A THEORY OF TEACHING

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The problem with which this study is concerned is the development of a mathematical model and theory of teaching. The mathematical model consists of a set of abstract axioms. The fundamental elements or terms of the axioms are undefined. These primitive or undefined terms obtain their definitions only implicitly through the axioms.

Through a preliminary search of the literature on teaching and teaching theories, some parameters of teaching are identified. The parameters identified are (1) maternal teaching style, (2) home environment, (3) socio-cultural pattern, (4) peer-group culture, (5) campus atmosphere, (6) classroom climate, and (7) time. Certain authors were chosen to represent each of the teaching parameters and a review of the current literature (1950 to present), relevant to each teaching parameter is made. The literature reviewed for each parameter is restricted to the authors chosen to represent that parameter.

A geometrical configuration is developed based on the parameters identified, and an interpretation of this configuration is given which suggests that the parameters of teaching, along with the relations between these parameters, are all elements of a single unified structure.
The geometrical configuration is then expanded by adding other elements which intuition, experience, and discussion with others seemed to justify as significant to the teaching-learning process.

By viewing the elements of the geometrical configuration as points and the relations between the elements as sets of directed line segments, the geometrical configuration is then generalized. This generalization is then used as the basis for developing the axioms. When examined independently of all other materials the axioms show no direct relation to any human affairs. They are abstract statements about the relations between some undefined terms.

The axioms are presented in two sets: the primary axioms and the secondary axioms. All the axioms are stated in the language of sets. The primary axioms are stated entirely in terms of the primitive terms "functional," "relational," and "modify." Relationals are the active elements of the axioms. That is, relationals modify functionals.

After stating the primary axioms some properties of relationals and functionals are assumed and discussed. It is assumed that relationals have the properties of power and efficiency. The meaning of these properties are left to the interpretation of the reader. It is assumed that functionals have the properties of power, complexity, and sensitiveness. These properties are defined only by analogy. A property of
some functionals, "residualization," is assumed and defined by analogy. These properties of relationals and functionals, along with the intuitive notions of place and time are used in the statement of the secondary axioms. In the development of the theory, the primary and secondary axioms are used as a single set of axioms.

Some interpretation of the axioms is given in terms of teaching and learning situations. Some counseling situations are interpreted in terms of the theory, and some teaching situations are interpreted in terms of the theory. Finally it is shown how the theory may be used to direct research.
A THEORY OF TEACHING

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CHAPTER I

INTRODUCTION

Introduction to the Problem

Only a few years ago Gage wrote:

The term "teaching" should not be taken to imply that teaching is a basic process to which a general theory may apply. For "teaching" embraces far too many kinds of process, of behavior, of activity, to be the proper subject of a single theory. We must not be misled by the one word, "teaching," into searching for one theory to explain it (9, p. 274).

Perhaps so. There is more than one theory to explain the properties of light. There are several theories of learning, each making its own unique contribution to scientific thought. Surely several theories of teaching would be useful.

But there seems to be not even one theory of teaching at this time. In 1963 Gage (1, p. 133) said, "At any rate, we now take the venturesome path of dealing explicitly with a kind of theory--theory of teaching--which almost may be said not even to exist thus far in behavioral sciences,"

"Almost may be said" is not the same as "may be said."

Since 1963 research has continued. Some directions have been pointed and some theories have been offered (1, 2, 3, 7, 12). Whether they are acceptable to educators as theories of teaching depends much on the range of interpretation brought to the
theory and on the level of generalization and abstraction any one individual might require.

A survey of literature indicates, however, that there is, as yet, no generally recognized, unifying theory of teaching. Therefore, a study for the purpose of designing such a theory should be of interest.

Statement of the Problem

The problem is the development of a mathematical model and theory of teaching.

Purposes of the Study

The purposes of the study are to

A. Identify some major forces on the teacher and the student which affect the effectiveness of teaching.

B. Identify and describe some major activities and processes which are identified as teaching.

C. From the identified forces and activities design a teaching model.

D. Develop an abstract theory of teaching based upon this model.

Background of the Study

"Science progresses, not by recognizing the truth of the new observations alone, but by making sense of them" (11, p. 81). And an important function of theory is to "make sense of" or "explain" what otherwise might seem to be random data.
There seems to be no shortage of books and articles concerned with the nature of theory. Toulmin (17) provides an elementary discussion of forms and styles of theory as well as presenting a historical perspective of theory. The Delaware Seminar in the Philosophy of Science (5, 6) presents a technical, in-depth discussion of various philosophical aspects of science (5, 6). It is a two-volume collection of essays by various scientific writers, each volume containing several essays on the subjects of scientific explanation, prediction, and theory. These are essays on the philosophy of scientific theory, the various types of scientific theory, and the role and function of theory in scientific investigation.

Nagel (8) has written a 600-page essay in the philosophy of science. In this book Nagel has also included several chapters devoted to theory in the social sciences.

Rapoport (10) provides rich background reading for those not trained to read technical works. As he says in his preface, "The task here is to work with elementary ideas as much as possible but to lead into some of the technicalities of modern philosophy (symbolic logic, probability, statistical aspects of causality, mathematical notions of structure and order, etc.)." Included is a chapter on metaphors and models.

The American Educations Research Association (1) has provided a handbook of research on teaching which contains,
among many other topics, essays on theory, logic, and scientific method in research on teaching.

Criteria for theories have been developed. McClure (14) in an essay written primarily to delineate the logic of discovery, offers a set of formal criteria by which a speculative theory may be judged. The Association for Supervision and Curriculum Development, Commission on Instructional Theory (2) has developed an extensive set of criteria specifically for theories of instruction.

Rapoport (10, p. 203) says, "Generalizations depends on the discovery of analogous structures in dissimilar things." . . . Something is explained when it is shown to be like something familiar to us." The theorist, then, is likely to formulate his theories in terms of an activity with which he is very familiar. Thus Ryans (7, p. 35) developed a theory of instruction based on the notions of information systems, and Maccia (7, p. 88) presents a theory based on group dynamics.

Clarke (12, p. 403) offers a "general theory that deals with elements common to all teaching and recognizes that additional theory may be required for special types of teaching." His theory is developed around three levels of teaching acts: those (1) necessary conditions for teaching, (2) necessary and sufficient conditions for teaching, and (3) necessary for efficiency in teaching.

Conceptual teaching models are more numerous than teaching theories. And the role of models in scientific thinking
is discussed at length by Rapoport (10, p. 203) and Nagel (8). Nagel (8, p. 107) says, "Most theories . . . are generated within the matrix of some model." And, also:

The widespread use of metaphors, whether they are dead or alive, testifies to a pervasive human talent for finding resemblances between new experiences and familiar facts, so that what is novel is in consequence mastered by subsuming it under established distinctions. In any event, men do tend to employ familiar systems of relations as models in terms of which initially strange domains of experience are intellectually assimilated (8, p. 108).

DeCecco (4) reproduces four conceptual teaching models: a simplified four-unit model of his own (4, p. 12), a complex, computer-based model of Lawrence Stolurow and Daniel Davis (4, p. 13), a model by John Carroll in which most of the components are described in terms of time, (4, p. 15) and a social-interaction model by Ted Flanders (4, p. 16). Fattu (7, p. 62) presents a model in which the problem-solving behavior of the teacher is the key idea. Strasser (16, p. 63), using Taba's notion of teaching strategies and tactics, presents a rather intricate, well developed teaching model. And Williams (18, p. 7) has produced a multi-dimensional model for encouraging creativity in the classroom.

Henderson, Smith, Walberg, and Willis have each published teaching models (13, 15, 17, 19).

Thus there are theories of teaching, some more general than others; there are general teaching models and special teaching models. But no theory was found in which the fundamental elements or terms of the theory were undefined, these
"primitive" or undefined terms being defined only implicitly by the axioms of the theory, and in which most if not all other theories of teaching are subsumed as special cases of the stated theory.

Some Guideline Questions Used to

to Direct the Study

Some Guideline Questions Used to Direct The

Review of Literature

1. What are some environmental and social factors which affect the students' patterns of thinking and patterns of learning?

2. What are some models of classroom procedures and what are the implications of these models in terms of learning objectives?

3. Is there a relation between the noncognitive personal characteristics of the student, the noncognitive personal characteristics of the teacher, and learning behavior in the classroom?

4. What is the relation of time to learning patterns and learning behavior?

Some Guideline Questions Used to

Develop the Teaching Model

1. What are some significant parameters of teaching?

2. What interaction exists between parameters of teaching?
3. Is there a geometrical configuration, a labeling for the elements of this configuration and an interpretation of this configuration which suggests that the parameters of teaching along with the interrelationships of these parameters are all elements of a single unified structure?

4. Are there elements other than the parameters identified which intuition, experience, and discussion with others seem to justify as significant to the teaching-learning process?

Some Guideline Questions Used to Develop the Axioms

1. Suppose A is any element of the teaching model. What can be said about A knowing only that it is some element of the teaching model?

2. Suppose A and B are any two elements of the teaching model. What can be said about A, B, and the relationship between them knowing only that they are elements of the teaching model?

3. What can be said about any three elements of the teaching model and their relationship?

4. Is there a way of relabeling the original geometrical configuration which allows the configuration along with its explanation to retain its essential features yet permits more definite and general observations about the elements and their relationships than with the original labeling?
5. How may the effects of time and place be accounted for?

Procedures

The following procedures indicate the approach used in this study.

A. The literature on teaching and teaching theories was given a preliminary search.

B. As the preliminary search progressed, certain parameters of teaching began to emerge as current problems of interest to researchers and writers. These parameters were noted and further reading research was done on each.

C. Certain authors were chosen to represent each of the teaching parameters. This choice was made arbitrarily except that each is an author whose articles are published in professional journals of education, psychology, sociology, or science or whose books are written and published for professional educators, psychologists, sociologists, or scientists. In addition, an effort was made to choose those authors whose research of a parameter was reviewed and alluded to by writers in such a way that the work was considered professionally respectable.

D. A review of the current literature (1950 to present), relevant to each teaching parameter was made. The literature reviewed for each parameter was restricted to the authors chosen to represent that parameter.

E. A teaching model was developed based on the following procedure.
1. A geometrical configuration, based on the parameters identified in (B). above, and an interpretation of this configuration which suggests that the parameters of teaching which have been identified, along with the interrelations of these parameters, are all parts of a single unified structure.

