we conclude?

    a.   drinking coffee causes heart disease
    b.   smoking causes heart disease
    c.   the correlation between coffee drinking and heart disease may be due to the association between drinking coffee and cigarette smoking
    d.   all of the above

30. A correlation of +.70 between having a mother with a university degree and her daughter having a degree would indicate that:

    a.   a mother with a university degree is less likely to have a daughter with a university degree.
    b.   a mother with a university degree is more likely to have a daughter with a university degree
    c.   mothers with degrees ensure that their daughters have degrees
    d.   none of the above

Answer Key: Pretest for Elementary Statistics

Part B: Central Tendency, Variability, and Correlation

Central Tendency

1.	a	6.	c
2.	d	7.	c
3.	d	8.	d
4.	b	9.	b
5.	b	10.	a

Variability

11.	b	16.	b
12.	c	17.	d
13.	c	18.	c
14.	a	19.	b
15.	a	20.	a

Correlation

21.	d	26.	a
22.	b	27.	d
23.	a	28.	b
24.	c	29.	c
25.	c	30.	b

APPENDIX 3

ELEMENTARY STATISTICS PROGRAM

BOOKLET ONE

Elementary Statistics Program

Part A: Measures of Central Tendency

Age: _____

Sex: _____

ID: _____

INSTRUCTIONS

This is the first of three booklets on elementary statistics. You will complete all three booklets prior to your first exam in Psychology 162. Each booklet has three main sections. Section one outlines a program for learning elementary statistics. Section two contains the relevant content material. Last, section three consists of a 10 item multiple-choice self-test. Please take your time and work carefully through each booklet.

SECTION I

Elementary Statistics Program

There are four phases to the coping process described in this program for elementary statistics. The phases are Task Preparation, Task Engagement, Coping with Obstacles and Task Completion. This program provides you with three strategies to follow in your effort to cope with elementary statistics. These strategies include mental imagery, self-talk, and problem solving which should be used to meet the challenges of successive phases in the copying process.

> If your stomach disputes you lie down and pacify it with cool thoughts
>
> — SATCHEL PAIGE

Research indicates that anxiety about mathematics may represent a major obstacle to learning for many students. Studies also indicate that there is no single factor that can be identified as the cause of math anxiety, (Gaskill, 1978). A complex network of influences seem to act together to produce the anxiety that takes hold of so many students. Factors contributing to anxiety are previous experiences, perceptions of the usefulness of mathematics, and the fear of making a mistake. It has also been suggested that sexual biases in our society may cause math anxiety in women. Regardless of the cause of math anxiety, mental imagery can help students overcome or at least deal effectively with the problem.

Mental Imagery

Mental imagery has been used for centuries as a means of improving one's performance and self-esteem. Even hundreds of years ago, people realized that if they visualized themselves achieving their goals they could come closer to doing so. Today atheletes in Olympic competitions use mental imagery before performances and picture their successful completion of difficult tasks. Professionals now see the power of positive imagery for helping others improve performance and self-esteem. To put this principle to work during the first phase of the coping process (ie. Task Preparation) follow these steps:

1. **Task Preparation**
    a.   relax as deeply as you can by taking a deep breath and slowly exhaling;
    b.   draw a picture in your mind of your surroundings during the first session of statistics (e.g. imagine the room, its contents, others, papers infront of your), and importantly,
    c.   imagine yourself performing well during this session (e.g., see your facial expression, the way you sit, the things that you are doing with your hands).

It is helpful to practice this imagery success for a few minutes every day for a few weeks. It is also, very important to remind yourself of your positive image at the beginning of each session on statistics, self-test and just prior to exam one for Psychology 162.

> The one thing psychologists can count on is that their subjects will talk, if only to themselves; and not infrequently whether relevant or irrelevant, the things people say to themselves determine the rest of the things they do.
>
> — I.E. FARBER (1963)

Self-Talk

While mental imagery is a strategy for visualizing success before challenging situations arise, self-talk is used when you are actually in the situation that you would like to master. This technique requires two important responses by you:

1.   Coach yourself by silently thinking of words or phrases that will prompt you to take the action you would like to accomplish.
2.   Give yourself reassuring feedback about your actions and reactions when they are on target.

Self-talk should always contain positive messages. This is to overcome the fact that many of the things we say to ourselves in difficult situations are negative and leads us to both feel and act negatively. Improved performance in elementary statistics depends partially upon your taking advantage of positive self-statements at each phase of the coping proceess. For example:

1. Task Preparation

"Relax".

"Remain calm".

"I am confident that I can do this".

2. Task Engagement

"Focus on instructions and objectives".

"What is it I have to do?"

"Develop a plan to deal with it."

"One step at a time".

"Forge ahead, try out the plan."

3. Coping with Obstacles

"At times it seems hopeless but I'm sure that I will be able to solve this problem."

"I want to be sure not to let myself get stuck on just one approach to solving this problem."

"I can succeed if I use sufficient effort and a problem solving strategy".

4. Task Completion

"It worked."

"I did it."

"I was able to solve the problem through a combination of effort and appropriate strategies."

"I am pleased with the progress that I am making."

> A cognitive strategy is an internally organized skill that
> selects and guides the internal processes involved in defining
> and solving novel problems. In other words it is a skill by
> means of which the learner manages his/her own thinking.
>
> — GAGNE and BRIGGS (1974)

Problem Solving

Mental imagery and self-talk will provide you with a positive start in your
effort to cope with elementary statistics. However, you will need a problem
solving strategy as it is likely you will encounter occassional obstacles on
your way to success. Your success at elementary statistics will depend on your
readiness to see obstacles as opportunities to be persistent and apply
appropriate strategies rather than blocks that prevent your moving ahead. To
convert obstacles into opportunities, "I can't" messages into more optimistic
"I will's", you must develop an effective problem-solving strategy. You must
be willing to put this strategy into practice immediately instead of waiting
until an obstacle overwhelms you and weakens your belief in your success
potential. The problem solving strategy provides you with these steps to
follow during phase three of the coping process:

3. **Coping with Obstacles**
   a. **Problem Awareness**

      Effective problem solving requires that you first become aware of the
      fact that a problem exists. This may be more difficult than it first
      appears because many of us deny, even to ourselves, that we face
      certain kinds of difficulties. This program provides you with
      immediate performance feedback. At the end of each major topic in
      the content section are review questions on a separate page with an
      answer key on the back. When you make a mistake on a review question
      you should be alerted to the fact that a problem exists.

   b. **Objective Specification**

      After you have made a mistake and are aware that a problem exists,
      define the problem by determining which objective you have not met.
      You must have a precise picture of the objective that you need to
      accomplish from the entire list of unit objectives. To facilitate
      this review the objective list and place the number of the objective
      that needs to be met beside each error.

c. Generating Possible Action Plans

With the objective clearly in mind you are now ready to generate
ideas that can become action plans to meet the objective. This is a
highly creative time in which it will serve you best to open your
imagination. Experts in brainstorming have suggested the following
rules for generating plans.

1. Do not criticize any of the possible action plans listed.
2. List every plan that comes to mind no matter how wild it might
    seem;
3. Worry about quantity instead of quality by working on producing
    the longest rather than the best list; and
4. When the list is complete, review it and combine the best of the
    items that you find.

You might find it helpful to ask other students in your group or the
instructor for their ideas about how the problem can be solved. Keep in
mind the old adage that "two heads are better than one."

d. Decision Making

Just as there are rules for generation possible plans of action there
are rules for narrowing this list. These rules are:
1. Eliminate any possibilities that are clearly impractical;
2. Eliminate all action plans that take personal control over your
    problem away from you;
3. List the options in their rank of priority with the most-likely-
    to-succeed at the top of the list.

e. Trying the Action Plan

Select the option at the top of the list and put it into action.

f. Evaluating the Action Plan

Every problem-solving effort is an experiment. Two features make
your problem-solving effort an experiment:

1. It is impossible to know in advance whether your first choice plan will be successful, you treat it as though it is the best guess, but hold in reserve your other possible plans. Your belief that your first try might pay off is what scientists call an "hypothesis".

2. You carefully evaluate the results to determine whether the plan did, in fact, produce the anticipated result. Scientists call this information the "data" of their experiments.

When the experiment does produce the desired result you will be ready to tackle the next challenge that you will face. If however, the results are not as expected you must ask yourself two questions:

1. Did I act on my plan as well as I could have?
2. Would another alternative work better?

Conclusion

As you have seen there are four phases to the coping process described in this program for elementary statistics. These phases are task preparation, task engagement, coping with obstacles, and task completion. To help you realize the objectives for elementary statistics three strategies have been described. It has been suggested that you use positive mental imagery to visualize your success during task preparation. It has also been suggested that you rely on self-talk to move through each phase of the coping process. Finally a problem-solving strategy has been described to help you cope with obstacles in elementary statistics. It is not wise, to expect to succeed at elementary statistics without expending some - and often considerable - effort. It is important to expend effort and establish effective strategies in order that you may perform well.

Now that you have been introduced to the Elementary Statistics Program it is time to watch it in action. Prior to viewing the video presentation of a student modeling this program you should refer to the summary version of the Elementary Statistics Program that will be distributed to you. Read through the summary card to familiarize yourself with key points. Be sure to ask your instructor any questions you may have about the program. While viewing the video presentation remember to refer to the summary card as well. The model on the video is a student who had experienced difficulty in statisitcs prior to using the techniques described in the Elementary Statistics Program. The model has been asked to share her thoughts or think aloud as she performs the task.

Elementary Statistics Program
Summary Card

1. **Task Preparation**
   Mental Imagery
   a. relax as deeply as you can
   b. draw a picture in your mind of your surroundings
   c. imagine yourself performing well

   Self-Talk
   "Relax"
   "Remain Calm."
   "I am confident that I can do this."

2. **Task Engagement**
   Self-Talk
   "Focus on instructions and objectives"
   "What is it I have to do?"
   "Develop a plan to deal with it."
   "One step at a time."
   "Forge a head, try out the plan."

3. **Coping with obstacles**
   Self-Talk
   "At times it seems hopeless but I'm sure that I will be able to solve this problem."
   "I want to be sure not to let myself get stuck on just one approach to solving this problem."
   "I can succeed if I use sufficient effort and a problem solving strategy."
   Problem Solving
   a. Problem Awareness
   b. Objective Sepcification
   c. Generating Possible Action Plans
   d. Decision Making
   e. Trying the Action Plan
   f. Evaluating the Action Plan

4. **Task Completion**
   Self-Talk
   "It worked."
   "I did it."
   "I was able to solve the problem through a combination of effort and appropriate strategies."

SECTION II

Measures of Central Tendency

Instructions:

There are three major topics in section two following the practice exercise:

a.   Definitions for Measures of Central Tendency

b.   Procedures for Measures of Central Tendency

c.   Applications of Measures of Central Tendency

After each topic there are review questions. Answer the review questions and check your answers. When you have completed the review and believe that you can cope with any obstacles that you confronted during the review, continue on to the second major topic. Follow the same procedures for the second and third major topics in section two. When you have completed this section, do the ten item multiple-choice test in section three of this booklet.

After completing this section on Measures of Central Tendency the student will be expected to:

1.   define the mode, median, and mode;

2.   identify the procedures to calculate the mode, median, and mean;

3.   differentiate between the mode, median, and mean and their uses;

4.   calculate the appropriate measure of central tendency correctly given a particular situation and draw conclusions.

Finally, it is important that you use the summary card for the Elementary Statistics Program while you are working through section two.

