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PLACEBO PROGRAM BRANCHING AND LEARNER
SELF-CONCEPTS.

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PLACEBO PROGRAM BRANCHING

AND

LEARNER SELF-CONCEPTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Stanford Dean Ruggles, A.B., M.A.

* * * * *

The Ohio State University
1969

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The revolutionary changes that have occurred in education have revealed two clusters of emphasis in contemporary educational thought. The first broad area of focus is characterized by objectivity and systems approach; the second is characterized by the renewed emphasis on the individual and the conditions of his human existence.

**Context of the Problem**

Today students at all ages need to know more about more things due to the accelerated development of new knowledge and the modification of existing knowledge. Educators are faced with the task of defining what experiences are relevant for the student given his stated goals in life and those of the society in which he lives. Also, greater emphasis is placed on specificity of instructional objectives presented in behavioral or operational terms—this trend growing out of Pierce, James, and Dewey's pragmatic philosophy. In addition, increased demands are placed on educators to teach and instruct more students more effectively and in less time.
Parallel with this latter trend is the corollary assumption that educators will be held responsible for more objective proof that what they say they will teach will be evident in observable student behavior. This quality control applied to the output of an instructional system is clearly seen in what one might call the programed learning movement.

Programed instruction, as defined by Lange (1967), is essentially "a well-disciplined and experimental approach to instruction, characterized by explicitness, by sophisticated behavioral analysis, and by careful control of stimuli and student response and organized to elicit behavioral sequences that have been empirically determined (Lange, 1967, p. 3)." One can readily see in this definition the strong emphasis upon objectivity of student behaviors and a general over-all behaviorist orientation. This emphasis on structuring the learning environment and specifying behavioral objectives has been according to many educators a needed improvement in instruction. For instance, Gage (1967), discussing the psychological conceptions of teaching, notes that good teaching demands seemingly impossible complex, subtle, and rapid cognitive feats on the part of the teacher. He further contends that some kind of individualized, self-paced, prearranged flexible sequences
are needed for some important kinds of teaching. Gage feels that this prearranged yet flexible sequence is what programmed instruction provides. He suggests that many students of teaching are moving toward programmed instruction as a solution to many of the problems of teaching.

Gage (1968) feels that in the past educators have followed many fruitless paradigms. Gage states that one such "road into the wilderness" was the attempt to define good teaching by making rating scales composed of long lists of broad general traits supposedly desirable for teachers. Gage contrasts the so-called criterion of teacher effectiveness with the more fruitful approaches of research in programmed instruction. Gage notes that programmed instruction can effectively, at least in principle, deal with the problem of the cognitive complexity of the teacher's task.

Its programs can be worked out and tried out in meticulous detail, well in advance, at leisure, by the most skilled curriculum experts in the land, and then made available in all their subtlety and complexity to every teacher who uses the program (Gage, 1968, p. 605).

Stolurow (1962) made the following observations based on his interpretation of the implications of current research on programmed learning.

1. These methods and devices are here to stay.

2. Several things will be done to acquaint teachers with the potentiality of these developments.
3. The comparative study of live and automated teaching will stop.

4. Future research will concern itself with discovering the important characteristics of the materials and methods.

5. These developments will lead to a theory of teaching.

6. Courses will be revised as a result of the new insights provided.

7. Basic changes in our thinking about what a course is will take place.

8. Research will demonstrate the importance of sequence factors.

9. We will see a new form of dynamic individualized programming called ability-pattern programming.

10. The devices of the future will be either books (programmed or scrambled) or computer-based machines; small devices will drop out.

11. Learning from auto-instructional programming will be shown to be capable of aiding persons to solve problems creatively (Stolurow, 1962, p. 226).

Phil Lange (1967a) editor of the Sixty-sixth Yearbook of the National Society for the Study of Education entitled Programed Instruction concluded that:

Programed textbooks, programed lectures and demonstrations, programed audio-visual presentations, and programed computer-assisted instruction all exist with some valid claims of effectiveness. Their present effectiveness can only increase, and herein lies a fascinating area of speculation about the future (Lange, 1967a, p. 325).

Stolorow and Lange may or may not be correct in their projections, but on the whole programing has and apparently
will continue to exert a marked influence on educational thought and practice.

However, with all the current emphasis on objectivity, instructional systems and analysis of student behavior, there is a renewed and deeper concern with the learner as an individual in a context of human existence. Authors such as Rogers (1947), Erikson (1955), Montagu (1964), and Fromm (1955) have emphasized the importance of what the individual thinks about himself and his ability to learn. Studies such as those by Rosenthal and Jacobsen (1968) have revealed that what a person thinks he can do and what others believe he can do significantly and drastically affect what, in fact, he does accomplish. Phillips (1964) states that the study of self understanding and self acceptance is one of the more important tasks of psychology and education. Phillips reviewed much of the early theorizing and concluded that the "self concept" has recently "come to be recognized as a hitherto unnoticed factor in every learning situation, whether the teacher is aware of it or aiming for it, or not (Phillips, 1964, p. 109)."

Many of the recent studies of disadvantaged youth have recognized the importance of examining the self-concepts of youth. Bowman (1966) points out that the importance of self-concept in the education of children is just beginning
to be understood, and its importance to the education of children from the disadvantaged areas is even greater because there is a larger proportion of seriously damaged self-concepts among them.

Spiegler (1967) notes the importance of building a self-image in order to raise the educational level of the disadvantaged pupil.

It is axiomatic that before we can raise the educational and vocational aspiration levels of the disadvantaged pupil, we must raise his self-esteem. Otherwise, we deal with a psychological block of monumental proportions (p. 187).

The perception that one has of himself is important not only for the "disadvantaged" child, as indicated by Bowman and Spiegler, but is an important force in all persons.

Bowman (1966) notes that it is generally assumed that the way a person thinks of himself determines to a great degree the general intent and direction of a person's behavior. He further states that clinicians have observed that changes in the way a person conceives of himself are likely to precede outward behavioral changes, and they therefore assume a correlational relationship.

Expressing this same belief, Rogers (1947) reports that as changes occur in ones perception of self and in the perception of reality changes occur in behavior, "... as the perception of self alters, behavior alters (Rogers, 1947, p. 359)." Rogers concludes that if certain
psychological conditions exist, the individual has the capacity to reorganize his field of perception including the way he perceives himself. Part of the psychological climate which will allow for a change of self concept is, as Rogers notes, a consistent atmosphere of understanding and freedom from threat to the self-image.

Programed instruction and self-concept theory have emerged as two significant areas of contemporary educational concern. These two areas serve as the context out of which the present study has developed.

Statement of the Problem

Edgar Dale (1967) points out that a program is a set of controlled and sequenced actions. Dale further notes that programing and systems development are basically "a process of determining empirically a sequence of actions or operations that follow a preset order to assure a dependable performance at an established standard (Dale, 1967, p. 31)." Markle (1967) states that programed instruction can be thought of as the application of quality control applied to the design of instruction.

Briggs (1968) writing on the subject of "Learner Variables and Educational Media" in the Journal of Educational Research indicates that the several categories of variables related to program research can for purposes
of analysis and study be categorized as learner variables and program variables. Learner variables, Briggs notes, refer to such constructs as personality, intellectual, and cultural variables in the learner. Program variables concern such items as size of step or frame, mode of response, item sequence, and the like.

Branching is one such program variable in programmed instruction. A variation of branching will be one of the variables studied in this dissertation. Branching and linear programs are usually contrasted as the two basic approaches to programing. First, linear programing will be briefly examined followed by a description of branching as defined by Crowder (1959) who first introduced branching.

Green (1962) points out that the straight line or linear program was first developed and used by Skinner and his associates. The linear program usually consists of small steps leading logically through the subject matter from topic to topic. Green feels that the linear program should so be constructed that the student makes as few errors as possible.

A series of frames may be viewed as a sequence of stimuli or stimulus elements sharing some elements from frame to frame. One may regard learning as the conditioning of behaviors to the elements within a frame. Through reinforcement, the probability of a correct response is increased to those elements within a specific frame; one then moves to the next frame. The probability of response
to the next frame is higher than it otherwise would be because some intercept elements are shared with the previous frame or frames, to which the response has already been conditioned. Thus, the organism proceeds from the known to the unknown (Green, 1962, p. 32).

Linear programs present feedback of correct answers, a student can usually proceed through the sequence at his own pace, and every student completes the steps in direct sequence in linear order, thus the term linear program.

Crowder (1959), however, felt that the linear Skinnerian type of teaching machine was too narrow in its approach.

If I understand Skinner correctly, he views the teaching machine as a means of setting up a carefully controlled situation in which the student is conditioned to emit appropriate responses to the stimuli presented. . . . The effective learning is evidently considered to be intimately bound up with the process of the student's responding. (Crowder, 1959, p. 114).

Crowder, consequently, introduced branching in programed learning. He referred to his method as "intrinsic programing." Crowder considered his intrinsic programing as providing the flexibility needed in a problem that to Crowder was basically a matter of learning as effective communication.

To me the essential problem is that of controlling a communication process by the use of feedback. The student's response serves primarily as a means of determining whether the communication process has been effective and at the same time allows appropriate corrective
action to be taken when the communication has been ineffective. The structural peculiarities of automatic tutoring materials are designed to serve this testing and correctional purpose, and the material is not constrained by any particular theoretical learning model. If an error has occurred, the problem is not solved by revealing the right response to the student, as the failure (of communication) occurred before the response was emitted. What is required, in the case of an error, therefore, is to repeat or revise the communication process. This is what the automatic tutoring materials are designed to do (Crowder, 1959, p. 114).

Crowder noted that the simplest form of intrinsic programming is found in the scrambled book.

The scrambled book is used as follows: on page 1 of the book the student finds the first unit of information and the first multiple-choice question. Each of the alternative answers to the question is identified by a page number. For example, the question on page 1 of the scrambled book may look like this:

"In the multiplication $3 \times 4 = 12$, the number 12 is called the product and the numbers 3 and 4 are called the

Page 12 quotients.
Page 29 factors.
Page 43 powers.

The student chooses what he believes is the correct answer to the question and turns to the page number given in front of that answer. If he has chosen the correct answer, the page to which he turns will present the next unit of information or the next concept to be mastered, and the next question. If he has chosen an incorrect answer, the page to which he (thereby) turns will explain why his answer was incorrect, and will direct him to return to the original choice page to try again. Thus the student cannot progress through the book except by eventually choosing the right answer to each question (Crowder, 1959, pp. 110-11).

Crowder provides the following example of correctional
material that appeared on one of the wrong answer pages
to the above material.

Page 43—Your answer was: 'powers.' We'll
get to powers of numbers pretty soon, but .
we're not there yet. The numbers that are
multiplied together to form a product are
called 'factors,' not 'powers.' Now return
to page 1 and choose the right answer (Crowder,
1959, p. 111).

Crowder felt that this type of scrambled book branching
provided more flexibility than the type of teaching machine,
for example, that was advocated by B. F. Skinner and his
students.

Crowder pointed out that the material the student is
presented is determined directly by the student's immedi­
ately preceding behavior in choosing an answer to the
presented multiple-choice question.

Since the student's behavior in choosing an
answer to the multiple-choice question is de­
termined, presumably, by his state of know­
ledge at the time he makes his choice, the
automatic tutoring device adapts the program
of material directly to the present state of
knowledge of the individual student (Crowder,
1959, p. 110).

Crowder concluded that this flexible individualized self
instructional method provided needed alternatives and could
do so without elaborate external programing devices.

In summary, the branching programed book is one that
presents the learner with one or two paragraphs of informa­
tion followed by a multiple-choice question. The learner
is then asked to choose the best response. If he chooses
the correct alternative, he is directed to a page which
indicates that he has made a correct response. The learner
is given new material and another test question. However,
if the student makes a wrong choice, he is directed to
another page that tells him he is wrong and gives him an
explanation of why he is wrong. Some programs tell the
learner he is wrong, give him hints and additional simpli­
fied material, and direct him back to the page to try again.
Branching seems to have the advantage over linear program­
ing of adjusting more to the individual needs of the learner
by allowing the learner with correct responses to proceed
without being distracted by unnecessary explanations. The
learner making the wrong responses is told that he is wrong,
is given review, told to return to the original page, read
again, and make a new response to the question.

It is at this point that an important problem emerges
when considering branching and the learner variable of self­
concept. Recent studies in the culturally disadvantaged
schools, for instance, suggest that one of the major prob­
lems with failure to learn deals with the concept that the
child has concerning himself. If the learner believes that
he cannot learn, if he feels very deeply that he is a fail­
ure, then this poor self-concept attitude will, in fact,
affect his ability to learn.

Ausubel (1965) expresses the idea that when a student
with a low sense of self-worth fails something, the student
not only feels the grief of a particular and isolated failure, but he experiences a complete loss of self-worth and self-confidence. Any single failure or minor setback has a much more devastating effect on persons with a low self-concept as compared with students with more self-confidence.

Is it possible that branching programs have been written that allow for individual differences of students with high self-concepts but which are less than adequate in meeting the needs of those students with low self-concepts?

When the student with the low self-concept makes a wrong response in a branching program, he is then directed to another page which tells him he has made a wrong choice. Indicating this wrong decision may serve to confirm his inner attitude that he cannot learn and that he is a failure. Is it possible that we place too great an emphasis on evaluation and informing persons they are incorrect? Rogers (1961), for instance, seriously questions the psychological outcome of constant student evaluation.

In almost every phase of our lives—at home, at school, at work—we find ourselves under the rewards and punishments of external judgments. "That's good"; "that's naughty." "That's worth an A"; "that's a failure." "That's good counseling"; "that's poor counseling." Such judgments are a part of our lives from infancy to old age. I believe they have a certain social usefulness to institutions and organizations such as schools and professions. Like everyone else I find myself all too often making such evaluations. But, in my experience, they do not make for
personal growth and hence I do not believe that they are a part of a helping relationship (Rogers, 1961, p. 54).

In the branching program one need not necessarily inform the student that he has made a wrong choice. The programmer "knows" that the student made a wrong choice or the student would not be on the review page.

The student that has what one might characterize as a low self-concept may be negatively affected by informing him that he made a wrong choice. Unwittingly by telling him he is wrong the experience may become miseducative. As Dewey (1963) noted, not all experiences are equally educative.

The belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative. Experience and education cannot be directly equated to each other. For some experiences are miseducative. Any experience is miseducative that has the effect of arresting or distorting the growth of further experience. An experience may be such as to engender callousness; it may produce lack of sensitivity and of responsiveness. Then the possibilities of having richer experience in the future are restricted (Dewey, 1963, p. 25).

The present writer feels that with some students the effect of confirming the wrong response may produce "lack of sensitivity and of responsiveness" for further learning.

The writer proposes an alternative branching program which he will call "placebo branching." The term placebo is used to emphasize the connotation of something given for its psychological effect.
A placebo branching program would be defined as a unit of instruction in which material would be presented to the learner after which he would be asked to respond to a multiple choice question. However, no matter which answer he chooses, right or wrong, he would not be told he was wrong but simply directed to the appropriate page for either advanced or review material. If the response is wrong, the learner will be directed to a certain page at which point he will be encouraged and given review and new direction. He will not be asked to return to some original page and start over, and he will in no way be overtly told he made a wrong response. The programer will know the wrong responses and correct for these by directing the respondent to different pages, but the learner will not be made aware of this point.

Purpose of Study

The purpose of this study is to critically examine what relationship, if any, exists among four variables, namely what is the relationship among students with high self-concepts and non-placebo branching; high self-concepts and placebo branching; low self-concepts and non-placebo branching; and low self-concepts and placebo branching as compared on an achievement test covering the same material.

Stated briefly, the problem is what relationship exists between two types of branching (placebo and non-placebo)
and students with high or low self-concepts. Will the type of branching make any difference with low or high self-concept students as measured on an achievement test?

**Hypotheses**

The hypotheses proposed by the writer are as follows: First, with high self-concept learners no significant difference exists between the placebo or non-placebo method of branching as measured on an achievement test covering a given unit of study. Second, with low self-concept students, students using the placebo branching method will score significantly higher than those students using the non-placebo branching as measured on an achievement test covering the same unit of study.

These substantive hypotheses will be tested by using null statistical hypotheses which state that no relationship, other than those by chance fluctuations, exists among the variables tested. The statistical hypotheses and their formulation are presented in the chapter "Design and Method of Analysis for the Study."

**Definition of Terms**

For the purposes of this study the writer defines the following terms:

1. **Non-placebo branching.** Non-placebo branching is defined as any branching or intrinsic program of
the Crowder (1959) variety which informs the student he has made an incorrect choice or given a wrong response. The nonplacebo program may or may not ask the student to return to the original page for recycling through the program.

2. Placebo branching. Placebo branching is defined as a branching program in which at no time the student is informed he has made a wrong or incorrect response. Also the placebo branching program will not require the student to return to an original page for recycling through the program.

3. Self-concept. Self-concept is defined as an individual's inner view of himself. The self-concept is further defined as the cluster of beliefs the individual has accepted as definitions of himself.

4. High and low self-concepts. High and low self-concepts are terms used by the writer to designate the degree to which a person reports that he has self-confidence, the degree to which he feels adequate for normal social and academic tasks, and the degree to which the student feels generally "at home in the human world."
For the purposes of this study self-concept is operationally defined as that measure obtained from a self-report as obtained from the first five groupings of Part I of the California Test of Personality Intermediate Series.

**Importance of the Study**

The educational significance of this study is that hopefully possible new knowledge might be obtained regarding the psychological effect of a new form of branching programing, called placebo branching by the writer, with students that vary in their self-concept.

Leon Eisenberg (1967) psychiatrist at John Hopkins Hospital notes that for the child who seriously questions his own adequacy the school becomes a place where he discovers what he cannot do rather than a place where he is taught what to do.

The child's sense of himself in relation to academic skills comes from repeated exposure to frustration and failure, and to the presence of the teacher who, all too frequently, reinforces his poor self-image by seeing him as the failure . . . Academic skills are cumulative, so he falls further and further behind, and his self-concept becomes progressively less adequate (Eisenberg, 1967, p. 22).

If students with low self-concepts do, in fact, find the nonplacebo branching as a source of conformation for their inner definition that they are failures, then placebo branching may serve as a needed anodyne to their feeling
of inadequacy and also help to strengthen and develop a more positive atmosphere for learning.

Educators are aware that the learning styles of children vary, and educational materials must be the best possible "fit" to these unique needs. In addition, information may be gained concerning the effectiveness of writing programed self-instructional units of study in the industrial arts curriculum.

The basic purpose of this study will be to determine if a new approach to programed branching materials referred to as placebo branching will make a significant difference in the learning of students characterized as having high or low self-concepts.