2. The geometrical configuration of (1), above, was expanded by adding other elements which intuition, experience, and discussion with others seemed to justify as significant to the teaching-learning process.

F. The teaching model was used as the basis for developing an abstract set of axioms. The axioms were stated in terms of some preidentified undefined, (primitive), terms. These primitive terms obtain their definitions only implicitly through the statement of the axioms. Furthermore, when examined independently of all other materials, the axioms show no direct relation to any human affairs. They are abstract statements about the relations between some undefined terms.

G. The axioms are interpreted in terms of teaching procedures and a theory of teaching was developed based on the axioms.

This paper is a theoretical paper and will not tend to follow the classical form of an experimental paper. No special format has been imposed on the study; thus the paper will have an internal integrity of its own.
CHAPTER BIBLIOGRAPHY


CHAPTER II
SOME PARAMETERS OF TEACHING

Introduction

Chaplin (10, p. 345) defines a parameter as "... a variable which is constant during a particular experiment but may be varied from experiment to experiment."

And Hough and Duncan (23, p. 6) feel, "The act of teaching is a complex process that is influenced by a field of forces of which teachers can be only in part aware and which the teacher can only partially control."

It is with the individual elements of this "field of forces" that this chapter is concerned. It is the purpose of this chapter to suggest some variables which influence teaching and to review some of the literature which tends to establish each variable as a parameter of teaching.

Maternal Teaching Style

Bettelheim (4) says that the psychoanalytic theory infers that the attitudes formed in infancy are critical factors in conditioning classroom experience. And according to Bloom (6), the characteristics an individual acquires early in life are the most stable of all. Bloom (6, p. 88) states further that "In terms of intelligence measured at age 17, about 50
per cent of the development takes place between conception and age 4, about 30 per cent between ages 4 and 8, and about 20 per cent between ages 8 and 17."

Assuming that until age four the child is most intimately associated with its mother, both physically and emotionally, the nature of that relationship would appear to be critical. And assuming that a very close mother-child relationship continues at least until age eight, the relationship would continue to be highly significant in terms of future development of the child.

Hess (20, p. 15), after some description of research done on mother-child communications, and on self-concept and motivational structure of mothers, argues that "... inadequacy in the cognitive features of early mother-child exchange fosters later alienation of the child and adolescent from the educational processes and other basic sectors and institutions of society."

Fantini and Weinstein (12, p. 98) interpret Hess and Shipman (22) as saying that "... the child's intellectual growth will be determined largely by the nature of the communication system established between mother and child." Fantini and Weinstein (12, p. 96) themselves feel that "Long before the child can comprehend the meaning of her words, his mother soothes and reassures with her voice, thus setting the patterns for his later speech as well as his cognitive and emotional grasp of his immediate environment." And further
underline their statement by saying (12, p. 103), "In summary, the choice and extent of the words and phrases used by the mother shapes the child's cognitive and objective perception of the world."

Havighurst (18) illustrates social disadvantage by describing two cases of maternal teaching, one a case of social disadvantage, the other not. His analysis of the two cases points out that the mother of the disadvantaged child does not try to explain things; thus the child does not have the opportunity to learn the "why" of things. She uses a very restricted vocabulary, thus severely restricting the vocabulary of the child, and she exerts her authority through categorical statement, so that the natural curiosity of the child is pushed back.

Hess and Shipman (20, p. 869) conducted a study using 160 Negro mothers and their four-year-old children. The group was selected from four different social status levels. Among their conclusions is that "... the central quality involved in the effects of cultural deprivation is lack of cognitive meaning in the mother-child communication system."

Home Environment

The maternal teaching style is determined as parameter number one. The studies on the maternal teaching pattern concern themselves, primarily, with the personal interaction between the mother and child in the very early years, whereas studies of the home environment include physical aspects of
the home as well as interaction between child and father, child and sibling, and mother and father.

Bloom and others report:

Research reveals the aspects of the home environment which seem to be most significant in affecting the level of measured intelligence of the child as well as his school learning. In most general terms these may be described as involving provisions for general learning, models and help in language development, and parental stimulation and concern for achievement and learning on the part of the child. For the most part, it is the adults in the home who serve to stimulate the child's intellectual development (7, p. 12).

And Silverman says:

Studies repeatedly show that the home is the single most important influence on the intellectual and emotional development of children, particularly in the preschool years. The ways in which parents spent time with their children at meals, in play, and at other times during the day have been found to be central factors in developing skills which prepare children for school. The objects in the home, the amount of parental interest in learning, and the amount of practice and encouragement the child is given in conversation and general learning have been found to be significant influence on language and cognitive development, of interest in learning, attention span, and motivation of the child (33, p. 69).

And Bloom in another of his works states:

... it would seem to us that the home environment is very significant not only because of the very large amount of educational growth which has already taken place before the child enters the first grade but also because of the influence of the home during the elementary school period (6, p. 110).

Fantini and Weinstein (12, p. 42) refer to the extramain forces at work on shaping the child as "the hidden curriculum" and name the parents as the key agent of the hidden curriculum. And they add (12, p. 47), "Obviously, if
the formal curriculum is to achieve its purpose, it must be consistent with, or at least accommodating of, the learning imparted by the hidden curriculum."

Strom (37, p. 379) feels, after reviewing the results of research on family influence on school achievement, that family experiences are significant forces in shaping the child's patterns of thinking and attitudes toward learning.

Hess and Shipman (21, p. 869) in a study cited earlier, also assert that the growth of cognitive processes is fostered in family control systems which offer and permit a wide range of alternatives of action and thought and that such growth is constricted by systems of control which offered predetermined solutions and few alternatives for consideration and choice.

Bing (5) used specifically designed tests to measure children's verbal and non-verbal abilities, such as spatial and numerical. She also measured their total IQs. Using these data she identified groups of children with discrepant abilities such as high verbal--low non-verbal, high non-verbal--low verbal. She concludes:

The findings led to a general conclusion that discrepant verbal ability is fostered by a close relationship with a demanding and somewhat intrusive mother, while discrepant non-verbal abilities are enhanced by allowing the child a considerable degree of freedom to experiment on his own (5, p. 647).

Yamamoto (44, p. 101) in his analysis of the college student and the culture of the college student, found two major
sources of educational inspiration among the working class youths in his sample. The primary source was certain conditions of the family.

Hence, the home environment is determined as parameter number two.

Social-Cultural Pattern

The Dictionary of Education defines a cultural as

... an interrelated, interwoven, and virtually inseparable group or cluster of culture traits that, taken together, produce an established and typical result such a way of thinking, living or acting or a particular and distinctive collection of material objects, for example, the culture pattern of American public education which represents a cluster of such culture traits as occupational specialization, general literacy, and universal suffrage (15, p. 147).

The term "socio-cultural pattern" will refer to the culture pattern associated with a society, community, or any other relatively large group in which the family is the basic unit and which contains several families such that the individuals in the society or community or group tend to have common attitudes, ways of thinking, and ways of everyday living. This socio-cultural pattern need not be identified with a particular socio-economic pattern.

Bruner and others (8) studied cognitive growth as it occurred in the young children of widely divergent cultures and also as it occurred in children of the same ethnic group and culture but dramatically different school experience.

We take the view that cognitive growth in all its manifestations occurs as much from the outside in as from the inside out. Much of it consists in a human
being's becoming linked with culturally transmitted "amplifiers" at different times in a child's life. One need not expect the course of cognitive growth to run parallel in different cultures, for there are bound to be different emphasis, different deformations (8, p. 1).

And Bruner says explicitly that culture teaches.

What culture "teaches" and how it goes about the task of doing so will concern us in much detail in later pages. What seems plain enough is that the most characteristic thing about the lessons that are imparted—whether with respect to matters of value, of existence, or of self—is their productive generality. Whatever is learned seems to be converted into general rules never before encountered (8, p. 58).

Maccaby and Modiano (25) found significant differences in the patterns of thinking of the rural and urban children.

If the peasant child is not dulled by village life, he will experience the uniqueness of events, objects and people. But as the city child grows older, he may end up by exchanging a spontaneous, less alienated relationship to the world for a more sophisticated outlook which concentrates on using, exchanging, or cataloguing. What industrial, urban man gains in an increased ability to formulate, to reason, and to code the ever more numerous bits of complex information he acquires, he may lose in a decreased sensitivity to people and events (25, p. 269).

Greenfield and others (17, p. 315) also concluded from their studies that rural life is less conducive to the development of abstraction.

Although socio-economic status is often associated with disadvantaged cultures, it does not, in itself, identify cultural advantage or disadvantage. This is emphasized by Tanner and Tanner (38), who offer as counterexamples most low-income Jewish and Oriental families on the Lower East Side of
For as Bloom (6, p. 124) emphasizes, "It is what parents do in the home rather than their status characteristics which are the powerful determiners in the home environment."

Consider as further evidence of this point a study by Caudill and DeVos (9) on Japanese Americans who had been moved from the West Coast to the Chicago area during World War II. The authors show how first- and second-generation Japanese Americans, because of certain cultural traits and values, have been able to climb from low socio-economic status to middle class socio-economic status, and to high acceptance by middle class Americans. It is pointed out that they were able to accomplish this in the Chicago area whereas they were not able to move upward on the Pacific Coast because of anti-Oriental prejudice, and also because of some of the strict social customs of the Pacific Coast Japanese community itself. Thus their success is due to a happy interaction of their own cultural traits and values with those of Chicago-area middle class Americans.

Strom (37, p. 379), after reviewing some research on the attitudes toward school of lower class people and middle class people, says, "In general, the lower class child is oriented to the school as an institution with which he must cope, while the middle class child views the school as a place for learning." But he, also, cautions against over-generalization.
Fantini and Weinstein name the neighborhood as a key agent of socialization and state:

Since the particular socio-cultural group one is born into will determine the language code one comes to know and to use, this language code will, in turn, influence the way in which one processes his sensory experience. In other words, what is made available for learning will vary—as a function of the language style used—along different socio-cultural groups (12, p. 49).

Bruner (8, p. 230) makes a similar observation when he says, "... models are first adopted from the culture and are then adapted to individual use."

Greenfield and others also make an observation concerning certain similarities in patterns of thinking between culturally deprived American children and unschooled native children.