SECTION II

Practice Exercise
Frequency Distribution

Such things as test scores, class rank, weight, and income are called variables. Income, for instance is called a variable because different income values are possible. The number or times a particular value of a variable occurs is referred to as the frequency of that value. A distribution is a series of separate values such as scores which are arranged or ordered according to magnitude. A group of ordered scores, that is a group of scores ranging from the lowest to the highest score, is a distribution. A set of ordered scores and their corresponding frequencies is called a frequency distribution. This can be represented in table or graph form. The table below shows the number of times a score occurs in its group.

Scores	Frequency
13	1
11	11
9	111
8	1
5	1

Frequency distributions can also be graphically illustrated. The two most common graphs used to illustrate the frequency distribution are the frequency polygon and the histogram. If scores and their frequencies are illustrated with points connected by lines, it is called a frequency polygon. For example:

When a frequency distribution is illustrated in the form of a histogram, the scores and their frequencies are designated by rectangular boxes. It is the accepted practiced for the vertical side of a graph, called the ordinate axis, to be used to designate the frequency. The horizontal side, called the abscissa axis, is used for the scores. For example, this is displayed in the histogram below:

Review: Practice Exercise

1. In general, things that vary in value from case to case or time to time are called ___variable___

2. If 17 students receive a score of 70 on a test, then the score 70 has a ___frequency___ of 17!

3. A group of scores ranging from the lowest to the highest is a ___distribution___.

4. The arrangement below is called a ___frequency table___ *distribution*

Scores	Frequency
10	1
8	11
6	111
4	11
2	1

5. Illustrating scores and frequencies by rectangular boxes is common to ___histograms___.

6. If scores and their frequencies are illustrated with points connected by lines, it is called a ___frequency polygons___

7. When plotting data the direction of increase for the variable is from left to right on the ___abscissa___ axis.

Review Answers: Practice Exercise

1. Variable
2. Frequency
3. Distribution
4. Frequency Distribution Table
5. Histograms
6. Frequency Polygon
7. Abscissa

Measures of Central Tendency

A.   Definitions for Measures of Central Tendency

A question we frequently ask is: "is this behavior representative of this person or group?:" To answer such a question we look not at just one sample of behavior but at several samples of behavior, in order to achieve an estimate of the individual's or group's most expected behavior. To obtain such an estimate we can make use of any of three possible measures of central tendency or focal tendency.

When we talk of a measure of central tendency we are referring generally to that score about which all the other scores tend to cluster (some being above it and some below). In other words, we are referring to that score which provides us with an indication of the location of our distribution of scores. For example, if we wanted to know what an individual's most typical running speed was, we would time him/her over several runs rather than just one, and then look for the score which seems most representative of the whole series. Of course, some of his/her scores will be above this "focal" score and some will be below it.

The three measures of central tendency are the mode, median, and mean. first we will define each one then second, outline the procedures to calculate each one. Third, we will go into how they are used and give examples of each.

The mode is the most common or frequently obtained score, that is the score obtained by more individuals than any other score in the distribution.

The median refers to that score or point above and below which 50% of the scores fall. In other words, if you had 100 scores, 50 would lie above the median and 50 below.

The mean refers to the arithmetic average of all the scores. The mean might be defined as the point in the distribution corresponding to the sum of the scores divided by the number of scores.

Review Definitions

1. When we look for an individual's or group's most representative score, we look for that score about which all others tend to _cluster or gather_

2. The score or point about which the other scores tend to cluster is referred to as a _measure of central tendency_.

3. The measures used to describe an individual's or group's most representative score are:
   a. _Mode_
   b. _Median_
   c. _Mean_

4. The score or point above and below which 50% of the scores fall is the _Median_.

5. The most common or frequently obtained score is the _mode_.

6. The arithmetic average of all the scores is the _mean_.

Review Answers: Definitions

1. cluster, gather

2. measure of central tendency

3. a. mode
    b. median
    c. mean

4. median

5. mode

6. mean

B.   Procedures for Measures of Central Tendency

Finding the Mode

The mode is easily determined as it would be the most frequently occuring score in a frequency distribution, the highest point on a frequency polygon, or the tallest bar on a histogram. For example, the frequency table below shows the number of times each uniform size occurs in a group of 10 nurses.

Scores	Frequency
20	1
16	11
12	1111
8	11
4	1

The mode is quickly determined by counting the number of nurses wearing each size and is thus 12.

The same data may be plotted on a frequency polygon. For example:

It is quite possible to have more than one mode in a distribution. For example if we were to measure the uniform size of a group of 10 male and 10 female nurses, we would end up with a distribution two modes. This is called a bimodal distribution. For example in the frequency polygon below point A would be the mode for women, and point B would be the mode for men. There would be some degree of overlap between the two groups in terms of uniform size. That is, a some women may wear size 34 and some men would wear size 4.

Finding the Median

One way to find the median is to rank order the scores and simply find the
midpoint of the rank ordered set of scores. For example:

    11, 10, 9, 7, 6, 5, 3, 2, 1

are rank ordered. There are 9 scores so the halfway point would be the fifth
score or the score 6. You might be asking yourself, what is the median when
you have an even number of scores·in the distribution?

If the distribution has an even number of scores, the median is still halfway
through the distribution but now it is a point rather than a score. In this
case the median is found by finding the point midway between the middle two
scores of the distribution. For example in this set of scores:

    15, 14, 13, 12, 10, 9, 7, 6, 5, 4

there is an even number of scores and the median must lie between the middle 2
scores. In this distribution the middle 2 scores are 10 and 9. The point
halfway between them is:

$$\frac{10 + 9}{2} \text{ or } 9.,5$$

9.5 is, therefore the median of the above distribution.

Since the median is the midpoint in the distribution of scores, what do think will happen if you were to add an odd number of scores to the distribution? For example, take the scores:

8, 7, 6, 5, 4, 3, 2

where the median is 5. Now if we add the scores 9, 10 and 1, what happens to the median?

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

The median changes. In this case it moves up because we added 2 scores to the top and only 1 score to the bottom of the distribution. What would happen if we were to add the same numbers of scores to the top and bottom of the distribution? For example, add 9, 10, 1 and 0 to the distribution.

8, 7, 6, 5, 4, 3, 2

and the median remains the same; that is the median would still be 5 since 5 is still the midscore of the distribution.

Finding the Mean

The mean ($\bar{x}$) is the arithmetic average of a set of scores. Since $\bar{x}$ (symbol for mean) is the arithmetic average of a set of scores, one way to find it is to simply sum the scores and divde by the number of scores in a distribution. For example, to find the $\bar{x}$ for the distribution:

15, 12, 11, 10, 9, 8,5

We sum the given scores (15+12+11+10+9+8+5) and then divide by 7 the number of scores). As, 15+12+11+10+9+8+5 = 70 and, 70/7 = 10 the $\bar{x}$ for the above scores is 10.

There are several other symbols we use for convenience sake. Let's look at these before going any further. We use the symbol X to stand for a single score. So, if we wanted to represent the fact that we are adding 4 scores, we do so in this way:

$X_1, + X_2 + X_3 + X_4,$

where x with the subscript 1 stands for the first score; x with the subscript 2 stands for the second score; and so on.

When we add the scores, we get their sum. To represent the fact that we have a sum of scores, we use the symbol   for the sum and X for all the individual scores. So, to represent the fact that when adding a set of scores we get a sum of scores we use:

$$X_1 + X_2 + X_3 + X_4 = \quad X.$$

This reads the first score plus the second plus the third plus the fourth equals the sum of scores.

To represent the number of people in the distribution we use the symbol N. For example, if we wanted to indicate that we have scores for 10 people, we would do so by:

$$N = 10$$

Since the X is found by first finding the sum of scores and then dividing by the number of scores (that is the number of people for whom we have scores), we would represent this fact by:

$$\bar{x} = \frac{x}{N} \qquad \text{(mean equals the sum of the scores divided by the number of scores).}$$

When we talked about the medain, we looked at the effect on the median of adding scores to either (or both) the top half or bottom half of the distribution. Now let's see what happens to the mean when we add scores to the distribution. Given the scores;

    20, 20, 15, 10, 10, 5, 5, 5, 5, 5,

first find the sum of the scores, and

    20 + 20 + 15 + 10 + 10 + 5 + 5 + 5 + 5 + 5 = 110

second, divide the sum by the number of scores,

    110/10 = 11.

Thus the mean is 11. If we add the score 33 then,

    143/11 = 13. If we add the score 1 then,

    111/11 = 10.

As you see, adding a score to the top of the distribution moves x̄ up. Adding a score to the bottom of the distribution moves x down. Note, though that as long as the scores we add are neither too much higher than the top nor too much lower than the bottom score, the mean shifts only a little.

Now look at these scores again:

20, 20, 15, 10, 10, 5, 5, 5, 5, 5.

Suppose this time we add to the other scores the score 88. Now the mean is:

$x = 198/11$

$x = 18$.

As you have seen, the more extreme the score that is added to the distribution the greater the shift will be in the mean.

You will remember that when we added just one score, no matter how extreme, the median shifted only a little because it expresses just the midpoint of the distribution, not the average. This then illustrates the fact that the mean is much more sensitive to extremely high and extremely low scores than is the median and will reflect this by moving either up or down more than will the median.

Review: Procedures

1. The mode of the distribution:
   2, 3, 4, 4, 4, 5, 5
   is __4__ .

2. If a distribution has two peaks, it is called __bimodal__

3. The median of the distribution:
   54, 48, 50, 52, 51, 44, 47, 46, 39, 43, 41, 42, 35, 38, 37
   is (a) __44__ . It is the median because it is the (b) __midpoint__ .

4. Given the following set of scores:
   12, 15, 9, 8, 13, 14, 10
   The median is (a) __12__ . If the scores 19, 18, 17, and 7 were added, the
   median would be (b) __13__ . If the scores 19, 18, 17, 7, 6, and 5 were
   added, the median would be (c) __12__ .

5. Given the distribution:
   5, 10, 20, 15, 25, 5, 10, 15, 5, 10
   What is   X ? (a) __120__
   What is N   ? (b) __10__
   What is $\bar{x}$? (c) __12__

6. Find the median of the following set of scores:
   97, 87, 94, 86, 88, 93, 82, 85, 95, 92, 81, 80
   __87.5__

Review Answers: Procedures

1.   4
2.   Bimodal

3.   (a) 44
      (b) middlescore/midpoint

4.   (a) 12
      (b) 13
      (c) 12

5.   (a) 120
      (b) 10
      (c) 12

6.   87.5

C. APPLICATION OF MEASURES OF CENTRAL TENDENCY

Utilization of the Mode

The mode is not generally used unless there are a large number of cases in a distribution. When the number of cases in a distribution is small, it is more likely that several scores will have the same frequency. The frequency polygon shown below is an extreme example. It is evident that the mode is 10 but it does not give a close approximation of the average case. The mean is 25 (= 125/5). The cases, in ascending order are

10, 10, 25, 35, 45

with the number 25 at the middle of the distribution; thus 25 is the median.

The mode is used in preference to either the median or the mean, when a measure of the most characteristic value of a group is desired. What is meant by "the most characteristic value" can be exemplified by clothing fashions. The mode is what is being worn the most.

The mode is used also to be sure that the average you obtain exists in actuality. In finding the average size of automobile tire that is purchased, the mean or median size might be a tire that doesn't exist. Therefore, one would want to know the size of tire bought most often. This would be the mode.

In addition, the concept of modality is useful in describing the shape of some distributions. If a frequency polygon or histogram has two peaks, it is referred to as a bimodal distribution. If there are more than two peaks, it is called multimodal.

