# AN ANALYSIS OF RELATIONSHIPS AMONG CONSISTENCY OF BELIEFS, DIVERGENT THINKING, AND MENTAL ABILITY OF ELEMENTARY EDUCATION STUDENT TEACHERS IN SCIENCE

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# AN ANALYSIS OF RELATIONSHIPS AMONG CONSISTENCY OF BELIEFS, DIVERGENT THINKING, AND MENTAL ABILITY OF ELEMENTARY EDUCATION STUDENT TEACHERS IN SCIENCE

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# PREFACE

There were two basic goals to this investigation; to study the possession of and changes in the logical consistency of beliefs toward education in a pretest-posttest situation, and, secondly, to determine any relationships which might exist among the logical consistency of belief toward education, the factors of divergent thinking, and mental ability within the chosen sample.

The work reported in this study was performed under a graduate teaching assistantship at Oklahoma State University. The writer wishes to acknowledge and thank the students enrolled in Education 4K2 during the spring semester of 1967 for their cooperation in participating in this study.

I wish to express my deep appreciation to my advisory committee. I am especially grateful to Dr. Kenneth E. Wiggins, Chairman of the Advisory Committee for his encouragement, interest, and guidance throughout the program of study.

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

# CHAPTER I

## PRESENTATION OF THE STUDY

Contemporary science courses are stressing "discovery methods," "inquiry," "problem solving," and a whole series of "involvement" approaches to learning.

There are many new programs at all levels. Those related to high school offerings were the first to be completed. But there are now some aimed primarily at the junior high grades and several emphasizing the elementary sciences. The stress within the courses is on variability and involvement, much like the process used by a practicing scientist.

It was not the purpose of this study to look critically at any or all of the elementary science programs and compare them with one another. The interest in and among the various programs which have spurred this study is the array of methods used in studying a given generalization, and the variety of suggested teaching procedures emphasized.

Veteran teachers and new teachers alike must understand this new emphasis in the sciences as well as modern learning theory as promoted by Bruner, Piaget, and many others. Wardeberg (53) states that, "It is the teacher's job to nurture curiosity and the inquiring mind."

The path to discovery and learning is not the same for all students. Teachers must adjust their presentations to include experience

for all students.

John Dewey (9) believed children should have experiences with the scientific method even though they may not be aware of it. He believed the child should:

1. engage in meaningful experiences
2. recognize a problem within the experiences
3. be guided in methods of collecting data
4. provide a hypothesis or possible solutions to the problem
5. test the hypothesis

This should lead the child to have a greater understanding of his experiences and, therefore, be able to continue with similar and more complex experiences.

Bruner (3) states that grasping the structure of a subject means understanding it in a way that permits many other things to be related to it meaningfully. To learn structure is to learn how things are related.

Bruner points out that it is possible to present the fundamental structure of science in a way that exposes some of the exciting sequences which lead a student to discover for himself.

He asserts:

> Motives of learning must be kept from going passive in an age of spectatorship, they must be based as much as possible upon the arousal of interest in what there is to be learned, and they must be kept broad and diverse in expression.

One major facet of Piaget's (44) theory is that children should be taught the underlying themes of a subject matter area, after which they will be able to relate individual items to the general structure. Piaget also believes the teaching situation should be structured so that the child is active and creates structure himself. Situations should be created where structure can be discovered.

Livermore (33), reporting for the Commission of Science Education of the American Association for the Advancement of Science, states that science is more than a body of facts. The Commission believes that science should include ways of investigating and exploring. The ways of investigating--the process of science--are stressed in the early grades. The process includes recognizing space-time relationships, observing, classifying, using numbers, measuring, communicating, inferring, and predicting. Material has been developed to implement these processes in a progran entitled, Science--A Process Approach. Many of the new approaches to teaching science to children utilize the discovery process in teaching concepts in science. Teaching by this method is not easy.

Paul DeHart Hurd (24) states that the first task of the science teacher is to teach the process of inquiry. Inquiry capabilities furnish the student the tools for independent learning, establish a process and an understanding of classification, and help establish a conceptual framework. These basic levels serve as building blocks for further conceptualizations of a more complex nature, tieing past experiences to present problems and situations, and permitting evaluation and prediction.

Parker (43) has said that it is not enough to be divergent, but a really successful teacher must be able to assess the problems of a given student, or group of students, and choose the proper divergent tactic which will promote the greatest amount of learning.

A step toward early identification of good prospective teachers might be enhanced by identifying those qualities inherent within the correlation among the logical consistency of beliefs toward education,

mental ability, and divergent thinking.

If today's graduating student teachers are accepted into the professional world of teachers, it appears that this group could provide the measurement of stability against which a basic comparison in early identification could be made. In addition, more detailed study is greatly needed to help establish the authenticity of divergent thinking factors. Knowledge of these factors is necessary if future science education courses and inservice courses are going to train teachers in methods of handling a variety of approaches toward a given topic.

## Need for the Study

In the new curricula, learning is student-centered and student-oriented. Student-oriented learning demands not a sameness of activities or ideas but the basic recognition of a variety of possible approaches to solving problems. Student-centered learning creates a structured requirement of student-student and student-teacher verbal and non-verbal interaction. "Teaching is listening--listening to children as they talk not only to the teacher but, even more important, to each other." (27)

All the new science programs involve the students and the teacher in structured activities of one form or another. The teacher, however, must be able to move freely about, helping each and all students. This requires that the teacher be flexible in thought and open-minded in attitude, accepting and respecting the various ideas of her students as they render divergent solutions to the existing problems.

Kageyama (27), of the Science Curriculum Improvement Study declares:

> Giving children direct experience with materials and allowing them to do individual experiments makes different demands upon the teacher than a traditional science program. The teacher has to play a different role. She can no longer be the dominant figure of authority or the only source of information. . . . She has to create an environment that invites and supports curiosity, investigation, and inquiry.

As suggested from a search of the literature related to the new science programs and to contemporary learning theory, a teacher must possess certain qualities to be content teaching one of the new science programs and to be satisfied with her results. The literature further suggests that certain fundamental qualities have been identified in three general areas.

The qualities seemingly necessary are: 1) certain factors of divergent thinking as defined by Guilford, 2) the possession of some logically consistent belief toward education, and 3) the attainment of a qualified, minimum mental ability.

If relationships do exist among any of the measured traits, then they might prove to be basic to the pre-training and inservice training of elementary science teachers and, consequently, to the reorganization of the science methods courses. The degree of promise an elementary science teacher possesses in regard to teaching a variety of divergent procedures as used in new science programs may possibly be established by analysis of her performance on the instruments of measure utilized in this study.

With the possibility of being able to earlier identify prospective elementary science teachers who possess all or some of the qualifications listed above, and with the possibility of providing a basis for redesigning the teacher's science training courses, this investigation may be helpful to the general area of science education.

## Statement of Problem

It was the purpose of this investigation to determine which traits of divergent thinking are possessed by preservice elementary science teachers, their ability to apply these traits, and whether these traits are significantly related to their logical consistency of beliefs toward education and to their mental ability.

Secondarily, it was the purpose of this study to determine if any significant change in their logical consistency of beliefs toward education occurred after experiencing a period of student teaching.

## Hypothesis

The general hypothesis which guided this investigation was stated in the null hypothesis form as follows:

> There is no significant difference in the logical consistency of beliefs toward education prior to or following student teaching among the student teachers tested. Similarly, there are no significant differences among the traits of divergetn thinking possessed by pre-service elementary science teachers. Neither are there any significant relationships existing among the factors of divergent thinking, the ability to apply divergent thinking (semantic redefinition), the logical consistency of beliefs toward education, and the mental ability of the pre-service elementary science teachers tested.

To reduce the above hypothesis to manageable proportions, the following sub-hypotheses were offered:

1. There is no significant display of logical consistency of beliefs toward education among the elementary student teachers tested.

2. There is no significant change in the logical consistency of beliefs toward education after experiencing a period of student teaching.

3. The elementary student teachers display no significant difference among the sub-tests of the divergent thinking instrument.

4. No significant relationship is expressed toward the dependent variable, semantic redefinition, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for logical consistency of beliefs toward education, and the scores of the mental ability tests.

5. No significant relationship is expressed toward the dependent variable, logical consistency of beliefs toward education, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for semantic redefinition, and the scores of the mental ability tests.

6. No significant relationship is expressed toward the dependent variable, mental ability, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for logical consistency of beliefs toward education, and the scores of the semantic redefinitions tests.

## Definitions of Terms

Logical Consistency of Beliefs Toward Education: This term refers to an acquired framework of thought about education, which consistently enables one to select or reject items in terms of the point of view he holds.

Student Teaching: A period of guided teaching when a college student assumes increasing responsibility for directing the learning of a group or groups of learners over a period of consecutive weeks.

Student Teacher: A college student engaged in an assigned student teaching experience.

Divergent Thinking: The ability to reason about a topic or situation from several dissonant points of view. Contemporary literature considers divergent thinking to be manifested in three basic components, fluency, originality, and flexibility. In this study divergent thinking was measured by the accumulative points of the individual sub-test scores. The sub-tests are defined as:

Ideational Fluency is a test of the faculty to bring forth a quantity of ideas relative to a given situation or condition. The test is timed and the score is the number of right responses written by the subject.

Semantic Originality is a test of the ability to call up a word or a group of words which may be clever or uncommon to describe a situation. The specific test consisted of a story for which the subjects were to supply the title. The titles were divided into two areas, descriptive and commentary. The answers were interpreted in accord with the author's scoring guide.

Symbolic Originality is a test of the ability to produce a set of symbols which will represent a given situation. In scoring the tests, all symbols which show some relation, however remote, between it and the object or action described were permitted. Limitations of symbol acceptance were stick figures and repetition of symbols.

Figural Adaptive Flexibility is a test of one's ability to produce divergent figural transformations from given patterns. The score is the number of correct solutions. Both symmetrical and asymmetrical designs were specified.

Semantic Spontaneous Flexibility is a test of one's ability to call up words within a variety of relatively unrestricted categories

but analogous to a given stimulant word. Scoring is based on a change in categories.

Semantic Redefinition: A cognition factor (not a sub-test of divergent thinking) utilizing the ability to apply the attributes measured by the other instruments in a creative or ingenious situation. The test consists of twenty multiple-choice questions and tests one's genius to shift the function of an object, or part of it, and use it in a new and unrelated way.

Mental Ability: The thinking power or the degree of maturity of the mind as measured by the Otis Quick-Scoring Mental Abilities Tests.

## Assumptions of the Study

1. The sample selected was representative of the population.
2. The instruments selected are suitable for measuring the intended characteristics.
3. The characteristics can be measured by paper-pencil tests.
4. A logical consistency of beliefs toward education does exist and is accumulated through educational experiences.
5. The logical consistency of one's beliefs toward education has positive value for that person.
6. The possession of logical consistency of beliefs toward education is desirable.
7. Degrees of divergent thinking ability exist in the population and the selected sample.

## Limitations of the Study

1. The study was limited to the segment of the female population at

Oklahoma State University enrolled in the course; Science for the Elementary School, Education 4K2, during the spring semester, 1967.

2. The study was limited by the exclusion of male members of the population.
3. The study was limited by the extent to which the instruments could factually measure the traits tested.
4. The study was limited by the ability of the investigator to correctly evaluate the data obtained by the instruments used.
5. The study was limited by the fact that the students did not participate in identical experiences during student teaching.

## Organization of the Study

In Chapter I the background and significance of the study were presented. In addition, it included the statement of the problem, the hypothesis by which the study was guided, the clarification of terms, the assumptions, and the limitations.

In Chapter II a review of the pertinent and selected literature will be provided.

In Chapter III a delineation of the specific sample and the population from which it was obtained will be presented. Also, the procedures utilized within the investigation and a description of the measuring instruments will be given. The statistical tools used in analysis of the data will conclude the chapter.

Chapter IV will present a statistical analysis of the data.

In Chapter V a discussion of the analysis will be offered. Also, implications of the study and recommendations for further investigations will be brought forth.