Summary

This chapter presented a brief indication of current educational thought concerning programed learning and self-concept theory. It was noted that these two areas of concern evolved from the broad emphasis of thought dealing with objectivity of goals and systems approach in instruction and a renewed emphasis on the individual learner and his definition of himself in human existence. It was noted that the problem of this study involved the question of what relation exists between students with high and low self-concepts and a form of programed branching defined as
placebo branching. The hypotheses proposed stated that no relationship exists between students with high self-concepts and placebo branching but that a relationship does exist between placebo branching and students with low self-concepts. The purpose and importance of the study were noted as the possibility of discovering new knowledge regarding the new form of branching devised and the possible influence of this branching on students who vary in self-concept.
CHAPTER II
REVIEW OF THE LITERATURE

This chapter will present a brief discussion of the major concepts in self-concept theory, proposed definitions of the construct of self, and review relevant research dealing with the self-concept and learning. The second portion of this chapter will deal with current research on programmed learning that relates to the nature of the problem of this dissertation.

Self-Concept Theory

Bowman (1966) states that the modern study of "the self" evolved from the ruminations and inquiry of early philosophers to the social science theorists who attempted to deal more analytically with ideas about the self. Bowman cited G. H. Mead who dealt with the concepts of "I" and the "me", Erikson's studies of identity formation, Freud and his concepts of the ego and superego, William James, Carl Rogers, and others who have been concerned with the self-concept. Bowman concludes that attempts have been made to quantify and experiment in this area, but only a beginning has been made.
Borg further notes that in contemporary psychology the self-concept is considered to be an important factor underlying the individual's behavior. Borg defines this self-concept to be the individual's perception of himself. This self picture consists of the ideas, perceptions, and beliefs that the individual has of himself. This self picture, Borg states, may be highly realistic in the well-adjusted individual or it may be completely detached from reality as in the case of the psychotic. Theorists in general, he says, emphasize the need to preserve and enhance the self-concept as a basic human motivation.

Raimy (1948), like Borg, postulated that a person's notion of himself is of ultimate psychological significance in organized behavior.

The self-concept is the more or less organized perceptual object resulting from present and past self-observation. Self-perception is a process which is more than activation of internal or distance receptors. In agreement with textbook definitions, there is in self-perception an organization which involves memorial and situational factors as well as the sense data themselves.

To oversimplify the theoretical position, one can say that we perceive ourselves just as we perceive a chair or another person. What we perceive in ourselves (the Self-Concept) may have only partial correspondence with what other people perceive in us or the so-called objective personality.

Yet as always, we behave in accordance with our own perceptions even though the opinions of others or the urgencies of our biological make-up interact to influence our perceptions of ourselves. Our general behavior, then, is to a large extent regulated and organized by what we perceive
ourselves to be just as behavior toward a chair is regulated by our perception of a given chair (Raimy, 1948, p. 154).

Raimy concludes that in the search for dominant factors in personality the obvious has been too long neglected. This obvious factor that Raimy refers to is the idea that what a person believes about himself can be used as an accepted factor in the social comprehension of others.

Jersild (1952) defines the "self" in terms of a subjective environment.

The self is a composite of thoughts and feelings which constitute a person's awareness of his individual existence, his conception of who and what he is. A person's self is the "sum total of all that he can call his..." The self is a person's total subjective environment (Jersild, 1952, p. 9).

Jersild further notes that each person's self is something individual, and yet it has a social origin. This point is important for educators because it is in the school environment that many of the strongest social influences are brought to bear upon the child.

Kilpatrick (1941) emphasizes, as Jersild does, the continual process of interaction of the self and the environment.

Life at any level is exactly the continual interaction between organism and environment. The human individual as a self-conscious personality is thus continually called upon to adjust his own life to conditions that arise about him, at times to mold these conditions to his aims and purposes, at other times to submit himself to conditions that he cannot control. In this sense life is continual adjusting...
Maladjustment is, of course, failure at adjusting. It is the way the self-observing self builds itself as it realizes its failure at adjusting; it is the kind of self that is built in unsuccessful reaction to difficulty. In fact, what makes the phenomenon a matter of "personality maladjustment" is exactly that the self as such gets hurtfully involved. . . .

What the person sees, feels, and takes account of, how he reacts, especially to his own sense of failure and to what others will think in connection, and how he tries by various subterfuges to maintain a self-deceived self-respect— it is such things as these that we find when we study how maladjustment actually takes place (Kilpatrick, 1941, p. 147).

Koo (1964) notes the interaction of self and environment but also points out that the self is not some static structure.

Koo (1964) points out in an article entitled "The Structure and Process of Self" that James, Dewey, Kilpatrick, and Mead questioned the idea of the self existing as a static substance. Koo states that these authors and many contemporary theorists consider the self as a function of the processes of man's interaction with his environment. The man-environment interaction is viewed as a complex process of man becoming himself.

After examining the views of several philosophers and psychologists regarding the concept of self, Koo concludes that a more careful examination of the concept of self as process would offer "an integrative dimension" to many of the dichotomous approaches to educational problems (Koo, 1964).
Snyder (1965) discusses the self-concept theory suggests the following three basic postulates which indicate a similar belief as held by Koo.

1. The individual's self-concept functions to direct his behavior.

2. The self-concept emerges from the social situations in which the individual is a participant.

3. As the individual participates in situations with varying social expectations, his self-concept is modified.
   a. The individual self-concept reflects the actual or perceived expectations of significant others in the situation.
   b. Without the support of the group's expectations the self-concept is threatened, and will, with high probability, be modified (Snyder, 1965, p. 244).

Snyder implies in these three assumptions that the self concept is not some static personality structure but a continually emerging process. Snyder notes, however, that the self-concept does have a continuity and is not "completely fluid."

As indicated by the several authors cited, there is not complete agreement as to the specific nature of the self and the self-concept, but on the whole several common denominators seem to be present. First, it appears that the person in relation to his environment soon becomes aware of himself as an object of his own perception, and secondly, a person develops a cluster of consistent attitudes toward his own person, and the latter phenomena may be defined as the person's self-concept.
Self-Concept and Learning

Combs (1962) describes what he calls the positive view of self and relates this to the possible influence of the school upon the student's self-concept.

Extremely adequate, self-actualizing persons seem to be characterized by an essentially positive view of self. They are themselves as persons who are liked, wanted, acceptable, able; as persons of dignity and integrity, of worth and importance. This is not to suggest that adequate people never have negative ways of regarding themselves. They very well may. The total economy of such persons, however, is fundamentally positive (Combs, 1962, p. 51).

Combs states that if we are to develop the positive self, we must provide experiences that teach individuals they are positive people. He states that it is a common fallacy among some teachers that since the world is a very hard place and people often fail that children should be introduced to failure early. Combs points out that this assumption is false and that research suggests that the best guarantee that a person will be able to deal with the future effectively is that he has been essentially successful in the past. "People learn," Combs says, "that they are able, not from failure, but from success (Combs, 1962, p. 53)."

Montagu (1964), an anthropologist, expresses a view similar to Combs but perhaps even more extreme when he states:
The self grows in relatedness and develops by what it feeds on. No one is born with a self, though all are born with genetic potentialities for realization of a self which are never alike in any two individuals. . . . Allowing for genetic differences, those genetic potentialities will enable the individual to develop a self only as he is exposed to appropriate environmental stimuli (Montagu, 1964, p. 5).

Montagu feels that the human organism is oriented in the direction of self-creation, but that in our society we rarely permit human beings to create themselves.

We teach children to follow within predestinate grooves etched out upon them by their socializers. . . .

The real evil lies in the difference between what a human being is capable of becoming and what he has been caused to become. . . .

. . . . . . . . . . . . . . . . . . . . . . . .

. . . but a culture which produces ineffectual human beings is badly in need of revaluation. The teachers of the land must carry out that revaluation and the changes it dictates. They are the best qualified, or should be to remedy the ills to which man is subjected, so that he may learn to live in dignity and enjoy the autonomy and power of his own personality, of his own self (Montagu, 1964, p. 8).

Similarly, it was noted in the ASCD 1962 Yearbook entitled Perceiving, Behaving, Becoming that the preoccupation of much schoolwork with "right" answers has interfered with the growth of self acceptance.

Our whole educational structure is built upon "right" answers. Such a preoccupation is likely to produce in the individual a lack of trust in himself and his beliefs and give him the feeling that the only 'good things are those which he is not. Worship of what others
think destroys the capacity to accept one's self. There are few right answers, anyhow—only better or worse answers (ASCD, Yearbook, 1962, p. 121).

One, of course, may want to qualify this view somewhat. However, the central idea does have a degree of validity. One such qualification is that a little worry, as some research (Kowitz, 1967) suggests, may actually help a child is the child perceives himself as competent for the task. However, as Kowitz notes (1967), the child with a weakened self-concept may under certain school situations change from a state of worry where there is still control and mastery to a state of unfocused anxiety.

Lecky (1951) in his book *Self-Consistency: A Theory of Personality* states that if an individual is immersed in an environment which he does not and cannot understand, the individual may create a substitute world which he can understand and in which he puts his faith. Lecky believes that the individual "acts in consistency with this conception, derives his standards of values from it, and undertakes to alter it only when convinced by further experience that it fails to serve the goal of unity (Lecky, 1951, p. 123)."

The author notes that a person's self-made scheme of life is a source of security, and its preservation can become a goal in itself. Lecky points out that often a child unwittingly cast in the role of a troublesome child by the criticism of parents and teachers may come to act this
part continually and even find security in the role. "Youths," Lecky states, "who are placed in reformatories usually emerge not reformed, but confirmed in their self-definition as social outcasts and potential criminals (Lecky, 1951, p. 182)." Lecky notes that the response of an individual is not determined by the external stimulation as such but by the interpretation which the individual gives to the situation in consequence of learning and experience (Lecky, 1951, p. 82).

Fromm (1955) expands on Lecky's point and adds that people frequently misunderstand the psychological implications of loving oneself.

Self-love... is the opposite of selfishness. The latter is actually a greedy concern with oneself which springs from and compensates for the lack of genuine love for oneself. Love, paradoxically, makes me more independent because it makes me stronger and happier... (Fromm, 1955, p. 33).

As Fromm has suggested, it is important that the individual genuinely like himself.

Jersild (1952) in his book entitled In Search of Self states that there is a continuous impact between self and consequent self-concept which the learner has brought to school and the stream of experiences involved in the school learning environment. Jersild concludes that the learner uses this self system as a criterion for accepting, resisting, interpreting, or rejecting what he meets at school.
In the healthy course of the development of the self, one is involved in a continuing process of assimilation and integration of new experiences, new discoveries concerning one's resources, one's limitations, and one's relations with oneself and with others. . . . A person accepts and incorporates that which is congenial to the self system already established, but he seeks to reject or avoid experiences or meanings of experiences which are uncongenial. He is active in the maintenance of the self picture, even if by misfortune the picture is a false and unhealthy one. If he meets experiences which demand a modification of a false self picture, he is likely to resist, and the necessary modification, if it takes place at all, takes place only as a result of struggle (Jersild, 1952, p. 14).

Leon Eisenberg (1967), psychiatrist in charge of the Children's Psychiatrist Service of the Johns Hopkins Hospital, points out that some children who believe they will fail adopt "no-win behavior" which they believe will get them out of the situation. Eisenberg notes that teachers who don't understand this attitude of no-win ascribe it to lack of intelligence.

Eisenberg states that "no evidence exists anywhere that the intellectual potential of lower-class children is one bit different from that of middle-class children." But, the author notes, nobody would believe the potential was the same if he visited an all-negro school in the inner city and a middle-class white suburban school. Many of the children in the first school who score 2.5 on a standard reading test in the sixth grade, Eisenberg states, had precisely the same score in the third grade. In contrast,
children in the middle-class suburban school will read at higher levels and speak in long sentences.

The critical difference, according to Eisenberg, is not intellectual potential but rather self-concept, the individual's inner view of himself. The student with a high self-concept sees himself "as an active participant in the determination of his future" and possesses a conviction of competence in managing his affairs.

Eisenberg concludes that the basic answer to this problem is not "saccharine compliments from the teacher for a child who performs poorly" but providing continued experiences of success and mastery.

A sense of potency can be derived only from the experience of mastery: seeing one's self, hearing one's self, feeling one's self succeed. For a teacher to accomplish that with a child who enters school proficient in academically undesirable behavior and deficient in the fundamental skills required for academic learning, she must understand the child's range of abilities, and style of learning. Then she must build on the skills he has and work to shift his attitude so that he will try to develop competence (Eisenberg, 1967, p. 22).

This change in attitude Eisenberg concludes can in fact lead to greater real benefit and test revealed intellectual performance.

Raebeck (1965) states that teachers must ask themselves whether they create an atmosphere in which children begin to "feel and experience faith in the goodness of their selfhood."
Children, Raebeck continues, might begin to know themselves more joyously, more enthusiastically, and more hopefully. Raebeck points out that positive honest support can bring about an inner awakening in children that will transcend the fearful need for defensive behavior.

Fromm (1955) states that it is important for an individual to see the world, nature, other persons, and oneself as they are and not distorted by fears and anxiety. Fromm further notes that the more man develops this objectivity the more he is in touch with reality and the better he can create "a human world in which he is at home (Fromm, 1955, p. 64)."

**Measurement of Self-Concept**

Strong and Feder (1961) made a very comprehensive critique of the literature concerning the measurement of the self-concept. In this study the authors point out that Raimy (1948) was the first to develop a methodology for measuring self-reference changes during counseling. Todd and Ewing replicated Raimy's study and confirmed his original findings. Basically these two studies found that after successful counseling with clients, there was a statistically significant increase in positive self-references and a significant decrease in negative self-references (Todd and Ewing, 1961).
After Raimy's first study and as a consequence of other confirming research, the construct of the self-concept emerged as an important variable in the study of human behavior. It is noted that all of these studies rest on the assumption expressed by Strong and Feder that "every evaluative statement that a person makes concerning himself can be considered a sample of his self concept, from which inferences may then be made about the various properties of that self-concept (Strong and Feder, 1961, p. 170)."

Strong and Feder indicate several methods for measuring the self-concept. The more successful methods with a brief indication of their advantages and limitations are pointed out by the authors as follows:

1. **The Q Sort Technique.** The Q sort procedure requires the subject to sort various self-reference statements into a series of piles or classes along a continuum of appropriateness of self-description from those that are "least like" him to those that are "most like" him. The resulting sort is scored and compared to an external criterion of adjustment level. Another variation is to compare a "self sort" to an "ideal-sort" to a sort which would be made as to what an ordinary person is like, "ordinary-sort." Judgment is then made on the
discrepancy between the self concept and the concept of the desired or ideal self. The Q sort is very adaptable and several research studies have shown high degrees of reliability, but the one obvious limitation is that the procedure is time consuming and usually administered on an individual basis only.

2. Likert-Type Rating Method. The Likert-type method involves the use of statements or personality traits rated on a five-point scale usually ranging from "never" or "seldom" to "very often" or "most of the time." The values of the ratings are used as numerical weights, and a total score for all the items can be obtained. The authors list the following scales as examples employing this method: The Index of Adjustment and Values, The Self-Rating Inventory, The Berger Scales, The Phillips Questionnaire, The Self-Activity Inventory, The Sheerer Scale, The Jourard Questionnaire, The Fey Questionnaire, and The Ewing Personal Rating Form.

The advantage of this method is that it can be group administered and is not too time consuming.
Bills, Vance, and McLean (1951), for example, cite fairly high reliability and indicate the formation of norms for their test. Two basic limitations reported by the strong and Feder are: first, the assumption that all items are of equal importance in the calculation of a final score, and the inherent problem that subjects may tend to rate consistently in the direction of the middle or the extremes as a carry-over effect from one item to the next.

3. Free Response Methods. Questions or open-ended sentences have been used to measure self-concept. The answers are scored according to preselected categories. The W-A-Y Technique and The Incomplete Sentences Blank are cited as examples of this projective type test. Strong and Feder state that the basic limitation of these methods is obtaining validity and obtaining reliable objective scores due to the subjective judgment involved in the scoring technique.

4. Check Lists. The check list method of measuring self-concept usually involves the checking by the individual of appropriate adjectives or
statements that describe himself. Many times the individual is only asked to check those items that directly apply to him. Examples of check lists are: The Interpersonal Check List, Matteson Self-Evaluation, and Merrill and Heathers Check List. The authors suggest that a fundamental limitation is that the check list method provides no structure for qualitatively rating the separate items involved. The authors also state that each item in the check list is treated in an all-or none-fashion, and this does not determine the degree of involvement by the individual.

Strong and Feder concluded that after their review of self-concept measures, that even though some of the measures left much to be desired in terms of validity that over-all what is most promising is the tendency to approach personality adjustment in terms of a totality of response. The authors further conclude that the current measurement of self-concept reveals an apparent "objectification of what has been considered heretofore to be essentially projective techniques subject only to interview appraisal (Strong and Feder, 1961, p. 175)."

Feldhusen and Denny (1965) noted that in their study of creativity children who ranked high on a creativity scale
seemed to see much more of creative characteristics in themselves than their teachers did. The authors found that the teacher-rating of creative characteristics were significantly lower than the children's self-ratings. This study suggests that a child can report what he feels about himself, and that this measure does have validity. This view is also held by Erikson (1955) who points out that terms like "a sense of doubt," "a sense of health," and "a sense of not being well" are ways of experience and ways of behaving and as such are accessible to introspection and observable. He notes that these terms represent objective inner states that are determinable by test and analysis.

Experimental Studies Involving Self-Concept

Mandler and Seymour (1952) conducted a study at Yale exploring the relationship of anxiety with performance on typical intelligence tests. The study strongly suggested that anxiety present in the testing situation was an important variable in test performance. Two groups were formed on the basis of an anxiety questionnaire and classified as high anxiety and low anxiety groups. Each of these groups were randomly divided into three sub groups: success, failure, and neutral. Half-way through the intelligence test one subgroup was told they had done extremely well, one they had done very badly, and one was told simply to continue. This evaluation was, of course, not based on
their actual performance. The authors discovered some very interesting results. First, they concluded that it is questionable whether intelligence test scores adequately describe the underlying abilities of individuals who have high anxiety in the test situation. Secondly, the authors point out that the failure report given to the high anxiety group acted to depress the scores. Telling those students, classified as high anxiety students, they had failed when in reality they had not had a distinct effect on their performance. In contrast, the researchers discovered that those students with low anxiety actually improved their scores when they were given failure reports.

Anxiety, therefore, does not necessarily depress scores but may serve to elicit improvement. Also telling a student he is wrong may not significantly hinder the performance of some students. But, one must constantly ask whether the students in question have high or low anxiety levels. Mandler and Sarason's study strongly suggests that the anxiety level, and as the author of this study believes also, low self-concept, may determine whether it is to the student's benefit to tell him he is wrong or failing. The high anxiety student may not possess the psychological stamina to tolerate these traditional means of so-called motivation.
Taylor and Combs (1952) reports a study concerning self-acceptance and adjustment in which they found that students designated as adjusted, according to the California Test of Personality, were much more able to accept damaging or threatening statements about themselves as compared to those students designated as less well adjusted.