Last, the mode is used with a skewed distribution. A skewed distribution is a
distribution with more scores appearing toward one end of the distribution than
the other, that is, it is asymmetrical. When there are only a few low scores
and a large number of relatively high scores in the distribution (the tail of
the curve to the left), the curve is said to be negatively skewed.
For example:

NEGATIVELY SKEWED CURVE

If, on the other hand, there are many low scores and only a few high scores in
the distribution (the tail of the curve is to the right), the curve is said to
be positively skewed. For example:

POSITIVELY SKEWED CURVE

On a negatively skewed curve, the mode will have the highest value, followed by
the median, with the mean having the lowest value. On a positively skewed
distribution, we have the reverse; the mode has the lowest value, the median
would be a higher value, and the mean has the highest value of our three
measures of central tendency.

When you have a skewed distribution, the mode provides a more accurate estimate of the average for a particular situation. For example, if we want to know the average income for nurses in Canada, we would have a positively skewed curve such as:

From this graph, the mode would be about $15,000.00, the median would be a bit higher at about $17,000.00, and the mean would be about $18,000.00. From the shape of the curve, the mode of $15,000.00 would be the fairest estimate of the income most nurses would receive.

UTILIZATION OF THE MEDIAN

The median is also easily obtained and like the mode, is generally used with special types of distributions. The median is used in distribution having only a few <u>atypical</u> scores. Atypical, in that the scores appear to be quite different form the majority of scores in the distribution. For example, the following distribution of scores was found for a group of introductory psychology students on a commonsense test:

2, 1, 1, 3, 4, 2, 2, 3, 2, 40.

If we determine the mean for this distribution ($x/N = 60/10$) it is 6. When we determine the median on the other hand, we find that it is 2. Hence, the median provides a much better estimate of the performance of most individuals in the group. The median then, is used most often when there are atypical scores in a distribution.

UTILIZATION OF THE MEAN

The mean is used in most situations other than those cited for the mode and median, for several reasons. First, the mean is rigorously defined. That is all scores in a distribution are taken into account in the calculation of the mean. Second, it can be used in further algebraic treatment. For example, in the second booklet, Measures of Variability, we will see that the concept of the mean is used to calculate the standard devaiation for a distribution (i.e., you determine the average deviation from the mean). In the third booklet on Correlation, the role of the mean in the calculation of the correlation coefficient is made explicit. Third, and last the mean provides the best estimate of the population parameter. Remember that in psychology we rely on samples from total populations. When we obtain measures from a sample, these measures are called statistics. If we collected measures on every member of a population, and calculated an average this measure for the population would be called a populaton parameter.

Review: Applications

1. The mode is not generally used unless:

    a. _____

    b. _____

    c. _____

2. The shape of the frequency polygon below is (a) _____.

    The distribution of the histogram is (b) _____

    The frequency polygon is (c) _____ skewed.

    Whereas the histogram is (d) _____ skewed.

3. Referring to the frequency polygon below it is evident that line A

    indicates the (a) _____ since (b) _____. Line B is not

    affected as much as line c, thus   it must be the (c) _____.

    Line C is the (d) _____; it was influenced the most by

    the (e) _____.

4. The frequency polygon below is (a) _____ skewed. Line A indicates the
    (b) _____ . Line B indicates the (c) _____ . The Line C indicates
    the (d) _____ .
    The mean of a positively skewed distribution is located to the _____ of
    the center.

5. In the following distribution, the best estimate of the group performance
    would be to calculate the (a) _____ as there are (b) _____ in
    the distribution

        1, 5, 2, 3, 4, 30, 80

6. The mean is used in most situations for all of the following reasons
    except:

    a.   it is rigorously defined
    b.   it is not influenced by extreme scores
    c.   it is the best estimate of a populaton parameter
    d.   it can be used in further algebraic treatment

Review Answers: Applications

1.   a.   There are a large number of cases in a distibution.
     b.   You seek an average that exists in actuality
     c.   The distribution is skewed.

2.   a.   Bimodal
     b.   Multimodal
     c.   Negatively
     d.   Positively

3.   a.   Mode
     b.   Not influenced by the extreme scores
     c.   Median
     d.   Mean
     e.   Extreme scores

4.   a.   Negatively
     b.   Mean
     c.   Median
     d.   Mode
     e.   Right

5.   a.   Median
     b.   Atypical scores

6.   b

APPENDIX 3

ELEMENTARY STATISTICS PROGRAM

BOOKLET TWO

Elementary Statistics Program

Part B: Measures of Variability

Age: _____

Sex: _____

ID: _____

INSTRUCTIONS:

This is the second of three booklets on elementary statistics. You will complete all three booklets prior to your first exam in Psychology 162. Each booklet has three main sections. Section one outlines a program for learning elementary statistics. Section two contains the relevant content material. Last, section three consists of a 10 item multiple-choice self-test. Please take your time and work carefully through each booklet.

SECTION II

Measures of Variability

Instructions:

There are three major topics in section two:

a. Definitions for Measures of Variability
b. Procedures for Measures of Variability
c. Applications of Measures of Variability

After each topic there are review questions. Answer the review questions and check your answers on the reverse side. When you have completed the review and believe that you can cope with any obstacles that you confronted during the review, continue on top the second major topic. When you have completed this section, do the ten item multiple-choice test in section three of this booklet.

After completing this section on Measures of Variability the student will be expected to:

1. define the range, variance and standard deviation.
2. identify the procedures to calculate the range variance and standard deviation and perform the calculations.
3. differentiate between the uses of the range, variance and standard deviation and apply each appropriately.

Finally, it is important that you use the summary card for the Elementary Statistics Program while you are working through section two.

<u>SECTION II</u>

Measures of Variability

<u>INSTRUCTIONS</u>:

There are three major topics in section two following the practice exercise:

a.   Definitions for Measures of Variability

b.   Procedures for Measures of Variability

c. · Applications of Measures of Variability

After completing this section on Measures of Variability the student will be expected to:

1.   define the range, variance and standard deviation.

2.   identify the procedures to calculate the range, variance and standard deviation

3.   differentiate between the uses of the range, variance and standard deviation and apply each appropriately.

SECTION II

Measures of Variability

A. Definitions for Measures of Variability

As you have seen, the measures of central tendency are good estimates of the performance of most members of a group. However, the value of measures of central tendency is limited since they may only express the most expected or representative score within a group. In order to evaluate more completely any group of scores it is neccessary to have some expression of how the scores vary within that group.

As an example of the limited value of the measures of central tendency, consider a situation that could occur with nursing students. A not too bright nursing coordinator received a memo stating the average Canadian nurse is 5' 6" tall and weighs 130 pounds. Our nursing coordinator then orders new uniforms on this basis. The result is one nurse who is 5' 1" tall looks as though s/he is drowning in the uniform and another nurse 6' 2" tall looks as though s/he is wearing cabbage patch doll clothes.

As another example, consider a situation where the personnel director at the hospital must decide between two applicants for a critical care nurse position. The director wants a nurse who is bright, yet consistent and responsible in behavior. The applicants, Bonnie and Betty have both graduated from fine colleges, both have a G.P.A. of 3.50 (B+). On the surface they appear equal. The personnel director decides that more information is needed and writes for their college transcripts. When the transcripts arrive, the personnel director plots graphs for their performances as follows:

Now, we would agree that Bonnie has many more A's than Betty. However, Bonnie also has some F's, D's, and C's as well. Betty on the other hand, has all A's and B's. Betty therefore, is much more consistent in performance, and as far as the personnel director is concerned this is desirable.

As a third example, consider the question that parents and educators have been arguing about for many years: Why are private preparatory schools better than public high schools? To answer this question, we might begin by assessing the general aptitude (intelligence) of students in both private and public schools. To our astonishment we find that the average intelligence for both the private and public high school is 110. What then might account for the difference?

If we plot the variability around these averages for each type of educational approach, we have:

PUBLIC   PRIVATE

Thus, one great difference is that there is much greater variability in the general aptitude of students in the public high school. The private prep school, on the otherhand, is able to select only those students with ability within a small range. This difference would show up in the instructional situation, that is, working with students having similar abilities would be less difficult than working with a group of students with a wide range of abilities.

Before dealing with the measures of variability, it is of value to have you become familiar with the common terms that denote variability. The terms Scatter, Spread and Dispersion all refer to the variability of scores around a measures of central tendency. The terms are used interchangeably.

Further, we should establish the idea that there are two types of variability. The first is <u>Intra-Individual Variability</u>. This type of variability refers to variation within the individual's performance, such as the variability of Bonnie's grades in the second example. The second type of variability is <u>Inter-Individual Variability</u>, which refers to variability in performance between individuals, as was the case in the example of the private prep verses the public high school.

One way to express scatter, spread, dispersion or variability of scores in a group of scores is by the <u>range</u> of scores. A second way to express variability is by the <u>variance</u> and third by the <u>standard deviation</u>. We will define each of these measures of variability, outline the procedures to calculate them. Finally, we will go into how they are used and give examples of each.

By <u>range</u> of scores we mean the distance between the highest and lowest score in a distribution.

Another way of expressing the variability of scores is in terms of their distance from the mean; that is their deviation from their mean. We are interested in the average deviation of scores from the mean without regard to direction or, the <u>variance</u>.

Finally, the <u>standard deviation</u> is a measure of variabilty that takes into account the distance between the mean and every score in the distribution.

Review: Definitions

1. In order to get a more complete description of a group or a truer
    comparison of two groups, then, we should examine not only their means but
    also the _____ of scores in the group or groups.

2. Consider the height of the two groups of people below. Both groups have a
    mean and median of 6 feet but the more variable is group _____

3. The variability in performance between individuals is referred to as

    _____

4. The variation within an individual's performance is referred to as _____

5. The distance between the highest and lowest score in a group is the _____

6. The standard deviation takes into account the distance _____

Review Answers: Definitions

1.   scatter, spread, dispersion or variability

2.   A

3.   inter-individual variability

4.   intra-individual variability

5.   range

6.   between the mean and every score in the distribution

B. Procedures for Measures of Variability

Finding the Range

The range is a very simple, quickly obtained measure of variability. After rank ordering the scores in a distribution, the range is the difference between the highest and lowest score. Take the following distribution as an example:

    150, 147, 147, 141, 139, 135, 134, 129, 115, 110, 30

The high of 150, minus the low of 30, gives a range of 120.

Finding the Variance

Another way to express variability of scores is to calculate the variance or the mean of the squared differences between each individual score and the mean of the distribution. In statistical shorthand, we express the deviation of a score from mean ($\bar{x}$) as $x - \bar{x}$ where x stands for a raw score and x for the mean. For example, if we wanted to express the fact that we were dealing with the deviations of say, three raw scores we would do so by:

$$x_1 - \bar{x};\ x_2 - \bar{x};\ x_3 - \bar{x}$$

where x_1, stands for the first score, x_2 for the second score and x_3 for the third score. Consider the following raw scores, where the mean is 70:

Raw Score	Deviation Score
80	80 – 70 = 10
75	75 – 70 = 5
70	70 – 70 = 0
65	65 – 70 = –5
60	60 – 70 = –10

Each of these differences is called a deviation score simply represented by the lower case letter (d).