In conservation behavior too, we saw this "early arrest of the process of intellectual growth" in the unschooled children. And so the difference between those in school and those out increase with age. This has also been a persistent observation concerning the difference between "culturally deprived" and other American children. Thus it seems that the conceptual development of lower class American children resembles that of the unschooled Wolof children in this regard. If so, then early intellectual stabilization signifies that full cognitive skill is not being attained. In short it appears that some environments "push" cognitive growth longer than do others (17, p. 318).

Thus, the socio-cultural pattern is determined as parameter number three.
Peer-Group Culture

The peer-group is named as a key agent by Fantini and Weinstein in the socialization of children (12, p. 42). They emphasize further:

Our purpose here is to suggest that the school's traditional approach is not attuned to various cultural differences existing between the school and many of the children it serves, nor does it realize the role of the peer-group in reinforcing these children's cultural values.

Yet limited attempts by schools to utilize the structure and control of peer-groups in the hidden curriculum have indicated not only the strength of these groups, but also the potential value of such a strategy (12, p. 90).

Coleman (11) studied ten schools in varying types of communities, of varying sizes, and with apparent differences in their status system. He warns,

This setting apart of our children in schools—which take on ever more functions, ever more "extra-curricular activities"—for an ever longer period of training has a singular impact on the child of high school age. He is "cut-off" from the rest of society, forced inward toward his own age group, made to carry out his whole social life with others his own age. With his fellows, he comes to constitute a small society, one that has most of its important interactions within itself, and maintains only a few threads of connection with the outside adult society (11, p. 3).

Coleman's studies show that the peer-group comes to exert more influence on the adolescents than the home; and that when the adolescent sub-culture of a school places higher value on social success or athletic prowess than on intellectual achievement, then the students of highest ability will
not, in general, be the students with the highest academic achievements.

Adolescent sub-cultures in these schools exert a rather strong deterrent of academic achievement. In other words, in these adolescent societies, those who are seen as the "intellectuals" and who come to think of themselves in this way, are not really those of highest intelligence, but are only the ones who are willing to work hard at a relatively unrewarded activity (11, p. 265).

Yamamoto's study of college students shows that the nature of the student's peer associations and his participation in school activities were major sources of educational inspiration.

Working class students whose acquaintances plan to go to college are more likely to go themselves. Among those who report that none of their acquaintances plan to go to college, only ten per cent expect to go themselves.

Working class students who participate in extracurricular activities have an opportunity to associate with middle-class students, most of whom plan to enter college, and as a result may be encouraged to develop interest leading to higher education (44, p. 94).

The peer-group culture is thus established as parameter number four.

Campus Atmosphere

There are pressures in a school environment other than those exerted by the student culture. There are policies which act as constraints and policies which tend to impell in certain academic and social directions; there are traditions which sometimes are consistent with the stated academic objectives of the school and sometimes work against these objectives. There are strong influences of some individual
faculty members, and strong influences of certain faculty groups. The campus atmosphere may be viewed as the system of pressures, practices, and policies which influence the development of students, or tend to prevent such development, toward the attainment of important goals of education.

The pressures and influences of student sub-cultures would be included in this definition, but Pace feels that this is definitely only a part of the picture.

... one might suggest that about thirty percent of the distinctive environment of a school is accounted for by the distinctive character of the students it admits. This leaves most of the potential impact of a college squarely up to the decisions of its faculty, administration and trustees (29, p. 56).

Concerning a study in 1960 by Thistlewaite (40), Pace says:

It seems quite clear from these studies that different college environments do have demonstrable consequences on student behavior, over and above the student culture which is part of the total college culture (29, p. 54).

McConnell (26, p. 40) feels that "Committment to intellectual and civil liberties is probably as much the product of campus life as it is the outcome of formal instruction."

Smith emphasizes:

There are depths of personality which the university cannot touch within the confines of regular academic routine; if these depths are to be influenced at all within the framework of higher education, it will be necessary for the university not only to pay more attention to the total atmosphere within which each student works, but also to shift emphasis from the mass back to the individual (35, p. 319).
Gottlieb and Hodgkins (16, p. 240), also, feel, "It is both reasonably accurate and heuristically desirable to consider the academic environment as a distinctive socio-cultural system existing within the larger structure of American society."

That there exist extensive differences between school environments was shown by Stern (36) in data presented in an institute lecture series on college students. Rowe (32) feels we need to learn to relate student personality patterns with the types of campus environment pattern in which the student is most likely to succeed. He suggests specifically:

If the characteristic strong press of an institution's environment is for personal and social development, civic responsibility and practical activities; and the strong needs of the individual student are for detached intellectualization, critical judgement and independence, and the acquisition of knowledge and theory for its own sake; the student may be a misfit in the institution and choose to depart from it as soon as possible (32, p. 137).

And Mitchell, after pointing out statistical difficulties which make the analysis of campus environment studies difficult, is still willing to conclude that

There is now some evidence of varying strength that Ph. D. productivity is related to certain environmental press variables (e.g., enthusiasm, humanism, affiliation, independence, achievement, and supportiveness); that changes in plans to seek advanced training are positively correlated with excellence of faculty in major field and negatively with faculty press for compliance; that career choice at graduation is affected by the proportion of other students in the student body planning careers of a particular type; and that withdrawal
from college is associated with certain environ-
mental press, e.g., lack of concern for the
individual student (27, p. 713).

Herr, Warner, and Swisher (19), after examining research
on high school environments, conclude that high schools can be
differentiated through the use of environmental assessment
techniques and therefore can be examined in terms of per-
ceived demands they place on students. They argue further:

While research on college environments has
shown that students are attracted to colleges
with environments which are compatible with indi-
vidual need patterns, the high school student is
not given that opportunity. He may be placed in
an environment whose demands are quite dissimilar
to his individual need pattern. Once there, the
individual is expected to conform to the demands
of that environment. Hence, while educators talk
about recognizing individual difference, sometimes
they unknowingly establish certain institutional
characteristics and demands which all but preclude
the possibility of an individual to be different
or indeed, to be treated differently (19, p. 62).

Campus atmosphere is thus established as parameter number
five.

Classroom Climate

The definition of campus atmosphere will be adapted to
define classroom climate. That is, the classroom climate may
be viewed as the system of pressures, practices, policies in
the classroom which influence the development of students, or
tend to prevent such development toward the attainment of im-
portant goals of education. This is entirely consistent with
Flanders' description:

The term "classroom climate" refers to gener-
alized attitudes toward the teacher and the class
that the pupils share in common despite individual differences. . . . Thus, the word "climate" is merely a shorthand reference to those qualities that consistently predominate the most teacher-pupil contacts and in contacts among the pupils in the presence or absence of the teacher (13, p. 3).

Flanders (13, 14), after studying the results of research on teacher influence and student attitudes in Minnesota and New Zealand, concluded that classroom climate can make a significant difference in student learning. Flanders feels that the weight of research supports the view that teacher behavior exerts more influence on pupil attitudes than vice-versa, but that "patterns of teacher influence and pupil behavior per se constitute an interaction process."

Trickett and Moos, after a study of a group of high school sophomores in various classroom settings, concluded,

To summarize, the results of the present study suggest that prediction of classroom behavior may be enhanced by measurement procedures which systematically sample individuals, settings, and modes of response for various behavioral dimensions. Further, the interactional aspect of student classroom behavior is an extremely important source of variance and as such deserves greater attention (41, p. 389).

Trickett and Moos (41, p. 387) review other studies which also suggest that "setting differences and the interaction of person and setting must be taken into account if prediction of behavior is to improve."

Thelen (39), also, identifies classroom culture as a proper target of efforts to make classrooms more educative.
Wendel (43, p. 330) argues that "Without too drastic a revision in methods, teachers can significantly alter the classroom environment to allow for more self-initiated and thus more significant learning."

Anderson (2, p. 150), in a doctoral dissertation, examined the effects of class properties on individual learners. "The results suggest that characteristics of class groups have significant effects on learning and that there are wide differences in these effects for students differing in ability and sex."

Peterson (31) recognizes that sometimes the classroom climate may exert a strong negative effect on learning and offers several possible approaches to a solution. And Walker (42, p. 37) says, "Classroom climate can encourage teaching-learning experiences that may make possible the fullest development of the individual."

Classroom climate, then, is parameter number six.

Time

Whatever happens in terms of human growth and development, happens over a period of time or along a time axis. Bloom has presented a well documented account of the growth and development of many human characteristics. His conclusions concerning the growth of intelligence have been quoted previously but need to be repeated.

Both the correlational data and the absolute scale of intelligence development make it clear that intelligence is a developing function and that the
stability of measured intelligence increases with age. Both types of data suggest that in terms of intelligence measured at age 17, about 50 per cent of the development takes place between conception and age 4, about 30 per cent between ages 4 and 8, and about 20 per cent between ages 8 and 17 (6, p. 88).

It is obvious from these results that intelligence grows at a varying rate, and that as much development takes places in the first four years of life as in the next thirteen years. By combining the results of achievement tests, teacher's marks, and vocabulary tests, Bloom estimates that by age nine (grade three) at least 50 per cent of the achievement pattern at age eighteen (grade twelve) has been developed, and at least 75 per cent has been developed by age thirteen (grade seven). Recasting the same data, he shows that above 17 per cent of the growth takes place between six and nine, suggesting the importance of kindergarten through grade three in the development of general learning patterns.

In spite of the difficulties of obtaining observational data, Bloom feels that the data available tend to be in harmony with theoretical literature on personality development in the early years. He adds:

Although this state is subject to many qualifications and limitations, it is clear that personality, at least in the early years, is not a simple development over time. There are periods of very rapid change in this area of human characteristics just as there are in other areas (6, p. 177).
Summarizing the longitudinal evidence on interests, attitudes and specific personality characteristics, he concludes,

All this evidence suggests that there is change in these characteristics throughout life and that this change (or stability) is very close to estimates based on an age curve of development. Thus the picture we have of height remaining essentially the same from about 20 to 50 is very much different from the picture that emerges from the longitudinal evidence on interests, attitudes, and personality (6, p. 178).

Bloom summarizes the import of the entire book in three propositions.

1. The relation between parallel measurements over time is a function of the levels of development represented at the different times.
2. Change measurements are unrelated to initial measurements but they are highly related to the relevant environmental conditions in which the individuals have lived during the change period.
3. Variations in the environment have greatest quantitative effect on a characteristic at its most rapid period of change and least effect on the characteristics during the least rapid period of change (6, p. vii).