# CHAPTER II

# REVIEW OF SELECTED LITERATURE

## Introduction

The review of literature for this study will be presented in four parts. The subjects of this study were participating in their assigned student teaching activity during their senior year at Oklahoma State University. Part one is restricted to those research reports which relate to the study of a logical consistency of beliefs toward education and the changes which may occur to those beliefs during student teaching. The second part reviews literature regarding the primary and concomitant aspects of divergent thinking as a component of creativity. The third section discusses the topic of Teaching for Divergent Thinking. The last section reviews some of the key relationships and conditions found in the social structure of the classroom which may be used to foster divergent thinking and creative performance.

## The Logical Consistency of Beliefs Toward Education

Much has been written about personalities and attitudes of student teachers; however, very little has been done to measure the logical consistency of their beliefs toward education.

The logical consistency of beliefs toward education has been defined for this study as an acquired framework of thought about education, enabling one to select and to reject items in view of the point

of view he holds.

The very structure of the general process of education underlies and molds one's positive beliefs about education. Throughout the number of years one remains in formal education, a framework of thought is constantly composed, analyzed, and recomposed. For some this framework becomes more logically consistent with the points of view of modern empiricism, and for others it supports the ideas of the classical philosophies. Those who accentuate neither of these two positions on the continuum comprise a third group, which, for this study have been called the inconsistent. Gowin (18) believes that the more formal education one has, the more positive will be his belief system about education.

The framework of thought one possesses encompasses a belief system. Rokeach (47) states that . . .

> The belief system is conceived to represent all the beliefs, sets, expectancies, or hypotheses, conscious and unconscious, that a person at a given time accepts as true of the world he lives in. He further asserts that . . . logical systems, conceived as human products, are but a sub-class, a special kind of psychological system...In psychological systems the parts may be interrelated without necessarily being logically interrelated. In fact, what may be of interest to the psychologist is that the parts are isolated and segregated from each other. It is precisely this isolation or segregation of parts which describes their relationship that makes possible certain predictions about behavior.

Newsome, Gentry, and Stephens (41), using the same scale as was used in this study, found that student teachers:

> . . . enter student teaching with consistent ideas about education. Although some groups are more consistent than others, all groups in this study were consistent beyond expectation. Moreover, all groups were consistent in the empirical rather than the rationalistic (classical) school of thought.

The beginning student teacher has been the recipient of education and has been oriented toward it from the way it has been expressed to her formally and informally. Students entering student teaching have formulated a framework of thought about education and the profession of teaching. The period of student teaching is accompanied by another facet of education, that of participating as a professional educator. The discipline associated with a teaching position, the compliance with school duties and policies, and the companionship of other faculty members could initiate a stunning blow to the composure of ones belief system. Still, on the other hand, the experience could serve as a reinforcing agent, or it could have no effect whatsoever.

The period of college training in which professional education courses are studied and student teaching is done, has been revealed by some research to have altered the beliefs of those tested. Various studies pertaining to student teaching point up the changes in the attitudes and behaviors of student teachers as a result of their experience in the classroom. Corrigan and Griswold (8) found student teachers linked the importance of certain teaching principles to the extent that the various supervisors enforced them. The lack of enforcement of the principles caused the student teachers to question their value.

Price (45) found:

> . . . that a considerable change occurred in student teachers' attitudes during the student teaching semester and that there was a tendency for their attitudes to change in the direction of the attitudes held by their respective supervising teachers.

McAulay (31) states that student teachers are greatly influenced by the methods and techniques employed by their cooperating teachers.

In a study of student teachers from various disciplines at

the high school level and of the elementary grades, Newsome, Gentry, and Stephens (41) concluded:

> Statistically significant losses in consistency after student teaching occurred in the total group and in three subgroups. These losses suggest that student teaching experiences affect student's ideas about education.

They further state that, "No significant gains or losses in consistency after student teaching were exhibited by the elementary education majors."

From a study of student teachers in Kansas, Weinstock and Peccolo (54) concluded from their investigation that:

> Sixty-six percent of student teachers tested were using a consistently logical and empirical framework from which they formulated their ideas about teaching. No significant change in logical consistency about teaching could be attributable to teaching participation . . .

In spite of confused research findings, it is generally accepted by teachers, students, administrators, legislators, and the general public that student teaching is, without a doubt, the single, most important phase in the educational process of our future teachers. Very few articles in the literature take issue with this aspect of teacher training. As stated in Life (32), "Hardly anybody wants to do away with "method" instruction altogether; on the contrary, practice-teaching courses are extremely valuable." Even Conant (7) in his critical analysis of teacher education, agrees that the period engaged in student teaching is the most worthwhile and beneficial of all educational programs.

## Divergent Thinking

The nature of creative talent or creativity should be recognized by elementary teachers. According to Golan (17):

> Creativity has been viewed as a normally distributed trait, an aptitude trait, an intrapsychic process, and as a style of life. It has been described as that which is seen in all children, but few adults. It has been described as that which leads to innovations in science, performance in fine arts, or new thoughts.

There are myriads of definitions for creativity. It is usually defined as a product or as a process. However, it has been defined as a form of personality and even as a condition of the environment. E. Paul Torrance (51) defines creativity as:

> . . . The process of sensing problems or gaps in information, forming ideas or hypothesis, testing and modifying these hypotheses, and communicating the results.

It is generally agreed that creative thinking is not a unitary ability but one that involves several component abilities or traits.

Guilford (21) believes that, "Creativity and creative productivity extend well beyond the domain of intelligence." He is primarily interested in the mental abilities that enter into creative production. Guilford fosters the thought that different manners of creativity may utilize different fundamental abilities. No one individual possesses any special creative ability. Guilford continues:

> . . . all the abilities represent continuous variables which may be found in differing degrees in all people. Hence, the nature of the abilities may be studied in people who are not distinguished for their creativity.

Through factor analysis techniques Guilford (19) has identified five groups of thinking factors. They are: 1) discovery factors, 2) production factors, 3) divergent thinking factors, 4) evaluation factors, and 5) symbolic factors. These five factors of thought tend to reveal themselves in groups of corresponding relationships which depict the following three traits, figural (relationships between things), conceptual (relationships between meanings), and structural

(relationships determined by other than figural or conceptual properties).

Guilford combined these two classifications of factors into a third group based on the type of action performed. Using this "action performed" criterion, the new categories have been called traits and have been identified as: production traits, cognitive traits, and evaluation traits. Guilford suggests that all three traits are required in executing a creative act.

Each of the traits has been further analyzed by factor analysis and certain factors found to belong within a given trait. Within the production thinking abilities, two distinctions have been made. The first is a situation for which there is a unique right answer, called convergent thinking, this first form is distinguished from that which requires "going off in different directions," or divergent thinking. Three divergent thinking factors have been found by Guilford. These are: 1) fluency, 2) flexibility, and 3) originality. These three factors have been utilized in this study. A cognition factor, Semantic Redefinition, was also used to test the ability of the subjects to apply the attributes measured by the other instruments.

Guilford has compiled a set of tests by which to measure the various factors of these traits. He implies that if creativity is distributed over the population, with no restriction of superior intelligence as some believe, then proper educational experiences should encourage the growth of creativity.

Lowenfield (34) conducted similar but independent research from that of Guilford, but arrived at essentially the same traits: Sensitivity, fluency, flexibility, and originality. He further suggests

that creativity in the arts has common attributes with creativity in the sciences. If this is true, then creative talents acquired through the study of one discipline should transfer to other activities. This assumption has yet to be experimentally verified.

## Teaching for Divergent Thinking

Margaret Mead (36), in a blistering indictment of American public schools, and particularly of a teacher training program, states that the teachers are not selected, trained, or hired on the basis of any creative quality. In fact, she says, the quality of conforming seems to be the key criterion in the selection and training of American teachers.

How does a teacher structure her course to motivate the students toward divergent thinking? Perhaps the greatest motivation is the ability of the student to succeed. The need for students to weigh evidence, make analyses, and have their solutions put to use in new problems may be important in structuring divergent thinking.

Future problems may then be more easily solved by intelligently meeting the situation in light of past experiences. The source of answers one has available are related to past experiences, not just recall from reading. To expect a student to think divergently calls for a variety of teacher-made problems to be solved, and the acceptance of all solutions.

Once all answers are accepted, there is need for evaluation. This calls for control of accepted solutions through the establishment of criteria by which the students can establish cause and effect indices, analyze component parts, and arrive at generalizations from an

understanding of interrelationships.

Students should also participate in establishing the goals of specific learning experiences. From understanding the goals of the problem, they will be better able to provide their own criteria of acceptance for the solutions presented. Teachers must expect and accept divergent and, at times, almost opposing goals.

Contemporary science courses comprised of exercises varying in degrees os specificity, which overlap and interact, offer a maximum of freedom for the student to discover science as it permeates his life.

Instead of a chance-happening or incidental style of teaching, science should be taught as a structured, yet flexible, program. Carin and Sund (4) in their book, Teaching Science Through Discovery, make the following points regarding structural science programs:

1. A structural program provides a framework of science principles which can help teachers unify their own experiences and give them confidence in meeting difficult classroom situations that arise.

2. A structured program does not have to be a rigid one . . . there are many choices which permit the teacher to adapt the program to the needs of the class. Both the unit approach and the provision of a variety of materials and situations which foster children's creativity and originality are possible within a structured program.

3. The freshness engendered by the use of unanticipated incidents is not lost in a structured program . . . A structured program helps the teachers anticipate, identify, and incorporate into the program the many incidents which arise during the school year.

4. A structured program makes it easier for children to acquire the science concepts essential for their understanding of the complex world they live in.

5. A structured program is a democratic one: many can share in building it and changing it . . .

The consensus is that students in the elementary grades are ready for creative learning (11), (15), (26). However, prior to the actual

process of learning the teacher must create an assortment of situations within the classroom where the student's contributions and acceptance patterns can be utilized in a variety of ways. Pupil-pupil and pupil-teacher rapport and interaction is most important in creative development.

Writing to this pupil-teacher relationship, Torrance (51) proclaims:

> The creative relationship between the teacher and pupil requires a willingness on the part of the teacher to permit one thing to lead to another, to embark with the child on an unknown adventure. It is also like the creative thinking process in that the teacher may work hard to establish this kind of relationship, may fervently want it, and still may fail. Then suddenly it seems to "just happen." The teacher has to be ready to accept the relationship when it happens, just as the inventor or scientific discoverer has to do. This aspect of the relationship, if nothing else, makes it vastly different from what is frequently referred to as permissiveness in education. The environment created by the teacher is definitely a responsive one in which the child finds adequate guidance.

Discussing the need to permit more controlled student freedom during an investigation, Klausmeier (30) states:

> Pupils need freedom to attempt their own patterns of exploration and sufficient time to pursue an investigation to the point where they experience the satisfaction that accompanies inquiry and discovery.
>
> The varied activities possible in well-equipped science rooms permit the students to learn as individuals on some occasions and as members of groups of varying sizes on others.
>
> Learning experiences must be selected on the basis of knowledge, skills, and attitudes to be learned. The teacher must be able to provide guidance for this learning. Desirable identifying figures for the learner should be provided. These models...provide the learner with ready-made behaviors which he can use as his first attempts at the desired behavior.

Aylesworth (1) says, "ideally, the teacher is a helper rather than an instructor." He reminds us that the teacher may provide the idea or

stimulus but that the real learning is made by the students through their approaches and discoveries.

In discussing methods of teaching students to think DeZafra (10) states:

> . . . traditional topical content can easily be reworded into a sequence of student-oriented problems.
>
> . . . By such rewording of topics and reworking of classroom procedures, what was static and impersonal to the pupil becomes personal and meaningful to him. Even more important than the information gained is the problem-solving experience of working, often cooperatively with others, toward recognized goals.
>
> When properly motivated students stay with a problem longer, they are more likely to achieve a break-through by perceiving new interrelationships among pertinent data, discovering a hidden factor, viewing the whole problem from a new approach. Pupils come to enjoy the sense of discovery and relief, the feeling that things are "right" and that they "make sense" . . .