Having obtained the deviation for each score, our next step is to square these deviations and add them up. **For example**

Deviation Score Squared (d^2)

$(10)^2$ =   100
$(5)^2$ =   25
$(0)^2$ =   0
$(-5)^2$ =   25
$(-10)^2$ =   100

$(x-\bar{x})^2$ or $(d)^2$ = 100 + 25 + 0 + 25 + 100
= 250

Finally, to obtain the mean of the squared differences between each individual score and the mean of the distribution, we then divide by the total number of scores (in this case, 5). This is the variance (S^2). The reason we square the deviation scores is to eliminate their positive and negative signs. If we simply summed the deviation scores, the positive and negative values would always cancel each other out resulting in **d = 0. The formula for the variance is**

$$s^2 = \frac{(x - \bar{x})^2}{N} \quad \text{or} \quad s^2 = \frac{(d)^2}{N}$$

Finding the Standard Deviation

We are interested in the average deviation of the scores from the mean without regard to direction (above or below the mean). **Once we have found the** variance, we can easily obtain the standard deviation (SD) by taking the square root of the variance. **Since we squared the deviation scores to compute the** variance, we can now get back to the original scale of measurement by taking the square root of the variance. **Expressed using statistical symbols the** formula for the standard deviation is:

SD =   or SD =

In other words, to find the standard deviation using the formula above, we first find the deviation score corresponding to each raw score $(x - \bar{x})$, square each of these deviation $(x - \bar{x})^2$, and then find the sum ( ) of all these squared deviation scores; $(x - \bar{x})^2$. Having found the sum of the squared deviation scores we divide by the number of scores (N).

and then we find the square root of the resulting number

For example, to find the standard deviation of the set of scores:

30, 25, 20, 15, 10

1. First, find the mean of the distribution ie.,

$\bar{x} = \quad /N$

$\bar{x} = \dfrac{30 + 25 + 20 + 15 + 10}{5}$

$\bar{x} = 20$

2.   Then, find the deviation scores:

Raw Score	Deviation Scores
30	30 − 20 = +10
25	25 − 20 = + 5
20	20 − 20 = 0
15	15 − 20 = − 5
10	10 − 20 = −10

Note: At this stage, the positive and negative deviation values should cancel out. If these values do not cancel out, you have made an error in computing the mean or in obtaining deviations.

3.   Square each of the deviation scores:
Deviation Score Squared

$(+10)^2$ = 100
$(+5)^2$ = 25
$(0)^2$ =   0
$(-5)^2$ = 25
$(-10)^2$ = 100

4.   Find the sum of the squared deviation scores.

$$(x - \bar{x})^2 = 100 + 25 + 0 + 25 + 100$$
$$= 250$$

5.   Divide by N.

$$\frac{(x - \bar{x})^2}{N} = \frac{250}{5}$$

6. Find the square root (use a table or calculator).

$$\frac{(x - \bar{x})^2}{N} = 50$$

= 7.07. This is the standard deviation.

Review Procedures

1. The range of the following scores:

    25, 24, 23, 220, 18, 15, 14, 11, 10, 9, 8

    is _____ .

2. Find the deviation scores for the following raw scores when the mean is 35

    · 38, 35, 30, 28, 25, 50, 60, 40.

    _____   _____

    _____   _____

    _____   _____

    _____   _____

3. Deviation scores are scores which express the (a) _____ between the mean and a (b) _____ .

4. The s^2 is the _____

    _____

5. Find the variance for the following distribution of scores:
    5, 10, 15, 20, 50
    s^2 = _____ .

6. Find the standard deviation for the following distribution of scores:
    10, 8, 6, 4, 2

Review Answers Procedures

1. $25 - 8 = \underline{17}$

2. $38 - 35 = 3$ $25 - 35 = -10$
    $35 - 35 = 0$ $50 - 35 = 15$
    $30 - 35 = -5$ $60 - 35 = 25$
    $28 - 35 = -7$ $40 - 35 = 5$

3. difference, raw score.

4. mean of the squared differences between each individual score and the mean of the distribution.

5. $\bar{x} = 20$

Raw Score	Deviation Score	d^2
5	$5 - 20 = -15$	225
10	$10 - 20 = -10$	100
15	$15 - 10 = -5$	25
20	$20 - 20 = 0$	0
50	$50 - 20 = 30$	900

of deviation scores squared = 225 + 100 + 25 + 0 + 900 = 1250
x of deviation scores = 1250 divided by the number of scores (N) which is 5. Thus, the variance (s^2) = 250.

6. 1. $\bar{x} = 6$
    2. +4, +2, 0, −2, −4
    3. 16, 5, 0, 4, 16
    4. 40
    5. 8
    6. 2.828

C. APPLICATION OF MEASURES OF VARIABILITY

UTILIZATION OF THE RANGE

Although the range is easy to understand and calculate, it has some serious disadvantages. **The range is rarely used as nothing else can be done with it.** The size of the range depends a good deal upon the size of the sample. There is more chance of simultaneously drawing a very high score and a very low score when the sample is larger. **Consequently, the range generally increases with an increase in the size of the sample.**

The range is the least informative measure of variability. For example, if in a distribution of 20 IQ scores, the highest IQ is 160 and the lowest is 70, then the range is 90 (160-70 = 90). But **suppose the other 18 people all have** IQs of 110? If we knew only the range of scores, we might be led to believe that the scores in this distribution vary far more than they actually do. Far more useful and accurate than the range would be a measure of how much each score varies from the mean on the average.

Utilization of the Variance

The variance is a measure of variability that results from the mean of the squared differences between each individual score and the mean of the distribution. **Although it is necessary to square the deviation scores before** summing them as otherwise the positive and negative values would cancel each other out this leads to a measure of variability (S^2) that is not in the original scale of measurement so, because the deviation scores are squared to compute the variance, to get back into the original scale of measurement the square root of the variance (or standard deviation) is calculated.

Utilization of the Standard Deviation

Psychologists tend to prefer the standard deviation over the variance as a measure of variability because the SD is expressed in the same unit of measurement as the original (raw) data. There are a number of characteristics of the standard deviation that you should be aware of. First, the standard deviation is used to describe variability within and among groups or individuals. Second, the standard deviation is a unit of measurement along the baseline (abscissa) of a frequency polygon. Third, the standard deviation is expressed in raw score units. Fourth, in a normal distribution with a large N, there are approximately three standard deviations below, the mean. A normal distribution also called the normal curve is a symmetrical, or bell-shaped curve based on the probable occurrence of chance events. In a normal distribution the mean, median, and mode would be the identical score.
For example:

The Normal Distribution

Finally, the larger the number representing the standard deviation, the greater the variability. The smaller the number, the less the variability of scores around the mean.

Review: Applications

1. The least informative measure of variability is the _____.

2. The range generally _____ with a(n) _____ in the size of the sample.

3. Calculate the range for distribution of annual hospital employee salary:

    150,000, 100,000, 30,000, 30,000, 20,000, 20,000, 20,000, 20,000, 20,000, 15,000

    What is the problem with relying on the range for an estimate of reliability in this situation?

    _____

    _____

4. The SD is preferred over the variance as a measure of variability because

    _____

    _____

5. In distributions where scores spread out a good deal on both sides of the mean, the standard deviation will be _____.

6. In distributions where scores cluster quite closely around the mean, the standard deviation will be _____.

Review Answers: Applications

1.   range

2.   <u>increases</u> with an <u>increase</u> in the size of the sample.

3.   150,000 − 15,000 = 135,000
      If we knew only the range of scores we might be led to believe that the
      scores in this distribution vary far more they actually do.

4.   The SD is expressed in the same unit of measurement as the original (raw)
      data.

5.   In distributions where scores spread out a good deal on both sides of the
      mean, the standard deviation will be <u>large</u>.

6.   small

SECTION III

SELF-TEST: MEASURES OF VARIABILITY

1.   Measures of variability indicate all of the following except
       a.   spread
       b.   dispersion
       c.   scatter
       d.   average

2.   The range is the

       a.   average distance of scores from the mean
       b.   deviation of scores from the mean
       c.   distance of the highest score from the mean
       d.   distance between the highest and lowest score

3.   The sum of the deviations from the arithmetic mean is:

       a.   1
       b.   0
       c.   variable
       d.   always more than 1

4.   Intra-individual variability refers to

       a.   variability in performance between individuals
       b.   variability within an individual's performance
       c.   the spread from the lowest to the highest score in a distribution
       d.   the average score for an individual

5. The mean of the squared deviation between each individual score and the mean of the distribution is summarized as:

   a.   c.

   b.   d.

6. Which of the following is NOT a step required in determining a standard deviation

   a.   determine the average squared deviation and take the square root
   b.   take the square root of the squared deviations from the mean
   c.   sum the squared deviations from the mean
   d.   determine the mean

7. In distributions where scores spread out a good deal on both sides of the mean, the variance will be:

   a.   large
   b.   small
   c.   the same as the standard deviation
   d.   the same as the mean

8. Calculate the variance for the distribution:
      0, 2, 2, 8

   a.   25
   b.   36
   c.   9
   d.   3

9. Calculate the standard deviation for the distribution: 1, 3, 4, 5, 7

    a. 2
    b. 4
    c. 9
    d. 3

10. Calculate the most stable measure of variability for the distribution:
       0, 2, 2, 8

    a. 25
    b. 36
    c. 9
    d. 3

SECTION III

Answers Self-Test: Measures of Variability

1. d
2. d
3. b
4. b
5. a
6. b
7. a
8. c
9. a
10. d

ELEMENTARY STATISTICS

PROGRAM

Elementary Statistics Program

Part B: Measures of Variability

Age: _____

Sex: _____

ID: _____

INSTRUCTIONS:

This is the second of three booklets on elementary statistics. You will complete all three booklets prior to your first exam in Psychology 162. Each booklet has three main sections. Section one outlines a program for learning elementary statistics. Section two contains the relevant content material. Last, section three consists of a 10 item multiple-choice self-test. Please take your time and work carefully through each booklet.

SECTION II

Measures of Variability

INSTRUCTIONS:

There are three major topics in section two following the practice exercise:

a.   Definitions for Measure of Variability

b.   Procedures for Measures of Variability

c.   Applications of Measures of Variability

After completing this section on Measure of Variability the student will be expected to:

1.   define the range, variance and standard deviation.

2.   identify the procedures to calculate the range, variance and standard deviation

3.   differentiate between the uses of the range, variance and standard deviation and apply each appropriately.

APPENDIX 3

ELEMENTARY STATISTIC PROGRAM

BOOKLET THREE

<u>Elementary Statistics Program</u>

Part C: Correlation Approach

Age: _____

Sex: _____

ID: _____

<u>INSTRUCTIONS:</u>

This is the last of three booklets on elementary statistics. you will complete
this booklet prior to your first exam in Psychology 162. This booklet has
three main sections. Section one outlines a program for learning elementary
statistics. Section two contains the relevant content material. Last, section
three consists of a 10 item multiple-choice self-test. Please take your time
and work carefully through the booklet.

SECTION II

Correlation Approach

Instructions:
There are three major topics in section two:

A. Definitions for the Correlation Approach

B. Procedure for Correlation

C. Interpretations of Correlation coefficients

After each topic there are review questions. Answer the review questions and check your answers. When you have completed the review and believe that you can cope with any obstacles that you confronted during the review, continue on to the second major topic. Follow the same procedures for the second and third major topics in section two. When you have completed this section, do the ten item multiple-choice test in section three of this booklet.

After completing this section on the Correlation Approach the student will be expected to:

1. define correlation and the correlation coefficient;
2. understand the procedures for calculating a correlation coefficient;
3. understand types of correlations and correlation coefficients;
4. apply knowledge and understanding of the concepts of correlation to draw conclusions in a variety of situations.

Finally, it is important that you use the summary card for the Elementary Statistics Program while you are working through section two.

Correlation Approach

A. Definitions for the Correlation Approach

So far, we have examined how a single distribution of scores can be manipulated to derive meaning from them. Now we will go one step further and investigate one of the ways in which we can summarize the relationship between two or more sets of data. Frequently in everyday life we see instances where things are related. For example, the price of a house is related to the demand for houses. When there is a greater demand, the price goes up; when there is a lesser demand, the price comes down. Another example is that tall people typically tend to weigh more than short people with the tallest tending to weigh the most and the shortest to weigh the least.