According to Almy (1, p. 6), Piaget (1) has postulated four main developmental stages: sensorimotor from birth to the age of about one or two, preoperational from about one or two to about six or seven, concrete operational from six or seven to about eleven or thirteen, and formal operational, from about eleven to thirteen on. The age at which each stage develops varies with the individual and with the culture. But the sequence never varies; the stages develop in the order listed.

Furthermore, concerning the relationship among abilities within stages, Almy (1, p. 35) says, "... the theory specifies
that abilities during the period of their formation are not applied equally well to all kinds of tasks. For example, the ability to conserve its substance."

Kohlberg (24) has shown in cross-cultural studies of cognitive beliefs about dreams that there is an invariant sequence of stages in which the child moves from a view of dreams as real to a view of dreams as subjective or mental.

And, therefore, time is established as parameter number seven.

Summary

The following parameters were identified:
1. Maternal teaching pattern
2. Home environment
3. Socio-cultural pattern
4. Peer-group culture
5. Campus atmosphere
6. Classroom climate
7. Time
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CHAPTER III

DEVELOPMENT OF THE TEACHING MODEL

Introduction

A model for a theory of teaching is presented in this chapter. This model consists of a labeled geometric configuration accompanied by a detailed explanation of the geometric configuration in terms of teaching processes and teaching problems. This model is presented in terms of three different figures. The elements of Figure 1 are essentially the parameters of teaching documented in Chapter II. The Time parameters will be discussed in terms of Figure 3. The elements of Figure 2 are mostly speculative. It is submitted, however, that they are entirely reasonable in terms of the parameters documented in Chapter II and in terms of the literature reviewed.

Additional literature is reviewed in Chapter III. This literature suggests relationships between elements of the model. However, there are elements of the model with no documented relationship. In such cases some relationship will be assumed for the purpose of generalizing the model. For some pairs of elements there exist volumes of literature suggesting or establishing relationships between the elements. Only a sampling of this is reviewed.
Fig. 1--Configuration constructed with parameters identified in Chapter I
Fig. 3—Relationships of elements of figure 1 and figure 2 along a time axis
Explanation of the Model

The elements of Figure 1 are the parameters documented in Chapter II. The diagram is interpreted to suggest a field of forces or influences interacting with each other in such a way as to affect the interaction between a teacher and a student. No qualitative implications or inferences are intended by the model. The forces may be good or bad, reinforce teaching, or tend to neutralize teaching. But the forces of influence are there.

Mutual relationships between school climate and classroom climate are assumed, and also between peer-group culture and socio-cultural pattern, and between home environment and maternal teaching pattern.

Much of the research and writing on teaching has concerned itself with the patterns of relationships between the teacher-student elements. The literature reviewed represents only some of the main thrusts or themes in research on instruction.

Moore (16) says there are three main thrusts evident in research on instructional theory. The first of these, says Moore, is the body of research based on the programmed approach associated with the work and thought of B. F. Skinner.

Moore feels that the strengths of Skinner's methods lie in its efficiency (promoters of this method have been able to teach certain bodies of content at a very high rate), and the ability of its promoters to state what they intend to do and then, afterward, give strong evidence they have done it.
Skinner’s methods would relieve the teacher of certain duties and functions, and place more emphasis on the pacing and sequencing of the material to be learned. Skinner himself says:

The whole process of becoming competent in any field must be divided into a very large number of steps, and reinforcement must be contingent upon the accomplishment of each step. By making each successive step as small as possible, the frequency of reinforcement can be raised to a maximum, while the possibly aversive consequences of being wrong are reduced to a minimum (21, p. 21).

Concerning the importance of the teacher, Skinner says,

If the advances which have recently been made in our control of behavior can give the child a genuine competence in reading, writing, spelling, and arithmetic, then the teacher may begin to function, not in lieu of a cheap machine, but through intellectual, cultural, and emotional contacts of that distinctive sort which testify to her status as a human being (21, p. 27).

The second main thrust in instructional research, according to Moore, is that symbolized by the work of Piaget and his associates. Piaget himself has not interpreted his theories in terms of instructional procedure (11, p. xviii). However, he does say,

In the realm of education, this equilibration through self-regulation means that school children and students should be allowed a maximum of activity of their own, directed by means of materials which permit their activities to be cognitively useful. In the area of logico-mathematical structures, children have a real understanding only of that which they invent themselves, and each time that we try to teach them something too quickly, we keep them from reinventing it themselves (1, p. vi).
Sigel, in a discussion of teaching strategies derived from Piagetian conceptualizations, says,

Probably any teaching is the coalition of a number of factors expressed in a single act. A major thrust of a teaching strategy is to confront the child with the illogical nature of his point of view. The reason for confrontation is that it is a necessary and sufficient requirement for cognitive growth--Strategies employing confrontations must be consistent with the child's stage of development (11, p. 472).

Sigel (11, p. 475) also emphasized the importance, according to Piagetian principles, of physical arrangements in the classroom and verbal interaction with peers and teachers.

Copeland (7) has interpreted Piaget in terms of the learning of mathematics and Almy (1) has written a special interpretation of Piaget for teachers in general.

The third thrust in instructional research, according to Moore, is reflected in the works of Carl Rogers and A. W. Combs. According to Moore, this is a thrust into the affective domain, an emphasis on the development of the self-concept of the student, and the teacher as a human relations expert. It emphasizes the responsibility of the teacher in helping the student learn to learn, to help the student become self-impelled, and eventually to become independent of the teacher.

Both Skinner and Combs recognize the interaction process between teacher and student. But Skinner feels it is a handicap to teaching while Combs feels it is necessary to good
teaching. Both feel that good teaching is situational or contextual. That is, a method is not "good" or "bad" but good only in terms of the exact situation. But Skinner feels the teacher should not be one of the variables whereas Combs feels the teacher must be (5, 6, 21).

Taba (24), interested primarily in teaching thinking, or problem solving, rather than substantive knowledge, classifies thinking as occurring at three levels: the lowest is grouping and labeling; the next is interpreting information and making inferences; the highest is predicting consequences.

Believing these represent thought levels the student must master in sequential order, Taba, according to DeCecco (9, p. 467), believes that as the teacher introduces new subject matter he must recycle the student through three levels of thought. DeCecco interprets Taba as saying that the teacher employs four teaching strategies in this process: (1) focusing; (2) thought extension; (3) lifting thought to a higher level; (4) controlling thought.

According to DeCecco (9), B. O. Smith (23) says that teaching occurs in an "ebb and flow" pattern or "cycle of giving and taking instruction."

DeCecco describes it:

A cycle consists of a teacher phase and a student phase, which mirror each other. In the teacher phase the teacher perceives the student's behavior, diagnoses the student's state of interest, readiness, knowledge and so on, and finally acts. In the
student phase the student perceives and diagnoses the teacher's behavior, and finally acts (9, p. 28).

Ausubel proposes the use of advance organizers in the introduction of each new unit to be learned:

The advantage of deliberately constructing a special organizer for each new unit of material is that only in this way can the learner enjoy the advantages of a subsumer which both (a) gives him a general overview of the more detailed material in advance of his actual confrontation with it, and (b) also provides organizing elements that are inclusive of and take into account most relevantly and efficiently the particular content contained in this material (2, p. 111).

Flanders (12, p. 1) has developed a teaching model called a social-interaction model. He conceives of class events recurring in a cycle of six sequential stages:

First, an intellectual difference or problem is created; second, the major dimensions of the problem are identified; and third, relationships within the problem are isolated. Fourth, work occurs—such as the gathering of information, the application of a formula or the trial solution of a problem. Fifth, progress is evaluated and tested. Sixth, the new knowledge is applied to additional problems and interpreted in some meaningful way (13, p. 196).

Flanders, according to DeCecco (9, p. 17), classifies teacher action into two categories: indirect influence and direct influence. Learning is affected by the directness or indirectness of teacher influence in each part of the cycle.

That the home environment and parents influence the thinking patterns of the child (student) has been documented in Chapter II. By definition of home environment the child must exert some influence on the environment of the
home. It will be assumed that the child can have some influence on that aspect of the home environment which affects learning behavior. It will also be assumed that the child can have some influence on the learning behavior of his parents.

Osborne (17) and Edwards (10) each offer evidence that the classroom teacher can influence parents and, therefore, the home, in ways which enhance the learning behavior of children. That the teacher may learn something from this interaction that is helpful to her teaching shall be assumed.

Karnes (15) offers evidence that the maternal teaching pattern can be influenced in positive ways by giving mothers special training, and suggests that there is encouraging evidence that this influence will be spread in the community, through the mothers given special help, to other mothers in the community.

An interactional relationship is assumed between the home environment and the socio-cultural pattern. Similarly, an interactional relationship is assumed between the student and the peer-group culture and the student and the socio-cultural pattern.

That there is an interactional relationship between the school climate and the peer-group cultural and the school climate and the socio-cultural pattern is given support by the works of Coleman and Barker and Gump (8, 3). Flanders attests to the interactional relationship between teacher
and classroom climate (12, 13). And both Vassos (25) and Sloggett (22) show that knowledge of the peer-group culture can be used by the teacher to enhance the learning behavior of the student.

Figure 2 is almost entirely speculative. Since each element of Figure 2 is closely related to at least one element of Figure 1, it is submitted that the relationships suggested by Figure 2 are reasonable in terms of the documentation of Figure 1. Mutual interactional relationships are assumed between the elements of each pair of elements of Figure 2.

The teacher has direct influence on this semester's class. This class influences the entire student body, and hence, next semester's students. Through siblings and friends, this year's student body influences future student bodies.

The teacher influences individuals through intraclass activities and relationships. The model names, specifically, groups of one to six. These in turn influence other students and future students. It is submitted that the proper use of such small informal groups working in close relationship with the teacher can be a major influence force, supporting and reinforcing the direct efforts of the teacher.

Ex-students influence parents, present students, and future students. Surely the influence of alumni associations on the school needs no documentation.
Administrators affect the school climate through school policy, administrator-faculty interaction, and through teacher selection. Administrator-parent contact is quite usual through P. T. A. meetings, Dads' Clubs, and the like.

School-future student contact is perhaps most often made by pre-counseling programs in which counselors from a high school, for example, visit the feeder elementary school for a few days each year, helping elementary students plan their high school programs. It is submitted that more elaborate and frequent planned and organized contacts between teachers and administrators of a school and their future students could be helpful in creating an atmosphere which would be especially helpful to new students.