In a later study by Combs (Combs, 1964), one of the authors just cited, fifty junior high school boys with 115 IQ or better were divided into an achiever group and an underachiever group. The cumulative grade-point average was computed, and if this average fell below the first quartile in scholastic achievement for his grade, the boy was defined as an underachiever. A boy with an average above the median for his grade was considered an achiever.

Scores were then obtained on self-perception covering six factors: self-adequacy, self-acceptance, self-acceptance of peers, acceptance of adults, approach to problems, and freedom of expression.

Combs reports significant differences between the groups on all of the self-perception variables. The underachievers as compared to the achievers saw themselves as less adequate, less acceptable to others. They saw their peers and adults as less acceptable, showed an inefficient and less effective approach to problems and showed less freedom and adequacy of emotional expression.
Combs concluded that some school techniques for dealing with this problem are less than adequate.

Pressure or stress techniques are often applied by teachers in order to bring about the behavior or learning they desire. It is only the adequate student who can truly benefit from such stress techniques. Many of these techniques have the effect of reducing feelings of personal adequacy, of inhibiting emotional responses, and of restricting the number of approaches to particular problems. These techniques often increase the distance between the underachiever and other pupils or between him and the teachers, or restrict communication with them.

The underachiever fails to achieve because he lacks a feeling of personal adequacy. He lacks the feeling that he is accepted either by his peers or by the adults with whom he deals. Because he feels unacceptable, he cannot invest in others or run the risk of failure (Combs, 1964, p. 50).

This study, like that of Mandler and Seymour (1952), lends strong support to one of the hypotheses of this dissertation—that students with high self-concepts will be much more likely to accept and tolerate negative evaluative statements as compared to students with low self-concepts.

Several research studies uphold the idea that self-concept is an important variable in learning and that the feeling the student has about himself will, in fact, affect achievement in learning. The following five studies though somewhat different in approach lend credence to this supposition.
Wattenberg and Clifford (1964) hypothesized that measures of self-concept and ego strength would be predictive of reading achievement later in a student's school career. The authors felt there was an association between poor self-concepts and reading disabilities. The authors tested this hypothesis by obtaining measures of self-concept for 185 kindergarten children and two and one-half years later again measuring self-concept and reading achievement. Intelligence test scores were also obtained at the beginning and conclusion of the study. The authors reported that a statistically significant correlation was found indicating that measures of self-concept and ego strength are predictive of reading achievement. The mental test scores, the authors noted, were not significant as predictors of reading achievement at this particular level. The authors concluded that as earlier research has suggested "even as early as kindergarten, self-concept phenomena are antecedent to and predictive of reading accomplishment at the least (Wattenberg and Clifford, 1964, p. 466)." The authors recommended that future studies might seek experimentally to change self-concepts in order to discover whether such changes affect academic achievement.

The present study, as previously noted, though not dealing with reading achievement, is an effort to study the effect of a branching program variable manipulation
on the achievement of students studying a unit in industrial technology.

Rosenthal and Jacobsen (1968) in their book *Pygmalion in the Classroom* pointed out the effect upon grade school children of what the authors called "interpersonal self-fulfilling prophecies." This concept was described by the authors as "how one person's expectation for another person's behavior can quite unwittingly become a more accurate prediction simply for its having been made." The experiment was conducted with an experimental group of about 65 students in a public elementary school referred to by the authors as Oak School. These children were selected at random and reported to their teachers as possessing great potential for intellectual growth. Statistically significant gains in IQ were reported for the experimental group as compared to the control group on an eight-month posttest. The authors concluded that perhaps the teachers who expected improved intellectual performance were more pleasant, friendly, and encouraging to these students.

The authors further speculated that perhaps the facial expressions, physical touch, and over-all attentiveness may have lead to more rapid reinforcement of learning. In addition, it was suggested that these communications may have helped the students to learn by changing their self-concepts,
their own expectations of their own behavior, and their motivation.

A field study by Walter Borg involving about 4,000 pupils and covering a four-year period strongly suggested that when comparing ability grouped students with randomly grouped students, ability grouping is destructive to the self-concept of the slow pupil. In addition, Borg pointed out that at the higher ability level the self-concept of the student in the ability group seemed to drop over a two-year period.

The principal measure of self-concept employed in Borg's research was the Index of Adjustment and Values developed by Robert E. Bills. Borg's research findings comparing the change in student's self-concept as affected by random and ability grouping lead Borg to state:

Whether the less favorable scores on the self-concept variables that occurred rather consistently in the ability grouped samples are considered "good" or "bad" depends on one's point of view. When considered in the light of psychological research in related areas such as aspiration level, however, the author must conclude that the apparent effects of ability grouping upon the self-concept variables that emerged from the Utah study are probably harmful to the development of at least some of the pupils who are educated under such a system of grouping (Borg, 1965, p. 75).

Borg's point is related to that view advanced by Rosenthal and Jacobsen (1968).
Brookover, Thomas, and Paterson (1964) hypothesized that a significant relationship exists between self-concept of ability and school achievement. A sample of 1,050 seventh grade students revealed a statistically significant positive relationship between self-concept of ability and grade point average. The authors noted that this relationship persisted even when measured intelligence was controlled. The authors also pointed out that self-concept is significantly and positively correlated with the perceived evaluations that significant others such as father, mother, teacher, and best friend hold of the student. The authors suggested that changing the performance of students through changes in self-concept would have great practical implications for educational programs.

Albert Marston (1968) conducted several research studies dealing with low-confidence feelings of students. Marston concludes that:

"... the act of feeling self-confident can serve two functions: a. it will lead to learning and improvement in the level of skill that led to feeling self-confident, and b. it will increase the likelihood that the person will exhibit overtly that learned skill. Once self-evaluation is recognized as a response with characteristics which can be manipulated, learning theorists will have considerably widened the path for the investigation of the more complex process involved in controlling human behavior (Marston, 1968, p. 135)."
One of Marston's research studies suggested that the subject who was given positive external feedback when that subject made a positive self-evaluation learned more than the subject who was given positive feedback but made no positive self-evaluation.

Applied to the classroom, one might conclude that it is not enough to reward the child for a correct answer, but that the child must also feel that it is the correct answer to obtain the optimal learning for the child.

_Programed Instruction Research_

Schramm (1962) notes that in the early development of programing and teaching machines that extravagant claims of accomplishment and over-emphasis on machines tended to close many doors to experimentation in programing.

The fact that to make programs was much more difficult than to make machines, and that most of these programs, once made, could be studied at least as effectively without machines, took several years to soak in. By that time, most of the lay public and many school boards and school administrations had filed programed instruction with water coolers and air-conditioning, rather than with curricula and teaching method. . . . But the premature emphasis on the teaching machine has served to distract attention from the teaching program, and from the really crucial questions about how students learn and how the activities in a school are to be selected and arranged in sequence and combined (Schramm, 1962, p. 16).
Since Schramm made this observation, the literature and research suggests a more scholarly and critical view of programed instruction.

Schramm has suggested, as Cronbach, Glaser, and others have noted, that a major contribution of programing is adapting the instruction to fit different kinds of individuals rather than selecting individuals who will fit an inflexible and rigid educational structure. For instance, Ripple (1963) conducted a study at Cornell University in which two hundred and forty students in an introductory psychology class were randomly assigned to four groups each using a different method of instruction. The four methods of instruction using the same basic materials were as follows: group one used a standard programed text with reinforcement, group two used the same program but without the reinforcement, group three read the same material in conventional text form and group four listened to a lecture based on the programed material. A criterion test was administered two days after the instruction and again ten days after the instruction period. According to Ripple the programed material plus reinforcement group yielded gains of approximately 7 per cent to 16 per cent in learning efficiency over the reading text group. Statistically significant differences were found on both the two-day posttest and the ten-day retention test. The program plus
reinforcement group was also significantly higher than the lecture only group as measured on both the posttest and retention test. Ripple reports that his study supports similar findings by Holland.

Some authors have cautioned, however, that programed instruction may have weakness. Crutchfield and Covington (1966) state five potentially detrimental effects of programed instruction which paradoxically as they note stem directly from the basic pedagogical virtues of the method. First, the authors feel that programed instruction may lead to an undesirable uniformity or homogenization in both content and ways of thinking. Secondly, the highly structured and controlled character of the programed instruction might make it less able to accommodate distinctive and idiosyncratic ways of thinking. Thirdly, programed instruction might not call forth enough mental searching and striving because it is so effortless and smooth. Fourthly, programed instruction may hamper creative thought by not allowing for intelligent and critical repudiation of authority.

The sheer efficiency and effectiveness of a good program which marches the individual in a "logical lock-step" through pre-determined cognitive paths may tend to instill in the individual a sense of deference to the authority of the program (Crutchfield and Covington, 1966, p. 18).

Finally, the writers point out that a basic aim of the programed instruction is to achieve the utmost of clarity,
precision, and definiteness in each step. However, the authors contrast this goal with the ability to tolerate ambiguity, complexity, and lack of closure while progressing toward the solution of the problem. This latter ability many feel is one of the essentials of creativity.

The authors conclude that all of these five possible potentially detrimental features of programing can be overcome.

But in fact, all of these features of programed instruction potentially detrimental to creativity can be mitigated in their effects by avoiding overly strong commitment to rigid forms of programing and by inventing new programing techniques that are positively adapted to the requirements of creativity training. The self-pacing, self-directing, and self-administering features of programed instruction lend themselves directly to the requirements of creativity training, for these characteristics do place the focus of cognitive initiative in the individual, and they open the way for an optimal accommodation of the program to the distinctive cognitive style of the individual. To meet these requirements more fully, we need to emphasize and extend these particular characteristics of programing. For example, through appropriate branching techniques we need to provide for greater freedom in choice of materials and the choice need to provide better and more sensitive diagnostic tools enabling evaluation of the progress of the individual through the materials and enabling selection of appropriate subsequent steps and paths (Crutchfield and Covington, 1966, p. 180).

The latter observations by the author support the over-all approach of this dissertation in that both a program branching variable and a learner variable are examined.
Programed Instruction and Learner Variables

Carr (1960) reports that only a few studies have dealt with programed instruction and the characteristics of the learner. For example, Carr notes Porter's study which found no relationship between the sex of the student or the liking of the instructional method and achievement. Carr further states that what studies have been made tend to simply relate some characteristics of the learner to achievement resulting from programed instruction as opposed to instruction by more standard teaching methods. Carr feels that more definitive studies are needed and in reference to the above statement comments:

Although such studies answer an important question, they do not get at many possible interactions between characteristics of the learner and the other variables which influence the effectiveness of automated instruction. For example, a study relating optimum size of step to the intelligence of the learner seems very much in order. Such a study and others like it would add the concept of individual differences to the other classes of variables, all of which must be examined as part of a functional analysis of automated instruction (Carr, 1960, p. 561-562).

Stone (1965) also noted that little has been done to specify the effects of learner characteristics on performance under conditions of programed instruction. Consequently, Stone conducted a study which examined the effects of study habits and student attitudes to programed instruction. Stone hypothesized that student study habits would
not be related to performance for students receiving programed instruction but that study habits would significantly affect performance for students receiving conventional instruction. He further felt that students with positive attitudes toward concepts associated with programed instruction would perform significantly better on a criterion test of achievement gain than would those students who had a negative attitude toward these concepts.

Stone reported that the results of his study failed to substantiate these two hypotheses. Stone found no significant difference in student performance as measured on two posttests for his first hypothesis, and no significant relationship was found between student attitudes toward the program and performance as he suggested in his second hypothesis.

Goldberg, Dawson, and Barrett (1964) conducted a study in which three methods of instructing beginning statistics were compared. Forty-seven clerical employees were used as subjects for the study. One group used a programed textbook, one group used a programed teaching machine, and one group was instructed in a conventional classroom using lectures, class discussions, and individual practice in problem solving. The subjects were given three weeks of instruction after which an achievement test was administered to all students. One week later each group met and completed an
attitude questionnaire, and six months later each group was retested using the previous achievement test. The authors reported that an analysis of variance of scores on the two tests revealed no significant differences in mean scores of the three groups.

A further analysis of the data was made comparing the top half and lower half of the groups of students as measured on an intelligence and ability test. These comparisons did not show statistically significant differences among the three methods of instruction. However, the authors made some interesting observations.

It should be noted that the lower half of the classroom group attained a considerably lower score on Achievement Test 1 than either of the programed groups. Similarly, the top half of the classroom group scored considerably higher on Achievement Test 2 than either of the programed groups. Although these differences are not statistically significant nor can they be compared with each other in the present study, they do suggest differential effects of the methods of instruction on different ability groups, an hypothesis which can be tested in future research (Goldberg, Dawson, and Barrett, 1964, p. 112).

This opinion suggests that slower learners may most profitably use the programed method of instruction.

In response to the attitude questionnaire, the authors raised an interesting question. They asked to what extent do certain personality variables, such as dependency and sociability relate and interact with different teaching methods.
Woodruff, Faltz, and Wagner (1966) stated, as Schramm did previously, that with the initial development of programmed learning there was an overoptimism which assumed that this approach would meet the problem of individual differences among learners. It was thought that allowing the learner to progress through the materials at his own pace and providing maximum reinforcement would "lead the learners through a homogeneous learning experience." The authors pointed out that this expectation was short lived and educators concluded that learner variables were more critical than formerly thought.

The authors conducted a study which they hoped would give new information concerning the relationships that might exist between certain basic learner characteristics and learner accomplishments on programmed materials. The authors used ninth grade students enrolled in a general science course. These students were given a validated program entitled "Introduction to Biology." The three instruments used to establish certain learner characteristics were the Edwards Personal Preference Schedule, the Gordon Personal Inventory, and the James Internal-External Scale.

The following personality measures revealed a significant correlation at the .01 level to the number of correct responses: achievement (as measured on the Edwards Personal Preference Schedule), cautiousness, original thinking,
personal relations, and vigor (the last four items as measured on the Gordon Personal Inventory).

The authors concluded that their inquiry indicated that simply allowing the students to progress through a linear program at their individual rates of speed does not meet all of the problems of individual differences in learning performance. Furthermore, the authors did not attempt to determine the relative effects of each personality variable.

This study does lend support to the thesis that self-concept is an important learner variable in programed learning and must in some way be considered in the writing of the program.

Campeau (1965) conducted a study in which the effect of learner test-anxiety and the presence or absence of feedback in programed instruction were compared. The author noted that the emphasis on anxiety as a variable grew out of the belief that non-intellectual differences among learners must be considered in dealing with the larger problem of improving the adaptability of programed instruction.

Campeau hypothesized that students classified as high-anxious students (test anxiety defined as the tendency to become anxious in evaluation situations) would perform significantly better under a feedback program treatment, as compared to the students performance on a no-feedback
program. Campeau noted that the rationale for this assumption was as follows:

The high-anxious learner should perform best if he received feedback, as compared to no feedback, because providing feedback to the high-anxious learner would: (1) constitute a low-threat condition which, (2) by reducing anxiety, would (3) minimize task-irrelevant responses to anxiety, and finally, (4) task-relevant responses he did make would be reinforced by feedback, thereby increasing the competitive advantage of task-relevant responses over task-irrelevant responses (Campeau, 1965, p. 11).

Simply stated the student who became anxious about tests would view the program without feedback more as a test rather than the program that had feedback. When the test anxious student viewed the program as a threatening test situation, his performance and learning would be decreased.

The study used 80 fifth grade students who were consequently divided into two groups—high and low test anxiety students. An immediate and delayed posttest revealed that for girls anxiety-by-feedback interaction was significant thus confirming the hypothesis. For the boys, however, no significant effects were found. The original hypothesis did not indicate that the sex difference would be a significant factor. One might question the reported conclusion that high-anxious girls need feedback. Strictly speaking, the study does not support this ex post facto conclusion.
Campeau's study does focus on the interactive effects of certain learner variables with program variables. Also, anxiety as a psychological dimension of the learner, to some extent in girls at least, does appear to be related to presence or absence of feedback in programs. Furthermore as Campeau noted:

This study suggests that for different kinds of learning situations it is likely that anxiety, or other non-intellectual characteristics of learners, should be considered in regard to the format of instruction (programed, or otherwise) (Campeau, 1965, p. 21).

Branching Program Experiments

A review of current literature reveals that many studies have not found significant results in favor of branching programs. Other studies raise pertinent questions regarding certain branching variables. Several studies, however, have found significant results which suggest that branching programs make a difference in learning.

This section will cite several studies that found no significant difference in learning, report experiments that relate to specific objections raised concerning branching, and note several studies that show positive results for program branching.

Roe conducted a study in which he compared various branching and linear versions of a unit of instruction in statistics. The subjects consisted of 189 students enrolled
in a freshman engineering laboratory course at the University of California, L. A. Roe did not use a scrambled textbook but rather a box containing four-by-six-inch cards, each card of which consisted of one complete item in a program. The author tested what he called forward, backward, backward alternate, linear, random, and pretest forward programs. Data were collected on the learning time, error score during learning, criterion test time, and criterion test score for each student. Roe found no significant difference in learning time or test scores between the forward branching and the linear method.

Therefore, the simple branching procedures tested here do not, by and large, seem to be more effective than a linear procedure. This, however, should not discourage investigation into more complex branching procedures, particularly those which allow modifications to the branching rules or strategies during the course of student learning (Roe, 1962, p. 409).

No attempt was made in Roe's study to ascertain the effect of learner variables upon the success of the various programs presented.

Campbell (1963) reports a study which attempted to discover whether programed instruction might be improved by providing different instructional sequences. Different response modes were assumed to give greater flexibility and adjustment to individual differences among learners. The design provided three learning methods. First, the bypass version or branching method allowed the student to skip up
85 per cent of the learning material as a consequence of correctly responding to fifteen basic required steps, or if incorrect responses were made, he continued through a branch or remedial loop of instruction. Second, the short form presented no remedial branches, and the learner simply progressed through the fifteen steps in a linear pattern. The third version included the fifteen steps and all remedial branches with no opportunity to skip any of the loops. The author reported that the bypass group test means were higher than the short group means, but the long group means were higher than the bypass group.

As with all behavioral studies certain human factors may have unduly complicated the study and made certain conclusions questionable. The author, for instance, noted that with the fourth and sixth grade students about 20 per cent of all bypassing decisions were in error. In other words, students who should have taken the remedial branch or loop did not do so. The over-all effect of this problem is not known.

Another problem in the design was that the long linear version was not administered to the high school sample due to scheduling problems.