Assume that we have two sets of scores on a group of students. One set is from an English test and the other set is from a French test. One of the questions frequently asked in this situation is: "Is there a relationship between these two groups of scores such that those persons who did best on the English test tend also to have done best on the French test?" In other words, do high grades in English tend to be associated with high grades in French? When we ask such questions we are really asking if there is a relationship between the observed variables. What is the relationship between performance on the English test and performance on the French test? One of the techniques for describing this kind of relationship is correlation.

Correlation is a measure of relationship between two or more variables.

If a river rises when it rains, the two events are said to have a positive correlation. That is, an increase in one variable coincides with an increase in another variable.

Altitude and air pressure have a negative correlation. That is an increase in one variable coincides with a decrease in another variable.

The correlation coefficient is a single number that expresses the degree of relationship between two or more sets of data.

One of the most common methods for determining the relationship between two sets of scores is Pearson's Product-Moment Coefficient of Correlation, which is denoted by the lower case r. The r may take any value from -1.00 to +1.00. For example:

r = +1.00

r = + .80

r = + .23

r =   0.00

r = - .22

r = - .85

r = -1.00

and all values in between these. That is, the maximum size r may reach is 1. Zero indicates no relationship.

The perfect positive correlation is +1.00. That is, we can predict perfectly from a person's performance on A, his/her performance on B. In a perfect positive correlation we would have the

Subject	Test A	Test B
Kathy	90	80
Bob	85	70
Greg	75	65
Kelly	70	60
Sue	65	50

In this example, each student maintained the same position on the two tests; hence, the perfect positive correlation.

The <u>perfect negative</u> correlation is −1.00, and indicates an inverse relationship.

For example:

Subject	Test A	Test B
Kathy	90	50
Bob	85	60
Greg	75	65
Kelly	70	70
Sue	65	80

In this example, Kathy with the highest score on Test A, received the lowest score on Test B, and so on.

As you have seen, the size of the number denotes the degree of the relationship. When r = 0.00, this indicates <u>no relationship</u>. When r = +1.00 we have a perfect positive relationship and when r = −1.00 we have a perfect negative relationship. An r = +.80 is a fairly high positive correlation and r = +.23 is a low positive correlation. An r = −.85 is a fairly high negative correlation and r = −.22 a low negative correlation. An overall "rule of thumb" for judging correlation size is to consider an r of 0.70 to 1.00 (either + or −) as a high correlation and an r of 0.20 to 0.40 as a relatively low correlation.

The sign (+ or −) indicates the direction of the relationship. A positive (+) sign indicates that the relationship is in the same direction. A negative (−) sign indicates an inverse relationship between the two variables or sets of scores.

A scattergram is used to plot a correlation. The scores for one measure are placed on the baseline (abscissa) and the scores for the second measure are placed on the vertical axis (ordinate). By using the scattergram you can easily determine the direction of the correlation; and as you become more experienced, the approximate size of the correlation maybe determined. If the scores tend to fall around a central line, "best-fit" line, from the lower left to the upper right, This indicates a positive (+) correlation. If all the scores fall on a straight line running from lower left to the upper right, this would be a perfect positive correlation. For example:

Scattergram of a Positive
Correlation

Scattergram of a Perfect
Positive Correlation

If the scores tend to fall around a central line, "best-fit" line, from the upper left to the lower right, this indicates a negative (-) correlation. If all the scores fall on a <u>straight line</u> running from upper left to lower right, this would indicate a perfect negative correlation. For example:

Negative Correlation   Perfect Negative Correlation

For correlations that are less than perfect, the scores will be dispersed around the best-fit line. The <u>greater</u> the dispersion or variability of scores around the best-fit line the lower the correlation. If the scores tend to fall in a <u>circular pattern</u>, that is, there does not appear to be any direction to plot a best-fit line, then there is no correlation. For example:

Scattergram Showing No Correlation

Review: Definitions

1. The relationship of one variable to another is known as _____.

2. With children, bedwetting and age usually have a _____.

3. When an increase in one variable coincides with an increase in another variable, the two variables have a _____.

4. The most common numerical measure of correlation is the _____.

5. The magnitude of the correlation between variables may range from _____ through _____ to _____.

6. Using an overall "rule of thumb" how would you describe a correlation of $r = -.35$?

7. Which of the variables (x, y, or z) has the highest r with the variable A? (a) _____ which has the lowest r with the variable A? (b) _____.

8. The size of the number denotes (a) _____, the sign indicates (b) _____.

Review Answer: Definitions

1. Correlation

2. Negative Correlation

3. Positive correlation.

4. Pearson's Product – moment Correlation Coefficient

5. –1.00 through 0, to +1.00

6. low or relatively low negative correlation.

7. (a) Y
   (b) Z

8. (a) degree of relationship
   (b) direction of relationship

B. Procedure for Correlation Approach

To compute Pearson's Product-Moment Correlation Coefficient we have to utilize two statistics discussed previously—the mean and the standard deviation. The formula for r is:

$$r = \frac{(dx)\ (dy)}{N.SD_x.DS_y}$$

Where (dx)(dy) stands for the sume of each person's deviation from the mean on the X measure multiplied by his/her deviation from the mean on the Y measure. N refers to the number of individuals in our sample (not the number scores, as you have two scores for each person). SD_x is the standard deviation for the X measures and SD_y is the standard deviation for the Y measures.

The procedure to calculate r is summarized as follows:

1. Determine the mean for the X measure.
2. Determine the mean for the Y measure.
3. Determine the standard deviation for the X measure.
4. Determine the standard deviation for the Y measure.
5. Obtain the cross-products (deviations on the two measures for each individual).
6. Add the cross-products.
7. Insert the necessary data into the formula and solve for r.

For example, we will employ this procedure to find the relationship between students scores on a common-sense test and their scores on a 10 item multiple-choice self-test for elementary statistics.

Student	Common-Sense Test(X)	Statistics Test (Y)
Kathy	1	1
Bob	3	2
Greg	5	3
Kelly	7	5
Sue	9	4

Student	X	Y	dx	dx^2	dy	dy^2	(dx)(dy)
Kathy	1	1	−4	16	−2	4	+8
Bob	3	2	−2	4	−1	1	+2
Greg	5	3	0	0	0	0	0
Kelly	7	5	2	4	2	4	+4
Sue	9	4	4	16	1	1	+4

$$x= \quad y= \quad dx^2= \quad dy^2= \quad dxdy =$$
$$25 \quad 15 \quad 40 \quad 10 \quad 18$$

$$\bar{x}_1 = 5 \qquad \bar{x}_2 = 3$$

The mean for x values ($\bar{x}$). The mean for y value ($\bar{x}_2$).

$$\bar{x}_1 = \frac{25}{5} \qquad SD_x = \frac{40}{5} \qquad\qquad \bar{x}_2 = \frac{15}{5} \qquad SD_y = \frac{10}{5}$$

$$\bar{x}_1 = 5 \qquad SD_x = 8 \qquad\qquad \bar{x}_2 = 3 \qquad SD_y = 2$$

$$SD_x = 2.83 \qquad\qquad\qquad SD_y = 1.41$$

It is important that in the algebraic multiplication of the dx and dy for each person that the sign is brought over to the (dx)(dy) column. The addition of the values in the (dx)(dy) column will determine whether the correlation will be positive or negative in nature.

Inserting the values into the r formula, we now have:

$$r = \frac{18}{(5).(2.83).(1.41)}$$

$$r = \frac{18}{19.9515}$$

$$r = .+ .90$$

The r = +.90 obtained is a high positive correlation between common-sense test scores and the elementary statistics test scores.

Review: Procedure

1. Which statistical symbol stands for correlation coefficient? _____

2. The correlation obtained from a single pair of observations is _____

3. The Pearson Product-Moment Correlation Coefficient equals _____

    _____

4. For a class of nursing students what is the correlation between their
    height in inches and their height in centimeters?

    _____.

5. The following are paired values on X and Y The correlation coefficient is:

    _____

X	Y
9	10
7	6
5	1
3	5
1	3

6. Summing the values for _____ will determine whether the
    correlation will be positive or negative.

Review Answers: Procedure

1.   r

2.   Impossible to find

3.   Cross-products of deviations on two measures divided by the product of the number of individuals and the standard deviations on two measures.

4.   Should be +1.00

5.   +.70

6.   dxdy

C. Interpretations of Correlation Coefficients

We can predict the occurrence of one event from another event, but we cannot say that one event "CAUSES" the other event. For example, there is a positive correlation between the number of drownings per day and ice cream sales, but drownings do not cause the ice cream sales or vice versa. A third variable heat, is probably the cause of both events. Thus, we do not use the term "cause" when interpreting correlation coefficients. When the term "cause" is used, it implies that you have a great deal of knowledge about the variables under investigation. We will use the term "INFLUENCE" as we are dealing with the mutual relations between, variables and do not have sufficient data to imply causality.

High correlations, Positive or Negative

A correlation coefficient of .70 or above should be considered a high correlation. With correlations of this magnitude, there are three possible interpretations:

1. the X variable may influence the Y variable;
2. the Y variable may influence the X variable;
3. both the X and the Y variable may be influenced by some factor common to both

For example, consider a situation where we have found a correlation of r = .94 between scores on a math test and scores on a chemistry test. Possible interpretations are

1. having a good math ability may influence one's chemistry ability;
2. having a good chemistry ability may influence one's math ability;
3. both math and chemistry may be influenced by factors common to both, i.e., intelligence, superior teaching, a home environment emphasizing the importance of these sciences.

Low Correlations, Positive or Negative

For our purposes, low correlations are those with an r of 0.20 + 0.40. Here again, there are three possible interpretations:

1. the X variable may influence the Y variable;
2. the Y variable may influence the X variable;
3. X and Y (or both) may be influenced by factors not common to both.

As an example consider a situation where we have obtained a correlation of
r = .25 between intelligence test scores and grades in school. Possible
interpretations are:

1.   intelligence test scores may influence grades in school;

2.   grades in school may influence scores on an intelligence test;

3.   intelligence and grades in school may each be influenced by different
      factors, i.e., intelligence may be influenced by hereditary factors,
      whereas the grades a child receives in school may be influenced by such
      factors as: teacher bias, the child's health or the child's motivation,
      appearance, study habits, etc.

Review Interpertations

1. We use the term (a) _____, rather than (b)_____ when
    we are describing the mutual relationship between variables because
    (c) _____.

2. For a correlation of −.35 between two variables the possible
    interpretations are:

    (a) _____
    (b) _____
    (c) _____

3. For a correlation of −.80 between two variables the possible
    interpretations are:

    (a) _____
    (b) _____
    (c) _____

4. Among the correlation coefficients, +.30, +.40, −.50 and −.60, between x
    and y, which is the most efficient in predicting y from x? _____

5. A correlation coefficient of _____ should be considered a
    high correlation.

6. A correlation from (a) _____ to (b) _____ should be
    considered a low correlation.

Review Answers: Interpretations

1. (a) influence
   (b) cause
   (c) we do not have sufficient data to talk about causality.

2. (a) x variable may influence y variable;
   (b) y variable may influence x variable;
   (c) x and y (or both) may be influenced by factors not common to both.

3. (a) x variable may influence y variable;
   (b) y variable may influence x variable;
   (c) x and y may be influenced by some factor common to both.

4. −.60

5. 0.70

6. (a) 0.20
   (b) 0.40

SECTION III

SELF-TEST: THE CORRELATION APPROACH

1.   Which one of the following types of descriptive statistics applies to data involving two or more variables simultaneously?

    a.   measures of central tendency
    b.   measures of variability
    c.   transformation of variables
         measures of relationship

2.   The sign of a correlation coefficient indicates:

    a.   degree of relationship
    b.   direction of relationship
    c.   both of these
    d.   neither of these

3.   If the relationship between two variables is perfect, r will be:

    a.   +1.00
    b.   −1.00
    c.   both of these
    d.   neither of these

4.   The range of r is:

    a.   0.00 to +1.00
    b.   −1.00 to +1.00
    c.   −0.99 to +0.99
    d.   −1.00 to 0.00

5. A perfect relationshiip on a scattergram is

    a. an ellipse
    b. a straight line
    c. a circle
    d. none of these

6. In a scattergram, which indicates to us the degree of the relationship?

    a. the width of the "best-fit" line
    b. the length of the "best-fit" line
    c. the direction of the "best-fit" line
    d. the number of scores falling on the "best-fit" line.