Figure 3 represents the set of, and the sequence of, teacher and teaching situation influences, and their interaction with each other. This figure suggests that any given teaching situation may be influenced by more than one teacher, and conversely. It also suggests that a given influence on a given student at a given time is an interaction of several teachers and situations, and that this influence exists along a time continuum.

Discussion of the Model

Re-examine Figure 1. Evidence has been presented to indicate that the maternal teaching pattern, the socio-cultural pattern, and other parameters, are each important factors in
shaping the patterns of thinking and ways of learning of an individual. Suppose the teacher can make a reasonable diagnosis of the pattern of thinking of a student. This could be helpful in teaching the student. Gant (14) and also Phillip and Jacob (18) offer evidence that it can be very helpful. This would be a specific example of "entering behavior" as in Glaser's model (9, p. 11) and "student characteristics" as in the model of Stolurow and Davis (9, p. 14).

Now each teacher has a pattern of thinking which also has been strongly influenced by a maternal teaching pattern and socio-cultural pattern. If there is a great dissimilarity between the pattern of thinking of the student and that of teacher, the learning situation could be severely handicapped. For this reason and similar ones, a teacher who is a good teacher in a middle class school may be a poor teacher in a ghetto school, and a good high school teacher may be no good teaching elementary school or college.

A similar argument holds for good teaching methods and bad teaching methods. Combs (6) feels strongly that teaching methods are not good or bad. It is outcomes that may be judged good or bad. The teacher must be able to shift with the situation. Several others stress the contextual and situational aspects of good teaching (3; 12; 25; 21, pp. 21-27).

Refer now to Figure 2. Figure 2 suggests that what the teacher does and says in the lunchroom, faculty room, and
halls can effect, either positively or negatively, the classroom climate. Furthermore, the classroom climate this year can affect the classroom climate next year and even several years from now. Flanders (12, p. 4) says: "... the pattern a teacher develops is likely to persist in his classroom the following year with different pupils." The teacher may be directly responsible for most of this persistence of atmosphere, but the model suggests that indirect influences through this year's students to future students would also account for this persistence. Next year's students know what to expect, and tend to act accordingly.

The teacher has several means of exerting indirect influence on a class. The model specifically names, among them, small groups who are in close, informal contact with the teacher. Shepherd says:

The small group is an essential mechanism of socialization and a primary source of social order. There is little doubt that a small group provides the major source of the values and attitudes that people have, and an important source of pressures to conform to social values and attitudes. ... The small group serves an important mediating function between the individual and the larger society (19, p. 1).

It is implicit in the model that similar paths of influence are available to the administrator.

Look now at Figure 3 and consider the following quotations:

My children have raised rats from the Wistar Institute in the usual chaos of a human habitat.
and these rats were considerably more exploratory, venturesome, and intelligent personalities than the rats who lived in the gray atmosphere of the laboratory. Reviewing the literature in early sensory deprivation, I have come to the conclusion that one of the chief effects of such restrictions is that to put it metaphorically, the animals are prevented from developing adequate models of the environment in which they will eventually have to live—or, technically stated, there is interference with the formation of what Hebb has called cell assemblies and phase sequences, the hypothetical neural structures that are constructed in our brains to represent and abstract the texture of the environment.

The reader may properly wonder at this point whether I am proposing that such forms of deprivation be used for controlling behavior in the spirit, say, that Huxley's planners in Brave New World produced "gammas." On the contrary, I am suggesting that we are already inadvertently controlling behavior by imposing irreversible limits upon it with many of our practices in education, considering education now in the broad sense. We should be asking whether there are critical periods for the introduction of training in mathematics and language guiding myths.

A final psychological point about limitation of exposure. Many students of human development have noted that there is a phenomenon by which supply creates demand. Gordon Allport has written of the functional autonomy of motives, the sequence whereby a habitual activity seems to acquire a motive of its own for its continuation. Karl Bühler, commenting on the development of language in children, as you will recall, proposed the concept of "Funktionlustpleasure" derived from the exercise of a newly developed function or skill. Donald Hebb and Robert White (whose views we visited in an earlier essay) more recently have suggested that there seems to be an intrinsic pleasure of self-reward in gaining competence that feeds upon itself in the sense that the development of taste leads to increasing development of taste. How important this is in cultivating a taste for discovering we have already seen. It may well be that early sensory and intellectual deprivation prevents the kind of intellectual and emotional unfolding that nourishes early learning and makes later learning possible (4, pp. 142-3).
Consider this along with what has already been noted concerning the importance of the maternal teaching pattern. Every student experiences not only a set of teachers at a given time but also a sequence of teachers along a time axis. Even self-teaching can be understood in terms of "internalized" past teaching interacting with the environment.

What is suggested is that Figure 1, Figure 2, and Figure 3 together form a single three-dimensional model in which time is one axis. The student then can be thought of as passing through this teaching field and is influenced by this field in a manner somewhat analogous to the manner that an electron stream is affected by the forces imposed upon it in a television tube—a color television tube. The field is structured in space but changing in time—again, here, the "changing," "color," picture of a television tube is a crude but perhaps useful analogy. To push the analogy further, everything else being equal, the force field nearest the electronic source produces the greatest effect on the electron beam.

Summary

1. Interrelations between some of the parameters of teaching identified in Chapter I have been documented.

2. Some additional factors of teaching have been suggested, based upon intuition, experience, and discussion with others.
3. It has been assumed that some interrelationship exists between any two factors mentioned in (1) and (2) above, regardless of whether documentary evidence has been presented.

4. A geometric configuration, along with an explanation of this configuration has been developed which suggests that those factors of teaching mentioned in (1) and (2) above belong to a single, unitary structure.

5. Some discussion of the nature of this structure has been presented.
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CHAPTER IV

PRELUDE TO THEORY

The purpose of this chapter is to provide a transition from the model to the theory. This transition will include a discussion of the generalization of the teaching model and the abstraction of some concepts used in theory. Included, also, is a statement of some philosophical assumptions made in formulating the theory.

The language of sets will be used in the theory. Therefore, there is also in this chapter some definitions of some of the terms used in set theory which is useful in expressing the theory.

The Geometry of the Teaching Model

Generalization of the Pattern

A very young child examining Figure 1 and Figure 2 would see mostly a geometric pattern, since the words would mean nothing to him. He would see some rectangles connected by lines, as in Figure 4.

![Fig. 4--Generalization of Figures 1 and 2](image-url)
There is nothing significant about the rectangular form. Circles would do as well. And the size of each rectangle or circle is a mere convenience for labeling. If no labeling were desired, points would serve as well as circles. Such a generalization would produce a network, then, of points and lines, where each point is connected to every other point by a line. There would be a set of points interconnected by a set of lines, as in Figure 5.

![Figure 5: Simplification of Figure 4](image)

**Generalization of the "Points" of the Geometry**

Some of the rectangles of the teaching model represent people or groups of people. Other rectangles represent not people, as such, but attributes of people or functions of people. There is a rectangle labeled "student," one labeled "teacher," and one labeled, not "administrators," but "administration." To introduce some uniformity, then, each point in the geometry should, must be interpreted as representing a person or group of persons, and the problem of their attributes and functions shall be handled some other way.

Close examination of the teaching model reveals that an individual may be (and usually is) associated with more than
one rectangle. An individual student, for example, is a member of his own peer-group, a member of the student body, a member of a class, a member of his own socio-cultural group. Consider the model as it applies to a small-town school system. Every rectangle of the model has associated with it some sub-group of the town population. Also, each member of the town population would conceivably be associated with at least one of the rectangles of the model. This situation is reminiscent of the mathematical concept of "power set." Given a set $S$, the power set of $S$ is defined to be the set of all subsets of $S$. Mathematicians consider the null set to be a subset of every set, but since the concept of the null set makes no contribution here, it will be ignored. Hence if $S$ denotes the set of all people in a town and $PS$ the power set of $S$, excluding the null set, then $PS$ is a set containing as its elements each individual in the town, and each possible combination of individuals in the town including $S$ itself.

The concept of point is now generalized by letting $S$ denote some set of people, $PS$ the power set of $S$, and interpreting each point of the geometry to represent some element of $PS$. Thus a point may represent an individual, or a group; and one point represents $S$ itself. Every element of $PS$ is represented by one, but only one, point.
Generalization of the Lines of the Geometry

For each two points of the geometry there is a line connecting them. Every line has an arrowhead at each end, pointing in opposite directions, implying a bidirectional system. But this is a generalization and therefore an over simplification of the model in any particular teaching situation. In a given situation an arrow might, properly, point in only one direction, or there may be several arrows from one rectangle pointing to another rectangle, or several pointing in each direction. Here, each arrow might be interpreted as a single type of influence from one unit to another, or a single incidence of influence. Hence, if A and B are two points of the geometry, the line connecting A and B is analogous to a cable. This cable carries some lines, (influence links), from A to B and also carries some lines from B to A. In general, then, if A and B are two points of the geometry, there is a set of directional lines from A to B and a set of directional lines from B to A. Each line, then, is reminiscent of the mathematical concept of relation.

Further Generalization of the Teaching Model

For the sake of uniformity, the points of the geometry were, in many cases, relabeled. Whereas in the initial model some points represented attributes or functions of people, in the more generalized model every point is a set of people. (A set may contain only one member,) Now every set of people
(and every individual), has certain attributes and functions which are characteristic of that set of people. Certainly many of these characteristics are of some interest in terms of teaching theory.

But consider a concept such as "administration." There may be some question as to whether it is one function, a combination of functions, or a combination of skills and functions. Also, if A and B are each administrators, it seems quite reasonable that A's administrative functions may be quite different from that of B.

In addition to A's function as administrator, suppose that A is a history teacher. These two functions may not be entirely separate and distinct.

To circumvent such difficulties an entity called a functional will be postulated. This is a primitive, or undefined term of the system. Every point of the geometry will then have associated with it a host of these functionals. Each attribute or function of one of the points may then be interpreted as a certain grouping or arrangement of these "primitives" called functionals.