In a recent study Cogan (5) found that, " . . . warm and considerate teachers got an unusual amount of original poetry and art from high school students." Reed (46) found that teachers who were warm and friendly favorably affected pupils' interest in science.

As reported by Sears and Hilgard (49), Schaftel, Crabtree, and Rushworth (48) state that a teacher working with children must do the following things:

1. Make sure that the social climate of the classroom is suitable for the development of a healthy self-concept.
2. Evoke problems when they are not immediately apparent to the children.
3. Stimulate a problem-solving climate, which involves the process of search rather than focusing on the right answer.
4. Plan a curriculum which stimulates problem-solving, by the use of experience units, construction activities, science experiments, group work, dramatic play, and role playing.

Sears and Hilgard continue:

> Much of modern curriculum-planning concerns itself with structure of knowledge and with the kind of thinking that is divergent rather than convergent; when conditions are appropriate motivation appears to take care of itself . . . If students have an opportunity for divergent rather than merely convergent thinking, intrinsic motivation appears to be readily aroused.

Gallagher (14) points out that the pattern of questions and statements set by the teacher will enhance the production of divergent thinking by the students. He goes on to say, ". . . a slight increase in the teacher's percentage of divergent questions brings forth a large increase in divergent production by the student."

Teachers must abound in ever-increasing abilities to give adequate attention to individual students or to groups of students, each uniquely approaching the problem at hand with his own "scientific method."

In the elementary science methods book, Science in Elementary Education, Gega (15) emphasizes the position of good teaching when he states:

> The best teaching rapidly and continually widens individual differences. In fact it is one of the best indicators we have of determining how successful we are in meeting the needs of our pupils.

## Key Relationships Found in the Social Structure of the Classroom

The social system of the classroom harbors many interactions among the students and the teacher. Several of these associations may foster divergent thinking.

The social structure of the classroom involves the affective-cognitive balance of both the students and of the teacher.

Rokeach (47) states the position of the affective in relation to cognitive behavior as:

> . . . analysis in terms of beliefs and systems of beliefs does not restrict us only to the study of cognitive behavior. We assume that every affective state also has its representation as a cognitive state in the form of some belief or some structural relation among beliefs within a system. With respect to the enjoyment of music, for example, we all build through past experience a set of beliefs or expectancies about what constitutes "good" and "bad" music. It is in terms of such expectancies, which are more often implicit than explicit, that we enjoy a particular composition. Thus, a person who is exposed to a particular piece of classical music or jazz may enjoy it, even though it may be totally unfamiliar to him, because it is congruent with an already existing set of beliefs he has built up over time. Depending on the extent to which he is prepared to entertain new systems, he may or may not enjoy Schonberg, or other music perceived as incompatible with his own beliefs about what constitutes good music . . . In all cases, enjoyment or its opposite is the affective counterpart of a belief organization and can be thought of as being in one-to-one relation (isomorphic) with it. Thus, our cognitive approach is as much concerned with affection as with cognition.

Teacher behavior and teacher-pupil interaction provide strong motivational effects. This balance provides an interdependence between the teacher and the student where both are in a position to withhold the attainment of one another's need-dispositions. The extent to which this is accomplished could stifle the divergent thinking and creativity of the student and/or the teacher.

Students have two outlets for their emotional needs within the classroom social system. One is with their fellow students, the other is with the teacher.

Nelson (39) states that for a child to survive in the classroom he will give:

> . . . his first attention to the manner in which he will be treated by those who have power in the group, not to mastering formal learning tasks as some teachers might naively think. He will be concerned with the problems of securing

himself in the group by discovering what behaviors will bring acceptance and by identifying those behaviors which will bring rejection or punishment. He will be expected, therefore, to be affectively oriented and positively disposed toward those teachers who take his affective needs into consideration.

The teacher is also pressured by two groups, her students and her supervisors, and must in some way adjust to insure self satisfaction between her personality-needs and her perceived role-expectations.

Nelson (39) states:

> To be sure, most teachers are motivated by a desire to be accepted by the pupils, but they have certain other needs that can be satisfied only through the effective action of the classroom group. These needs include acceptance by one's colleagues, supervisors, and patrons. In addition, certain economic needs are satisfied through success in the classroom. Since acceptance as a teacher is dependent upon fulfilling the role "teacher" as prescribed by supervisors and the public, and since this role is generally thought of as one in which the person fulfilling the role imparts knowledge and/or teaches skills, it is most likely that the teacher's primary classroom orientation will be cognitive . . . Teachers tend to reject those students who are not cognitively disposed in the classroom, and to accept those who are. Pupils who are affectively oriented cannot, therefore, expect to obtain emotional support within the group and may be expected to withhold need satisfaction from the teacher since they do not respond cognitively to the teacher.

The relationship between affectivity and cognition is not always obvious. However, one always complements the other. The teacher needs to search out the affective as well as the cognitive and permit them their relationship.

Placing the responsibility on the teacher, Nelson continues:

> . . . since the teacher is in the major power position and has the advantage of maturity and training, it would seem that effective group action can come about through teacher recognition of the affective orientation of students, acceptance of that attitude, and use of it to achieve cognitive goals. If the teacher can make possible the satisfaction of the pupil's affective needs within the classroom, then the pupil will be more likely to respond cognitively. This will provide satisfaction of teacher needs and the classroom will become an effective group.

Jenkins (25) has suggested:

> . . . that the teacher will contribute to the classroom processes in proportion to the amount that he is able to get his needs satisfied in the classroom situation.

Sears and Hilgard (49) state:

> . . . the teacher's awareness of the affective interaction with pupils is as important in a curriculum directed toward cognition as one with other goals, such as those of social competence or personal adjustment . . . a teacher's evaluative activities go far beyond marking papers; they include attention to many experiences of success and failure, of expanded or restricted autonomy, of immediate and long-term goal setting, of recognition of individual progress, and of attitudinal response to divergent behavior. These evaluative behaviors have the characteristics of positive and negative reinforcers, and, as such, are motivationally relevant to learning. . . . Hence, teachers must know their pupils and must be flexible in their approaches if they are to have the most favorable results.

A second condition which exists in the social structure of the classroom is that of the authoritarian teacher and creative learning. The most successful teachers are often those who discard their opportunity to be authoritarian.

E. Paul Torrance (51) states:

> Teachers generally have insisted that it is more economical to learn by authority. Recent research suggests that many things, though not all, can be learned more effectively and economically in creative ways rather than by authority. It also appears that many individuals have an especially strong preference for learning creatively, learn a great deal if permitted to use their creative thinking abilities, and make little educational progress when we insist that they learn by authority. Such suggestions open exciting possibilities for better ways of individualizing instruction.

To derive the greatest amount of productivity from the modern science classes, it seems necessary to develop and maintain a democratic, nonauthoritarian, and querying climate.

Wilson (55) found that,

> . . . the development and employment of an objective, comprehensive, and consistent philosophical point of view, is the most desirable way to bring about a more democratic climate.

Newsome and Gentry (40) have shown strong support for the hypothesis that a logical consistency of beliefs toward education would be inversely related to authoritarianism in personality. They state:

> The relationship of logical consistency of basic educational ideas and authoritarianism in personality was found to be negative and significant. This relationship suggests a clash between role and personality on the one hand, and fundamental beliefs or philosophy on the other. It suggests in particular that philosophical inconsistency is related to authoritarianism, and conversely, that philosophical consistency is related to nonauthoritarianism.

A third conflict within the social structure of a classroom is the reluctance of the teacher (and some students) to change their method of accomplishing a task.

Teachers must be able to accept change. Their methodologies must be constantly revised to keep current with new subject-matter information and with new approaches to learning.

Lund (35), speaking of changes and innovations in science curricula, borrowed a phrase from the past when he stated:

> "The dogmas of the quiet past are inadequate to the stormy present, as our case is new we must think anew and act anew." These words were first used by Abraham Lincoln around 1850. Change is always present and the response to it must be intelligent in order to utilize its full import in the educational enterprise.

Eichholz (13), in discussing the resistance to change exhibited by elementary teachers, states:

> Five forms of rejection were uncovered. Placed on a continuum, they are: ignorance (unawareness), suspended judgment (it's better to be safe with traditional methods), situational (it's all right, but others are equally as good), personal (own ability to use), experimental rejection (tried, does not work) . . . Most rejections were because of some "inner state" of the teacher.

The "inner state" mentioned by Eichholz is likely a retention of past values or preferences made by the teacher in accordance with past experiences. McGee (38) states:

> There's need to question our own values and those of others and subject them to careful scrutiny. . . . Man has great difficulty accepting change; there is that in man which makes him tend to hang on to the "old values." He is more comfortable with the valuations he has previously made. . . . An individual must be flexible enough in his own value orientation to revise his values, even his value norms, to meet shifting situations. He must be open in his valuations, holding them with a growing edge.

A fourth condition which may be found in the classroom social system is the balance which must exist between the institution (school) and the individual (teacher and student). This institution-individual relationship becomes much more involved when the teacher plays the role of the institution to her students, the individuals. The teacher is, in effect, playing two parts; that of the institution to her students and that of the individual to her superiors.

In the paradigm proposed by Getzels and Thelen (16) there are two basic dimensions. These are:

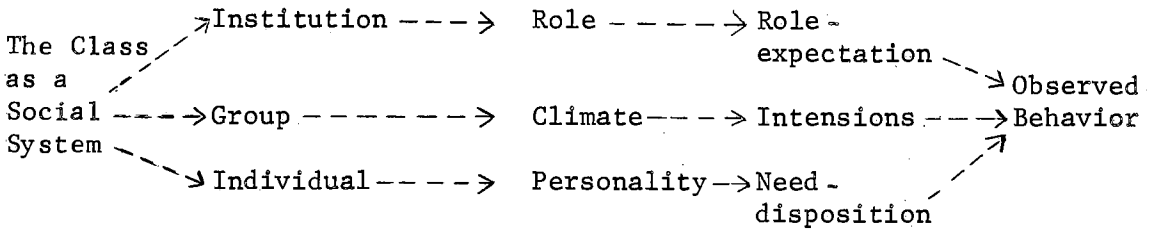
1. The nomothetic dimension, composed of the institution, the role, and the role-expectations which fulfill the goals of the institution.

In this dimension, education is defined as, ". . . the handing down of what is known to those who do not yet know."

2. The idiographic dimension, formed by the individual with her personality, and need-dispositions which constitute the goals of the individual.

The authors have defined education in this dimension as, ". . . helping the person know what he wants to know, as it were."

(Nomothetic Dimension)




(Idiographic Dimension)

Behavior is a function of Role and Personality, B = f(RxP)

The roles of the institution must be performed by personalities. When the goals of the institution cannot be met or when the need-dispositions of the individual cannot be attained there is often conflict. To overcome the conflict which may arise, a blending of the extreme dimensions described in the Getzels-Thelen model would be desirable. To this end, the aim provided by Getzels and Thelen (16) is:

> . . . to acquire a thorough awareness of the limits and resources of both individual and institution within which the teaching-learning process may occur and to make an intelligent application of the two as a particular problem may demand. In the equation B=f (RxP), R and P are maximized or minimized as the situation requires. . . . The standard of behavior is both individual integration and institutional adjustments . . . the processes in the classroom may be seen as a dynamic transaction between roles and personalities. . . . In working out this balance between the institution and the individual, the group develops a "culture" or, perhaps better here, a climate, which may be analyzed into the constituent intentions of the group (the transactional dimension). The stability and concomitant flexibility of the group in moving between the nomothetic and idiographic extremes depends on the belongingness that individuals feel within the group. The development of this belongingness is accompanied by increased security for all the members of the group. The greater the belongingness, the greater the ease of significant communications between the teacher and the pupils themselves and the greater the shared pride in the achievement of both institutional and individual goals.