7. Which of the following is not necessary to find a correlation coefficient using the formula:

$$r = \frac{dxdy}{N.SD.SD_y}$$

    a. sum the deviations for x and sum the deviations for y.
    b. sum the deviations squared for x and sum the deviations squared for y..
    c. obtain the cross products (deviations on the two measures for each individual.
    d. sum the cross-products.

8. You have correlated height in feet with weight in ounces and the r = .64. You decide to recompute, after you have divided all the weights by 16 to change them to pounds. What will the new r be?

    a. .04
    b. .40
    c. .48
    d. .64

9. A negative correlation would most likely exist between which of the
    following sets of two variables?

    a. height and weight
    b. IQ and scholastic performance
    c. educational level and problem-solving ability
    d. amount of practice on a task and number of errors.

10. The high correlation existing between amount of alcohol consumed and of
    auto accidents means that:

    a. drinking causes auto accidents
    b. some factor intervenes between drinking and driving to cause
        accidents
    c. a relationship exists between drinking and driving
    d. all of these are true.

ANSWERS – SELF–TEST: THE CORRELATION APPROACH

1. d
2. b
3. c
4. b
5. b
6. d
7. a
8. d
9. d
10. c

ELEMENTARY STATISTICS

PROGRAM

SECTION I

Elementary Statistics Program

<u>How to Study Better</u> (adopted from Thomas and Robinson, 1972)

At the end of the first unit is Psychology 162, when you are sitting
face-to-face with exam one will you know, understand and be able to apply
elementary statistics? If some of your classmates remember the material better
than you do between now and the test, they may owe part of their success to
their intelligence, but it may also be due to more effective learning
strategies. What is the difference effective and ineffective learning? A
century of psychological research has produced some answers to this question.

Motivation

Common sense suggests that highly motivated people learn most effectively, but
research has qualified this assumption. To begin with, the intent to learn is
not even necessary to learn. We acquire a great deal of information during an
average day without consciously trying to learn it. Much learning is
unintended not to mention unwated. For example, you may remember only too well
that your semester grades for certain course are C's; or that your phone bill
is higher than expected. On the otherhand a person may have every intention of
learning, but choose an ineffective strategy. Psychological research suggests
that while a certain amount of motivation is necessary for effective studying,
the most significant difference between effective and ineffective learning is
what happens during the learning process.

Rehearsal

Simply repeating the material over an over, that is passive rehearsal, is
probably the most common learning strategy. Millions of students have learned
how to read and write and do arithmetic through simple repetition.
Psychologists have confirmed that this technique does work. For example Heller
(1962) presented a nonsense syllable to subjects 1, 2, 4, or 8 times. It was
found that the longer the interval, the more was forgotten, but the more
repetitions the less was forgotten. Glenberg, Smith, & Green (1977) however,
found that mere repetition without any intent to learn, does not seem to
enhance learning. A child may see the same mailboxes day after day for years
on the way to school and still be unable to repeat the names of the mailboxes
along the way. The mail carrier, however, probably could.

Suppose that you have just finished reading section two of this booklet entitled, "Measures of Central Tendency". What is the next step? You could simply reread the section until you have drummed it into your head. A more efficient approach, however, is active rehearsal, or recitation. After reading the section, close the booklet and try to remember what you have read. The more time that is spend recalling or attempting to recall the material, the better you will learn it within a given time. but there is an even more efficient strategy that begins before you have read the chapter.

Many colleges and private firms offer courses to help people remember more of what they read. These courses are usually based on observations about memory processes. One technique that seems to work is the PQ4R Method (Thomas and Robinson, 1972). This unusual names comes from the six phrases that summarize the study program. To use this method you must follow the following pattern:

1. Preview
    Before you begin to read, survey the section from front to back and note the general topics to be discussed. This will give you a sense of what you will read and make it easier to see how ideas are related. Decide how to break the section into units. Then use the next five steps on each unit.

2. Questions
    Before you start to read, translate each unit heading into a question about the text to follow. This helps you compare the new material with what you already know. It also helps to bring the main points into sharp relief. Ask yourself, "Why is it called Measures of Central Tendency?" "How many measures are there?" "What are the used for?" It is usually helpful to write these questions out.

3. Read
    Read the apprropriate unit of information. Look for the answers to the questions that you have just asked yourself. If you find major points not directly related to your questions, try either to revise or refine your old questions to include the new material, or to make up new questions specially for this material.

4. Reflect

    Think about what you read as you are reading it. Think of examples, try to relate the information to what you already know.

5. Recite

    When you have finished reading and refleccting on the unit of information, close the booklet and recite from memory the answers to your questions and any other major points that you can remember. It may help to jot down your answers in outline form or even to recite them aloud to somebody. Then open the book and check to be sure you have covered all the major points in the section. Repeat steps 2, 3, 4, and 5 for each unit of information.

6. Review

    After you have completed the section, review your notes and then recite your questions and answers, from memory. Relate the material to other ideas thinking of particularly good examples or illustrations. Get involved. The PQ4R method forces you to react, to have a kind of kind of dialogue with the text. This interaction makes the material more interesting and meaningful and improves your chances of recalling it. It also organizes the material and relates it to what you already know. Although this seems time-consuming, you will probably spend less time overall because studying for exams later should go much more quickly.

Even the name of this method is a memory aid. PQ4R is a mnemonic to help you recall the six steps in the program. The most important feature of the techniques is that it forces elaborative processing of the material. This is the advantage of reading with questions in mind. Making your own questions contributes even more to good memory than practicing the answers to questions (Anderson, 1978). If you haven't tried it, perhaps it's worth a try.

APPENDIX 4

SELF-EFFICACY POSTTEST

POST TEST

Part A: **Self-Efficacy for the Elementary Statistics Examination**
Central Tendency, Variability and Correlation

SEX   _____

AGE   _____

ID   _____

INSTRUCTIONS:

Each questionnaire item requires that you read specific questions on a overhead transparency that are identical to particular questions on the Elementary Statistics Examination Central Tendency, Variability and Correlation. Please DO NOT perform any calculations. Simple refer to the scale below each item on this questionnaire and circle the numerical value corresponding to how confident you are that you are able to learn how to perform the statistics problem correctly.

A. Central Tendency

1. Please read questions 1 through 4 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to

a. define the mean, median, and mode correctly.
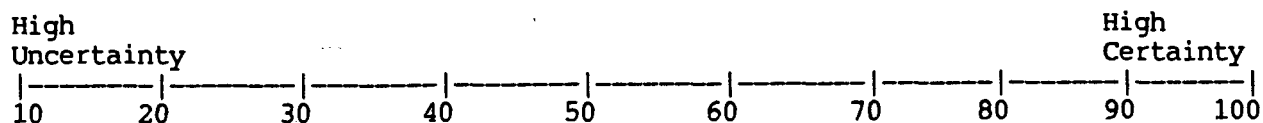
```
High                                                        High
Uncertainty                                                 Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

b. identify the procedures for the mean, median, and mode correctly.

```
High                                                        High
Uncertainty                                                 Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

c. differentiate correctly between the mean, median and mode and their uses.

```
High                                                        High
Uncertainty                                                 Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

d. calculate the appropriate measure of central tendency correctly given a particular situation and draw conclusions.

```
High                                                        High
Uncertainty                                                 Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

B. Variability

2. Please read questions 5 through 8 on the overhead transparency and circle the numerical value that corresponds to how certain you feel that you are able to

a. define the range variance and standard deviation correctly.

```
High                                                              High
Uncertainty                                                       Certainty
|————|————|————|————|————|————|————|————|————|————|
10    20    30    40    50    60    70    80    90    100
```

b. identify the procedures for the range variance and standard deviation correctly.
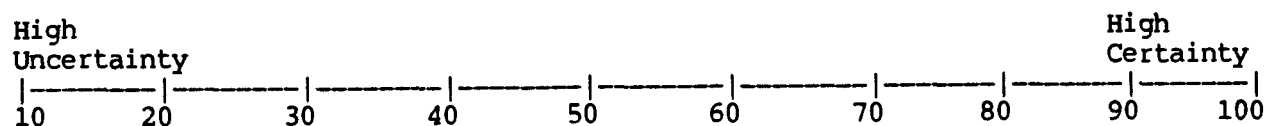
```
High                                                              High
Uncertainty                                                       Certainty
|————|————|————|————|————|————|————|————|————|————|
10    20    30    40    50    60    70    80    90    100
```

c. understand the characteristics of the standard deviation.

```
High                                                              High
Uncertainty                                                       Certainty
|————|————|————|————|————|————|————|————|————|————|
10    20    30    40    50    60    70    80    90    100
```

d. calculate the range, variance and standard deviation for a particular distribution correctly and draw conclusions.

```
High                                                              High
Uncertainty                                                       Certainty
|————|————|————|————|————|————|————|————|————|————|
10    20    30    40    50    60    70    80    90    100
```
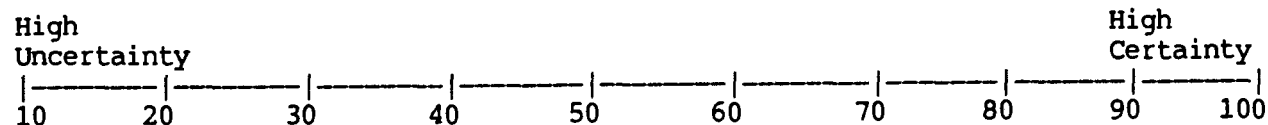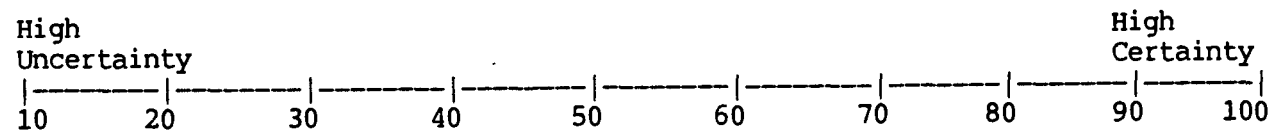
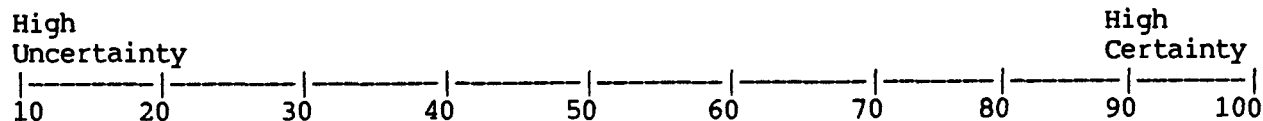C.   Correlation

3.   Please read questions 9 through 12 on the overhead transparency and
      circle the numerical value that corresponds to how certain you feel that
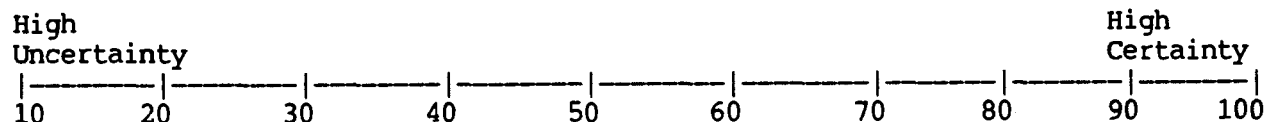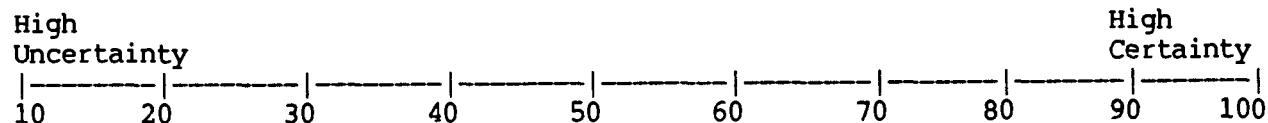   you are able to

a.   define correlation and correlation coefficient.
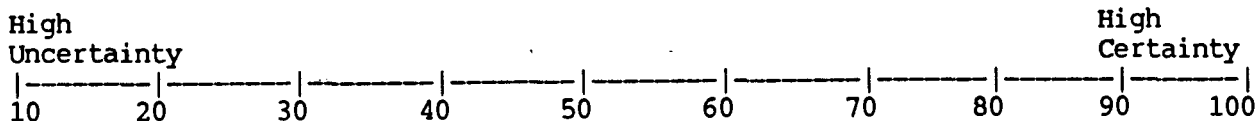
High   High
Uncertainty   Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

b.   understand the procedures for calculating the correlation coefficient.