Having noted these design problems, Campbell felt that the results of the study still substantiated the statement
that the value of bypassing for either initial learning or review has yet to be shown.

Perhaps the generally accepted rationale for adaptive and remedial instruction deserves critical reappraisal. In any case the problem cannot practically be ignored. There are core subject matters in which we want all students to learn the fundamentals. Branching and by-passing in self-instruction programs may not prove to be effective for any given one, but the problem of how those who fail initially can learn to a minimum criterion of mastery will remain (Campbell, 1963, p. 345).

Duncan and Gilbert conducted a very interesting study in which they compared the effectiveness of three versions of a programed text. One version consisted of the original branching program, the second called the prime version had the branches omitted, and the third referred to as the continuous text version had all the multiple choice questions and branches removed.

Each of the three versions was presented to about twenty 15-16-year-old boys in a military school. The differences between groups as measured by an achievement test was not statistically significant. Statistically significant correlations were found in study time and between intelligence and attainment. The first correlation is not a profound discovery in that one would expect the person with higher intelligence to finish the program sooner, and the slower student would naturally take more time in that he would be reading more material in the branching. The authors
stated that "the frequency of such excursions to branches must be partly determined by intelligence (Duncan and Gilbert, 1967, p. 317)." The second correlation is more significant in that the introduction of programing variables seems to diminish the extent to which achievement depends on intelligence.

The authors presented several opinions about the results of their study. First, slightly superior immediate results were obtained from the continuous text version as compared to the two branching versions. However, on a delayed post-test the branching versions appeared to be superior to the continuous text version. These observations were not found to statistically significant in either case.

The authors state in their conclusion:

The findings of this experiment further support the view that specific features of programing style are relatively unimportant to learning once the material to be learned has been adequately ordered and structured.

Specifically, the presence of multiple choice questions and branches requires extra study time and is not associated with improved learning or with significantly improved retention after a delay of twenty weeks. However, the presence of these programing features does apparently diminish the extent to which attainment is dependent on intelligence (Duncan and Gilbert, 1967, p. 318).

The author of this dissertation feels that this conclusion, except for the last statement expressed in the last sentence, is not a warranted assumption based on the information
presented in the study. Duncan and Gilbert say there was no significant difference which means that the results they obtained might happen by mere chance rather frequently, but then conclude, as if supported by scientific evidence, that "The findings of this experiment further support the view that specific features of programming style are relatively unimportant to learning . . . ." An additional contradiction emerges when one notes that the authors state that the study statistically supports the conclusion that program variables "apparently diminish the extent to which attainment is dependent on intelligence." This certainly cannot be considered as "relatively unimportant to learning." Paradoxically the writer feels that the study does suggest that certain program variables do affect learning. If it is suggested that students with lower measured intelligence learn more by a branching program than those using a continuous text version of the same program, then one can justifiably say something important has been learned about learning.

McDonald and Allen (1962) developed a program format which they felt would maximize learning efficiency. Basically this format provided at each step in the program, an item of information and an example relevant to the information, a question on the item asked, correction of answers provided, and an explanation of the correctness of answers
and incorrectness of alternatives given. This version was tested with four other versions in which one of the above mentioned factors was omitted. The last version, and thought by the authors to be the weakest, presented only an item of information on each page of the program.

The authors randomly assigned one hundred and twenty-two high school students to the five program conditions. Two criterion tests were used—one following the program and one three weeks later. An analysis of variance of the scores revealed no significant difference for either mean scores or variances.

The authors further were of the opinion that:

The problem of research on programmed instruction is, in part then, to determine the conditions under which programmed instruction is relatively more effective than instructional alternatives. Three categories of potentially relevant factors may be the length of the program, the complexity of its content, and the ability level of the learner using a particular programming format (McDonald and Allen, 1962, p. 505).

The authors' research indirectly supports the writer's hypothesis that no significant difference in branching methods will be found between students with high self-concepts. The authors' projection of future research problems also lends support to the writer's interest in exploring one possible learner-program interaction, namely the effect of placebo and nonplacebo branching on students with low self-concepts.
Objections to Branching Programs

Branching programs usually do not contain the prompting that one finds in many linear programs. Prompting, however, may not be so critical in programing as revealed in a study by Anderson, Faust, and Roderick (1968). The authors compared two versions of a psychology program and found that the students who were given a standard version scored significantly higher on a posttest than those students who were given a heavily prompted version. The prompted version included one additional prompt on about 90 per cent of the frames. The authors reported the prompting method as follows:

Prompts were introduced according to the following rules: (a) the response term was always underlined in copying frames; (b) the appropriate article was used before each response blank and ambiguity about whether the response was plural or singular was removed; (c) in multiple-choice frames the first alternative was always correct; (d) strong connectives (e.g. therefore) were added when these emphasized existing prompts; and (e) when nothing else seemed possible, the first letter or two of the response was provided (Anderson, Faust, and Roderick, 1968, p. 89).

The authors concluded that this heavily prompted version was not as effective as the standard version because the students of the prompted version were able to respond correctly on the basis of prompts without noticing the cue. In other words, the students did not have to think about the presented material.
One might also ask whether the prompted version was so written as to be quite boring to the readers. Well-written, heavily prompted versions might not produce ineffectual learning. In this study the heavily prompted version, for whatever reason, did prove to be less effective as measured on a criterion posttest.

Branching programs are also criticized as not containing adequate feedback as compared to linear programs. Several studies raise serious questions as to the necessity of feedback at each small step taken in the program. Oppenheim (1968), Bivens (1964), and Pressey are cited as examples of those who question the degree of feedback needed in the program.

Oppenheim (1968) conducted a study in which he postulated that scores on criterion tests would be highest for students receiving 100 per cent feedback from model answers on a linear program, intermediate for those receiving feedback at a self-selected rate, and lowest for those receiving no feedback from model answers.

A posttest was given immediately following the completion of the program, and a delayed posttest was given one week later. Analysis of the test results showed no significant difference in test scores among any of the three groups. The author concluded that test performance within a wide range of intelligence was the same whether the students received 100 per cent feedback, a more limited feedback, or
no feedback in the form of model answers. The author further noted that these results are not consistent with Skinner's position that confirmation of a correct response is reinforcing and is of critical importance for the effectiveness of linear programs. Oppenheim suggests that the results of his study indicate a more flexible approach is needed to the use of linear programs. Perhaps, students do not need mechanical feedback after each response.

Bivens (1964) made a study in which he experimented with "a more flexible approach to feedback" and found results similar to those of Oppenheim. Bivens noted that conventional explicit feedback in which the correct answer is given following each program question might be replaced with a more complex and indirect procedure.

Rather than presenting the correct answer to a given program question, one might show the student the solution to a similar problem and require him to generalize from it to judge the correctness of his own answer. Such a procedure might not only produce more active student participation but might prevent immediate closure of a given concept and lead to better retention . . . . (Bivens, 1964, p. 156).

Bivens tested this assumption in a study using eighth grade students. His study failed to show that the more complex feedback method produced statistically significant learning gains as measured on an achievement test. However, as the author pointed out, substituting complex for explicit feedback did not hamper learning. This observation, Bivens
notes, suggests that immediate and explicit feedback may not be as necessary to effective programming as has previously been advocated.

Bivens also notes that clarity and logical order alone do not necessarily imply that students will attend to and learn the material.

In many small-step linear programs, much of the students' time is spent in passively responding to program items requiring a minimum of thought of interpretation. A student may complete a program with a minimal error rate without ever having interpreted or generalized the concepts in the program beyond the immediacies of required program responses. Furthermore, unimaginative application of confirmation principles in linear programs may contribute to this lack of interpretation and thought. Although there are exceptions, feedback as typically used in linear programs permits the student to check his answer and go on to the next program item with little or no further thought about the concept at hand (Bivens, 1964, p. 155).

Bivens concludes that educators should investigate programming techniques which encourage the student to think more about the concepts and participate more actively in the learning.

Pressey (1967) seriously questions the Skinner type linear fragmentation of subject matter and suggests that the learning process is more "integrative" than educators think. Pressey points out that from his experience with students incisive feedback materials adjunct to organized subject matter do aid study and greatly increase efficiency. But Pressey states that the size of the step or "frame" may
vary from a single sentence to a whole chapter. Also, Pressey contends that feedback should occur only when needed and in terms of that need.

Campeau (1965) holds a position similar to that expressed by Pressey. Campeau in her study entitled Level of Anxiety and Presence or Absence of Feedback in Programed Instruction states that:

... reinforcement is a potential component of feedback, whereby the motivational effect will depend on individual differences among learners. That is, a student who has found learning to be an unsuccessful and frustrating experience may be positively motivated by observing (through feedback) that he actually is able to give right answers as he proceeds through the program. On the other hand, a highly confident, highly able and successful student might tend to be bored or insulted by consistent provision of feedback and might thus be negatively motivated (Campeau, 1965, p. 5).

Branching Programs Showing Significance

Silberman, Melaragno, Coulson, and Estavan (1961) report a study conducted in Los Angeles county comparing three modes of programing; a fixed sequence program of instruction, a back branching program, and a textbook branching program. The study, using seventy-one high school students, revealed that the textbook method which permitted the student to branch at his own option was superior to the fixed sequence program. The back branching program indicated no significant difference when compared to the other two modes of presentation.
This study suggests that the flexibility of branching, as presented in the textbook branching, is superior to the fixed sequence method. The remedial material and prompting in the branching program apparently increased learning as compared to the fixed sequence. It should also be noted that the students using the textbook branching did not make an overt response.

Schramm (1962) reports a study by Donald G. Beane in which linear programs in geometry were compared to branching programs. The study indicated that students learned significant amounts of knowledge with both programs. The branching program was more efficient than the linear program when time was made a critical factor.

Ter Keurst (1965) reports a study in which groups using branching programs made statistically significant scores as compared to a control group using a regular classroom form of instruction. This study, however, has major design weaknesses. For instance, the experimental group was given regular classroom instruction plus the intrinsic program, and the control group was given basically only regular classroom instruction. Secondly, the experimental group was told the tests were going to be counted on the final grade whereas the control group was told the grades would not become part of the final grade. One might question the study and state that the higher grade motivation accounted for the
difference in scores, or one might conclude that spending more time on a subject whether it is programed or not will make a difference in learning. It is unfortunate in the writer's opinion that this researcher did not exercise better design and control in his experiment. Ter Keurst in the conclusion of his study suggested that the experiment showed that programed instruction need not be limited to highly structured material.

Lawson, Burmester, and Nelson (1960) report that the faculty at Michigan State University in charge of teaching the general education course in natural science developed a scrambled book branching program. The branching program was developed, the authors noted, as a possible means of handling more students per staff member by placing greater responsibility for learning upon the students themselves. The authors conducted an experiment to determine the usefulness of the branching program as compared to the regular instructional methods. Two hundred and seventy-five students were divided into two groups—experimental and control. All the students were given an objective type criterion test. A comparison of mean scores revealed a significant difference at the one per cent level in favor of the branching program group. According to the author's data the branching program was more effective in teaching, and greater learning had been achieved with the branching programed textbook as
compared with the regular instruction method. The quality of learning, apparently, had been enhanced by the use of the branching program.

Coulson, Estavan, Melaragno, and Silberman (1962) compared two groups of high school students, one using a fixed sequence program and the other using a branching program. The branching program was based on student errors and on the student's evaluation of his own readiness to advance to a new topic. The authors reported that post-test scores were statistically significant at the .05 level in favor of the branching group. Training time differences were not significant for the two groups. This experiment indicated that students learned more using the branching procedure and that student training errors and responses to self-evaluation questions provided effective criteria for branching. This study further suggests that this branching procedure did provide an accurate diagnosis of student needs.

Coulson and Silberman (1961) report several experiments comparing a branching program with a fixed sequence program. One study used 80 junior college students studying elementary psychology. Manually operated teaching machines presented one group with a simplified branching program and the other group with a fixed sequence mode. Results of the study revealed that the branching program group required significantly less training time than the fixed sequence
group. However, these two groups did not differ signifi-
cantly on a post-training criterion test.

The authors conducted another study using an automatic
teaching machine. This study compared to the above study
allowed for a much more elaborate branching procedure.
Again the researchers hypothesized that the performance of
students receiving a branching sequence would be superior
to that of students receiving a fixed sequence as measured
on a criterion test. The authors indicated the complexity
of the branching procedure.

In the branching group a student who had
made errors on relatively difficult "main stream"
items covering a topic branched to a longer re-
medial list of simpler items covering the same
topic. It was anticipated that by providing
extra remedial items to students who had dif-
ficulty, the machine would minimize the number
of items seen by the brighter students and the
number of errors made by those of low aptitude.
The over-all effect was expected to increase
the amount of learning in a given time for each
individual (Coulson and Silberman, 1961, p. 12).

The authors further noted that student aptitude, training
time, and instruction material used were statistically
equated for the two groups.

Like the first study reported, an analysis of test
scores yielded no significant difference between the amount
learned by the two groups.

A third study by Coulson and Silberman using what they
called optional branching revealed different results than
the two studies reported above. The authors state "whereas
the previous study used branching which depended on students errors, this study was designed to evaluate a procedure in which the student was allowed to branch at his own discretion (Coulson and Silberman, 1961, p. 13)." Again fixed sequence groups were compared to the optional branching group using a text-like program not a teaching machine. An analysis of criterion test scores revealed a significant difference between groups in favor of the optional branching group. The optional branching group, according to this study, learned more than the fixed sequence groups.

The important implication of this last study for this dissertation problem is that the attitude of the student apparently played an important part in the success of this branching procedure. The student who felt he needed review was given a remedial branch, and those who did not could move ahead.

Taber, Glaser, and Schaffer (1965) point out that one important advantage of branching is that it allows the programmer to capitalize on the diagnostic value of errors. If the student makes an error, he is sidetracked or branched to supplementary material designed to correct his particular error. The authors noted that well-motivated students may find the branching program more interesting than linear short frame programs.
Summary

This chapter concerned the derivation of the nature and definition of the construct of the self-concept. A brief discussion was presented of the self-concept and its relation to learning. Various methods of measuring the self-concept were given and several experimental studies involving the self-concept were reported.

A general discussion of current programmed instruction research was presented. The relationship of certain learner variables and programmed instruction were examined. Some advantages and disadvantages of branching programs were presented, and several branching program experiments were discussed. Throughout the review of literature several references were made citing possible support for the hypotheses of this dissertation. Also references were made which indicated the possible educational relevance of this study to learning practice.
CHAPTER III

DESIGN OF STUDY

This chapter will present the experimental design and hypotheses of the study. The development of the instruments, the subjects used, and the method of selection for the sample will also be discussed.

Hypotheses

The problem of this study, as previously noted, is to critically examine what relationship exists between two types of branching (placebo and nonplacebo) and students with high and low self-concepts. The hypotheses proposed by the writer are that using students with high self-concepts no significant difference exists between the placebo and nonplacebo method of branching as measured on an achievement test covering the same unit of study. Secondly, students with low self-concepts using the placebo branching program will score significantly higher than those students with low self-concepts using the nonplacebo form of branching as measured on an achievement test covering the same unit of study.

In order to statistically test the proposed substantive hypotheses, the following two statistical null hypotheses are presented.
Hypothesis I

There is no statistically significant difference between the mean achievement scores, at the .05 level of significance, of the high self-concept placebo group and the high self-concept nonplacebo group as measured on the selected achievement test.

Hypothesis II

There is no statistically significant difference between the mean achievement scores, at the .05 level of significance, of the low self-concept placebo group and the low self-concept nonplacebo group as measured on the selected achievement test.

Experimental Design

In order to test the proposed hypotheses the following experimental design was used. A model of this experimental design is shown graphically in Figure 1.

First, a sample was selected, and this sample of 173 students was given the five groupings of the first half of the California Test of Personality. This test yields a personal or self adjustment score. Since this test deals with such concepts as self-reliance, sense of personal worth, sense of personal freedom, and feelings of belonging, the writer defined this portion of the test as a measure of self-concept. If a student fell one-half standard
Figure 1
THE EXPERIMENTAL DESIGN
deviation or more below the mean, he was designated as having a low self-concept. If a student scored one-half standard deviation or more above the mean, he was characterized as possessing a high self-concept.

Consequently, from the self-concept test two groups based on the above criterion were selected and designated as high self-concept group and low self-concept group. These two groups were further subdivided by a method of random assignment into two subgroups called placebo branching group and nonplacebo branching group.

Once the 173 students in the sample had been identified as high or low self-concept students and these groups identified as control and experimental groups, then the problem was how could the high self-concept placebo and nonplacebo students and the low self-concept placebo and nonplacebo students in the same classroom be given the appropriate branching program without knowing they were being given different treatments. This was accomplished by making master lists of students in each class. This list had the names of all students in the class, and after each name a code of "P" or "NP" was written. This list was seen only by the teacher in charge of that particular class. The branching program booklets had identical covers and were of the same shape and size except for the white plastic binder. The placebo program booklets had slightly larger spiral bindings,
and the nonplacebo program booklets had slightly smaller spiral bindings. The booklets were all placed in a large box and as the teacher read the names of the students, he would note the code and give the student the appropriate booklet. All teachers in the experiment stated that no students noticed that the booklets had different size spiral bindings. If, for instance, different color bindings had been used this would have been quite evident to the students. The slight size difference, however, was never detected.

It should be further noted that those students who were not classified as either high or low self-concept students were also given the branching program booklets, but these, of course, were not used in the final analysis of data. Classes varied in the schools used in the sample. For instance, some classes had many low self-concept students and some had more high self-concept students, and some had few of either classification. The important point is that regardless of the composition of the class, all students within the classes thought they were studying the same branching program.

After the four subgroups had received the appropriate branching program, all four groups were given an identical achievement test. An analysis of the data was made between the two subgroups of the low self-concept students and between the two subgroups of the high self-concept students to determine any statistical significance. A detailed
analysis of data is presented in Chapter IV. Conclusions and inferences were drawn from this analysis of data and reported in Chapter V.

Independent Variable

The independent variable or the presumed cause is the type of branching program presented. The four groups each received the same program (Let's Look at Bridges) except for the type of branching used in the program. The non-placebo branching consisted of statements informing the student he had made correct and incorrect selections. The placebo branching informed the student that he was correct when he made a correct selection but did not tell the student he was wrong when he made an incorrect selection. The placebo review simply gave the student a review of the concept covered.

The content of the review was essentially the same for placebo or nonplacebo branching. The nature of the non-placebo incorrect response branch, of course, necessitated a different introduction to the review as compared to the nonplacebo incorrect response branch.

Dependent Variable

The dependent variable or presumed effect is the degree of cognitive learning as measured by the score obtained on
the achievement test covering the material presented in the  
**Let's Look at Bridges** program.