This is another example of the necessity for flexibility on the part of the teacher. The need to be firm but nonauthoritarian on one

hand, and the need to accomplish the established goals on the other.

## Summary

The literature reveals that a student teacher has developed a framework of thought about education. This belief system is oriented toward the empirical philosophy and is subject to change.

Divergent thinking is a component of creativity and can be measured separately. The role of mental ability in the process of divergent thinking is not yet determined. The ability to think in a divergent manner can be taught and can be affected in the classroom. Teachers who use this process should have certain abilities, among which are the following:

1. To recognize and aid in structuring a democratic social system and a proper climate in the classroom
2. To operate within a consistent set of beliefs toward education
3. To understand the balance and the value between affection and cognition
4. To structure her course to bring forth the individual and collective creative abilities of all her students
5. To accept all answers provided by the students and use them to build new learning experiences
6. To bring out divergent production by using proper patterns

The literature suggests that a teacher who wishes to teach for divergent thinking be non-authoritarian, aware of affective-cognitive ties, be receptive to change, and exercise a balance between role and personality.

Finally, the review of the literature did not expose any similar study as the one proposed by this investigator.

# CHAPTER III

## RESEARCH DESIGN AND METHODOLOGY

The expressed purpose of this chapter is to present: (1) the description of the sample, (2) the basic plan of the study, and (3) the methodological procedures used with the instruments of measurement, collection of data, and the statistical design.

### Description of the Sample

The sample consisted of female students enrolled in the course Education 4K2, Science in the Elementary School Curriculum, during the spring semester of 1967 at Oklahoma State University. Education 4K2 is a science methods course for seniors, offered during the first half of the semester in which they participate in student teaching.

Sampling was restricted to female participants, since in the past less than three per cent of the enrollment have been male and only one male was enrolled during the time this study was undertaken. All participants had taken at least one high school laboratory science course, and two years of high school mathematics. In their college career, all participants had taken a minimum of eight hours of science, usually including four hours each of biology and physical science. In addition, each had taken a minimum of six hours of college mathematics. All participants in the study had maintained at least a 2.3 overall grade point average (4.0=A) while enrolled in the university.

Additional limitations which restricted the sampling were: (1) exclusion of those who were not in attendance when data were collected, (2) exclusion of those who had previous teaching experience, (3) exclusion of those over 25 years old at the time the instrument was administered. The sample used in this study was comprised of a total of seventy students.

## Procedure for Collecting Data

The Educational 4K2, Science in the Elementary School Curriculum, class was divided into three sections. The sections met individually for seventy-five minutes on Mondays and Wednesdays. An additional one-and-one-half hour meeting was scheduled on Mondays which permitted the entire class to meet together.

Education 4K2 was one of the courses in the teaching block and, therefore, met only during the first half of the semester. During the remaining eight weeks of the semester, the students participated in student teaching within various schools of the state.

Portions of the three one-and-one-half hour class meetings immediately preceding the end of the classroom phase of the block were designated data collection days. The Otis Mental Ability Test (42) was given during the first meeting. Divergent thinking sub-tests were given at the first and second sessions. The Semantic Scale was administered during the second meeting. During the third data collecting session which immediately preceded the students' departure for their student teaching assignment the GNC Scale (Gowin, Newsome, Chandler) (18) was administered. This same GNC Scale was readministered to the students upon their return to the campus after eight weeks of student

teaching. The two tests thus created a pretest-posttest situation. The GNC Scale is a measure of one's consistency of beliefs toward education.

The total time utilized in administering the nine tests is shown in Table I.

TABLE I

TIME SCHEDULE FOR TESTING

| Instrument | Minutes |
|---|---|
| GNC Scale (Pretest) | 40 |
| GNC Scale (Posttest) | 40 |
| Otis Mental Abilities Test | 30 |
| Divergent Thinking | |
| Ideational Fluency | 6 |
| Semantic Originality | 6 |
| Symbolic Originality | 10 |
| Figural Adaptive Flexibility | 10 |
| Semantic Spontaneous Flexibility | 4 |
| Semantic Redefinition | 10 |
| Total | 156 |

## Instruments of Measurement

The GNC Scale (18) is designed to evaluate one's logical consistency of ideas about education. It consists of 100 statements representing two opposing philosophies. One-half of the statements represent the era of philosophical thought prior to the advent of organized science. This has been termed the rationalistic (classical) philosophy. The remaining fifty statements represent the empirical (scientific) philosophy. The two sets of statements are consistent within themselves, but inconsistency and contradiction exists between sets. A copy of this scale and the answer sheet can be found in Appendix A.

The statements of the GNC Scale all relate to educational endeavors (aims, discipline, methodology, goals, curriculum, and the like). The respondent sorts the statements into eleven categories ranging from most like an ideal teacher to least like an ideal teacher. A forced sort technique (Q-Sort) was used to determine the scores, thus a normal distribution curve was obtained. The consistency with which the subject aligns himself was determined by weighted scores for each sort.

The authors of the GNC Scale have determined levels of significance for logical consistency by considering (a) the maximum possible raw score of 330, (b) the maximum possible theoretical score due to random sort of 250, and (c) a comparison of the net score to the theoretical random sort score. The maximum possible net score is 80. At the .05 level of confidence, a net score of 32 is significant. Scores of 37 and 41 are significant at the .02 and .01 levels of probability, respectively.

The GNC Scale was chosen because it evidently is the only available test which was designed to specifically measure logical

consistency of ideas about education.

The authors of the GNC Scale (18) state:

> The person who has consistent framework of thought should be able to reject and to select items in terms of the point of view he holds. The reader who does not bring to the scale a consistent framework of thought should reveal such inconsistency with distribution of items approximating a random placement.

The GNC Scale appears to be reasonably valid and a reliable measure of logical consistency. A panel of experts independently classified the statements in the scale and these compared very favorably with the author's sorting. The specific percents of agreement were 95, 96, and 97. The reliability of the GNC Scale was further supported by a test-retest program separated by a four months' interval. The reliability coefficient (18) was .86. Through factor analysis (40) of the GNC Scale two factors have been identified. A general verbal factor that presumably included such things as intelligence and reading abilities was barely significant, loading at .34. The second significant factor is a logical factor and"...probably represents the meaning of "logical consistency" which the scale purports to measure; this factor loads at .78."

The Otis Quick Scoring Mental Ability Test, Gamma Form AM (42) is a measure of mental ability. The test was first published in 1939 and revised in 1954. The 1954 edition was used for this study. Arthur S. Otis (42), the author, has stated:

> It should be understood from the outset that it is not possible to measure mental ability directly. It is possible only to measure the effect mental ability has had in enabling the pupil to acquire certain knowledge and mental skill. It must be remembered, however, that any test which involves the use of language can measure mental activity only to the extent to which we may assume that pupils of the same age have had approximately the same opportunity to learn . . . in a given community in which all have approximately the same

> educational opportunities, it is reasonable to assume that a pupil who progresses rapidly in school and learns much has a greater mental ability for his age than one who progresses less rapidly and learns less. To this extent, therefore, certain achievement questions, such as vocabulary and arithmetic-reasoning questions, even though depending on language, do measure mental ability.

The reliability of this test found by the split-half method was .85. The validity of the test was found to be .61 as measured by finding the biserial coefficient of correlation between each item and the total score. Appendix B contains a sample of this test.

Divergent thinking is manifested in three component sub-tests: fluency, originality, and flexibility, each of which is the most valid of its kind found in contemporary literature. Each of the sub-tests is further divided into specific factors. The choice of the sub-tests were arbitrarily chosen for this study as being the most representative.

Discussing the scores of divergent thinking factors, Guilford (20) relates that, to make a good score in a test, "the examinee must allow himself to go off in different directions." Guilford concludes that the various factors incorporated in the divergent thinking tests were obtained through the process of factor analysis, and are probably most relevant to creative scientific thinking.

The various sub-tests of divergent thinking have been defined in Chapter I and are listed below for the readers convenience. Samples of each are located in Appendix C. A scoring guide issued by the author was used in helping to determine the scores.

The sub-tests are:

Ideational Fluency
Semantic Originality
Symbolic Originality
Figural Adaptive Flexibility
Semantic Spontaneous Flexibility

The literature indicates scattered evidence of validity and reliability data. Factor loadings on each of the sub-tests range between .36 and .62; a loading of .30 is considered significant.

Albert S. Thompson (50) writing a review in The Sixth Mental Measurements Yearbook pertaining to the fluency factor commented:

> Validity to date is of the construct type . . . based on a number of factor analysis studies. However, they (the tests) can be recommended for continued experimental use and for further research on the nature and correlates of creative behavior.

Guilford (22) points out that construct validity or relevant validity of a test serve as indicators of a given trait. To this end he states:

> If the trait happens to be one found by factor analysis, we speak of factorial validity, a special case of relevant validity. The degree of factorial validity of a test is indicated by its factor loading, which . . . is the correlation of the test with the factor.

Regarding the predictive validity of a given test, Guilford (22) further states:

> So long as there is some correlation between this test and any other measure, we can make some prediction of that other measure for each person. . . . The index of a predictive validity in the practical situation is usually a coefficient of correlation between the . . . measure and a criterion of success.

In a study of divergent thinking involving ideational fluency and originality, Liberman (31), working with kindergarten children, found reliabilities of .56 and .87 respectively.

Reporting on the ideational fluency test, Keats (28) reports, "The reliabilities are of the order of .7 and no validity data are available apart from factorial validity."

Barron (2) studied 100 Air Force captains selected by their superiors for their disposition toward originality, and measured the

construct validity of several variables designed to measure originality. The test for originality used in this investigation was correlated to the selected originality rating of the officers made by the assessment team. The correlation was significant at .36.

## Basic Plan of the Study

The basic research design for this study was a posttest-only, except for the GNC Scale in which a pretest-posttest relation was established. However, in each instance the independent variables had already been established and the investigator had no control over them. The design used was basically ex post facto (or quasi-experimental) and conforms to Kerlinger's (29) definition:

> Ex post facto research may be defined as that research in which the independent variable or variables have already occurred and in which the researcher starts with the observation of a dependent variable or variables. He then studies the independent variables in retrospect for their possible relations to, and effects on, the dependent variable or variables.

This writer is aware that an ex post facto design is generally considered less scientific than the experimental design. The inability to manipulate the independent variable and the inability to control the effect of accumulated irrelevant variables are perhaps the two most important points of concern in ex post facto research. Since the subjects possess varying degrees of the independent variable in which the investigator is interested and accumulative forms of irrelevant variables, the possibility of bias in design and improper interpretation of results is enhanced.

In opposition to the supposed weaknesses of ex post facto research, Kerlinger (29) comments:

> Despite its weakness, much ex post facto research must be done in psychology, sociology, and education simply because many research problems in the social sciences and education do not lend themselves to experimental inquiry. . . . If a tally of sound and important studies in psychology, sociology, and education were made, it is likely that ex post facto studies would outnumber and outrank experimental studies.

## Statistical Design

The various statistical tests used in this study employ parametric techniques which is in keeping with similar studies. Parametric procedures are further ordered by the data being at the interval level of measurement.

After accumulating the data for each of the eight instruments utilized in this study, specific statistical tests were performed to determine if significant differences or relationships existed as proposed by the hypotheses stated in chapter one. The level of confidence was set at .05 for all hypotheses tested. Another way of stating this is to say that if a difference between two groups does exist, the probability of such a chance happening is five times, or less, in a hundred.

The existence of a consistent belief toward education was measured by predetermined evaluations set forth by the authors of the GNC instrument (18).

Changes in consistency of beliefs toward education attributable to student teaching, and exhibited differences in aspects of divergent thinking were assessed by the t-statistic. The t-statistic is described by Wert (55) on pages 129-142. This technique was also used for hypotheses number three.

The remainder of the hypotheses, numbers 4, 5, and 6 were tested

by placing the data into multiple regression analysis and the associated analysis of variance and multiple correlation.