High   High
Uncertainty   Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

c.   understand types of correlations and correlation coefficients.

High   High
Uncertainty   Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

d.   apply knowledge and understanding of the concept of correlation to draw
      conclusions in a variety of situations.

High   High
Uncertainty   Certainty
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100
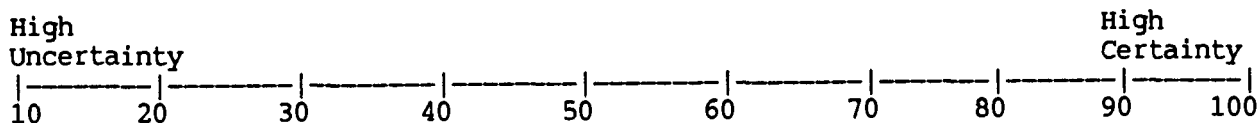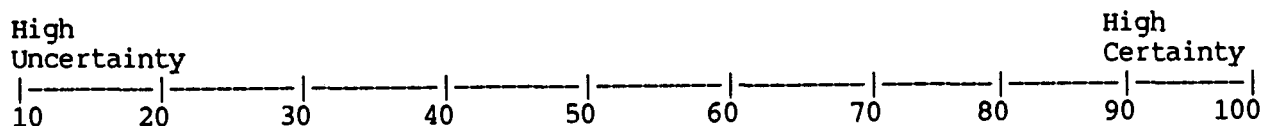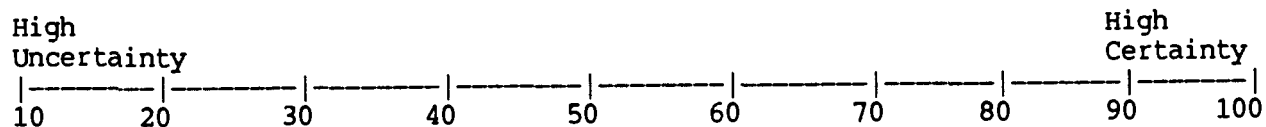
APPENDIX 5

POST TEST FOR

ELEMENTARY STATISTICS

RESEARCH METHODS AND MAJOR THEORIES

PSYCHOLOGY 162

EXAM ONE
SPRING, 1986

Each item is worth two points. Please choose the most correct response.

1. The most popular score (the score with the greatest frequency) in a
    distribution is called the:

    a. standard deviation
    b. average
    c. median
    d. mode

2. A single number which represents a whole series of numbers provides a
    measure of:

    a. variability
    b. central tendency
    c. relationship
    d. consistency

3. We have to know how many scores there are in a sample before we can
    calculate:

    a. the mean and the mode
    b. the mean and the median
    c. the mode and the median
    d. the mode, the median and the mean

4. The statistic whose value is such that it exceeds half the score values
    and is exceeded by half the scores values is called the:

    a. mean
    b. mode
    c. median
    d. none of the above

5. What is the median of this group of scores?

        2, 2, 3, 4, 5, 12

    a. 2
    b. 3
    c. 3.5
    d. 4

6. In the following group of scores, what is the mode?

        1, 2, 3, 3, 4, 5, 5, 5, 6, 9

    a. 3
    b. 4
    c. 4.5
    d. 5

7. What is the mean of the following distribution?

        10, 20, 30, 40

    a. 20
    b. 25
    c. 30
    d. 35

8. In the distribution 7, 8, 8, 9, 10, 12, 13, 14; the best measure of central tendency is:

    a. mean
    b. median
    c. mode
    d. midpoint

9. In the frequency polygon below the best measure of central tendency is:

    a. mean
    b. median
    c. mode
    d. midpoint

10. Judging from the histogram below, the best measure of central tendency would be:

    a. mean
    b. median
    c. mode
    d. average

11. The range and the standard deviation both tell us something about the
_____ of a group of scores.

    a.   dispersion
    b.   spread
    c.   variability
    d.   all of the above

12. The _____ is the easiest measure of dispersion to calculate:

    a.   standard deviation
    b.   mode
    c.   range
    d.   median

13. Which measure of dispersion is based on only two scores?

    a.   standard deviation
    b.   mode
    c.   range
    d.   none of the above

14. The most useful measure of variability is the:

    a.   standard deviation
    b.   mode
    c.   range
    d.   all are equally useful

15. In order to calculate the standard deviation you have to know the value of
what other statistic?

    a.   mean
    b.   range
    c.   mode
    d.   none of these

16. If individual differences decrease, the standard deviation will:

    a.   change in an unpredictable direction
    b.   decrease
    c.   remain the same
    d.   increase

17. A distribution of scores with a standard deviation of 5:

    a. cannot have the same mean as a distribution with a standard deviation of 10.
    b. has less variability than a distribution with a standard deviation of 10.
    c. has more variability than a distribution with a standard deviation of 10.
    d. probably contains more extreme scores than a distribution with a standard deviation of 10.

18. The smaller the standard deviation of a distribution, the more representative is the _____ of the scores in the distribution.

    a. mean
    b. mode
    c. variance
    d. median

19. The mean age in months for nursery school children was reported as 25.5. The standard deviation for group 1 was 3.4 and for group 2, 4.9. From this we may conclude that:

    a. group 1 is more variable than group 2
    b. the mode for group 1 is higher than that for group 2
    c. group 2 is more variable than group 1.
    d. the median age for group 2 is higher than that for group 1.

20. After comparing the standard deviations for group 1 and group 2, it may be concluded that:

Group 1	Group 2
2	2
4	2
6	8
8	8

    a. group 1 is more variable than group 2
    b. group 2 is more variable than group 1
    c. neither group is more variable than the other.
    d. group 2 is twice as variable as group 1.

21. A graph that is commonly used in conjunction with the coefficient of correlation is called a _____.

    a. frequency distribution
    b. histogram
    c. scattergram
    d. none of the above

22. When some people earn high scores on each of two variables and others earn low scores on both, the correlation between the scores across people will be:

    a. positive
    b. negative
    c. perfect
    d. zero

23. The value of the correlation coefficient can range between:

    a. 0.00 and +1.00
    b. −1.00 and 0.00
    c. −1.00 and +1.00
    d. none of the above as there are no fixed limits

24. When the people who earn high scores on one variable are the same as those who earn low scores on the other, and vice versa, the correlation between these variables will be:

    a. positive
    b. negative
    c. perfect
    d. zero

25. People with poor eyesight read more slowly than those with good eyesight. The correlation between reading speed and eyesight would be:

    a. positive
    b. negative
    c. perfect
    d. zero

26. Among weight lifters, heavy people can lift greater weights than lighter people. The correlation between body weight and maximum weight lifted would be:

    a. positive
    b. negative
    c. perfect
    d. zero

27. Which of the following correlation coefficients represents the strongest relationship?

    a. +0.90
    b. +0.45
    c. −0.37
    d. −0.93

28. If you discovered that small rats eat less than their heavier litter mates, you could definitely conclude that:

    a. body size controls meal size
    b. meal size controls body size
    c. a third variable must control both body size and meal size
    d. none of the above

29. In regard to your observation that your grade for the first psychology 161 exam and first psychology 162 exam were the same it may be concluded that there is :

    a. +1.00 correlation
    b. -1.00 correlation
    c. 0.00 correlation
    d. insufficient data to calculate a correlation

30. If the correlation between musical aptitude and art aptitude was found to be .75, which statement would be justified?

    a. Three-fourths of the pupils who were above average on art aptitude were also above average on muscial aptitude.
    b. Many pupils who score low on the art test also score low on the music test.
    c. The relationship between art aptitude and music aptitude is 75 percent of perfect.
    d. The relationship between art aptitude and music aptitude is virtually insignificant.

31. A lifespan view of human development emphasizes changes that occur during:
    a. adulthood
    b. childhood
    c. infancy
    d. all of the above

32. Which of the following statements is correct?

    a. Developmental psychology is more concerned with discovering the underlying principles of learning than with describing differences between the learning processes of children and adults.
    b. Hospitalism, a common disorder among children in the 1800s and 1900s, refers to the child's fear of hospitals and children's homes.
    c. The scientific study of children is among the oldest of the social sciences.
    d. None of the above is correct.

33. _____ developed the first practical intelligence scale.

    a. Binet
    b. Freud
    c. Hall
    d. Watson

34. When an investigator assigns subjects to groups and controls as many variables as possible, it is called:

    a. a cross-sectional study
    b. an experiment
    c. a longitudinal study
    d. a specimen record

35. Suppose a researcher randomly assigns 50 sixth-grade students to one of two groups, A and B. Group A receives praise from the teacher for correctly solving math problems, and Group B does not. The researcher then measures the number of math problems completed by each group. The independent variable in this study is:

    a. the number of math problems completed by each group
    b. the praise from the teacher
    c. the random assignment of students to groups
    d. the use of an experiment rather than a survey

36. Suppose a researcher randomly assigns 50 sixth-grade students to one of two groups, A and B. Group A receives praise from the teacher for correctly solving math problems, and Group B does not. The researcher then measures the number of math problems completed by each group. The dependent variable in this study is:

    a. the number of math problems completed by each group
    b. the praise from the teacher
    c. the random assignment of students to groups
    d. the use of an experiment rather than a survey

37. Which of the following statements is correct?

    a. Experimental and control groups are equivalent to begin with, but the experiment group is then treated differently.
    b. Experimental and control groups are treated differently in an attempt to make them equivalent at the end of an experiment.
    c. The experimenter attempts to treat experimental and control groups in equivalent fashion.
    d. None of the above is correct.

38. A study of one group of children on frequent occasions over a span of several years is a/an _____ study.

    a. cross-sectional
    b. event-sampling
    c. longitudinal
    d. time-sampling

39. To determine whether the average eight-year-old is more intelligent than the average four-year-old, the most practical and economical approach would be a/an _____ study.

    a. cross-sectional
    b. experimental
    c. longitudinal
    d. time-sampling

40. Which of the statements is correct?

    a. Correlational studies do not establish causation.
    b. The results of psychological research should not be generalized to groups other than those represented by the research sample.
    c. The validity of questionnaire data frequently depends upon the assumption that respondents answered the questions honestly.
    d. All of the above are correct.