There are now two primitive terms in the geometry: functional, and relational. Each functional is associated with a single point, but each point has many functionals associated with it. Each relational is associated with a pair of points, but is directional. That is, a single relational is either
be many relationals from A to B and many from B to A. (See Figure 6.)

\[ \text{Fig. 6--Model suggesting two elements of PS with the associated relationals and functionals.} \]

It is the model of Figure 6, along with the model of Figures 1, 2, and 3, that form the heuristic bases for generating the axioms of the theory. Since this is a theory of teaching, not a theory of learning, the primitive term, relational, will be made the active agent of the theory. That is, relationals will modify functionals.

But the process of developing axioms for a theory is heuristic and intuitive rather than algorithmic. There is no linear procedure by which a useful set of axioms may be generated for a new theory. Axiom development is a combination of creative thinking and inductive thinking rather than deductive thinking.

Some Philosophical Assumptions

A geometry has been constructed; but it is a static geometry. Teaching is dynamic. There are some basic attitudes and philosophic assumptions behind the teaching model which
when stated explicitly will help establish the foundations for a theory of teaching.

First, it is assumed that teaching is primarily a human relationship. It may be more, but it is at least that. Books do not teach, machines do not teach; these are merely media of communication from one set of people to another set of people. That a person may teach himself is certainly consistent with this general assumption.

It is further assumed that teaching is not necessarily a deliberate, conscious act. One may teach without intending to teach. Much of what is taught by parents, peer groups, or our socio-cultural group is of this nature. Teachers are striving toward making each teaching act a conscious, preplanned, deliberate act. But one of the major tenets of the theory will be that the effect of any formal teaching act, if it is to be truly effective, will depend, among other things, upon the nature of the informal teaching a student has experienced.

It is assumed that good teaching is contextual. A teaching act may be appropriate for students of German culture and completely inappropriate for students of Japanese culture. A particular teacher may be good at teaching middle class children and a complete failure at teaching lower class children; good at teaching primary grades, not good at teaching high school.
No such terminology will be used in the formal theory, but the teaching relationship can depend much on the "expectation factor." Suppose a teacher has been teaching at one school for fifteen years. Her present students knew pretty well what to expect of that teacher their first day of class, for a tradition has built up around her which is passed down to younger children by way of friends and siblings of her present and former students. In a manner of speaking, this teacher began teaching her present students several years ago.

This same teacher has something else going for her besides the expectation factor. She is sponsor of the school newspaper, and consequently spends several hours a week in informal, intimate contact with the student newspaper staff. There is considerable opportunity for this group to get to know the teacher as a person, in addition to knowing her as a teacher. These are students whose opinions and attitudes count with other students. In a very real sense this teacher teaches her classes "through" this small, informal group.

But just as important, these students teach the teacher. She is able to monitor attitudes and gain insights that are invaluable to her as a teacher.

The situation is somewhat like that of electric conductors in close proximity. No change can occur in one without somewhat affecting another. The effect may be negligible or significant depending on the situation, but the effect is there.
There are other factors which may be important in determining the manner in which an individual or group responds to teaching. The time of day, the day of the week, the season--factors which usually are only subtle influences but at certain times wreak havoc on class organization. And then to repeat Bruner (1, p. 125) "When we are in church we act 'church.' When we are at the corner drugstore we act 'drugstore.'" We respond to our physical surroundings.

It would be convenient if all of these forces could be accounted for in a theory of teaching. By postulating a dynamic relationship between the primitive terms of the geometry, an attempt will be made to construct a theory of teaching which takes into account the above forces and perhaps others, also.

**Definition of Terms**

**Definition 1:** "A is a subset of B."

Suppose A is a set and B is a set. The statement that "A is a subset of B" means that "each element of A is also an element of B."

**Definition 2:** "A is a proper subset of B."

Suppose A and B are sets. The statement that "A is a proper subset of B" means that each element of A is an element of B but there is at least one element of B that is not an element of A.
Definition 3: The set "PS."

Suppose S is a set. The set "PS" is the set of all subsets of S, excluding the null set.
CHAPTER BIBLIOGRAPHY

CHAPTER V

THE THEORY

Introduction

In Chapter V are presented the axioms and a development of the theory. The axioms are stated in two groups. The first group, the primary axioms, are stated entirely in terms of the undefined terms "functional," "relational," and "modify." The second group, the secondary axioms, make use of the intuitive notions of time and place. Also, there are assumed some properties of functionals called "power," "complexity," and "sensitivity." These are defined and discussed by the use of analogy. No attempt is made to present a rigorous definition of power, complexity or sensitivity. There are assumed some properties of relationals called "power" and "efficiency." The interpretation of these properties is left mostly to the intuition of the reader.

A property of some functionals, "residualization," is also assumed in the secondary axioms. This property is explained in terms of the undefined terms "functional" and "modify" but again the explanation is by analogy.

In the development of the theory, both sets of axioms are used as if they were one set.
NOTATION: In the text "Pi" refers to primary axiom "i" and "Qi" refers to secondary axiom "i". For example, Q3 refers to secondary axiom 3.

Primary Axioms

1. There exists a set S.

2. Let PS denote the power set of S, exclusive of the null set. With each element X of PS there is associated with X a set of elements called "functionals."

3. Suppose A is an element of PS and B is an element of PS. (B not necessarily different from A.) There is associated with the ordered pair (A, B) a set of elements called "relations."

4. Let A represent an element of PS and B represent an element of PS. For any functional f of A, there exists at least one relational r of (B, A) which can modify f. (It will at times be convenient to write "the relational r from B to A." )

5. Let A represent an element of PS and B represent an element of PS, and f a functional of A. There exists a relational r_j of (B, A) such that if r_j is any relational of (B, A) which can modify f, then r_j can modify f at least as much as r_j.

6. Let A be an element of PS, and B an element of PS, and f a functional of A. There exists at least one element of PS, C, and a relational r of (C, A) and a relational r_1
of (B, C) such that \( r_1 \) can modify \( f \) through \( r \). (It will
at times be a convenience of language to say, "\( r_1 \) can
modify \( f \) through \( C \)."

Definition: Suppose \( A \) is an element of PS, \( B \) an element
of PS, \( C \) an element of PS, \( r \) a relational of \((C, A)\), \( r_1 \) a
relational of \((B, C)\), \( F \) a functional of \( A \). The statement
that "\( r_1 \) modifies \( F \) through \( r \)" means there exists a func-
tional \( f \), of \( C \), such that if \( r_1 \) modified \( f \), then \( r \) modi-
fies \( F \).

7. Let \( A \) be any element of PS and \( f \) any functional of \( A \). For
any element \( Y \) of PS different from \( A \) and for any rela-
tional \( r_1 \) of \((Y, A)\) there exists an element \( Z \) of PS,
\((Z \) different from \( Y)\), and a relational \( r \) of \((Z, A)\) such
that \( r \) can modify \( f \) at least as much as \( r_1 \).

8. Let \( A \) be an element of PS, and \( C \) be an element of PS.
And, further, let \( F \) be a functional of \( A \) and \( r_1 \) a rela-
tional of \((C, A)\) which can modify \( F \). There exists a \( B \),
an element of PS, and a relational \( r \) of \((B, C)\) such that
\( r \) can modify \( F \) through \( r_1 \).

The Role of Models and Analogies
in Theory Development

It is often necessary to make use of analogy in the de-
velopment of a theory. That this is acceptable is established
and discussed by Nagel.

Two features of theories have accordingly been
discussed at some length. It was noted, in the
first place, that theoretical notions are in general defined only implicitly by fundamental premises of a theory, whether the premises are formulated as abstract postulates or in terms of some model. In the second place, considerable stress was placed in consequence upon the necessity for rules of correspondence to link theoretical ideas with experimental concepts. On the other hand, some care was taken to make clear that the three components mentioned as usually present in a theory (an abstract set of postulates which implicitly define the basic terms of the theory, a model or interpretation for the postulates, and rules of correspondence for terms in the postulates or in the theorems derived from them) are not to be construed as separate items, introduced in succession at various stages in the actual construction of theories, but simply as features that can be isolated for purposes of analysis. It is in fact quite difficult to state fully and with precision the abstract postulates, freed of all interpretations, that are embedded in a theory, or to formulate in detail the tacitly used rules of correspondence. Most theories, at any rate, are generated within the matrix of some model and are codified, with at best only casual mention of any rules of correspondence, in terms of an interpretation for their fundamental premises. (1, pp. 106-107)

The widespread use of metaphors, whether they are dead or alive, testifies to a pervasive human talent for finding resemblances between new experiences and familiar facts, so that what is novel is in consequence mastered by subsuming it under established distinctions. In any event, men do tend to employ familiar systems of relations as models in terms of which initially strange domains of experience are intellectually assimilated. This is not always a consciously deliberate process in most contexts of experience. Similarities between the new and the old are often only vaguely apprehended without being carefully articulated. . . . Nevertheless, apprehensions of even vague similarities between the old and the new are often starting points for important advances in knowledge. When reflection becomes critically self-conscious, such apprehensions may come to be developed into carefully formulated analogies and hypotheses that can serve as fruitful instruments of systematic research.
In any event, the history of theoretical science supplies plentiful examples of the influence of analogies upon the formation of theoretical ideas; and a number of outstanding scientists have been quite explicit about the important role models play in the construction of new theories. (1, pp. 107-108)

Some Assumptions About Relationals and Functionals

It will be assumed that relationals have the properties of power and efficiency; that in a given situation, some relationals may have more power and efficiency than others for modifying a certain functional.

It will be assumed that a functional has complexity, power, and activeness. These three properties are not entirely separate and distinct. An analogy may help clarify the way these concepts are understood in relation to the nature of functionals.

Suppose a man can build a coffee table, a tool shed, a church, many things, and each of these is very sturdy but extremely simple in design. Furthermore, not only are the designs simple but all his coffee tables look very similar, and all his churches look very much alike. This man exhibits "power" but not much "complexity."

Suppose another man is a specialist in coffee tables. He can build a very sturdy coffee table. Furthermore, he can build a simple one or an elaborate one. He is in fact very creative and original in his design of coffee tables, but when he tries to build anything else he is often
unsuccessful. This man exhibits "complexity" but not much "power."

When either of these woodworkers is extremely hungry, or tired, or sleepy, or thinking about his vacation, his interest in woodworking lessens. He may even become clumsy and make mistakes. He finds it more difficult to read and follow instructions. His power and complexity have not decreased; he is just as skilled as before. His skill has decreased in "sensitiveness." At times his skill increases in sensitiveness, sometimes to such a degree it seems at these times everything he does is exactly right. Sensitiveness, then, is a very temporal, sometimes whimsical property. Consider the situation in which the woodworker sees a pretty girl and saws a piece incorrectly. (Or cuts a finger.)