In his book, Multivariate Procedures for the Behavioral Sciences, Cooley (6) describes multiple regression as:

> The best known method of multivariate analysis is multiple-regression analysis, which is used to examine the relation between a criterion or dependent variable and two or more predictors or independent variables . . . the significance of the multiple-correlation coefficient, and the significance of each predictor variable's contribution can also be tested.

The characteristics of multiple regression are described by Wert (55) on pages 237-52. The data were organized and were read into the IBM 360 computer at the University Computer Center of Oklahoma State University.

The formulae involved in each of these tests are shown in Appendix D.

# CHAPTER IV

## PRESENTATION AND ANALYSIS OF THE DATA

### The Logical Consistency of Beliefs Toward Education

The GNC Scale, a scale to study logical consistency of beliefs about education, was given to establish whether or not the subjects of this study possessed consistent ideas or beliefs toward education. With the GNC Scale, the subjects may be shown to favor the rationalistic (classical) philosophy of education, or the empirical (scientific) philosophy of education. In addition the subjects may be shown to be inconsistent with either of the two philosophies.

A statistical analysis of the GNC Scale was performed by it's authors and produced a predetermined score which is significant at the .05 level of confidence. The significant score was found to be $\pm$ 32, with the + and - representing the two dichotomous philosophies. It was also shown that a score of $\pm$ 41 was significant at the .01 level of confidence. For the purpose of this study the .05 level of confidence was chosen.

Hypothesis one states: There is no significant display of logical consistency of beliefs toward education among the elementary student teachers tested.

The scores of the GNC I Scale are presented in Table II.

TABLE II

GNC I (PRETEST) SCORES

N = 70

| | | | |
|---|---|---|---|
| 73 | 55 | 48 | 41 |
| 70 | 55 | 48 | 38 |
| 70 | 55 | 47 | 38 |
| 67 | 55 | 47 | 36 |
| 66 | 55 | 46 | 34 |
| 64 | 54 | 46 | 34 |
| 63 | 54 | 46 | 34 |
| 63 | 53 | 46 | 34 |
| 62 | 53 | 46 | 34 |
| 61 | 53 | 45 | 33 |
| 60 | 52 | 45 | 33 |
| 60 | 51 | 45 | 33 |
| 59 | 51 | 45 | 33 |
| 59 | 50 | 45 | 32 |
| 58 | 50 | 44 | 20 |
| 58 | 49 | 43 | 20 |
| 57 | 49 | 43 | 15 |
| 56 | 49 | | |

$\bar{X}$ = 48.37

From the scores in Table II it can easily be seen that all but three of the 70 subjects were exhibiting a logically consistent belief about education as measured by the GNC instrument. Sixty seven of the scores (95.71%) were greater than 32 and are significant at the .05 level of confidence and 54 of these were significant at the .01 level. All significant scores were oriented toward the empirical philosophy. Three scores were determined to be inconsistent and no rationalistic trends were discovered. The null hypothesis is, therefore, rejected.

Hypothesis two states: There is no significant change in the

logical consistency of beliefs toward education after experiencing a period of student teaching.

To test for significant changes suggested in hypothesis two, the subjects were divided into four groups (A, B, C, and D) according to the quartile ranking of the scores of the GNC Pretest, GNC I. The GNC I Test was the pretest administered just prior to the subjects experiencing student teaching. The same instrument was readministered to each subject during the first class session after returning to campus from her student teaching assignment. The scores of the second administration of the test were designated GNC II and represent the posttest.

The t-test of significance between the means of the pretest and posttest scores was performed for each of the four quartile groups and for the total sample. The significance level was set at the .05 level of confidence.

Table III presents the scores obtained by the subjects on the pretest and on the posttest of the GNC Scale.

In Table IV the following data are given for each group A, B, C, D, and total: number, degrees of freedom, means of GNC I, means of GNC II, variance, standard deviations, standard error of the mean, and the t statistic.

Groups A and B and the total groups mean scores were sufficiently different to be significant well beyond the established confidence level of .05. Actually the scores were significant beyond the .001 level. The null hypothesis is, therefore, rejected for the total group and for group A (the first quartile) and group B (the second quartile). For the third and fourth quartile groups (groups C and D) the hypothesis

TABLE III

QUARTILE SCORES FOR PRETEST AND POSTTEST OF THE GNC SCALE

N = 70

| Group A | | Group B | | Group C | | Group D | |
|---|---|---|---|---|---|---|---|
| Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest |
| 73 | 53 | 55 | 23 | 48 | 38 | 41 | 16 |
| 70 | 38 | 55 | 31 | 48 | 58 | 38 | 52 |
| 70 | 43 | 55 | 53 | 47 | 36 | 38 | 33 |
| 67 | 49 | 55 | 30 | 47 | 41 | 36 | 39 |
| 66 | 70 | 55 | 54 | 46 | 61 | 34 | 54 |
| 64 | 67 | 54 | 25 | 46 | 36 | 34 | 35 |
| 63 | 41 | 54 | 56 | 46 | 43 | 34 | 38 |
| 63 | 54 | 53 | 42 | 46 | 36 | 34 | 61 |
| 62 | 27 | 53 | 48 | 46 | 51 | 34 | 17 |
| 61 | 44 | 53 | 45 | 45 | 47 | 33 | 36 |
| 60 | 49 | 52 | 44 | 45 | 32 | 33 | 33 |
| 60 | 11 | 51 | 47 | 45 | 40 | 33 | 40 |
| 59 | 29 | 51 | 49 | 45 | 60 | 33 | 8 |
| 59 | 52 | 50 | 28 | 45 | 28 | 32 | 37 |
| 58 | 27 | 50 | 12 | 44 | 35 | 20 | 27 |
| 58 | 53 | 49 | 48 | 43 | 52 | 20 | 37 |
| 57 | 56 | 49 | 47 | 43 | 35 | 15 | 11 |
| 56 | 59 | 49 | 24 | | | | |

TABLE IV

DATA FOR $t$ STATISTIC OF THE DIFFERENCE BETWEEN THE MEANS FOR THE PRE-POST TESTS OF THE GNC SCALE

| Group | | N | df | GNC $\bar{X}$ | Variance | S.D. | Std. error of the mean | $t$ |
|---|---|---|---|---|---|---|---|---|
| A | Pretest | 18 | 17 | 62.555 | 24.143 | 4.913 | 1.158 | 4.722* |
| | Posttest | | | 45.666 | 225.764 | 15.025 | 3.541 | |
| B | Pretest | 18 | 17 | 52.388 | 5.310 | 2.304 | 0.543 | 4.347* |
| | Posttest | 18 | | 39.222 | 167.124 | 12.927 | 3.047 | |
| C | Pretest | 17 | 16 | 45.588 | 2.132 | 1.460 | 0.354 | 1.105 |
| | Posttest | 17 | | 42.882 | 103.610 | 10.178 | 2.468 | |
| D | Pretest | 17 | 16 | 31.882 | 48.110 | 6.936 | 1.682 | 0.541 |
| | Posttest | 17 | | 33.764 | 213.816 | 14.622 | 3.546 | |
| Total Group | Pretest | 70 | 69 | 48.371 | 144.497 | 12.020 | 1.436 | 4.400* |
| | Posttest | 70 | | 40.442 | 190.366 | 13.797 | 1.649 | |

* Significant at the .05 level.

is not rejected.

It should be noted that in groups A and B, there were no inconsistent scores on the pretest. However, on the posttest group A had four scores registering inconsistent and group B had seven scores in this category. Although there was a significant change on the posttest, all of the scores which remained significant continued to be oriented toward the empirical philosophy of education.

The change toward an inconsistent philosophy on behalf of the total sample on the posttest was significant at the .05 level, but all significant scores remained oriented toward the philosophy of the empiricists.

## Divergent Thinking

Hypothesis three states: The elementary student teachers displayed no significant difference among the sub-tests of the divergent thinking instrument. The individual scores from each of the sub-tests are found in Appendix E. The results of the tests for this hypothesis are recorded in Table V.

All possible combinations of sub-test means were examined by the t-test and in all pairs except the Ideational Fluency-Semantic Originality pair, there was a very significant difference shown. The hypothesis, therefore, is rejected.

The significant results clearly indicate that the student teachers do, in fact, exhibit variable qualities of divergent thought. Interesting, although not significant, is the exposed and apparent similarity of thought to bring forth titles in semantic originality and that needed in rendering single word answers in ideational fluency.

TABLE V

t-STATISTIC FOR THE DIFFERENCE BETWEEN THE MEANS OF THE SUB-TESTS OF THE DIVERGENT THINKING INSTRUMENT

| Sub-Test | N | Mean | SD | Difference Between the Means | df | Standard Error of the mean | t-Value |
|---|---|---|---|---|---|---|---|
| IF | 70 | 17.686 | 4.169 | .985 | 69 | 0.498 | 0.852 |
| OS | | 18.671 | 9.741 | | | 1.164 | |
| IF | 70 | 17.686 | 4.169 | 5.900 | 69 | 0.498 | 6.142* |
| OY | | 23.586 | 7.188 | | | 0.859 | |
| IF | 70 | 17.686 | 4.169 | 2.686 | 69 | 0.498 | 4.095* |
| FSS | | 15.000 | 4.337 | | | 0.518 | |
| IF | 70 | 17.686 | 4.169 | 7.843 | 69 | 0.498 | 12.023* |
| FAF | | 9.843 | 4.207 | | | 0.503 | |
| OS | 70 | 18.671 | 9.741 | 4.915 | 69 | 1.164 | 3.692* |
| OY | | 23.586 | 7.188 | | | 0.859 | |
| OS | 70 | 18.671 | 9.741 | 3.671 | 69 | 1.164 | 3.230* |
| FSS | | 15.000 | 4.337 | | | 0.518 | |
| OS | 70 | 18.671 | 9.741 | 8.828 | 69 | 1.164 | 7.434* |
| FAF | | 9.843 | 4.207 | | | 0.503 | |
| OY | 70 | 23.586 | 7.188 | 8.586 | 69 | 0.859 | 9.280* |
| FSS | | 15.000 | 4.337 | | | 0.518 | |
| OY | 70 | 23.586 | 7.188 | 13.743 | 69 | 0.859 | 17.671* |
| FAF | | 9.843 | 4.207 | | | 0.503 | |

TABLE V (Continued)

| Sub-Test | N | Mean | SD | Difference Between the Means | df | Standard Error of the mean | t-Value |
|---|---|---|---|---|---|---|---|
| FSS | 70 | 15.000 | 4.337 | 5.157 | 69 | 0.518 | 7.612* |
| FAF | | 9.843 | 4.207 | | | 0.503 | |

*Significant beyond the .05 level of confidence.

IF, Ideational Fluency; OS, Semantic Originality; OY, Symbolic Originality; SSF, Semantic Spontaneous Flexibility; FAF, Figural Adaptive Flexibility.

## Multiple Correlation and Multiple Regression Analysis

The remainder of the hypotheses of this investigation were tested by entering the data into the analysis of multiple regression and multiple correlation. These hypotheses are stated below:

Hypothesis four: No significant relationship is expressed toward the dependent variable, semantic redefinition, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for logical consistency of beliefs toward education, and the scores of the mental ability tests.

Hypothesis five: No significant relationship is expressed toward the dependent variable, logical consistency of beliefs toward education, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for logical consistency of beliefs toward education, add the scores of the semantic redefinitions tests.

Hypothesis six: No significant relationship is expressed toward the dependent variable, mental ability, from among the regression coefficients and multiple correlations of the independent variables--sub-tests of the divergent thinking instrument, the total scores of the divergent thinking instrument, the scores for logical consistency of beliefs toward education, and the scores of the semantic redefinitions tests.

To properly test for each of the hypotheses listed above and to determine the relative contribution of each of the independent

(predictor) variables, a step-wise, deletion regression analysis was performed for each of the three dependent variables; semantic redefinition (SR), logical consistency of beliefs toward education (GNC I), and mental abilities (OMA).

Each of the predictor variables was singularly eliminated from the regression equation and the significance of the loss was tested with the appropriate F-test. The proportional contribution of various combinations of independent variables was thereby determined.