**Confounding Variables**

When variables other than the independent variables or  
variable account for the true change in the dependent vari­
able, then these may be called confounding variables. One  
of Fisher's contributions to research was the concept that  
groups could be equated by randomization. The author of this  
study has assumed that he has controlled confounding variables  
by randomizing these possible variables between the high self­
concept subgroups and the low self-concept subgroups.

**The Sample**

A representative sample was selected from seventh grade  
students enrolled in industrial arts classes in Columbus  
Public Schools, Columbus, Ohio. Several considerations in­
fluenced this selection. First, it was predetermined that  
a minimum of twenty students were needed for each of the four  
groups in order to yield possible statistical significance  
to the study. Secondly, all seventh grade boys in the  
Columbus Public Schools are required to enroll in industrial  
arts courses. Consequently, it was assumed by the writer  
that this grade level would be more representative than  
other grade levels in which the students elect or are  
counseled to elect industrial arts classes.
The author recognizes that a true random sample would be one in which all seventh grade boys throughout the United States would have an equal chance of being selected in the sample. This, of course, was not done due to limited funds, time, and over-all capability. However, Columbus, Ohio is considered to be one of the more representative cities in the United States. With the availability of these students, it was decided to draw the sample from students within the Columbus Public Schools. After consultation with administrative personnel and experienced teachers within the Columbus Public School system, it was decided to draw a sample from one inner city school with Caucasian and Negroid students and one suburban school with students having varied sociological and economical backgrounds. A sample of 173 students was selected from these two schools. This sample represented all seventh grade boys currently enrolled in a two-period section of industrial arts education in Barrett and Wedgewood Junior High Schools in Columbus, Ohio. A total of about thirty seventh grade boys was excluded from the sample due to only one period assignments. These students would not have been able to complete the achievement test within the same time schedule as the other students and, consequently, were not included in the sample.

Within the limitations noted above, the sample selected is assumed to be a representative sample of seventh grade
junior high school boys enrolled in industrial arts classes. It is further assumed that the two major groups selected within the sample are equal by randomization except on the variable of high and low self-concept. It is also assumed that the two subgroups selected within each high and low self-concept group are equal by randomization except for the independent variable of placebo branching.

The sample of 173 students were given the self-concept test. Those students falling one-half standard deviation or more below the mean were designated as low self-concept students, and those falling one-half standard deviation or more above the mean were characterized as high self-concept students. Using this criterion for selection, 56 students fell in the low self-concept group, and 68 students scored in the high self-concept group. By randomly removing 6 students from the low group and randomly removing 18 students from the high group a final N of 100 was obtained. Random selection placed 25 students in each of the two low self-concept groups and 25 students in each of the two high self-concept groups.

**Instrumentation**

Many possible measures of self-concept were examined, and it was determined by the author that the first five groupings of the California Test of Personality Intermediate (grades 7 to 10) Form AA would be used as the instrument for
measuring high and low self-concept. Extensive information was available on the reliability and validity of this test. The authors of the California Test of Personality define the first five personal or self-adjustment components as follows.

**SELF-RELIANCE**—An individual may be said to be self-reliant when his overt actions indicate that he can do things independently of others, depend upon himself in various situations, and direct his own activities. The self-reliant person is also characteristically stable emotionally, and responsible in his behavior.

**SENSE OF PERSONAL WORTH**—An individual possesses a sense of being worthy when he feels he is well regarded by others, when he feels that others have faith in his future success, and when he believes that he has average or better than average ability. To feel worthy means to feel capable and reasonably attractive.

**SENSE OF PERSONAL FREEDOM**—An individual enjoys a sense of freedom when he is permitted to have a reasonable share in the determination of his conduct and in setting the general policies that shall govern his life. Desirable freedom includes permission to choose one's own friends and to have at least a little spending money.

**FEELING OF BELONGING**—An individual feels that he belongs when he enjoys the love of his family, the well-wishes of good friends, and a cordial relationship with people in general. Such a person will as a rule get along well with his teachers or employers and usually feels proud of his school or place of business.

**WITHDRAWING TENDENCIES**—The individual who is said to withdraw is the one who substitutes the joys of a fantasy world for actual successes in real life. Such a person is characteristically sensitive, lonely, and given to self-concern. Normal adjustment is characterized by reasonable freedom from these tendencies. (Thorpe, Clark, and Tiegs, 1953, p. 3).
The author of this study operationally defines the scores yielded by these five measures as the measure of self-concept.

Table I presents the reliability coefficients of the five self-adjustment components as presented by the authors of the California Test of Personality.

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<td>Personal Adjustment</td>
<td>.93</td>
<td>3.57</td>
</tr>
<tr>
<td>A. Self-reliance</td>
<td>.70</td>
<td>1.64</td>
</tr>
<tr>
<td>B. Sense of Personal Worth</td>
<td>.75</td>
<td>1.50</td>
</tr>
<tr>
<td>C. Sense of Personal Freedom</td>
<td>.92</td>
<td>0.99</td>
</tr>
<tr>
<td>D. Feeling of Belonging</td>
<td>.97</td>
<td>0.65</td>
</tr>
<tr>
<td>E. Withdrawing Tendencies (FDM.)</td>
<td>.83</td>
<td>1.34</td>
</tr>
</tbody>
</table>

Source: Thorpe, Clark, and Tiegs, 1953, p. 4.

The publishers of the California Test of Personality state that the California Test of Personality is a valuable and useful instrument of research. They support this claim by citing ninety research studies using their test in a publication entitled *Summary of Investigations Number One, Enlarged Edition, California Test of Personality* (Thorpe, Clark, and Tiegs, 1953, p. 9).
Table II, as noted by the same authors, presents an item analysis of the total test for 255 students in grades 7 through 9.

**TABLE 2**

**ITEM ANALYSIS DATA FOR THE CALIFORNIA TEST OF PERSONALITY—INTERMEDIATE (255 Students—Grades 7-9)**

<table>
<thead>
<tr>
<th>PHI COEFFICIENTS</th>
<th>Per Cent of Correct Response</th>
<th>.19 and below</th>
<th>.20-.30</th>
<th>.40-.50</th>
<th>.60-.70 and above</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>6</td>
<td>19</td>
<td>6</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-89</td>
<td>4</td>
<td>12</td>
<td>23</td>
<td>23</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>18</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>60-69</td>
<td></td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>50-59</td>
<td></td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>41</td>
<td>50</td>
<td>51</td>
<td>21</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Thorpe, Clark, and Tiegs, 1953, p. 5.
The program entitled *Let's Look at Bridges* was written by the author of this study. There are many possible units of study in industrial technology, and it was decided that the topic chosen for the program should meet the following criteria. First, the subject chosen should not be one that was currently taught in the schools selected to be in the study. Secondly, the topic should be one which was of general interest to boys in a seventh grade industrial arts class.

After consultation with experienced educators in industrial technology, education, and public junior high school teachers, it was decided that the topic of building bridges met these criteria.

Since placebo branching was an invention of the author of this study, no placebo branching program concerning bridge building was available. The general subject matter was derived from several authoritative sources on bridge building. The content of this program was also correlated with material written for seventh-grade students by a practicing civil engineer, a specialist in bridge building. This material was also examined for reading level and educational relevance by professional educators at The Ohio State University.

The achievement test for the program *Let's Look at Bridges* was written by the author of this study. A sixty-item multiple choice test was written covering the material
presented in the program. This test was given to fifty-nine students not involved in the experimental study. In consultation with public school teachers, the writer assumed that these fifty-nine students were relatively similar to the students who were to be involved in the experimental sample. However, no experimental statistical data was obtained to confirm this assumption. After the test was administered, an item analysis of the test was made. Table III presents the summary statistics obtained from this analysis. It was determined that any item would be omitted if it did not satisfy the following criteria: first, the point biserial correlation coefficient must be .3 or above. The point biserial correlation shows the relationship of the item to the total score on the test thus giving a measure of the validity of that item. Secondly, the corrected phi coefficient should be .05 or less to be considered significant. Based on these criteria, ten items were removed from the test. Reliability of the original test using the Kuder-Richardson formula 20 and formula 21 was revealed to be .922 and .911 respectively.

Table IV presents the summary statistics of an item analysis made of the revised achievement test. This test had ten items removed based on the criteria stated previously. The reliability of the revised test using the Kuder-Richardson formula 20 and formula 21 was shown to be .928
### TABLE 3

SUMMARY STATISTICS FOR ORIGINAL
LET'S LOOK AT BRIDGES 60-ITEM ACHIEVEMENT TEST

Total Test Statistics -- Test Distribution
- Number of Students Taking Test -- 59
- Number of Items in Test -- 60
- Mean Test Score -- 39.51
  - Median -- 40
  - Mode -- 23
  - Maximum -- 59
  - Minimum -- 14
- Standard Deviation -- 11.37
- Skewness -- -0.43
- Kurtosis -- -0.71
- Range -- 45

Group Statistics

<table>
<thead>
<tr>
<th>PERCENT</th>
<th>STUDENTS</th>
<th>NUMBER</th>
<th>MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100.00</td>
<td>59</td>
<td>39.508</td>
</tr>
<tr>
<td>Upper</td>
<td>27.12</td>
<td>16</td>
<td>52.437</td>
</tr>
<tr>
<td>Lower</td>
<td>25.42</td>
<td>15</td>
<td>23.867</td>
</tr>
</tbody>
</table>

Reliability Estimates
- Kuder-Richardson 20 -- 0.922
- Kuder-Richardson 21 -- 0.911

Item Analysis

#### Item Difficulty Distribution

<table>
<thead>
<tr>
<th>Range</th>
<th>Number of Items</th>
<th>Percentage of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.81-1.00</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>.61-.80</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>.41-.60</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>.21-.40</td>
<td>33</td>
<td>55</td>
</tr>
<tr>
<td>.00-.20</td>
<td>10</td>
<td>17</td>
</tr>
</tbody>
</table>

Mean Item Difficulty -- .342

#### Item Discrimination Distribution

<table>
<thead>
<tr>
<th>Range</th>
<th>Number of Items</th>
<th>Percentage of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.81-1.00</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>.61-.80</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>.41-.60</td>
<td>28</td>
<td>47</td>
</tr>
<tr>
<td>.21-.40</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>.00-.20</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Below .00</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Mean Item Discrimination -- .476
### TABLE 4

**SUMMARY STATISTICS FOR REVISED LET'S LOOK AT BRIDGES 50-ITEM ACHIEVEMENT TEST**

<table>
<thead>
<tr>
<th>Total Test Statistics -- Test Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students Taking Test -- 59</td>
</tr>
<tr>
<td>Number of Items in Test -- 50</td>
</tr>
<tr>
<td>Mean Test Score -- 33.49</td>
</tr>
<tr>
<td>Median -- 34</td>
</tr>
<tr>
<td>Mode -- 31</td>
</tr>
<tr>
<td>Maximum -- 49</td>
</tr>
<tr>
<td>Minimum -- 10</td>
</tr>
<tr>
<td>Standard Deviation -- 10.54</td>
</tr>
<tr>
<td>Skewness -- -0.47</td>
</tr>
<tr>
<td>Kurtosis -- -0.77</td>
</tr>
<tr>
<td>Range -- 39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERCENT NUMBER MEAN</td>
</tr>
<tr>
<td>STUDENTS STUDENTS SCORE</td>
</tr>
<tr>
<td>Total 100.00 59 33.492</td>
</tr>
<tr>
<td>Upper 25.42 15 45.733</td>
</tr>
<tr>
<td>Lower 27.12 16 19.375</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reliability Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuder-Richardson 20 -- 0.928</td>
</tr>
<tr>
<td>Kuder-Richardson 21 -- 0.919</td>
</tr>
</tbody>
</table>

**Item Analysis**

<table>
<thead>
<tr>
<th>Item Difficulty Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range Number Percentage of Items of Items</td>
</tr>
<tr>
<td>.81-.1.00 1 2</td>
</tr>
<tr>
<td>.61-.80 2 4</td>
</tr>
<tr>
<td>.41-.60 9 18</td>
</tr>
<tr>
<td>.21-.40 29 58</td>
</tr>
<tr>
<td>.00-.20 9 18</td>
</tr>
<tr>
<td>Mean Item Difficulty -- .330</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Discrimination Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range Number Percentage of Items of Items</td>
</tr>
<tr>
<td>.81-.1.00 0 0</td>
</tr>
<tr>
<td>.61-.80 19 38</td>
</tr>
<tr>
<td>.41-.60 22 44</td>
</tr>
<tr>
<td>.21-.40 8 16</td>
</tr>
<tr>
<td>.00-.20 1 2</td>
</tr>
<tr>
<td>Below .00 0 0</td>
</tr>
<tr>
<td>Mean Item Discrimination -- .527</td>
</tr>
</tbody>
</table>
and .919 respectively. This revised test was used as the instrument to test the cognitive learning of the students after they were presented the placebo and nonplacebo program.

Two consecutive forty-minute periods were used to complete the reading of the program and the administration of the test for each class. The self-concept test was administered in one forty-minute period for each class and one week before the presentation of the branching programs. Three weeks were used in presenting the branching and administering the tests to the 173 students in the sample.

After the administration of the achievement test to the 173 students, a final item-analysis was made. The item-analysis revealed a reliability estimate of .90 using the Kuder-Richardson formula 20 and a reliability estimate of .89 using the Kuder-Richardson formula 21. The mean item difficulty was .46, and the mean item discrimination was .49. The mean test score for the fifty-item test was 27.1, the median 26, the mode 25, the standard deviation 9.75, the skewness .20, the kurtosis -1.02, and the range 37.

Summary

This chapter concerned the experimental design and method of analysis for this study. The substantive and statistical null hypotheses were presented. The subjects
selected and the criteria for their selection were discussed. The independent and dependent variables were also discussed.

The branching programs, the self-concept test instrument, and the original and revised achievement tests were presented. Summary statistics concerning item analysis and reliability for the instruments used in this study were given and discussed.
CHAPTER IV
ANALYSIS OF THE DATA

This chapter will present an analysis of the data derived from the experimental study. The two statistical hypotheses stated in Chapter III will be tested, and the significance or nonsignificance will be reported.

Test of Significance

Hypothesis I as pointed out in Chapter III states that there will be no significant difference between the mean achievement score of the high self-concept group using the nonplacebo branching and the mean achievement score of the high self-concept group using the placebo branching. Written statistically, this is shown as follows:

\[ H_0 : \bar{x}_1 = \bar{x}_2 \]
\[ H_1 : \bar{x}_1 \neq \bar{x}_2 \]

alpha level equals .05

A "t" test was used to test hypothesis I to determine if any statistically significant difference existed between the means. The decision rule states that one is to reject the null hypothesis \( (H_0 : \bar{x} = \bar{x}_2) \) and accept the alternate hypothesis \( (H_1 : \bar{x}_1 \neq \bar{x}_2) \) if the observed "t" is greater
than or less than the 2.5 per cent level as shown on a two-tailed test, then one is to accept the null hypothesis $(H_0 : \bar{X} = \bar{X}_2)$.

In order to use the "t" test for the difference between two sample means, it is necessary that the population variances, from which the samples are drawn, are equal. The F ratio is used to test the equality of the variances of the two samples used. $F = \frac{V_1}{V_2}$ where $V_1$ is the larger of the two variances $S^2 (I)$ and $S^2 (II)$ and $V^2$ is the smaller value. The degrees of freedom for the numerator and denominator are $N (I) - 1$ and $N (II) - 1$ depending on which is in the numerator and which is in the denominator. Using a level of significance of .05, the 2 degrees of freedom, the calculated F value, and a table of F values the null hypothesis $S^2 (I) = S^2 (II)$ is tested.

The means and the standard deviations of the scores of the control group I and the experimental group II were calculated. Homogeneity of the variances was checked using the F test with a two-tailed level of significance of .02. The F test for groups I and II and the F test for groups III and IV supported the assumption of homogeneity of variance.

The results of the "t" test, as indicated in Table V, reveals that no significant difference existed between the means of the two groups.
TABLE 5
T-TEST FOR SIGNIFICANCE BETWEEN MEAN OF GROUP III AND MEAN OF GROUP IV FOR LET'S LOOK AT BRIDGES ACHIEVEMENT TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group III</td>
<td>29.3</td>
<td>1.6</td>
<td>24</td>
</tr>
<tr>
<td>High Self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonplacebo (control)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group IV</td>
<td>29.6</td>
<td>1.5</td>
<td>24</td>
</tr>
<tr>
<td>High Self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo (Experimental)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F = 1.1 (not significant)
t = .8 with 48 d.f. (not significant)

Therefore, the null hypothesis is not rejected. The author's hypothesis I is upheld which states that with high self-concept learners no significant difference in learning, as measured on the selected achievement test, will result between the placebo and nonplacebo method of branching.

Hypothesis II as indicated in Chapter III states that students with low self-concepts using the placebo branching program will score significantly higher than those students with low self-concepts using the nonplacebo form of branching as measured on an achievement test covering the same unit of study. To test this directional hypothesis the null hypothesis is presented which states that no significant difference exists between the mean achievement of the placebo group and the mean achievement of the nonplacebo group. The
null hypothesis and the alternate hypothesis are shown as follows:

\[ H_0 : \bar{X}_1 = \bar{X}_2 \]
\[ H_1 : \bar{X}_1 = \bar{X}_2 \]

alpha level equals .05

A "t" test was used to test hypothesis II to determine if any significant difference exists between the means. The decision rule given is to reject the null hypothesis \((H_0 : \bar{X}_1 = \bar{X}_2)\) and accept the alternate hypothesis \((H_1 : \bar{X}_1 = \bar{X}_2)\) if the observed "t" is greater than the 5 per cent level as shown on a one-tailed test. However, if the observed "t" is less than the 5 per cent level as shown on a one-tailed test, then the null hypothesis will be accepted.

As shown in Table VI, the results of the "t" test revealed that no significant difference existed between the means of the two groups. The null hypothesis is not rejected, and the author's hypothesis II is not upheld. This experiment suggests that with low self-concept students no significant difference exists in learning, as measured on the achievement test used, between the placebo branching program and the nonplacebo branching program.


**TABLE 6**

**T-TEST FOR SIGNIFICANCE BETWEEN MEAN OF GROUP I AND MEAN OF GROUP II FOR LET'S LOOK AT BRIDGES ACHIEVEMENT TEST**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonplacebo (control)</td>
<td>23.4</td>
<td>1.7</td>
<td>24</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo (experimental)</td>
<td>23.2</td>
<td>1.6</td>
<td>24</td>
</tr>
</tbody>
</table>

F = 1.2 (not significant)  
t = .4 with 48 d.f. (not significant)

Previous research, as noted in the review of the literature, suggests that students with high self-concepts will score significantly higher on achievement tests as compared with students with low self-concepts.