To interpret "residualized," as used in the axioms will take some discussion. First consider the statement, "As the twig is bent, the tree shall grow." Residualizing a functional is "bending the functional twig," so to speak. The tree definitely may keep growing. In fact it may become quite large, elaborate, strong, and beautiful. Furthermore a tree which grows from a seedling in an environment in which there is a more or less constant wind direction will not be "bent" in the usual sense, but will simply assume the direction of the prevailing wind as it grows. Both cases are analogies of the concept of "residualized" as used in the theory.
Now consider a piece of metal that is extremely difficult to bend but which can be elaborated (modified) by welding on other pieces of metal equally difficult to bend, and also can be strengthened (modified) by similar welding reinforcement. In the analogy this piece of metal is considered "residualized," as contrasted with a piece of metal which can be not only elaborated and strengthened by welding on additional pieces, but can be bent relatively easily, as well. A residualized functional, then, is a functional which has assumed a relatively permanent, fundamental form, a form which can be elaborated and strengthened, but remains basically permanent in its fundamental structure.

Secondary Axioms

1. Suppose A is an element of PS. If $F_k$ is the set of functionals associated with A at time k, and $F_{k+1}$ is the set of functionals associated with A at time $k+1$, then $F_k$ is a subset of $F_{k+1}$.

2. For any A and any B of PS, and any functional f, of A, at time t and place p, the relational r from B to A which can be the most powerful in modifying f will depend of the sensitiveness, complexity, and power of functionals associated with B and the sensitiveness, complexity, and power of the functionals associated with A at time t and place p.
3. Let $A$ be an element of $PS$ and $R$ be the set of reflexive relationals associated with $A$ at time $k$, and $F_k$ the set of functionals associated with $A$ at time $k$, and $F_{k+1}$ the set of functionals associated with $A$ at time $k+1$. There exists some proper subset, $R'$, of $R$ such that if $f$ is an element of $F_k$ and $r$ is an element of $R'$, and if $r$ modifies $f$, then there exists an element of $F_{k+1}$, $f'$, such that $f'$ is not an element of $F_k$.

4. Let $A$ be a singleton element of $PS$. For any functional $f$ of $A$, there exists an interval of time $T_{n,m}$ such that if $f$ is modified between time $T_n$ and time $T_m$, then $f$ becomes residualized.

5. For any singleton element $A$, of $PS$, there exists at least one functional $f$, of $A$, and at least one functional $F$ of $A$ such that $f$ can become residualized only if $F$ becomes residualized before $f$.

Development of the Theory

Pl: There exists a set $S$. Set $S$ will be interpreted to be a set of people. But $S$ is not just any set of people. This is a theory of teaching and it is desirable that any particular teaching situation be explained in terms of the theory. Therefore set $S$ will be interpreted as the set of all people, past or present who have, or who have had any influence on any of the individuals or groups in a given teaching situation. Set $S$ will also include all individuals or groups
which can be influenced by the individuals involved in the
given teaching situation. From S will be excluded any
individual or group that has no conceivable connection, in
the sense of direct or indirect influence, on the given teach-
ing situation. Therefore, for any group or individual, at
a given time and given place, set S is a well defined set.
But set S may vary with respect to time, place, and teaching
situation.

Now consider P2 along with Q1. "X is an element of PS"
will be interpreted to mean that X is either an individual
in S or a combination of individuals in S. P2 says there
is a set of functionals associated with S. Q1 says that
each of these functionals will remain associated with X as
long as X exists. Q3, which will be given additional dis-
cussion later, will be interpreted to mean that new function-
als can be added or "created" to an individual or group.
Associated with each element of PS, then, there is a field
of functionals.

Reread P3. There is associated with the ordered pair
(A, B) a set of elements called "relationals." Relationals,
then are associated with pairs—ordered pairs. The signifi-
cance of the ordering is that the relationals associated
with, say, the ordered pair [Mary, (Joe, Sue)] is a different
set of relationals than the set associated with the ordered
pair [(Joe, Sue), Mary]. To simplify the language, a
relational associated with \((A, B)\) is referred to as "a relational from \(A\) to \(B\)," and a relational associated with \((B, A)\) is "a relational from \(B\) to \(A\)."

Examine P4 along with Q2. Relationals modify functionals. Suppose \(B\) and \(A\) are elements of PS and \(f\) is a functional of \(A\). P4 assures the existence of at least one relational, say \(r\), from \(B\) to \(A\) such that \(r\) can modify \(f\). There may be many such relationals, some more powerful and efficient than others. The relative power of a particular relational to modify \(f\) depends on the configuration, or profile, of the functional field of \(A\) and the configuration, or profile, of the functional field of \(B\). Refer to the previous discussion of "power," "complexity," and "sensitiveness" of a functional. Power and complexity can be modified (that is, changed) by relationals, while sensitivity is free to change with a change in time and place. Therefore, while the power and complexity of the functionals of a particular individual or group may not change from one time interval to another, the relative sensitiveness of the functionals with respect to each other is free to change and hence the configuration, or profile, changes. And such a change may very well be caused by a change in place or a change in time. It should not be overlooked, however, that such a change may also be caused by modification by relationals—that is, by a change in the power or complexity of a functional or functionals.
P4 does not state that A is a different element from B. Therefore it is consistent with the axiom that for any functional f of A, there exists at least one relational r of (A, A) which can modify f. And, of course, P5 guarantees that there are more than one, and that some may be more powerful than others. Such relationals (from A to A) will be called "reflexive relationals," and reflexive relationals shall be the most effective relationals in the theory.

**Definition:** Let A represent an element of PS. A reflexive relational is any relational from A to A.

P5 guarantees that for any functional f of A, there is more than one relational from B to A which can modify f. P5 also implies that some relationals may be more powerful than others in modifying a given functional. That is, for any functional f, of A, where A is an element of PS and B is an element of PS, there is a relational r, from B to A, which is the most powerful relational from B to A, at least in the sense that no other relational from B to A is more powerful than r. There may be other relationals as powerful as r. Indeed, there may be a combination of relationals from B to A which, taken together, are more powerful than r. And certainly r itself, combined with other relationals may be more powerful than r. But no other single relational is more powerful than r.
Perhaps it is useful to repeat the dependence of \( r \) upon time and place. That is, \( r_i \) may be the most powerful relational from \( B \) to \( A \) at a given time and place, but a change in either may mean there exists a relational \( r_j \) from \( B \) to \( A \) such that \( r_j \) is more powerful than \( r_i \) in modifying a particular functional.

The implications of P6 will need to be examined in some detail. \( A, B, \) and \( C \) may denote three distinct elements of \( PS \), two elements of \( PS \), or just one.

Case I. Consider the most general case. Suppose \( A, B, \) and \( C \) are three distinct elements of \( PS \).

For this case, then, the axiom says there exists an element \( C \) of \( PS \) that has the property that if \( r \) modifies \( f \) then \( r \) can modify \( F \). Axiom (4) says there is a relational from \( B \) to \( A \) which can modify \( F \). Suppose \( r_i \) is a relational of maximum power, \([Axiom P (5)]\), from \( B \) to \( A \), and \( r_j \) is a relational from \( B \) to \( C \) which modifies \( F \) through \( C \). Then \( r_j \) may

\[ F \]

Fig. 7--A, B, and C mutually distinct.
very well be more powerful than $s_j$ in modifying $F$. And cer-
tainly a combination of $s_i$ and $s_j$ may be more powerful than
either $s_i$ or $s_j$ without the other.

Case II. Suppose $B$ and $C$ represent the same element of
PS with $B$ different from $A$.

Fig. 8--$B$ and $C$ the same element.

Here $r$ is a reflexive relational from $B$ to $B$. Now suppose $p$
is a relational from $B$ to $A$ of maximum power as guaranteed
by Axiom PS. Relational $r$ is not necessarily the same as $p$.
It is quite possible that $r$ will modify $F$ only if $s$ modifies
$f$. If $p$ is a relational of maximum power from $B$ to $A$ and
$p$ can modify $F$, then $r$ cannot be more powerful than $p$, but
can be at least as powerful. And, again, a combination of $p$
and $r$ may be more powerful than either alone.

Case III. Suppose $C$ and $A$ represent the same element
of PS with $B$ different from $A$.

Fig. 9--$C$ and $A$ the same element.
Here \( r \) is a reflexive relational from \( A \) to \( A \). \( F \) and \( f \) are both functionals of \( A \). The axiom says if \( r \) modifies \( f \) then \( r \) can modify \( F \). A similar statement concerning the relative power of relationals may be made as in previous cases.

Case IV. Suppose \( A, B, \) and \( C \) denote the same element of \( PS \).

\[ \text{Fig. 10—} A, B, \text{ and } C \text{ all the same element.} \]

Now both \( r \) and \( r \) are reflexive relationals from \( A \) to \( A \).

Case V. Suppose \( A \) and \( B \) denote the same element of \( PS \) with \( C \) different from \( A \).

\[ \text{Fig. 11—} A \text{ and } B \text{ the same element.} \]

If \( F \), then, is a functional of \( A \), there is a functional \( r \) from \( A \) to \( C \) such that \( r \) can modify \( F \) through \( C \).
This exhausts the special cases of Axiom P6. But, obviously, it is a powerful axiom.

P7 says that if $A$ is an element of $PS$ and $f$ a functional of $A$, there is more than one individual or group whose relationals can modify $f$. And furthermore the relationals of some individuals or groups may be more effective than the relationals of others in modifying $f$.

Consider, now, P6 in conjunction with P8.

Suppose $r$ is a creative relational from $A$ to $A$. That is, suppose $r$ is a relational from $A$ to $A$ which can create new functionals of $A$. According to P8 there exists some element of $PS$, say $B$, and a relational $r_1$ from $B$ to $A$ such that $r_1$ can modify $f$ through $r$. This implies a functional $F$ of $A$ such that when $r_1$ modifies $F$ then $r$ modifies $f$. By asserting P8 again, there exists some element of $PS$, say $C$, and a relational of $r_2$ of $(C, B)$ such that $r_2$ can modify $F$ through $r_1$. P8 also allows the possibility that there exists

Fig. 12—P6 combined with P8.
a reflexive relational \( \pi \) of \((A, A)\) such that \( \pi \) can modify \( f \) through \( r \). Therefore, although \( A \) creates its own new functionals, \( A \) may be aided in many ways from many directions.