From each pass the two-best and the three-best predictor variables were selected and a regression analysis was made for each. The results of the individual deletion regressions and of the combination passes are recorded as values of the multiple correlation of the various combinations of the independent variables to each of the three dependent criteria. The multiple correlations were attested by the F-test of the associated analysis of variance. In addition, the Y-intercept was computed and recorded for the total variable combination and for the best two- and three-predictor variable combination.

The output from each of these passes consisted of the means, standard deviation, correlation between the independent and dependent variables, coefficient of regression, the t-value of the coefficient, the multiple correlation of the independent variables to the criterion, and the Y-intercept. In addition, the significance of the regression was attested by the associated analysis of variance with the appropriate F-test.

The data of the regression passes for each of the three dependent variables are identified in the following manner: SR-Tables VI, VII, and VIII; GNC I - Tables IX, X, and XI; OMA-Tables XII, XIII, and XIV.

TABLE VI

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF REGRESSION, AND t-VALUES FOR THE REGRESSION OF CRITERION, SR. (N = 70)

| Variable | Mean | Standard Deviation | Regression Coefficient | t Value | Significant |
|---|---|---|---|---|---|
| OMA | 56.100 | 7.275 | .303 | .998 | NS |
| GNCI | 48.371 | 12.021 | .267 | 1.587 | NS |
| TDT | 84.786 | 18.344 | 2.978 | .950 | NS |
| IF | 17.686 | 4.169 | -2.156 | -0.755 | NS |
| OS | 18.671 | 9.741 | -2.622 | -0.851 | NS |
| OY | 23.586 | 7.188 | -2.843 | -0.938 | NS |
| FSS | 14.914 | 4.376 | -2.888 | -0.992 | NS |
| FAF | 9.842 | 4.207 | -2.735 | -0.908 | NS |
| SR | 46.743 | 15.515 | | | |

NS - Not Significant

TABLE VII

ANALYSIS OF VARIANCE FOR THE REGRESSION OF SEMANTIC REDEFINITION

| Source of Variation | DF | Sum of Squares | Mean Squares | F Value | Significant |
|---|---|---|---|---|---|
| Regression | 8 | 2644.480 | 330.560 | 1.444 | NS |
| Deviation from Regression | 61 | 13963.973 | 228.918 | | |
| Total | 69 | 16608.449 | | | |

NS - Not Significant

TABLE VIII

MULTIPLE CORRELATION, R, OF THE PREDICTOR COMBINATIONS WITH THE CRITERION, SR. F-Values and Significance Levels

| Predictor Combinations | R | Y-Intercept | F | Significance |
|---|---|---|---|---|
| $RY_3 \cdot X_1X_2X_4X_5X_6X_7X_8X_9$ | .39903 | 0.393 | 1.444 | NS |
| $RY_3 \cdot X_2X_4X_5X_6X_7X_8X_9$ | .38144 | | 1.508 | NS |
| $RY_3 \cdot X_1X_4X_5X_6X_7X_8X_9$ | .35285 | | 1.260 | NS |
| $RY_3 \cdot X_1X_2X_5X_6X_7X_8X_9$ | .38311 | | 1.524 | NS |
| $RY_3 \cdot X_1X_2X_4X_6X_7X_8X_9$ | .38905 | | 1.580 | NS |
| $RY_3 \cdot X_1X_2X_4X_5X_7X_8X_9$ | .38632 | | 1.554 | NS |
| $RY_3 \cdot X_1X_2X_4X_5X_6X_8X_9$ | .38352 | | 1.527 | NS |
| $RY_3 \cdot X_1X_2X_4X_5X_6X_7X_9$ | .38166 | | 1.510 | NS |
| $RY_3 \cdot X_1X_2X_4X_5X_6X_7X_8$ | .38452 | | 1.537 | NS |

NS = Not Significant

Best three Predictor Combinations and best two Predictor Combinations

| | | | | |
|---|---|---|---|---|
| $RY_3 \cdot X_1X_2X_8$ | .28572 | 13.245 | 1.956 | NS |
| $RY_3 \cdot X_1X_2$ | .28413 | 14.418 | 2.942 | NS |

NS = Not Significant

TABLE IX

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF REGRESSION, AND t-VALUES FOR THE REGRESSION OF CRITERION, GNC I. (N = 70)

| Variable | Means | Standard Deviation | Regression Coefficient | t Value |
|---|---|---|---|---|
| OMA | 56.100 | 7.275 | .498 | 2.270* |
| SR | 46.143 | 15.515 | .148 | 1.587 |
| TDT | 84.786 | 18.344 | -1.731 | -0.778 |
| IF | 17.686 | 4.169 | .979 | .458 |
| OS | 18.671 | 9.741 | 1.791 | .779 |
| OY | 23.586 | 7.188 | 1.493 | .659 |
| FSS | 14.914 | 4.376 | 1.760 | .808 |
| FAF | 9.843 | 4.207 | 2.173 | .060 |
| GNCI | 48.371 | 12.021 | | |

* Significant at .05 level

TABLE X

ANALYSIS OF VARIANCE FOR THE REGRESSION OF LOGICAL CONSISTENCY OF BELIEFS TOWARD EDUCATION

| Source of Variation | DF | Sum of Squares | Sum of Squares | F Value |
|---|---|---|---|---|
| Regression | 8 | 2211.444 | 276.430 | 2.173* |
| Deviation from Regression | 61 | 7758.992 | 127.197 | |
| Total | 69 | 9970.436 | | |

* $F_{8,69}$ = Significant at .05 level, p = 2.07

TABLE XI

MULTIPLE CORRELATION, R, OF THE PREDICTOR COMBINATIONS WITH CRITERION, GNC I

| Predictor Combinations | R | Y-Intercept | F | Significant |
|---|---|---|---|---|
| $RY_2 \cdot X_1X_3X_4X_5X_6X_7X_8X_9$ | .47096 | 26.801 | 2.173 | ** |
| $RY_2 \cdot X_3X_4X_5X_6X_7X_8X_9$ | .39507 | | 1.638 | NS |
| $RY_2 \cdot X_1X_4X_5X_6X_7X_8X_9$ | .43550 | | 2.073 | NS |
| $RY_2 \cdot X_1X_3X_5X_6X_7X_8X_9$ | .46269 | | 2.413 | * |
| $RY_2 \cdot X_1X_3X_4X_6X_7X_8X_9$ | .46810 | | 2.485 | * |
| $RY_2 \cdot X_1X_3X_4X_5X_7X_8X_9$ | .46267 | | 2.412 | * |
| $RY_2 \cdot X_1X_3X_4X_5X_6X_8X_9$ | .46504 | | 2.444 | * |
| $RY_2 \cdot X_1X_3X_4X_5X_6X_7X_9$ | .46203 | | 2.404 | * |
| $RY_2 \cdot X_1X_3X_4X_5X_6X_7X_8$ | .45807 | | 2.352 | * |

** $F_{8,69}$ = Significant at .05 level, p = 2.07

* $F_{7,69}$ = Significant at .05 level, p = 2.14

NS - Not Significant

Best three and best two Predictor Combinations

| | | | | |
|---|---|---|---|---|
| $RY_2 \cdot X_1X_3X_9$ | .38301 | 15.038 | 3.782 | ** |
| $RY_2 \cdot X_1X_3$ | .3781 | 14.416 | 5.590 | * |

** $F_{3,69}$ = Significant at .05 level, p = 2.74

* $F_{2,69}$ = Significant at .01 level, p = 4.92

TABLE XII

MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF REGRESSION, AND t-VALUES FOR THE REGRESSION OF CRITERION, OMA. (N = 70)

| Variable | Mean | Standard Deviation | Regression Coefficient | t Value |
|---|---|---|---|---|
| GNCI | 48.371 | 12.021 | .152 | 2.193 |
| SR | 46.142 | 15.515 | .053 | .998 |
| TDT | 84.786 | 18.344 | 1.393 | 1.122 |
| IF | 17.686 | 4.169 | -1.168 | -0.981 |
| OS | 18.671 | 9.741 | -1.595 | -1.246 |
| OY | 23.586 | 7.188 | -1.314 | -1.039 |
| FSS | 14.914 | 4.376 | -1.197 | -0.963 |
| FAF | 9.843 | 4.207 | -0.838 | -0.664 |
| OMA | 56.099 | 7.275 | | |

* Significant at .05 level

TABLE XIII

ANALYSIS OF VARIANCE FOR THE REGRESSION OF MENTAL ABILITY

| Source of Variation | DF | Sum of Squares | Sum of Squares | F Values | Significant |
|---|---|---|---|---|---|
| Regression | 8 | 1212.126 | 151.516 | 3.788 | NS |
| Deviation from Regression | 61 | 2440.155 | 40.003 | | |
| Total | 69 | 3652.281 | | | |

$F_{8,69}$ = NS - Not Significant

TABLE XIV

MULTIPLE CORRELATION, R, OF THE PREDICTOR COMBINATIONS WITH THE CRITERION, OMA

| Predictor Combinations | R | Y-Intercept | F | Significant |
|---|---|---|---|---|
| $RY_1 \cdot X_2X_3X_4X_5X_6X_7X_8X_9$ | .57609 | 35.532 | 3.788 | ** |
| $RY_1 \cdot X_3X_4X_5X_6X_7X_8X_9$ | .52485 | | 3.367 | * |
| $RY_1 \cdot X_2X_4X_5X_6X_7X_8X_9$ | .56655 | | 4.187 | * |
| $RY_1 \cdot X_2X_3X_5X_6X_7X_8X_9$ | .56398 | | 4.131 | * |
| $RY_1 \cdot X_2X_3X_4X_6X_7X_8X_9$ | .56684 | | 4.193 | * |
| $RY_1 \cdot X_2X_3X_4X_5X_7X_8X_9$ | .56111 | | 4.069 | * |
| $RY_1 \cdot X_2X_3X_4X_5X_6X_8X_9$ | .56572 | | 4.169 | * |
| $RY_1 \cdot X_2X_3X_4X_5X_6X_7X_9$ | .56680 | | 4.193 | * |
| $RY_1 \cdot X_2X_3X_4X_5X_6X_7X_8$ | .57186 | | 4.304 | * |

** $F_{8,69}$ = Significant at .01 level, p = 2.77

* $F_{7,69}$ = Significant at .01 level, p = 2.91

NS - Not Significant

Best three and best two Predictor Combinations

| | | | | |
|---|---|---|---|---|
| $RY_1 \cdot X_2X_4X_6$ | .52440 | 34.002 | 8.345 | ** |
| $RY_1 \cdot X_2X_6$ | .35431 | 47.155 | 4.809 | * |

** $F_{3,69}$ = Significant at .01 level, p = 4.08

* $F_{2,69}$ = Significant at .05 level, p = 3.13

Table XV presents the intercorrelation matrix of the predictor variables and the three dependent variables. Significance is noted at the .05 and .01 levels of confidence.

It would seem appropriate at this time to briefly explain the differentiation between regression and correlation. Regression estimates the relationship of one variable with another, by expressing one in terms of the other. Correlation estimates the degree to which two variables vary together or the amount of association between the two variables.

Looking further into the explanation of the variation in the criterion, the data presented in Table XVI show the R and $R^2$ values of each regression pass for each of the dependent variables. The $R^2$ value indicates the percent of variation in the dependent variable due to the combination of independent variables on which the criterion is regressed. As stated by Twyman (52), the fact that the $R^2$ value does not decrease appreciably after a given variable is deleted implies that the deleted variable was not significantly explaining any further variation in the dependent variable.

The variables chosen as the best two variable and best three variable predictor combination for each criterion are the ones which caused the $R^2$ value to decrease the most. These are indicated in Table XVI.