Although the hypothesis that such significance does exist was not part of the study, the author felt that this comparison would be of importance to the broader implication of this study and helpful to future research studies.

A "t" test was used to determine any significant difference between the mean of the high self-concept student's achievement scores and the mean of the low self-concept achievement scores.

As shown in Table VII, the results of the "t" test revealed that a significant difference existed between the
means of the two groups. This difference was significant at the .001 level of significance. Students with high self-concepts had significantly higher achievement scores.

**TABLE 7**

**T-TEST FOR SIGNIFICANCE BETWEEN MEAN OF HIGH SELF-CONCEPT GROUP AND MEAN OF LOW SELF-CONCEPT GROUP FOR LET'S LOOK AT BRIDGES ACHIEVEMENT TEST**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Self-concept group</td>
<td>29.5</td>
<td>1.1</td>
<td>49</td>
</tr>
<tr>
<td>Low Self-concept group</td>
<td>23.4</td>
<td>1.2</td>
<td>49</td>
</tr>
</tbody>
</table>

F = 1.2 (not significant)
t = 5.1 with 98 d.f. (significant at .001 level)

This significant difference supports previous research that suggests that self-concept scores are good predictors of future academic success. Those students who do well in school think well of themselves, and conversely, those students who think well of themselves are more likely to succeed in future academic tasks.

**Summary**

This chapter presented an analysis of the data derived from the experimental study. The statistical hypothesis and decision rules for hypotheses I and II were discussed. The
"t" test of significance revealed there was no significant
difference between the means of the high self-concept pla­
cebo and nonplacebo groups. No significant difference was
found between the low self-concept placebo and nonplacebo
groups. Consequently, the author's hypothesis I was upheld,
but hypothesis II was not upheld.

The "t" test of significance revealed there was a sig­
nificant difference at the .001 level of significance be­
tween the mean of the high self-concept group achievement
scores and the mean of the low self-concept achievement
scores. Students with high self-concepts had significantly
higher achievement scores.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter will present a summary of the problem, hypotheses, and findings of this experimental study. Conclusions will be drawn from the study, and recommendations will be made based on these conclusions and implications.

Summary

A review of contemporary educational thought reveals a renewed interest in quality control applied to the processes of instructional systems. This new area of focus is characterized by objectivity, programed instruction, and a greater emphasis on the individual in the conditions of his human existence.

Programed instruction is one attempt at structuring the learning environment and specifying behavioral objectives with the resultant outcome of improving the quality and quantity of human learning.

As noted previously, authors such as Rogers (1947), Erikson (1955), Montagu (1964), and Fromm (1956) have noted the importance of what the individual thinks about himself and his ability to learn. Studies by Rosenthal
and Jacobsen (1968) have revealed that what a person thinks he can do and what others believe he can do significantly affect what, in fact, he does accomplish.

This study evolved from the current studies in programmed instruction and research in learning related to self-concepts.

A new type of branching called placebo branching was devised by the author. This type of branching was defined by the author as a branching program in which the student at no time is informed that he made a wrong or incorrect choice.

The problem of this study, stated briefly, asked what relationship exists between two types of branching (placebo and nonplacebo) and students with high and low self-concepts. The hypotheses proposed by the writer were first, with high self-concept learners no significant difference exists between the placebo and nonplacebo method of branching as measured on an achievement test covering the same unit of study. The second hypothesis stated that with low self-concept students, students using the placebo branching method would score significantly higher than students using the nonplacebo branching as measured on an achievement test covering the same unit of study.

It was indicated that the educational significance of this study was that possible new knowledge might be
obtained regarding the psychological effect of a new form of branching program, called placebo branching by the writer, with students who vary in their self-concepts. It was felt by the author that if students with low self-concepts did, in fact, find the nonplacebo branching as a source of confirmation for their inner definition that they were failures, then placebo branching might have served as a needed anodyne to their feelings of inadequacy and also have developed a more positive atmosphere for learning.

The review of literature, as cited in Chapter II, revealed numerous studies which supported the belief that self-concept is related to learning achievement.

It was also found that some studies, though not all, suggested that branching was a significant method for presenting material to the student as compared to earlier linear programing. A synthesis of the studies presented in the review of literature, in the opinion of this writer, strongly supported the two proposed hypotheses.

To test the hypotheses presented, two statistical null hypotheses were given. The experimental design involved the selection of a sample, the administration of a self-concept test to this sample, and identifying high and low self-concept groups as defined by given criteria. These two groups were each subdivided into two subgroups (experimental and control). A placebo and a nonplacebo
branching program was administered to the low self-concept group and the high self-concept group. An achievement test was given to all students. A "t" test was administered to determine if the means of the control and experimental groups varied significantly.

An analysis of the data revealed that no statistical significant difference existed between the nonplacebo branching method and the placebo branching method for students with high or low self-concepts. Consequently, the first hypothesis was upheld, but the second hypothesis was not upheld. Students with low self-concepts did not score significantly higher by using the placebo branching program. The students with high self-concepts did equally as well using either the placebo or nonplacebo method of branching. This was hypothesized by the author and was upheld.

A significant difference, in favor of the high self-concept group, was found between the high self-concept group achievement scores and the low self-concept achievement scores.

Conclusions

Based on the evidence obtained from this study, the following conclusions are presented:

1. Placebo branching as developed in this study does not significantly affect the learning of low or high self-concept students as measured on the developed achievement test.
2. Evidence from this study does strongly support the author's contention that students in a branching program do not have to be told that they are wrong in order to learn the material presented.

3. This study does support previous research that indicates that students with high self-concepts will score statistically higher on achievement tests as compared with students with low self-concepts. The author performed a "t" test of significance comparing the scores of the high self-concept group (placebo and nonplacebo) with the scores of the low self-concept group (placebo and nonplacebo) and found the high self-concept group scores to be significantly higher at the .001 level of significance.

4. Though not a major objective of this research, this study suggests that units in industrial technology can be programmed for self-instruction at the junior high school level. Consultations with teachers and students suggested that students were enthusiastic in their response to the branching program method of presentation. This assessment is not based on statistical evidence.

5. As a result of this study, a branching program for junior high school students concerning the planning and building of bridges was developed. Also a fairly well-developed and reliable test was constructed according to the item analysis reliability, mean item difficulty, and
mean item discrimination estimates of the Let's Look at Bridges achievement test item analysis.

Recommendations

As a result of the development, findings, and conclusions of this study, the following recommendations are proposed.

1. It is recommended that further research might explore the effects of placebo branching over an extended period of time such as one semester or one school year. Just as a drug might be given only once to a patient and judged ineffective because the patient did not recover the next hour, likewise, the use of placebo branching may be judged ineffective because results were not obtained due to only one administration of the branching program. Whether a more extended use of placebo branching with low self-concept students might make a significant difference in learning can only be answered by a research study carried out over a longer period.

2. It is recommended that inquiry be made into the psychological effects of telling low self-concept students that they are wrong when they make incorrect responses. This study suggests that the concept commonly held—that a person must be informed that he is incorrect in order to obtain a level where he makes correct responses—is an assumption which can be seriously questioned. Incorrect responses can
be corrected without necessarily overtly telling the learner that he has made an incorrect choice. An exploration of this concept might yield new knowledge particularly in schools defined as disadvantaged areas.

3. It is recommended that additional studies be made to determine the relationship between high and low self-concept and achievement as correlated with intelligence quotient scores. Future academic success might be better predicted with self-concept scores than with intelligence tests.

4. It is recommended that future developmental efforts involve the preparation of self-instructional programs for the teaching of industrial technology concepts as related to new curriculum innovations currently being proposed in industrial arts education. These programs could be tested and evaluated as to their effectiveness in teaching technology concepts at various grade levels.

5. It is recommended that educational programs in which attendance is not compulsory might study the effects of placebo branching and nonplacebo branching. These types of studies might determine if a significant relationship exists between factors other than achievement such as attendance, general interest, and motivation as well as the use of placebo branching. For instance, adult education professors have noted that many adults returning to the
classroom have dropped out not because they were not achieving but because they were confronted with school conditions that seemed threatening to them. A study using placebo branching in such situations might shed light on this program.

6. Finally, it is recommended that new studies develop more definitive placebo branching programs and examine what relationships these might have to other learner and program variables. Also, this author recognizes that placebo branching may be related to the achievement of low self-concept students, but that the placebo branching program used in this study was neither sensitive nor powerful enough to generate this possible real relationship. Only further development of placebo branching will provide the additional evidence required.
APPENDIX A

PLACEBO AND NONPLACEBO

BRANCHING PROGRAMS ENTITLED

LET'S LOOK AT BRIDGES
PLACEBO AND NONPLACEBO
BRANCHING PROGRAMS ENTITLED

LET'S LOOK AT BRIDGES

The following appendix contains two branching programs written by the author of this study. Since the material presented in the program was identical except for the "error or wrong answer" branching portion, the appendix will show one program except on those pages where the variable was manipulated. The branching pages for the placebo program and the nonplacebo program will be indicated at the top of each appropriate page. This notation, of course, did not appear on the programs given to the students, and the students were not given the combined program as represented in this appendix. Again it must be noted that each group received either a placebo program or a nonplacebo program. For ease of analysis to the readers of this study, the placebo and nonplacebo branches have been combined and appropriately labeled.
LET'S LOOK AT BRIDGES

The first bridges were not built by man but were fashioned by nature. A log happened to fall across a stream, or a vine growing in a tree happened to fasten itself to a tree across a stream thus forming a crude bridge. These natural bridges were probably used by early cavemen while walking in search of food.

However, man somehow learned to make his own bridges out of logs, stones, or vines. Therefore, bridges became one of the oldest engineering projects devised by man. Even today, in England, there are stone slab bridges built by cavemen that are still standing. Some bridges over 2,000 years old are still in use.

There are thousands of bridges in every part of the world, but all these bridges have certain things in common. The reading of this booklet will tell many things that apply to most old and new bridges. You will find out such things as what a bridge is, what bridges are used for, and some of the materials used to build them. You will learn the names of the main parts of bridges, and you will be able to name these parts the next time you see a bridge.

Did you know there are only five basic types of bridges in all the world? After reading and looking at the drawings in this booklet, you will be able to name these five classes of bridges. Turn to page 2.
Remember the song that said "London bridge is falling down, falling down...?" London bridge did not fall down, but several big bridges have fallen down because they were not constructed properly. Building a bridge so that it will not collapse is part of what is called planning and designing a bridge. You are going to learn some important things about how to plan, design, and build a bridge.

What Is a Bridge?

A bridge is a structure that helps you to cross over an obstacle. An obstacle is anything that gets in your way of progress or anything that blocks your passage.

If you wanted to cross from one side of a stream to the other side, but the stream was too wide to jump across, and the water too deep to wade, then the stream becomes an obstacle. The stream blocks your way. If you lay a plank or log across the stream, then you have a bridge. This bridge allows you to cross over the obstacle in your way of passage.

Bridges are used not only to cross rivers but are also used to cross over other obstacles such as a railroad, a highway, or a valley.

Some bridges only carry trains across obstacles so we call these railway bridges. Some bridges are used only for automobiles; these are called highway bridges. There are even bridges that do not carry people at all. For instance
an aqueduct or water bridge carries only water across an obstacle.

Read the following statement, and then pick the answer that you feel best answers the question.

A pipeline carrying oil was laid underground until it came to a river. Then a cable (steel rope) was stretched across the river and the pipeline fastened and suspended under the cable.

If you feel the cable connected to the pipeline is a bridge, then turn to page 10.
If you feel the cable connected to the pipeline is not a bridge, then turn to page 5.
You said the wooden part of the bridge is the substructure. This is not correct. Maybe you did not look at the word closely enough because substructure means below. So the stone supports or abutments would be the substructure.

The top part of a bridge is called the superstructure because it is on top or above. The word super means above or on top of so the whole wooden part of this bridge is called the superstructure. The bottom or below part of this bridge as with all bridges is called the substructure because the prefix "sub" means below or underneath. You can remember the word substructure means the part of the bridge that goes down into the water by thinking of a submarine that goes underneath the water.

The wooden part of the covered bridge is above or on top of the stone supports so it is called the superstructure. The stone supports are underneath and are called the substructure.

Let us find out more about bridges so turn to page 12.
Covered bridges were used in the early days of our country, but did you know that the oldest covered bridge was built in Switzerland before Christopher Columbus even discovered America.

The top part of this ancient bridge as with other bridges is called the superstructure because it is on top or above. The word super means above or on top of so the whole wooden part of this bridge is called the superstructure. The bottom or below part of this bridge as with all bridges is called the substructure because the prefix "sub" means below or underneath. You can remember the word substructure means the part of the bridge that goes down into the water by thinking of a submarine that goes underneath the water.

The wooden part of the covered bridge is above or on top of the stone supports so it is called the superstructure. The stone supports are underneath and are called the substructure.

Let us find out about the five types of bridges, so turn to page 12.
You said the cable carrying the pipeline was not a bridge. This answer is wrong; you are not correct. Remember, we said that a bridge is a structure that carries traffic over an obstacle. The cable fastened to the pipeline is the structure that carries the pipeline traffic over the obstacle. A bridge does not have to carry people to be called a bridge. A bridge may carry water, oil, or some other substance over an obstacle. The bridge may be a plank, a log, or even a rope or cable stretched across a stream.

Bridges are any kind of things (called structures) that carry traffic over some river, valley, highway, or some other obstacle.

Now turn to page 6.
Let us look at some more ideas about bridges. A bridge does not have to carry people to be called a bridge. Some bridges carry coal over a river, some bridges just carry water or oil over some obstacle. We still call these structures bridges. Remember a bridge is a structure that carries traffic over an obstacle. Traffic may be automobiles, people, trains, or even oil in a pipeline. The bridge may be a plank, log, or even a rope or cable stretched across a stream. Bridges are any kind of things (called structures) that carry traffic over some river, valley, highway, or some other obstacle.

You are doing fine in reading about bridges so let us turn to page 6.
What Are the Main Parts of a Bridge?

All bridges consist of two main parts: the superstructure and the substructure. The word super means "above" or "on top of"; therefore, the superstructure of the bridge is that part which is above, on top of, or higher. The prefix sub means underneath or below just as a submarine goes underneath or below the water. The substructure is therefore that part of the bridge which is under or below the top part of the bridge. The substructure or the below part of the bridge supports the superstructure or top part of the bridge. These two words—superstructure and substructure—look and sound alike so to tell them apart just remember that "super" means above, and "sub" means below.

The substructure (below). The substructure consists of abutments and piers. The abutments support the ends of a bridge. They also serve as retaining walls to support the earth lying under the approach roadway. Suppose you placed a plank over a small stream but the banks were muddy, and the board kept sinking into the mud. To give the board support, you place two big rocks under the plank—one on each side of the stream.

The rocks support the ends of your bridge, and so they are called abutments.
Suppose you wanted to build another bridge across a wider stream, but one plank alone would not reach across. You could place a big rock in the middle of the stream, and use two planks to build the bridge.

The big rock in the middle of the stream is called a pier. A pier is a man-made support for a bridge. The pier is the intermediate or in-between support for the bridge. Some bridges have intermediate piers, and some do not.

The substructure or below part of our second bridge has two parts. The end rocks are called the abutments, and the middle rock is called a pier. All of these parts—the abutments and pier—become the substructure.

In modern bridges, the abutments and piers are usually made of reinforced concrete. Reinforced concrete has steel rods placed in the concrete to make it stronger. Abutments and piers must rest on an earth formation which will support them. Remember, the times you have walked on soft ground or mud, and you sank into the ground. A bridge can also sink into the ground if the bridge does not have proper support. Sometimes the piers can be built on bedrock which gives the strongest support. But sometimes the bedrock formation is so far underground that a substitute formation
has to be used called piles. Piles are long pieces of steel, concrete, or timber that are driven deep into the ground. Piles are driven into the ground with pile drivers which work like gigantic hammers.

After the piles are set in place, the piers or abutments are built on top of the piles.

The superstructure (above). The superstructure is that part of the bridge which is above or on top of the substructure. In the bridge shown, the superstructure is the two planks placed on top of the rocks. In other words the superstructure rests on top of the abutments and piers. The superstructure is the part of the bridge we walk or drive across. Remember we said that the people and things that cross the bridge are called the traffic. Therefore, the superstructure carries the traffic load.

Bridge builders call the distance a bridge extends between two supports the span.

If one beam was placed over one or more piers, we would have a continuous span.
In the early days of our country many bridges were made of wood. These bridges were called covered bridges because they were covered with a roof to help keep the timbers from rotting. Large stones were placed together to support the wooden bridge.

Would you call the wooden part a superstructure or a substructure?

If you would call the wooden part of the bridge a **superstructure**, turn to page 11.

If you would call the wooden part of the bridge a **substructure**, turn to page 4.
You said that the cable carrying the pipeline is a bridge. You are right. A bridge carries traffic over an obstacle. The pipeline traffic is being carried over the river by a "cable bridge" called a suspension bridge.

You are doing fine so let us move ahead by turning to page 6.
You said that the wooden part of the covered bridge is called the superstructure. Very good. The wooden part is the superstructure because it is above or on top of the stone substructure.

Now turn to page 12.
All bridges may be classified as fixed bridges or moveable bridges. Fixed bridges are all types of bridges that are permanently anchored in place. Moveable bridges are all those bridges that lift, open, or swing out of the way.

Where boats in a waterway are too tall to pass under a bridge, a moveable bridge is used. Moveable bridges are of three basic types: the bascule bridge, the vertical lift bridge, and the swing bridge.

The bascule bridge works on the principle of the lever and tips up to permit boats to pass. The French word bascule means a teeter-totter. The bascule bridge is like a giant seesaw or teeter-totter that is tipped up in the air. If the entire length is moved, it is called a single leaf bascule bridge. If two sides are moved, it is called a double leaf bascule bridge.

The lift bridge has a center section between two towers. This span can be lifted straight up and down like a huge elevator.
The swing bridge turns on a pier in the middle of the river. The entire bridge swings around to permit boats to pass. The disadvantage with this type of bridge is that the center pier on which the bridge turns uses up valuable space in the middle of the river which is needed by larger ships.

The trend today is away from building moveable bridges. With the heavy automobile traffic and boat traffic the trend is to build high-level fixed bridges.

In the Middle Ages many castles were built with a moat filled with water surrounding the castle. This moat served as a protection against the enemy. To pass in and out of the castle a wooden bridge was built across the moat. This bridge could be lifted by cables so no one could cross the bridge.

Would you classify this bridge as a fixed bridge or moveable bridge?

If you would classify this bridge at the castle as a fixed bridge, turn to page 20.

If you would classify this bridge at the castle as a moveable bridge, turn to page 15.
You said you would build a steel truss bridge, and you are correct. The river is 200 feet wide, and steel I-beams are used only for about 80 feet spans. The steel truss is very strong and will support the heavy load of the train.