Creative relational, as defined, are special cases of reflexive functionals. Some attention will now be given reflexive functionals in general. It is perfectly consistent with the axioms that an element of PS might become relatively self-subsistent and independent of other elements. Independent, that is, in the sense of continuous modification of its own functionals and the creation of new ones. Perhaps a well designed and well engineered pendulum is an acceptable analogy. That is, to the extent that an element operates as a good pendulum, to that extent, only minimum outside aid is needed. However, the analogy should not be pushed too far. It is also consistent with the axioms that outside aid can increase the power and efficiency of this self-subsistence process. An element may be operating independently at some level of efficiency and power when an outside "push" might cause it to operate at a higher level of power and efficiency.

Before continuing the examination of other axioms, some further implications will be examined of the axioms already stated. Consider a particular teaching situation with teacher \( A \) and class \( B \). \( A \) is an element of PS, \( B \) is an element of PS. There is a set of functionals associated with \( B \), and a set of functionals associated with \( A \), and a
set of relationals from A to B which can modify the functionals of B. Suppose A wishes to modify some functional f, of B. The relational, (or relationals), and the power and efficiency of such relationals, depend upon the nature of the functional field of A and the functional field of B at the particular time involved. Another time may, (but not necessarily), demand another set of relationals. Now suppose a student leaves the room, or a new student enters. (A, B) is no longer the ordered involved, but another, say, (A, C), since A is still the teacher. But C is a different element of PS from B, therefore has a different functional field. Hence, the relationals demanded may be, (but not necessarily), quite different. The picture is not one of completely unpredictable whimsical changes, but rather a situation in which the teacher should not be surprised if such changes occur, and should be as prepared as possible to make such changes.

Consider, further, the ordered pair (B, A). There is a set of relationals from B to A which can modify the functional field of A. When the functional field of A is modified, the set of relationals from A to B, from which A may choose, may be different.

And, certainly, it is consistent with the axioms, that given the same class with a different teacher, a different set of relationals may be demanded.
Consider again a teacher A and a class B with A working at modifying the functional field of B. It is consistent with the axioms that A may find a third unit C such that A can modify the functional field of B through C. And thus a combination of a direct and indirect approach may be more powerful and more efficient than a single approach.

Suppose A is an element of PS and B is an element of PS, f a functional of B and r a relational from A to B such that r can modify f. What determines the degree of receptivity of f to modification by r? The degree of receptivity to modification of f by r depends on the structure of the entire functional field of B. This structure can be modified in ways already discussed. Potentially, though, the most powerful means by which a functional field may be modified is by the reflexive relationals, recalling that among the reflexive relationals are the creative relationals.

Of course, it should not be assumed that a functional is automatically more receptive to modification by a relational just because the functional field structure is modified. Whether a functional becomes more receptive to change by a relational depends upon which functionals are modified, and the nature of the modification. But this is the mechanics by which major structural change in a functional field may be initiated.

A functional, once created, continues to exist as long as the element with which it is associated exists.
Modification by a relational may make the functional more elaborate in structure, or more powerful, or may even make fundamental changes in the structure of the functional, but the functional continues to exist and maintain its identity. There is a change in a functional, implicit in the axioms, which will not be regarded as modification. This is the change caused entirely by a change of time or a change of geographical location. This change will be regarded strictly as a change in the activeness of the functional. A functional, regardless of its structure or power, may be extremely active at certain times and places and very inactive at others. Thus, major characteristics of the functional field due strictly to relative activeness of its functionals may be regarded as relatively temporary. But when it is recalled that the receptiveness of a functional to modification by a relational is determined by the structure of the entire functional field at the time modification is attempted, then it becomes obvious that such "temporal" characteristics of the functional field can be important, and even critical.

Let A be a singleton element of PS. In particular suppose A is a newborn infant. According to P2, A is born with a set of functionals. By Q3, new functionals are created by reflexive relationals, specifically, special reflexive relationals called creative relationals. Suppose further that F is some proper subset of the functionals associated with A at, say, age 17. If 50 per cent of the elements of
F are residualized by the time A is age four, the nature of the modification of the elements of F before A is age four is critical. Now suppose F is the set of functionals of A which, taken together, represent some human characteristic, say, intelligence. It is obvious that not only is modification of the functionals with which A is born a critical factor, but also the adding or creating of new functionals is critical. For if many new functionals are added to F before age four, then the snowballing effect can be much more powerful.

Consider the situation in which all the elements of some proper subset F' of functionals associated with A became residualized over some relatively short period of time. This can be interpreted as some "stage" in the development of A. And if there exists some proper subset F" of A such that the elements of F" can become residualized only after the element of F' are residualized then an invariant sequence of stages may be detected.

Interpretation of Some Counseling Situations in Terms of the Theory

Suppose S is a client and C is a counselor. Suppose further that F is a subset of functionals associated with S which C, as counselor, is endeavoring to modify. If C is essentially directive he will strive to modify the elements of F directly as suggested by P4. That is, C will attempt
to make use of some set, \( R \), of relationals from \( C \) to \( S \) which will modify the elements of \( F \).

If \( C \) is essentially non-directive he will endeavor to modify the elements of \( F \) indirectly as suggested by P6 and by Figure 9, page seventy-nine, initiating the cyclic or pendulum action suggested by Figure 10, page eighty, by modifying some set \( F' \) of functionals of \( S \) which change the functional structure of \( S \) in such a way as to activate some set \( R' \) of reflexive relationals of \( S \). Furthermore, \( C \) will strive for a strategy which will assure that \( R' \) contains some subset of creative relationals. This would mean that \( S \) would be strengthened by the adding of new functionals as well as by the modification of his present ones.

Consider now the situation of \( S \) attending group therapy sessions with \( C \) as leader for group \( B \), where \( S \) is an element of \( B \). Now \( C \) may strive for a strategy which will modify the elements of \( F \) directly and indirectly as discussed above, but in addition may also make use of added resources by modifying the elements of \( F \) indirectly through the elements of the power set of \( B \).

**Interpretation of Some Teaching Situations in Terms of the Theory**

Suppose \( S \) is a student, \( T \) is a teacher, and \( F \) is some subset of the functionals of \( S \) which \( T \) is endeavoring to modify by a strategy of programmed learning. \( T \) assumes that
there exists some sequence \( f_1, f_2, f_3, \) etc., of the elements of \( F \) and some sequence \( r_1, r_2, r_3, \) etc., of relationals from \( T \) to \( S \) such that if \( r_1 \) modifies \( f_1 \), it is easier for \( r_2 \) to modify \( f_2 \), hence easier for \( r_3 \) to modify \( f_3 \), etc., until every element of \( F \) has been modified.

Now suppose \( T \) is endeavoring to make use of Comb's human relations approach. Then \( T \)'s strategy would be to modify some subset \( F' \) of functionals of \( S \) which would cause some set \( R' \) of reflexive relationals, some of which are creative relationals, through cyclic action, to indirectly modify the elements of \( F \) and also increase the functional resources of \( S \).

Use of the Theory to Direct Research

Concerning the use of models for the expansion of theories, Nagel says,

Emphasis has thus far been placed on the heuristic value of models in the construction and use of theories. The fact should not be overlooked, however, that models also contribute to the achievement of inclusive systems of explanation. A theory that is articulated in the light of a familiar model resembles in important ways the laws or theories which are assumed to hold for the model itself; and in consequence the new theory is not only assimilated to what is already familiar but can often be viewed as an extension and generalization of an older theory which had a more limited initial scope. From this perspective an analogy between an old and a new theory is not simply an aid in exploiting the latter but is a desideratum many scientists tacitly seek to achieve in the construction of explanatory systems. Indeed, some scientists have made the existence of such an analogy an
explicit and indispensable requirement for a satisfactory theoretical explanation of experimental laws. And conversely, even when a new theory does organize systematically a vast array of experimental fact, the lack of marked analogies between the theory and some familiar model is sometimes given as the reason why the new theory is said not to offer a "really satisfactory" explanation of those facts. . . . What is nevertheless beyond doubt is that models of some sort, whether substantive or formal, have played and continue to play a capital role in the development of scientific theory. (1, pp. 114-115)

Therefore, to render the theory more useful for the direction of research, it will be impressed back upon the teaching model developed in Chapter III. However, in order to articulate the theory more satisfactorily, a few changes will be made in the model. Instead of an element called the "peer-group culture," that element will be called the "peer-group." And associated with each peer-group there is a certain set of functionals which can be labeled the "peer-group culture." Instead of an element labeled "maternal teaching pattern," that element will be labeled "mother." Each mother has certain abilities, attributes, and characteristics which largely determine her maternal teaching pattern. Associated with these particular abilities, attributes, and characteristics is a certain set of functionals which can be labeled "maternal teaching pattern." This system of relabeling may be continued for each element of the model. And by examining the model with the theory
impressed upon it, questions are suggested which can be used to direct research.

The following set of questions is to be considered illustrative only, and not necessarily significant research questions.

Some Research Questions Suggested by the Theory

1. Are there identifiable conditions of the maternal teaching pattern which tend to activate in the early life of the child, the creative relationals associated with the child?

2. Suppose C is a class, T is a teacher, and F is a set of functionals associated with C. Suppose further that G is a small group working closely but informally with T. What is the nature of the set of relationals from T to G which are effective in modifying the elements of F through G?

3. Suppose S is a student, T is a teacher, and F is a set of functionals associated with S. Suppose further that P is the set of peers of S. What is the nature of the set of relationals from T to P which are effective in modifying the elements of F through P?

4. Suppose S is a teacher, F₁ is a set of functionals associated with the psychomotor domain of S, F₂ a set of fundamentals associated with the affective domain of S, and
$F_3$ a set of functionals associated with the cognitive domain of $S$, and suppose $R$ is a set of reflexive relationals of $S$ and that $R$ includes some set of creative relationals $R'$. What effects on $R$, and in particular $R'$, can be expected when the elements of $F_1$ are modified? What effects may be expected when the elements of $F_2$ are modified? What effects may be expected when the elements of $F_3$ are modified? If $T$ is a teacher, what is the nature of the set of relationals from $T$ to $S$ such that $T$ can modify the elements of $F_3$ indirectly by modifying the elements of $F_2$?
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