Hypothesis four: The multiple correlation (R) between criterion (SR), and the eight independent variables was 0.399. The loss of the OMA ($X_1$), GNC I ($X_2$), and FSS ($X_8$) variables from the regression equation produced R values of 0.381, 0.353, and 0.382 respectively. Although these three correlations were not significant, the three

TABLE XV

INTERCORRELATIONS OF CRITERION AND PREDICTOR VARIABLES

N = 70

| Variable | Notation | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ |
|---|---|---|---|---|---|---|---|---|---|---|
| OMA | $Y_1(X_1)$ | | .345** | .235* | .197 | .094 | -.089 | .234 | .123 | .431** |
| GNCI | $Y_2(X_2)$ | | | .231 | .001 | -.152 | -.029 | -.013 | .026 | .218 |
| SR | $Y_3(X_3)$ | | | | .240* | .164 | .196 | .091 | .056 | .189 |
| TDT | $X_4$ | | | | | -.452** | .750** | .639** | .515** | .558** |
| IF | $X_5$ | | | | | | .228 | .074 | .168 | .152 |
| OS | $X_6$ | | | | | | | .161 | .275* | .169 |
| OY | $X_7$ | | | | | | | | .169 | .447** |
| FSS | $X_8$ | | | | | | | | | .120 |
| FAF | $X_9$ | | | | | | | | | |

*Significant at .05 level

**Significant at .01 level

variables $X_1$, $X_2$, and $X_8$ were determined to be the best three variable predictor combination with a combined R of .286. OMA ($X_1$) and GNC I ($X_2$) were the best two variable combination yielding an R of .284. Neither correlation was significant, as shown in Table VII.

From these data, there is insufficient evidence to reject hypothesis number four.

Hypothesis five: The analysis of regression of the GNC I criterion shows it to be significant at $F_{8,69} = 2.17$, where $p = .2.07$. As shown in Table IX, the regression coefficient for the independent variable OMA ($X_1$) is the only significant coefficient in the regression.

The best three predictors (see Table XVI), identified by the multiple R as a result of the deletion regression technique are OMA ($X_1$), SR ($X_3$), and FAF ($X_9$). The loss of these variables from the regression equations produced R-values for the remaining variables of 0.395, 0.436, and 0.458, respectively. With the removal of the latter, FAF, ($X_9$), the remaining variables are still significant at the .05 level, F = 2.352 with 7 and 69 degrees of freedom. (Table XI shows these values)

The regression of the best three predictors shows an R-value of 0.383 and an F-value of 3.782, significant at the confidence level of .05 as shown in Table XI. The best two predictors are OMA ($X_1$) and SR ($X_3$). They produced an F-value of 5.590 for an R of 0.378 with 2 and 69 degrees of freedom and is significant at the .01 level.

The zero-order correlations in Table XV shows a highly significant relationship between GNC I ($X_2$) and OMA ($X_1$), .345, significant at the .01 level.

On the basis of the evidence collected, and the analysis of

TABLE XVI

PERCENT OF VARIATION IN THE Y VARIABLE BY THE $R^2$ VALUE FROM X COMBINATIONS

| Criterion | Variable Withheld | R | $R^2$ | % | Used as Predictors |
|---|---|---|---|---|---|
| Y = SR | -0 | .399 | .159 | 15.9 | |
| | $-X_1$ | .381 | .145 | 14.5 | * |
| (7 Predictors) | $-X_2$ | .353 | .124 | 12.4 | * |
| | $-X_4$ | .383 | .147 | 14.7 | |
| | $-X_5$ | .389 | .151 | 15.1 | |
| | $-X_6$ | .386 | .149 | 14.9 | |
| | $-X_7$ | .384 | .147 | 14.7 | |
| | $-X_8$ | .382 | .145 | 14.5 | * |
| | $-X_9$ | .385 | .148 | 14.8 | |
| (3 Predictors) | $(X_1,X_2,X_8)$ | .286 | .08 | 8.0 | |
| (2 Predictors) | $(X_1,X_2)$ | .284 | .08 | 8.0 | |
| Y = GNCI | -0 | .471 | .221 | 22.1 | |
| | $-X_1$ | .395 | .156 | 15.6 | * |
| (7 Predictors) | $-X_3$ | .436 | .189 | 18.9 | * |
| | $-X_4$ | .463 | .214 | 21.4 | |
| | $-X_5$ | .468 | .219 | 21.9 | |
| | $-X_6$ | .463 | .214 | 21.4 | |
| | $-X_7$ | .465 | .216 | 21.6 | |
| | $-X_8$ | .462 | .213 | 21.3 | |
| | $-X_9$ | .458 | .209 | 20.9 | * |
| (3 Predictors) | $(X_1,X_3,X_9)$ | .383 | .146 | 14.6 | |
| (2 Predictors) | $(X_1,X_3)$ | .378 | .143 | 14.3 | |

TABLE XVI (Continued)

| Criterion | Variable Withheld | R | $R^2$ | % | Used as Predictors |
|---|---|---|---|---|---|
| Y = OMA | -0 | .576 | .331 | 33.1 | |
| (7 Predictors) | $-X_2$ | .525 | .275 | 27.5 | * |
| | $-X_3$ | .566 | .320 | 32.0 | |
| | $-X_4$ | .564 | .318 | 31.8 | * |
| | $-X_5$ | .567 | .321 | 32.1 | |
| | $-X_6$ | .561 | .315 | 31.5 | * |
| | $-X_7$ | .566 | .320 | 32.0 | |
| | $-X_8$ | .567 | .321 | 32.1 | |
| | $-X_9$ | .572 | .327 | 32.7 | |
| (3 Predictors) | $(X_2,X_4,X_6)$ | .524 | .274 | 27.4 | |
| (2 Predictors) | $(X_2,X_6)$ | .354 | .125 | 12.5 | |

variance for the regression, hypothesis five is rejected.

Hypothesis six: Dependent variable OMA ($X_1$) with 8 and 69 degrees of freedom has an F-value of 3.788, which is significant at the .01 level of confidence. All multiple correlations produced by deletion analysis of regression are significant at the .01 level of confidence. These are displayed in Table XIV.

The best three variable predictors are GNC I ($X_2$), TDT ($X_4$), and OS ($X_6$). They have a combined R-value of 0.524 which is significant at the .01 level. GNC I ($X_2$) and OS ($X_6$) unite to form the best two variable predictor combination yielding and R-value of 0.354, significant at the .05 level of confidence.

The zero-order correlations in Table XV expose three-significant relationships with the criterion OMA. They are GNC I ($X_2$), SR ($X_3$), and FAF ($X_9$). In addition, OY ($X_7$) correlates at .234. To be significant a value of .235 was necessary. As shown in Table XIV, the regression of OMA on the X-variables did not show SR ($X_3$) or FAF ($X_9$) to be among the best three variable predictors, despite their zero-order correlations with the criterion. This indicates that the loss of either of these two variables does not significantly explain any further variation on the dependent variable. This indication is upheld by the $R^2$ value not decreasing appreciably as noted in Table XVI. The regression analysis is sufficient well beyond the .05 level for endorsing the rejection of hypothesis six.

## Summary of Findings

It was determined that the subjects studied in this investigation possessed a logical consistency of belief toward education and that the

orientation was toward empirical classification rather than the classical.

There was a distinct and significant change for some of the subjects in their beliefs about education after experiencing a period of student teaching. Those who possessed the highest scores on the pretest, groups A and B, and the total group changed their beliefs enough to be significant at the .05 level of confidence.

Hypothesis three was rejected at the .05 level of confidence when the analysis of the data indicated that the subjects did possess various forms of divergent thinking.

The three criteria, SR, GNC I, and OMA were singularly regressed on combinations of the X variables in a step-wise deletion regression. The regression coefficients and multiple correlations were obtained and significance levels established. The dependent variable SR did not show any significant relationship and hypothesis four was not rejected.

The other two criteria, GNC I and OMA were both significant at the .05 level and the best two and best three variable predictors were determined. Hypotheses five and six were, therefore, rejected.

# CHAPTER V

## SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The intent of this chapter is to; first, review the purpose and design of the study; second, discuss some general limitations of the study; third, develop conclusions from the analysis of the data presented in Chapter IV and to discuss their implications; fourth, present recommendations for further research.

### Purpose and Design of the Study

The purpose of this study was twofold: First, to ascertain whether the subjects possessed any logical consistency of beliefs toward education and if these beliefs were altered during a period of student teaching. Second, to quantitatively determine any relationships which might exist among measures of the logical consistency of beliefs toward education, the factors of divergent thinking, and mental ability within the chosen sample.

The subjects were 70 senior, women, elementary education, student teachers. The subjects were tested during their last semester, during the time in which they were engaged in student teaching, and prior to graduating from Oklahoma State University in May, 1967.

The instruments employed within this investigation were the GNC Scale to measure the logical consistency of beliefs toward education; the Otis Mental Ability Test, Gamma Form AM; and a battery of tests on

divergent thinking as developed by Dr. J. P. Guilford.

The research design for the first part of this study in determining if significant alternations of the subject's belief system were predicted on her student teaching experience was a pre-posttest. The results of these tests were submitted to statistical evaluation by the t-test.

The remaining part of the study was basically ex post facto. The data were evaluated through multiple correlation and regression analysis. The statistical evaluations were produced by the IBM 360 computer at the computer center of Oklahoma State University.

## General Limitations

To properly reduce the tendency to over interpret and over generalize, it seems appropriate to point out some conditions which may limit the findings.

First, the population sample, although representative of elementary pre-service teachers at Oklahoma State University, may have been atypically motivated in the light of the unique, television, methods course presentation by Dr. Wendall Spreadbury. Previous and subsequent classes may not have had this form of methods courses.

Second, the investigator is aware of the limitations present in using any single instrument as a measurement of a specific variable or trait.

A third group of limitations are those inherent in ex post facto research. Kerlinger (29) states:

> Ex post facto research has three major weaknesses . . . (1) the inability to manipulate independent variables, (2) the lack of power to randomize, and (3) the risk of improper

interpretation. In other words, other things being equal, ex post facto research lacks control; this lack is the basis of the third weakness: the risk of improper interpretation.

A fourth limitation may be the fact that the students did not participate in identical experiences during their student teaching.

## Conclusions and Implications

This section is divided into two parts: Part one presents the conclusions related to hypotheses one and two of Chapter I, part two deals with the conclusions pertaining to the remainder of the hypotheses.

The analysis of the data revealed the subjects were found to possess a consistent belief toward education and that the beliefs were oriented toward an empirical or scientific philosophy.

The subjects were retested after a period of student teaching and their posttest scores compared to their pretest scores on the basis of quartile ranking of the pretest scores. The subjects whose high pretest scores placed them in quartiles A and B were found to exhibit significant changes in their beliefs toward education. This was also true for the total group. Scores in quartiles C and D were not significant.

It would appear that the subjects in quartiles C and D experienced less shock in classroom teaching experiences and were better able to accept the reality of active teaching. Conceivably, the strong orientation toward the empirical points-of-view is an outgrowth of our present scientifically directed mode of living.

The sub-tests of divergent thinking were compared to each other by subjecting them to a t-test for the difference between the means.

All combinations were significant except one, ideational fluency-semantic originality.

The results of this test show that each of the sub-tests are, in fact, measuring some individual and unique trait and that the subjects do adequately display all the traits of divergent thinking for which they were tested.

By means of the techniques of multiple regression analysis and multiple correlation, the remaining three hypotheses were tested.

Semantic redefinition is a cognitive factor as defined by Guilford (23) and utilizes divergent thought in arriving at an answer. When semantic redefinition was regressed on the independent variables there were no significant relationships produced.

Only 15.9 percent of the variance in semantic redefinition was accounted for by the total combination of the eight predictor variables.

An examination of Table XV reveals two significant zero-order correlations to the criterion SR. These are OMA and TDT, total score of the divergent thinking instrument. Although TDT ($X_4$) was not one of the "best" predictor variables it seems apparent that it explores the same variance as OMA in relation to criterion SR.