You are learning a lot about bridges so turn to page 22.
You said that the wooden bridges used in the medieval castles were moveable bridges. You are right.

Now turn to page 16.
There are five common types of fixed bridges. You are going to learn the names of these common types of bridges and something about how they are built. The five types to be discussed are the beam bridge, the truss bridge, the cantilever bridge, the arch bridge, and the suspension bridge.

The Beam Bridge. The beam bridge is a simple and easy bridge to build. The beam bridge consists of a beam placed on top of piers. The beam could be a log, a plank, a straight piece of steel, or a reinforced concrete slab. The ends of the beam rest on two or more piers. Shown here is a simple beam highway bridge. Short span highway bridges often use steel beams. Straight steel beams are made in the shape of the letter "I". This is why they are called I-beams.

Steel I-beams are connected together and placed on top of reinforced concrete piers. Steel bracing and a roadway are added to the steel beams to complete the simple beam bridge.

Beam bridges can be used for short spans up to 80 feet or so. A span, as you will remember, is the distance between two piers or supports.
Another type of beam that is used to make beam bridges is prestressed concrete beams. A prestressed concrete beam has tightly stretched strands of steel wire that squeeze the concrete together as they pull from both ends.

These large beams are stronger than ordinary reinforced concrete beams and can be used for long spans. They are not, however, as strong as steel plate-girders.

Plate-girder bridges are a special type of beam bridge. Plate-girders are large beams that are fabricated and put together by welding, bolting, or riveting many pieces of steel plates and angles. The advantage of making large plate-girders is that they are stronger than ordinary I-beams.

The way to tell a plate-girder bridge from an I-beam bridge is to look for the "haunches" of the plate-girder. The haunches are the deep "V" shaped part of the girder just over the pier. Plate-girders or built-up beams are very strong and can be used for spans from 200 feet to 400 feet. One bridge in Europe that crosses the Rhine river at Dusseldorf has a plate-girder span of 676 feet, one of the longest in the world.
If a beam is placed across piers, then you have a simple beam bridge. Commonly used beams are steel I-beams, concrete prestressed beams, and plate-girder beams.

Truss bridge. A truss is a rigid framework made by connecting straight bars together in the form of triangles.

If you fastened long pieces of wood together as shown below, you would have built a wooden truss.

The truss is made of many triangles (three-sided figures) and is very strong because the triangle resists change of shape. You can remember that the truss bridge has triangles by remembering that both words start with the letter "T."

So when you think of the word truss, think of the word triangle. The word truss means "to bundle together" so a truss is really triangles bundled together.

The old covered bridges used wood to build the trusses, but today most trusses are made of steel. Steel trusses are very strong and will carry very heavy loads. Most railroad bridges are of the truss type because of the heavy loads they must carry.

A truss bridge usually consists of two trusses— one on each side of the roadway— with floor beams and stringers connecting the trusses and making the floor of the bridge.
Truss bridges are also called a "through-type" bridge if the roadway is between the main trusses, and you can actually drive through the bridge.

If the roadway rests on top of the trusses and you drive over the top of the trusses, then it is called a "deck-type" bridge.

Imagine that you are a bridge builder, and you have to design a railway bridge that must carry the heavy loads of trains. You must also span a river that is 200 feet wide with one span. Would you build a steel I-beam bridge or a steel truss bridge?

If you feel that you would build a steel I-beam bridge, turn to page 21.

If you feel that you would build a steel truss bridge, then turn to page 14.
You said that the lift bridge used at the medieval castle was a fixed bridge. You are not correct. Fixed means that it does not move. But the lift bridge moves so it cannot be called a fixed bridge. The lift bridge at the castle is a moveable bridge. Keep in mind that if a bridge moves in any way—up, down, or sideways—it is a moveable bridge. Bridges that lift up to let boats pass underneath or bridges that lift to keep other people from crossing are all classified as moveable bridges.

Let us move on to page 16.
If a bridge is fastened down so that it cannot be lifted or moved, we call this a fixed bridge. Fixed means not moveable. If, however, we can move a bridge by lifting it up so a boat can pass underneath, or if we lift a bridge so people cannot cross the bridge, then we call this a moveable bridge. Remember, if a bridge can be moved in any direction so that it is not in the same position, then we have a moveable bridge.

Those lift bridges used in the days of kings and knights in armor were moveable bridges because they could be moved up and down.

If a bridge can be moved, it is a moveable bridge. If a bridge cannot be moved, it is a fixed bridge.

There are only two types of bridges in the world—fixed or moveable.

You are learning about bridges so let us turn to page 16.
You said that you would use a steel I-beam bridge over a 200 foot span. You are wrong. This choice is not correct. Steel I-beam bridges are good for short spans of up to 80 feet or so. If we have to span a valley that is 200 feet, we would have to consider a different type of bridge.

The truss bridge is made by using many triangles. A triangle made of steel is very strong, and so the truss bridge can carry very heavy loads like trains and heavy trucks. The truss can also be used for longer spans of several hundred feet. Most railway bridges are truss bridges because of the heavy loads they can carry.

You are learning a lot about bridges so turn to page 22.
Let us learn more about steel I-beam and steel truss bridges. Steel I-beam bridges are good for short spans of up to 80 feet or so. If we have to span a valley that is 200 feet, we would have to consider a different type of bridge.

The truss bridge is made by using many triangles. A triangle made of steel is very strong, and so the truss bridge can carry very heavy loads like trains and heavy trucks. The truss can also be used for longer spans of several hundred feet. Most railway bridges are truss bridges because of the heavy loads that they can carry.

You are learning a lot about bridges so turn to page 22.
The Cantilever Bridge. The modern cantilever bridge is usually built with trusses that project out from the piers and connect in the center by a suspended span.

Modern cantilever bridges have several advantages. First, they are very strong bridges because they use the truss triangle type of construction. However, the greatest advantage is that you can build the cantilever across a river without using temporary supports to hold up the truss while you are building the bridge. These temporary piers are called falsework. Ordinary truss bridges usually use falsework while they are being built. But boats cannot pass while the temporary falsework is in place, and falsework can only be used in shallow rivers.

If the river is deep or if you cannot stop the passage of ships, then the cantilever bridge can be used. The cantilever trusses can be built without falsework because as the steel trusses are built out over the river, they are balanced by the portions on the other side of the piers.

To cantilever a truss means to balance the truss and to project it outwards. A diving board is anchored on the end
so when you walk out on the board, it does not fall into the water. The cantilever bridge is somewhat like two giant truss diving boards extending out from both sides of the river. The light center portion of the bridge is suspended from the two cantilever arms.

The ancient Chinese used to pile rocks at the sides of streams. Various lengths of poles stuck out from the rocks as shown below. Sticks were placed on the poles, and they would support people as they crossed the bridge.

If you feel that this ancient method is an example of a simple beam bridge, then turn to page 25.

If you feel that this ancient method is an example of a cantilever bridge, then turn to page 30.
You said the Old London Bridge was a deck type arch bridge, and you are right. The stone arches under the roadway tells you it is a deck type arch bridge.

Now turn to page 31.
You said the ancient Chinese bridge is an example of a simple beam bridge. This is wrong. The bridge shown is an example of a cantilever bridge.

Remember the word "cantilever" means a projecting beam or lever. A pole that is weighted down on one end and projects out is an example of a cantilever. A diving board or a balcony that projects out is also a cantilever type of construction.

The bridge shown here is an example of a cantilever bridge. Wooden beams are supported in stone abutments and project out from both sides of the river. A short wooden beam connects the two arms. The ancient Chinese originally used this method of cantilever construction.

The bridge shown below uses the same cantilever principle, but it has two piers with projecting arms from both sides of each pier. Notice the short "suspended span" between the two cantilever arms. Modern bridges use steel truss cantilever arms and are built over deep rivers where falsework cannot be used. Cantilever bridges can span long distances up to 1800 feet in length. Now turn to page 26.
Let us learn some more about cantilever bridges. The word "cantilever" means a projecting beam or lever. A pole that is weighted down on one end and projects out is an example of a cantilever. A diving board or a balcony that projects out is also a type of cantilever construction.

The bridge shown here is an example of a cantilever bridge. Wooden beams are supported in stone abutments and project out from both sides of the river. A short wooden beam connects the two arms. The ancient Chinese originally used this method of cantilever construction.

The bridge shown below uses the same cantilever principle, but it has two piers with projecting arms from both sides of each pier.

Notice the short "suspended span" between the two cantilever arms. Modern bridges use steel truss cantilever arms and are built over deep rivers where falsework cannot be used. Cantilever bridges can span long distances up to 1800 feet in length. Now turn to page 26.
The Arch Bridge. The arch bridge is one of the oldest types of bridge designs. The Romans who were among the greatest bridge builders of ancient times built circular stone arches. Many of these bridges built over 2,000 years ago are still standing. Today arch bridges are usually made of steel or reinforced concrete.

An arch bridge is a bow-shaped structure in which the forces of the load or weight placed upon it produce an outward thrust.

Man long ago discovered that the forces created in the stone arch keep all the stones locked in place. The bridge engineer would say that the arch is in "compression" throughout the length and width, and this is what keeps the stones in place.

Arch bridges can carry heavy loads and work very well when built over ravines (narrow valleys) with steep, secure walls.

Here is the idea of how the modern arch bridges work. If you bowed a stick and placed it between two heavy rocks, the rocks
would keep it bowed. You could also push down on the bowed stick, and it would carry a heavy load.

Another way to keep the stick bowed would be to tie a string across the ends of the bowed stick just like an archer's bow.

If we used a steel roadway as the bowstring to tie the arch together, we would have a "tied arch" bridge.

We have described two types of arch bridges—the regular arch that pushes against the abutments or rock walls of a ravine and the tied arch that pulls against the "bowstring-like" roadway.

Modern bridges use steel and reinforced concrete rather than stone and wooden timbers as the early bridge builders used. Steel arches often use a curved "box" girder or curved trusses. The roadway sometimes is hung from the arch to make a through-type bridge.
Or sometimes the roadway is placed on top of the arch to make a deck-type bridge.

Arch bridges are very attractive bridges and can carry heavy loads over long spans. The world's longest arch bridge is the Bayonne Bridge near New York City. This arch bridge has a 1,652 foot main span. Another famous arch bridge is in Sidney, Australia. It has a 1,650 foot span. These two bridges both use a steel arch. The steel arch in the Sidney Bridge exerts a pressure against the abutments of about 20,000 tons. This gives an idea of the tremendous strength of the steel arch. Compare this force to the few pounds of pressure on the bow string of an archer's bow.

The longest concrete arch bridge was built in 1962 in Sidney, Australia. This bridge, known as the Gladesville Bridge, has a 1,000 foot span.

Remember arch bridges may be made of stone, wood, steel, or concrete. The arch may press outward against abutments or be a tied arch. If you go through the arch, it is a through bridge, and if you drive over the top of the arch, it is a deck bridge.
From about 1200 to 1800 the famous Old London Bridge spanned the Thames River in London, England. What was so unusual about this bridge was that after the bridge was completed, people built houses and shops on top of the bridge. It was considered very fashionable to, in Queen Elizabeth's day, say that you lived on London Bridge. The bridge was originally forty feet wide, but after shops and houses were built on the bridge, the roadway became a dark narrow tunnel-like passage. The houses had to be propped up from the sides as they projected out over the river. Some of these houses were poorly constructed, and in 1481 one house fell off the bridge drowning five men. At one time there were over a hundred houses built on the bridge. In the 1820's a New London Bridge was built to replace the Old London Bridge. This bridge has no houses or shops built on the roadway.

Look at the sketch of Old London Bridge. Was this bridge a deck type arch bridge or a through-type arch bridge?

If you feel that Old London Bridge was a through-type arch bridge, then turn to page 31.

If you feel that Old London Bridge was a deck-type arch bridge, then turn to page 24.
You are right. This ancient Chinese bridge is an example of a cantilever bridge.

Now turn to page 26.
You said that the Old London Bridge was a through-type arch bridge, but this is not correct. The Old London Bridge had arches under the roadway. Therefore, it was a deck-type arch bridge.

The Old London Bridge had nineteen stone arches and was 936 feet long. The roadway was built on top of these stone arches. Remember if a roadway rests on top of an arch or arches, it is called a deck-type bridge. Most of the thousands of arch bridges in the world are deck-type arch bridges.

with the roadway placed on top of the arches.

However, some of the modern steel arch bridges use a steel arch that rises high in the air. The roadway is suspended or hangs from the arch. These bridges with the roadway going through the arch are called through-type arch bridges.

Now turn to page 32.
Here are some more interesting points about the Old London Bridge. The Old London Bridge had nineteen stone arches and was 936 feet long.

The roadway was built on top of these stone arches. Remember if a roadway rests on top of an arch or arches, it is called a deck-type bridge. Most of the thousands of arch bridges in the world are deck-type arch bridges.

With the roadway placed on top of the arches.

However, some of the modern steel arch bridges use a steel arch that rises high in the air. The roadway is suspended or hangs from the arch. These bridges with the roadway going through the arch are called through-type arch bridges.

Now turn to page 32.
The Suspension Bridge. Suspension bridges were first made thousands of years ago in countries that had warm climates. Long vines grew in these areas, and these vines were strung across rivers between trees. Men would simply crawl across these vines hand over hand. Later more vines were fastened together, and floors and hand rails were added. Also the vines were fastened to large rocks if there were no trees to anchor the cables. These large rocks became the anchorage for the vine cables.

Modern suspension bridges use the same idea of the ancient vine suspension bridges. However, bridges today are much stronger and have main spans usually of 1500 feet to the world's longest span of 4,260 feet.

There are four main parts to a suspension bridge: the cables, the towers, the anchorages, and the roadway.

The cables carry the load of the roadway and traffic. These cables must be very strong. To make strong cables, engineers use thousands of high-tensile steel wires. These wires are bound together and covered with a corrosion-resistant material to form large cables. The cables used in the Golden Gate Bridge (span 4,200 feet) are made of individual wires.
Each one of these steel wires which are about as big around as a lead pencil is strong enough to support the weight of two automobiles. Each cable used 27,572 of these wires to make a cable that was over three feet in diameter. If you took all the wire out of these cables, you could wrap it around the earth four times.

Sometimes in shorter bridges, chain or long eyebars are used to make suspension cables. However, most large suspension bridges use the wire cables.

The Towers. Most suspension bridges today use steel towers to support the cables. In the past wood, stone, and iron were used. The tallest bridge towers ever erected were the two towers of the Golden Gate Bridge. These towers soar 746 feet into the sky. At the top of the towers are placed cable saddles. These saddles are large smooth pieces of steel which keep the cables from "digging into" the tops of the towers.

The two cables pass over the towers and are anchored to the earth.

The Anchorages. The anchorages are what hold the ends of the cable to the earth. The anchorages keep the cables from falling and must support the weight of thousands of tons of pulling from the cables.
Ancient vine suspension bridges used trees or large stones for anchorages. Today the large suspension bridges are either anchored directly into the bedrock of the earth’s surface or into large concrete anchorages. Concrete anchorages are often several hundred feet wide and a hundred or more feet high. The cables are anchored to steel eyebars imbedded in the huge masses of concrete.

The Roadway. The roadway or bridge deck is the portion of the suspension bridge that carries the traffic. The roadway is suspended under the cables by strong "suspender" cables. An important part of the roadway is the stiffening trusses which stiffen and strengthen the roadway. The roadway or bridge deck is built out from each main tower to equalize the weight on both ends of the main span and the side spans.

Erecting a Suspension Bridge. To build a modern suspension bridge, you first build the supporting foundations or piers for the towers. These foundations may extend down one hundred feet or more. The towers are erected on the tower foundations or piers. At the same time the massive cable anchorages are built.

After the towers are erected and the cable anchorages are built, the cables are made. This process is called cable-spinning. This means that two or more slim wires are fastened to the anchorage on one side and carried up and over each tower and finally fastened to the anchorage on the opposite side of the bridge. On large suspension bridges
It takes over 200 days to spin the cables. Eighty thousand miles of wire were used to spin the two cables of the Golden Gate Bridge.

Finally, the stiffening trusses and roadway are suspended from the two main cables by smaller suspender cables. The suspension bridge has the advantage of being able to span long distances. The longest single span of any type bridge in the world is the Verrazano-Narrows Bridge in New York. This bridge is 4,260 feet. However, this is only 60 feet longer than the Golden Gate Bridge in San Francisco which is 4,200 feet.

We have learned that there are five types of bridges called beam bridges, truss bridges, cantilever bridges, arch bridges, and suspension bridges. The bridges all have fixed piers and abutments. However, sometimes bridges are built on boats or floating piers called pontoons. The pontoon bridge might use beams or trusses on the floating pontoons. Pontoon bridges are usually temporary bridges, but some pontoon bridges are permanent. The largest permanent pontoon bridge in the world is the Lake Washington Bridge in Washington state. The floating span of this bridge is over 600 feet long.

Imagine that you are building the world's longest suspension bridge. Would you build the roadway across the river first, and later build the anchorages, and cables, and then build the roadway?

If you would build the roadway first, then turn to page 45.

If you would build the towers, anchorages, and cables first, then turn to page 37.
You said that you would first consider many different ways to get to the island, and you are correct. Very good.

A suspension bridge may or may not be the type of bridge needed. Feasibility studies, cost estimates, and preliminary designs are all needed before a final design is decided upon.

Turn to page 42.
You said that you would build the towers, anchorages, and cables first. You are right. The roadway could not be built first because it is supported by these three main parts.

Turn to page 38.
Planning and Design of Bridges

There are four stages in the planning and design of a bridge: the feasibility study, the preliminary designs, the cost estimates, and the final design.

One of the first steps in planning bridges is to simply ask whether we really need the bridge and for what are we going to use the bridge. We might decide that not very many people would use the bridge, and so we would use a boat to carry the people across the river. This first phase is called the feasibility study and is the first step in any modern bridge planning. The feasibility study tries to find out if it is a good idea to build the bridge in the first place.

If you have decided that it is worth while to build the bridge, the second step in planning is to make several designs for the bridge. These beginning designs or plans are called the preliminary designs. During the preliminary planning phase you ask such questions as exactly where is the bridge to be located and what does the bridge have to do.

Is the function of the bridge to carry only people who are walking, or does the bridge have to carry automobiles and trains? We also have to determine how high the bridge should be and how long the span must be to cross the obstacle. Other important questions might be whether the bridge should be moveable or fixed and whether we can use intermediate piers to support the bridge. We would also study what materials we had available to use in the construction of the bridge.
After we have decided what type of bridge we are going to use, we next must determine how much the bridge will cost. The cost estimate study tries to get a fairly close idea of what the total cost of the bridge will be. Bridges may cost thousands to millions of dollars depending on the size and location. Usually the cost of the substructure is about equal to the cost of the superstructure.