41. The three personality levels in Freud's system develop chronologically in which of the following orders?

    a. ego, id, superego
    b. ego, superego, id
    c. id, ego superego
    d. id, superego, ego

42. The stages of psychosexual development are, in chronological order:

    a. oral, anal, latency, phallic genital
    b. oral, anal, phallic latency, genital
    c. oral, anal, phallic, genital, latency
    d. oral, latency, phallic, anal, genital

43. Carol, a pretty adolescent recently jilted by her boy friend, has started sucking her thumb. What Freudian term best describes this type of personality development?

    a. displacement
    b. fixation
    c. projection
    d. regression

44. Irrational and sometimes unhealthy ways for the ego mediate between the id and the superego are referred to by Freud as _____ mechanisms.

   a. defense
   b. fixation
   c. regression
   d. repression

45. Unlike Freud, Erikson emphasized:

   a. the child's sociocultural environment
   b. the healthy personality
   c. the role of the ego in the child's social development
   d. all of the above

46. Carla is a preschooler who feels bad because she has not cleaned her room, yet she also wants desperately to go out to play with her friends. This type of conflict is characteristic of the stage called by Erikson:

   a. autonomy versus shame and doubt
   b. identity versus identity diffusion
   c. industry versus inferiority
   d. initiative versus guilt

47. According to Piaget, we have two ways of adapting to and interacting with the environment. These are called:

   a. assimilation and accommodation
   b. convergent and divergent
   c. discrimination and generalization
   d. external and internal

48. According to Piaget, during what stage does the child become capable to dealing with the hypothetical?

   a. concrete operational
   b. formal operational
   c. intuitive
   d. preconceptual

49. The principle difference between reinforcement and punishment is:

   a. that one is a consequence and the other is not
   b. the effect each has on behavior
   c. whether a stimulus is applied or removed following a response
   d. none of the above

50. Reinforcing a response to bring it closer to a desired behavior is referred to as:

    a.   accommodation
    b.   modeling
    c.   shaping
    d.   the eliciting effect

Answer Key: Posttest for Elementary Statistics

Central Tendency

1.	d	6.	d
2.	b	7.	b
3.	b	8.	a
4.	c	9.	b
5.	c	10.	c

Variability

11.	d	16.	b
12.	c	17.	b
13.	c	18.	a
14.	a	19.	c
15.	a	20.	b

Correlation

21.	c	26.	a
22.	a	27.	d
23.	c	28.	d
24.	b	29.	d
25.	a	30.	b

Research Methods

31.	d	36.	a
32.	d	37.	a
33.	a	38.	c
34.	b	39.	a
35.	b	40.	d

Major Theories

41.	c	46.	d
42.	b	47.	a
43.	d	48.	b
44.	a	49.	b
45.	d	50.	c

APPENDIX 6

ATTRIBUTION POSTTEST

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POST TESTS

Part B: Attributions for Success and Failures on the Elementary Statistics

AGE   _____

SEX   _____

ID   _____

INSTRUCTIONS:

The following questionnaire items refer only to your performance on the
Elementary Statistics Examination. Please take a moment to recall your
performance on the test. Then answer each questionnaire item by circling a
numerical value located on the scale that corresponds to the likelihood the
factor in quotations influenced your success or failure.

Situation

When you were faced with a difficult statistics problem on the Elementary
Statistics Examination that you COULD answer, this was because

(a) well ... you really "DON'T KNOW" why you could answer it.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(b) the "PROBLEM WAS TOO EASY" for introductory psychology students.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(c) you were "LUCKY".

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(d) you are "GOOD AT" at statistics.

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

(e) you "WORKED HARD".

Highly   Highly
Unlikely   Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10   20   30   40   50   60   70   80   90   100

Situation

When you were faced with a difficult statistics problem on the Elementary
Statistics Examination that you **COULD NOT** answer correctly, had difficulty with
at this level or would have difficulty with at a more advanced level, was
because

(a)   well ... you really **"DON'T KNOW"** why you could not answer it.

```
Highly                                                                 Highly
Unlikely                                                               Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```
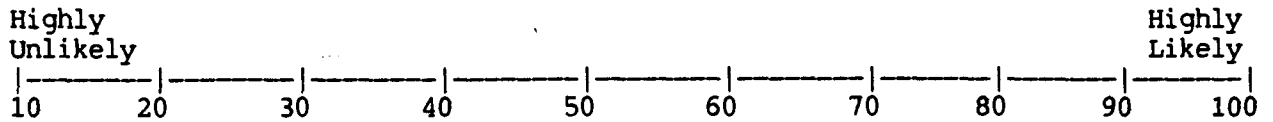
(b)   the **"PROBLEM WAS TOO DIFFICULT"** for introductory psychology students.
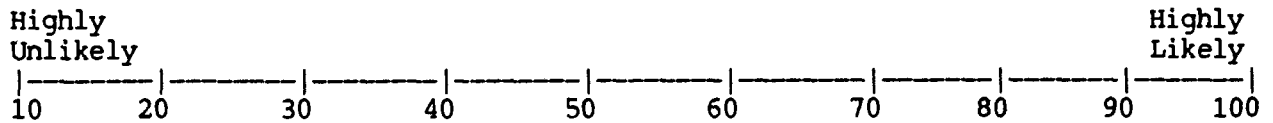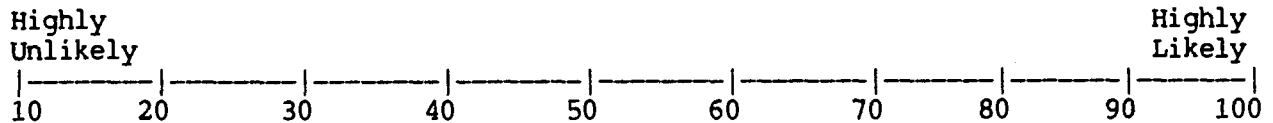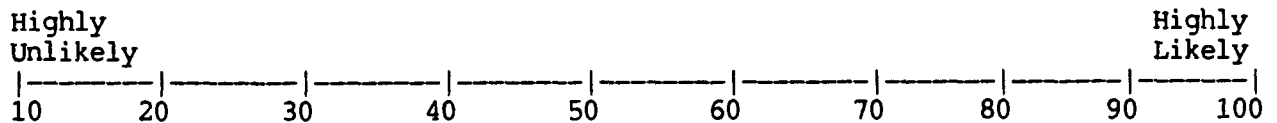
```
Highly                                                                 Highly
Unlikely                                                               Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

(c)   you were **"UNLUCKY"**.

```
Highly                                                                 Highly
Unlikely                                                               Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

(d)   you are **"NOT GOOD AT"** at statistics.

```
Highly                                                                 Highly
Unlikely                                                               Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```

(e)   you **"DID NOT WORK HARD"**.

```
Highly                                                                 Highly
Unlikely                                                               Likely
|———————|———————|———————|———————|———————|———————|———————|———————|———————|
10      20      30      40      50      60      70      80      90      100
```
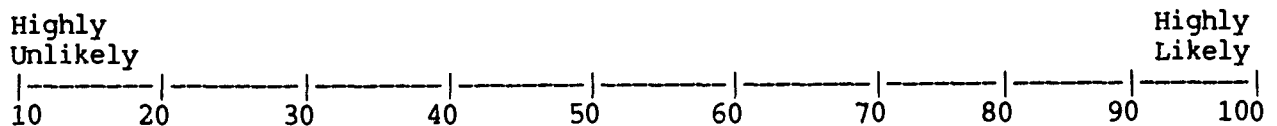
APPENDIX 7

MEANS (AND STANDARD DEVIATIONS)

Means (And Standard Deviations) For Attributions

	Experimental Condition		
	Control	Treatment 2	Treatment 1
Attributions			
Pretest (Success)			
Don't know	25.79 (19.24)	23.16 (24.51)	19.47 (16.15)
Task Difficulty	55.79 (25.89)	54.74 (27.96)	64.21 (31.68)
Chance	20.53 (14.71)	25.26 (26.95)	28.95 (28.85)
Ability	57.99 (25.07)	60.00 (29.81)	65.79 (29.12)
Effort	51.58 (26.51)	53.16 (30.74)	61.05 (26.01)
Posttest (Success)			
Don't know	41.05 (26.22)	35.26 (28.94)	28.95 (25.14)
Task Difficulty	31.05 (14.87)	38.42 (24.10)	37.90 (26.37)
Chance	31.05 (18.23)	36.84 (29.45)	29.47 (20.94)
Ability	48.95 (23.31)	56.32 (23.85)	68.95 (18.83)
Effort	68.42 (22.92)	60.53 (30.82)	78.95 (18.23)
Pretest (Failure)			
Don't know	34.21 (21.17)	31.58 (25.66)	27.37 (23.77)
Task Difficulty	30.00 (17.64)	34.74 (24.58)	41.58 (31.49)
Chance	25.26 (15.04)	16.84 (11.57)	25.79 (21.17)
Ability	32.11 (21.75)	41.58 (28.34)	37.90 (30.11)
Effort	42.11 (21.49)	41.05 (29.61)	44.21 (27.15)
Posttest (Failure)			
Don't know	41.58 (23.40)	50.00 (30.00)	36.84 (23.35)
Task Difficulty	43.68 (18.32)	37.37 (21.04)	54.21 (27.55)
Chance	28.42 (19.51)	28.95 (21.05)	24.21 (15.02)
Ability	42.11 (24.40)	34.74 (21.18)	40.53 (20.68)
Effort	46.32 (24.09)	49.47 (27.38)	45.79 (29.31)

Note: N=57, n=19 in each condition

Range of scale: 10 (Highly unlikely) - 100 (Highly likely)

Means (and Standard Deviations) For Self-Efficacy

| | Experimental Condition | | |
	Control	Treatment 2	Treatment 1
Self-Efficacy			
Pretest			
Central Tendency	73.16 (17.48)	69.16 (25.97)	75.16 (23.06)
Variability	64.63 (19.33)	65.16 (26.29)	75.05 (22.71)
Correlation	67.63 (14.10)	63.37 (28.39)	74.90 (19.78)
Posttest			
Central Tendency	81.68 (11.48)	86.37 (12.00)	89.42 (10.22)
Variability	78.37 (14.94)	81.79 (12.61)	87.95 (8.95)
Correlation	78.53 (14.88)	83.21 (11.825)	87.16 (12.571)

Note: N=57, n=19 in each condition

Range of Scale: 10 (Highly Uncertainty) – 100 (High Certainty)

APPENDIX 8

PEARSON CORRELATION COEFFICIENTS

Pearson Correlation Coefficients Between Pretest And Posttest For Attributions, Skill And Self-Efficacy

	Pearson Correlation Coefficient	Significance
Attributions		
Success		
Don't know	.31	*.009
Task Difficulty	.19	.073
Chance	.27	*.023
Ability	.18	.089
Effort	.40	*.001
Failure/Difficulty		
Don't know	.13	.166
Task Difficulty	.32	*.007
Chance	.44	*.000
Ability	.36	*.003
Effort	.28	*.016
Skill		
Central Tendency	.04	.378
Variability	.42	*.001
Correlation	.31	*.010
Self-Efficacy		
Central Tendency	.15	.132
Variabilty	.48	*.000
Correlation	.48	*.000

Note: N=57 One-tailed significance
* - stable

APPENDIX 9

SKILL: MAIN EFFECT

Skill: Main Effect For Condition

Multivariate Tests Of Significance (S=2, M=0, N=23 1/2)

Test Name	Value	Approx. F	Hypoth.DF	Error DF	Sig. Of F
pillais	.255	2.441	6.00	100.00	.030
hotellings	.307	2.452	6.00	96.00	.030
wilks	.756	2.448	6.00	98.00	.030
roys	.195				

Univariate F-Tests With (2,51) D.F.

Variable	F	Significance of F
Central Tendency Posttest	1.996	.146
Variability Posttest	1.928	.156
Correlation Posttest	2.876	.066