The last planning phase is to draw the final design for the bridge that has been selected. The final design shows the shape of the bridge, the size of each part of the bridge, and what kind of material will be used. These plans and directions are used by the men who erect the bridge.

Most bridges are owned by some division of government: federal, state, city, or county. These bridges are paid for by the taxes collected from the people in the community. Bridges are also owned by railroads, pipeline companies, and other businesses. Some individuals own small bridges.

Imagine that you are a civil engineer, and the people of a city want to develop a fast means of getting from their city to an island one mile from the coast. What would be some of the first things that you would do when you meet with the city officials to discuss this problem?

If you feel that you would first draw up the detailed plans for a one-mile suspension bridge and present this to the city officials, then turn to page 41.

If you feel that you would first ask how many people need to get to the island, how much do they want to spend, and then draw several preliminary plans of different ways to get to the island, then turn to page 36.
Very good! You saw that the truck was a "live load" and just too heavy for the bridge.

Now turn to page 47.
You said that you would draw the plans for a one-mile suspension bridge. This would not be the first step. You did not carefully consider the problem.

Designing and erecting bridges involves much planning. One of the first steps is to determine what the need is and how you can best meet that need.

If people had to get from a city to an island one mile away, you as a civil engineer would first think of all the possible ways to get people from one place to another. If not many people were involved and the people of the city only had a small amount of money to spend, then a fast ferry boat might be the answer. If the water was calm and shallow between the city and the island, then it might be possible to build many piers. Simple beam bridges could then be built from one pier to the next. This solution would cost much less than a single span suspension bridge. On the other hand if many people needed to go quickly to the island daily, and money was available, and if deep rough water lay between the city and the island, then a suspension bridge may be the final solution. The important point is that before a final type of bridge and detailed designs are selected, many preliminary questions must be answered.

Feasibility studies, cost estimates, and preliminary designs are all needed before a final design is decided upon.

Turn to page 42.
Designing and erecting bridges involves much planning. One of the first steps is to determine what the need is and how we can best meet that need.

If people had to get from a city to an island one mile away, you as a civil engineer would first think of all the possible ways to get people from one place to another. If not many people were involved and the people of the city only had a small amount of money to spend, then a fast ferry boat might be the answer. If the water was calm and shallow between the city and the island, then it might be possible to build many piers. Simple beam bridges could then be built from one pier to the next. This solution would cost much less than a single span suspension bridge. On the other hand if many people needed to go quickly to the island daily and money was available and if deep rough water lay between the city and the island, then a suspension bridge may be the final solution.

The important point is that before a final type of bridge and detailed designs are selected many preliminary questions must be answered. Feasibility studies, cost estimates, and preliminary designs are all needed before a final design is decided upon.

Turn to page 42.
Now that we have learned that there are four phases in planning and designing a bridge let us learn some terms that engineers use in designing the bridge structure. If you decide to build a bridge, you can use these ideas in your preliminary and final designs.

The terms we will learn deal with loads and forces. These terms are dead load, live load, wind load, and temperature stresses. Loads and forces are the weights and pressures that act upon a bridge. It is very important that the bridge is so designed that it will resist the loads and forces placed upon it.

Dead load refers to the weight of the bridge by itself. Suppose that you placed a long thin plank across a stream, and you saw that the plank sagged.

The weight of the board itself is the "dead load," and the dead load must be considered in the design of all bridges.

If you stand in the middle of the plank that you placed across the stream, you would notice that now the plank sags even more. Your weight is called the "live load." If you rode your bicycle across the plank, both you and the bicycle would be the "live load." Whatever traffic the bridge carries
is called the "live" load. Some bridges are designed to carry heavier "live" loads than others.

You might also notice that when the wind is strong, the bridge that you built shakes and lifts up and down. The force of the wind is called the wind load. A suspension bridge called the Tacoma Narrows Bridge in the state of Washington used to heave up and down like a roller coaster. The wind load caused the bridge to move up and down so much that people called it "Galloping Gertie." One day the wind was blowing forty miles an hour, and the bridge started to twist and gallop. However, this time the movement was so great automobiles could not cross the bridge. The bridge was heaving up as high as 28 feet. Finally as people watched from the banks, the roadway tore loose and crashed into the water. Fortunately no people were on the bridge, and no lives were lost. This bridge had been well-designed for all loads and forces except wind load.

Temperature stresses are caused by the expansion and contraction of materials when subjected to temperature changes. For instance, steel bridges are actually longer in the summer than in the winter. Heat causes the steel to expand and lengthen. The Golden Gate Bridge, the second longest suspension span in the world, is five to six feet longer in the summer than in the winter. Also, in cold weather the cables contract or get smaller, and this causes the roadway to lift about 15 feet. Steel bridges expand and contract about one inch for every 100 feet of span.
Not only steel but also wood and concrete expand and contract under temperature changes. Consequently, temperature changes must be considered in all bridge designs. In the construction of a simple beam bridge, a space is left between the ends of the bridge and the concrete abutment. This small space allows the bridge to expand and contract without breaking the abutments.

Remember the dead load is the weight of the bridge itself, the live load is the weight of the traffic on the bridge, and the wind load is the effect of the wind on the bridge. The temperature stresses in the bridge are caused by the expansion and contraction of the materials in the bridge due to temperature changes.

A heavy truck load with stone was crossing a wooden bridge that had recently been built in a public park. The truck was halfway across the bridge when suddenly the bridge collapsed. The bridge and truck fell into the water, but fortunately the driver was not seriously injured.

If you would say that the bridge collapsed because the "dead load" was too great for the bridge, then turn to page 46.

If you would say that the bridge collapsed because "live load" was too great for the bridge, then turn to page 40.
You said that you would build the roadway first and later build the towers, anchorages, and cables. You are wrong. In a suspension bridge the cables, towers, and anchorages are all needed to support the roadway. The roadway cannot support itself in a suspension bridge.

The modern suspension bridge is a marvelous engineering structure. It is composed of three main parts: the cables, towers, and anchorages. The towers support the cables and lift them high in the air. The anchorages hold the cables in place. After these three parts are in place, the roadway is hung or suspended from the cables. The cables carry the weight of the roadway and all the traffic on the roadway. The roadway cannot support itself. If you tried to build the roadway first, it would simply sag and fall into the river. Therefore, the towers, anchorages, and cables are built first. The last part that is constructed is the roadway. Turn to page 38.
Let us look at some additional information about suspension bridges.

The modern suspension bridge is a marvelous engineering structure. It is composed of three main parts: the cables, towers, and anchorages. The towers support the cables and lift them high in the air. The anchorages hold the cables in place. After these three parts are in place, the roadway is hung or suspended from the cables. The cables carry the weight of the roadway and all the traffic on the roadway. The roadway cannot support itself. If we tried to build the roadway first, it would simply sag and fall into the river. Therefore, the towers, anchorages, and cables are built first. The last part constructed is the roadway. Now turn to page 38.
You said the bridge collapsed because the "dead load" was too great for the bridge. You are wrong. This statement is not correct. The heavy truck was a "live load" placed on the bridge, not a "dead load."

Many years ago a bridge was being built using a long wooden truss and a wooden roadway. While the bridge was being built, braces called falsework were used to hold up the truss. These were to be removed after the arch was completed. After the arch was finished, the workmen removed the temporary supports, but to their disappointment the bridge collapsed. There was no one on the bridge. The bridge had collapsed because the weight of the bridge alone was too great. This is called "dead load."

Suppose you placed a long board across a stream, and then the board sagged so much that it collapsed before you could even step on it. You would have an example of the "dead load" being too great for the bridge.

When people, automobiles, trucks, trains, and other traffic are placed on a bridge, you have "live loads." Signs are often placed on old bridges showing what the "live load" limits are.

Remember "dead load" means the weight of the bridge when there is no traffic on the bridge. "Live load" means the weight of the traffic placed on the bridge. An automobile or a truck on a bridge is an example of a "live load."

Now turn to page 47.
Many years ago a bridge was being built using a long wooden truss and a wooden roadway. While the bridge was being built, braces called falsework were used to hold up the truss. These were to be removed after the arch was completed. After the arch was finished, the workmen removed the temporary supports, but to their disappointment the bridge collapsed. There was no one on the bridge. The bridge had collapsed because the weight of the bridge alone was too great. This is called "dead load."

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Remember "dead load" means the weight of the bridge when there is no traffic on the bridge. "Live load" means the weight of the traffic placed on the bridge. An automobile or a truck on a bridge is an example of a "live load."

Now turn to page 47.
Bridges are designed by civil engineers, sometimes assisted by architects and by manufacturers of steel and concrete products.

A contract is an agreement between two or more people to do something. Contracting to build a bridge means obtaining agreements by builders to construct the bridge a certain way and for a certain cost. There are several methods of contracting for a bridge. A general contractor may receive an award for the whole job; he may build the abutments, piers, and roadways with his own employees, but subcontract the superstructure to a steel company which manufactures, fabricates (puts together), and erects the superstructure supports.

Sometimes two or more contractors, one a specialist in heavy concrete work and the other in bridge superstructures, will work together as a team to do the job. At other times, the owner may award separate contracts for the substructure and the superstructure. Principal craftsmen employed in building bridges are ironworkers, operating engineers (equipment operators), carpenters, cement finishers, and laborers.

**Summary**

Bridges are structures that carry traffic over an obstacle such as a river, highway, or valley. All bridges
Consist of two main parts: the substructure (piers, abutments, and foundations) and the superstructure (roadway and other parts of bridge resting on the substructure). Bridges are either moveable or fixed. Three types of moveable bridges are the bascule (single or double leaf) bridge, the lift bridge, and the swing bridge. Five basic fixed bridges are the beam bridge, the truss bridge, the arch bridge, the cantilever bridge, and the suspension bridge. Bridges may also be classified as either a deck-type or through-type. Rigid frame bridges and pontoon bridges are special types of bridges. Bridges must be carefully designed and erected to insure the safety of the traffic crossing the bridge. Deck load, live load, wind load, and temperature stresses are some forces that must be considered in the design of a bridge. Large bridges cost millions of dollars and are usually owned by a division of government. Some bridges are owned by private companies and some by individuals. Civil engineers, architects, and specialists from bridge building companies may design and erect bridges. Bridges tell much about how advanced and how industrially developed a country has become. Bridges are built to meet certain needs of people.

END OF BOOKLET
APPENDIX B

ACHIEVEMENT TEST

FOR BRANCHING PROGRAM ENTITLED

LET'S LOOK AT BRIDGES
LET'S LOOK AT BRIDGES

Achievement Test

Directions:

1. The items on this test are multiple choice items designed to see how much that you know about bridges.

2. You will record your answers to the questions on a separate answer sheet. Do not make any marks in the test booklet.

3. When you have chosen the answer that you think is correct, blacken the appropriate blank neatly and completely.

4. If you change your mind about an answer, erase your first mark completely and make a new one.

5. Be sure that your name is on the answer sheet.
1. People and things that cross a bridge are called:
   A. wind load.
   B. traffic.
   C. contracts.
   D. business.

2. The word superstructure means the structure which is:
   A. above.
   B. below.
   C. beside.
   D. underneath.

3. The distance a bridge extends between two supports is called:
   A. the live load.
   B. the falsework.
   C. the span.
   D. the truss.

4. An example of a fixed bridge is:
   A. a swing bridge.
   B. an arch bridge.
   C. a vertical lift bridge.
   D. a bascule bridge.

5. A wooden plank is placed across a stream. This footbridge is an example of a simple:
   A. truss bridge.
   B. beam bridge.
   C. suspension bridge.
   D. pontoon bridge.

6. The substructure of a bridge is best described as that part which is:
   A. below the superstructure.
   B. above the superstructure.
   C. beside the superstructure.
   D. on top of the superstructure.

7. A pier is best described as:
   A. a part called the superstructure.
   B. a man-made support for a bridge.
   C. a part to which cables are fastened.
   D. a plate girder member.
8. Long pieces of steel driven into the ground are called:
   A. towers.
   B. abutments.
   C. falsework.
   D. piles.

9. The Romans built stone aqueducts like the one shown. These bridges were:

   \[ \text{\includegraphics{aqueduct.png}} \]

   A. beam bridges.
   B. arch bridges.
   C. truss bridges.
   D. suspension bridges.

10. The bascule bridge works much like:

    A. an elevator.
    B. a swing.
    C. a teeter totter.
    D. a merry-go-round.

11. Temporary piers or supports used during bridge construction are called:

    A. falsework.
    B. abutments.
    C. girders.
    D. cantilevers.

12. Over 2,000 years ago Alexander the Great used floating bridges made from boats and wooden planks. This type of bridge is called:

    A. a truss bridge.
    B. a through bridge.
    C. a pontoon bridge.
    D. a water bridge.

13. A footbridge hanging from two cables stretched across a stream is an example of a simple:

    A. suspension bridge.
    B. beam bridge.
    C. arch bridge.
    D. truss bridge.
14. A bridge that turns on a pier in the middle of the river is:

A. a suspension bridge.
B. a lift bridge.
C. a swing bridge.
D. a bascule bridge.

15. When a large beam is made by bolting, riveting, or welding many pieces of steel plates together, it is called:

A. a plate-girder.
B. a simple I-beam.
C. a prestressed beam.
D. a timber beam.

16. A load placed on top of an arch produces a thrust which is:

A. inward.
B. outward.
C. inward and upward.
D. upward.

17. The process of making large cables from smaller steel wires is commonly called:

A. cable-linking.
B. cable-binding.
C. cable-twisting.
D. cable-spinning.

18. Imagine that you are designing a highway bridge near a large city. Would you design the bridge to carry the weight or load of:

A. the fewest automobiles to use the bridge at one time.
B. the greatest number of automobiles to use the bridge at one time.
C. about the average number of automobiles to cross the bridge at one time.
D. only the weight of the bridge itself.

19. One of the advantages of building a cantilever bridge across a river is that:

A. falsework can be used to support the beams.
B. hundreds of piers can be built in the water.
C. boat traffic need not be stopped.
D. automobile traffic need not be stopped.
20. The anchorages of a suspension bridge support the:

A. cables.
B. towers.
C. piers.
D. roadway.

21. During an extremely cold winter a 200 foot steel span will become about:

A. two inches shorter.
B. two inches longer.
C. two feet shorter.
D. the same length as in summer.

22. The type of bridge shown is:

A. an arch bridge.
B. a truss bridge.
C. a suspension bridge.
D. a cantilever bridge.

23. The small space between the ends of a beam bridge and the abutments is needed to allow for:

A. wind load.
B. live load.
C. dead load.
D. temperature stresses.

24. Upon the removal of falsework from beneath a bridge span, the bridge collapsed from its own weight. This collapse was due to:

A. live load.
B. dead load.
C. wind load.
D. temperature stresses.

25. This bridge is a:

A. cantilever deck bridge.
B. simple beam bridge.
C. deck-type arch bridge.
D. through-type arch bridge.
26. Thousands of highway bridges are constructed by placing I-beams across concrete piers. This type of bridge is called:

A. a cantilever bridge.
B. an arch bridge.
C. a truss bridge.
D. a beam bridge.

27. A diving board is most like:

A. a cantilever.
B. an arch.
C. a truss.
D. a pontoon.

28. The main load carrying part of a suspension bridge is:

A. the cables.
B. the roadway trusses.
C. the abutments.
D. the arches.

29. Most railway bridges use the type of bridge called:

A. a suspension bridge.
B. a pontoon bridge.
C. a truss bridge.
D. concrete beam.

30. Wooden covered bridges had wooden roofs and sides. The roof and sides served to protect the:

A. superstructure.
B. substructure.
C. foundations.
D. piers.

31. The modern suspension bridge had its beginning when:

A. stone slabs were placed across rocks.
B. long logs were laid across streams.
C. vines were fastened across rivers.
D. stone arches were fashioned by nature.

32. An easy way to identify plate-girder bridges is to look for the:

A. cables.
B. haunches.
C. anchorages.
D. towers.
33. The ends of a bridge are supported by the:
   A. abutments.
   B. superstructure.
   C. saddles.
   D. towers.

34. A vertical lift bridge works much like:
   A. a teeter totter.
   B. a swing.
   C. an elevator.
   D. a merry-go-round.

35. The type of bridge shown is:

   ![Diagram of bridge structure]

   A. an arch bridge.
   B. a deck-type truss bridge.
   C. a through-type truss bridge.
   D. a suspension bridge.

36. As the cables of a suspension bridge pass over the tops of the towers, they pass over the:

   A. tied arch.
   B. anchorages.
   C. falsework.
   D. saddles.

37. The type of bridge shown is:

   ![Diagram of arch bridge]

   A. an arch bridge.
   B. a suspension bridge.
   C. a plate-girder beam bridge.
   D. a truss bridge.
38. The type of bridge shown is a:

A. a suspension bridge.
B. cantilever bridge.
C. beam bridge.
D. an arch bridge.

39. If long beams are placed over several piers, it is called:

A. a continuous span.
B. a long span.
C. a truss span.
D. an arch span.

40. When engineers try to decide whether a bridge should or should not be built, it is called:

A. a tax study.
B. a building plan.
C. a final design.
D. a feasibility study.

41. A bascule bridge is an example of

A. a moveable bridge.
B. a fixed bridge.
C. a swing bridge.
D. a pontoon bridge.

42. When a truss is balanced and projected outwardly, it is called:

A. to cantilever a truss.
B. to suspend a truss.
C. to hang a truss.
D. to prestress a truss.

43. The stress that keeps the stones of an arch bridge "locked" in place is called:

A. live load.
B. wind load.
C. tension.
D. compression.
44. The ancient Romans were best known for the building of:

A. suspension bridges.
B. cantilever bridges.
C. arch bridges.
D. plate-girder bridges.

45. When a steel arch bridge is made to pull against its roadway, it is called:

A. a cantilever arch.
B. a moveable arch.
C. a fixed arch.
D. a tied-arch.

46. When a roadway is suspended from a steel arch, it is called:

A. a through-type bridge.
B. a deck-type bridge.
C. a tied-arch bridge.
D. a suspension bridge.

47. When cavemen placed long stone slabs across rocks, they built simple:

A. suspension bridges.
B. beam bridges.
C. cantilever bridges.
D. arch bridges.

48. The towers of a modern suspension bridge serve to:

A. anchor the cables.
B. hold the cables high in the air.
C. hold the anchorages in place.
D. hold the abutments in place.

49. Most bridges in the world are owned by:

A. pipeline companies.
B. some division of government.
C. private individuals.
D. railroads.

50. One of the disadvantages with the swing bridge is that:

A. it can only be used for 80 foot spans.
B. it uses up valuable space in the middle of the river.
C. it lifts up in the air with cables.
D. it hangs from falsework.
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