The regression of criterion GNC I was significant (.05) as attested by an F value of 2.17. The best three predictor variables accounted for 14.6 percent of the variance (Sig. .05) in the consistency of belief scores. The two predictor combination was only slightly less, at 14.3 percent (Sig. .01). It may be concluded that the two variable combination is a reliable predictor of the criterion. OMA is the only zero-order correlation which is significant. It may be concluded that one's belief system is significantly correlated to his mental ability,

based on the findings of this investigation.

In the manual of directions for the Gamma Test Form AM of the Otis Quick-Scoring Mental Abilities Test, the author, Otis, (42) states:

> . . . in making up the test the aim has been for the most part to choose that kind of question which depends as little as possible on schooling and as much as possible on thinking.

This investigator could not help wondering what the relationship would be if the Otis Test was regressed on the sub-tests of divergent thinking and the scores gained from the GNC I Scale for consistency of beliefs toward education.

To do this would mean placing the mental abilities test as a dependent variable. In this case, the question may be asked, Are the traits of divergent thinking possible determinants of mental ability?

Kerlinger (29), in his book, Foundations of Behavioral Research states:

> The student should be alert to the possibility of a variable being an independent variable in one study and a dependent variable in another. . . . The independent and dependent variable classification is really a classification of uses of variables rather than a distinction between different kinds of variables. . . . Any variable that cannot be manipulated may be an assigned variable. . . . All variables that are characteristic of subjects--intelligence, aptitude, . . . education, for example--can be assigned (dependent) variables.

Since this study was basically one of exploratory nature, the investigator chose to place mental ability as a dependent variable and regress it on the eight predictor variables.

In the analysis of hypothesis six where OMA was the criterion, the regression on the eight independent variables produced an F-value of 3.788, significant at the .01 level of confidence. Independent variables GNC I, TDT, and OS made up the three best predictor combination,

significant at the .01 level.

It appears that the Otis Mental Abilities Test is constructed to include many of the variables which are independently measured by the sub-tests of the divergent thinking instrument, particularly the figural and symbolic attributes. This is evidenced by the zero-order correlations of OMA with FAF (.431) and OY (.234). There is also an intercorrelation of .235 between OMA and SR. Semantic redefinition requires one to use an object, or part of it in some new or unique way. This characteristic may also be included in the Otis Mental Abilities Test.

The findings indicated by the analysis of the data are further strengthened by the highly significant regression F-values and the $R^2$ scores which indicate 27-33 percent of the variance of OMA is due to the X variables on which it was regressed.

The evidence of these findings would perhaps point out the importance of figural and symbolic communications in educational procedures.

Based on this study, another seemingly hidden value of the Otis Mental Abilities Test is its possible orientation toward the empirical (scientific) philosophies. This is supported by the findings of this study as follows:

The subjects in this study were all oriented toward the empirical philosophies. Also, there was a significant (.01 level) correlation between the scores of the GNC I Scale and the Otis Mental Abilities Test. And, in addition, the only significant coefficient of regression for OMA was the one for the GNC I Scale. Further, the independent variable GNC I predicts 27.5 per cent of the variance within OMA.

## Recommendations

From the analysis of the data for this study, and from the conclusion derived, it would seem appropriate to make certain recommendations.

In the area of logical consistency of beliefs toward education the following suggestions are made.

1. Studies should be made with freshmen about their beliefs toward education in relation to the type of high school they attended. This type of early exploration may help in identifying potential education majors.

2. Follow up studies of the freshmen should be made during their senior year to measure any changes which may have occurred in their belief system.

3. Studies of beliefs toward education should be done on a comparison basis among the various colleges of the university and/or among major fields of concentration.

4. Studies of beliefs toward education among groups within a community may very well lead to understanding their reasons for not supporting referenda and other education-backed proposals.

Divergent thinking and creativity offer an almost endless array of recommended research possibilities. Selected ones are:

1. Studies which would generate new information about the effectiveness of the Otis Mental Abilities Tests as a predictor divergent thinking and possibly in identifying elementary school science teacher candidates.

2. Studies designed to determine the value of the use of figural and symbolic communication in science teaching.

3. Studies designed to determine the relative significance of gains in divergent thinking in relation to the social climate of the classroom, affective-cognitive relations, pupil-teacher-acceptance patterns.

4. Studies designed to evaluate the "carry over" effect of creativity in one discipline to another discipline.

5. Studies which would measure the increased productivity of divergent thinking in the class by varying specific teacher-made stimuli.

6. Studies designed to determine whether divergent thinking precedes evaluation and selection of a single, "correct" answer.

7. Follow up studies on specific factors of creativity with students in specific courses which are taught by identified teachers.

8. Studies to determine if the expression of divergent thinking changes with maturity and with or without external stimuli being applied.

It is hoped that the results of this study will be of service in education and might have value in aiding in the improvement and possible direction of elementary school science education programs of study.

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# APPENDIX A

## GNC' SCALE

## INSTRUCTIONS FOR COMPLETING THE GNC SCALE

We feel strongly that you are in a favorable position to make important judgments about characteristics of teachers. We are, therefore, seeking your reaction. Your responses will in no way determine your success or failure in this, or any other course.

The GNC Scale presents a range of viewpoints toward education. There are 100 statements characterizing what an ideal teacher might THINK ABOUT, BE LIKE, OR DO.

Each statement will be flashed on the screen. Ample time will be allowed for reading the statement two or three times. After reading each statement, if you think the statement is MOST like an ideal teacher, then you should write the statement number in a cell toward the right side of the scale. If you think the statement is LEAST like an ideal teacher, then you should write the statement number on the answer sheet in a cell toward the left side of the scale.

After you have read the statement, and entered the number of the statement in an empty cell on your answer sheet, do the same for each successive statement. Statements may NOT be repeated. Do not compare one statement with another. Judge each statement according to your own beliefs.

Each cell should have only one number in it and all 100 cells should be filled.

As you near the end of the statements, the number of spaces for recording answers will become fewer and fewer. Do not worry about this restriction because it is part of the design of the scale and is the same for everyone.

GNC Scale Statements

1. In the teaching of some subjects, the attitude of the teacher should be one of persuasion, not inquiry, in order that he may fulfill his function--that of an instrument of transmission of established truth.

2. Teaching is best conceived as a sequence of assign-study-recite procedures in which students must spend more time in preparation for class than in recitation.

3. A knowledge of history is worthwhile in itself because it embraces the accumulated wisdom of our ancestors.

4. The teacher does not teach; he creates a learning situation.

5. Students should not be taught to seek adjustment to things as they are, but should be given tools for the improvement of conditions in terms of what is possible.

6. The aim of instruction is mastery of objective knowledge.

7. Learning is essentially the impact of mind upon mind.

8. Knowledge for its own sake is of greater value than knowledge for some vocational or practical purpose.

9. If standards and values are to function effectively in the learner's life, then they must be created by the learner himself out of his own experience, including critical evaluations of the experience of others.

10. The function of the college teacher is not merely to teach the student how to think--as if this were an abstract skill, apart from subject matters thought about--but to get him thinking in and about the major fields of human interest.

11. A teacher of physics may teach that physical laws are unchanging and certain in their essential nature, although some slight error of measurement may make their particular expression in the classroom crude and imperfect.

12. The values of subject matter range in a hierarchy such that the study of arts and sciences is always better than a study of accounting or bookkeeping.

13. A teacher of physics may teach that physical laws are uncertain and subject to change since the best statements about the physical world are based on relativity and probability.

14. The learning goals of the class should be developed cooperatively by the teacher and the students.

15. A sound education can best be obtained by struggling with the great minds of Western culture.

16. Self-discipline is best achieved by, first, knowing what objective norms one ought to conform to (i.e., which are universally valid), and then conforming to them willingly.

17. Since it is not possible to interest all students all the time in what they need to know, the teacher should on some occasions use coercion to achieve student development.

18. Every subject has its vocational aspects which are important.

19. Education is liberal when it forms the student's mind after the pattern of objective reality and scientifically determined natural law.

20. Among students, respect for fact is not enough; there must be respect for authority--not the authority of a person, an institution, dogma, or doctrine--but the authority of intelligent inquiry.

21. The teacher should spend most of his time with those students who have the greatest intellectual potential.

22. What one knows about anything is what he can do with it or about it.

23. It makes little difference what subjects the student studies so long as he studies with great minds.

24. Teaching is a process of unfolding or drawing out what is already in the student.

25. To the extent that student is capable of thinking, he puts some portion of an apparently stable world in peril; and no one can wholly predict what will emerge in its place.

26. The good teacher is one who can sense the presence of the Eternal in the temporal; who can think the thoughts of God after man; who can feel that the course of nature is the art of God; who can think the universal reason in all things; and who can discern a universal will in all existence.

27. Upon the schools of America must rest, as their dominant task, the guardianship and transmission of the cultural heritage.

28. Required reading of literary works, even though it may bring an unfavorable attitude toward literature, is necessary in a sound educational program.

29. Teaching is essentially a stimulation and guidance of the learner's purposes in solving consciously perceived problems and gaining anticipated satisfaction.

30. Teaching is most efficient when the teacher has planned a carefully developed lesson, minute in detail and logical in organization.

31. Teaching consists of (a) providing and explaining a pattern of behavior for the student to imitate (instruction), (b) arousing the student to activity (motivation), (c) demanding achievement in that pattern through appropriate praise and censure (discipline).

32. Learning and teaching are co-operative ventures of creating knowledge and truth.

33. Teachers need not agree on any overall philosophy of education if they are able to agree upon a method by which disagreements may be settled.

34. There are certain bodies of subject matter which have inherent educational value and which should always be included in every curriculum.

35. The student's privilege of making choices should be limited only by his capacity to accept personal and social responsibility for the outcomes of choices made.

36. The best preparation for the future is a thorough knowledge of the past.

37. The way in which a learner reaches any conclusion (a fact, skill, or attitude) is usually of more significance to his development than the conclusion itself.

38. Beliefs and attitudes should not be accepted by students and teachers merely because they have been held valuable traditionally.

39. The teacher accepts the fact that he might incur the hatred of people, including his students, who have reason to fear the search for truth.

40. Students should be helped to understand that no conclusions, doctrines, and viewpoints originate from a source so superior as to preclude criticism, modification, or rejection.

41. There is no definite best educational procedure for teaching any subject, outside of a specific situation.

42. Self-discipline and the value of effort are learned by overcoming natural or intrinsic obstacles to desired goals.

43. All students should be helped to understand that there is no authority that is not susceptible to examination, criticism, and evaluation.

44. Students should frequently be required to perform difficult tasks in school as preparation for conditions they may meet later in life.

45. Whatever motivates the learner's effort defines the actual learning goal that is being sought by the learner.

46. The more abstract the knowledge, the greater its validity or certainty.

47. A teacher may teach that the individual person is in essence following the unchanging laws of human nature, even though in some cases students appear to violate these laws.

48. Education is a form of indoctrination: indoctrination is defined as positive teaching.

49. Students should learn that true knowledge of reality comes through revelation, and that reason is more important than sense perception in the quest for knowledge.

50. Subject matter lacks potency, meaning, and value for the learner unless related to his social context and range of interests.

51. Objective scientific procedures and results should be the final arbiter in determining educational policies.

52. In the interest of social stability, the youth of this generation must be brought into conformity with the enduring beliefs and institutions of our national heritage.

53. The function of the teacher is ultimately to make himself dispensible in the process of education.

54. In this period of rapid change, it is highly important that education be charged with the task of preserving intact the long established and enduring educational aims and social objectives.

55. Educators can never be certain which educational road leads to over-all progress.

56. The teacher is an impersonal channel of communication, transmitting knowledge from those who know to those who do not know.

57. Students should learn that moral values are held subject to revision in the light of further experience.

58. If democracy in education means shared thinking, then the person who fails to think, rather than the one who differs from the majority, is the least democratic in his basic attitudes.

59. It is more important that students first think and attack problems than that they first master specific bodies of required content.

60. All beliefs and attitudes should be open for examination as to their meaning and usefulness for present day and future living.

61. Students should not be given freedom to control themselves and make their own decisions before they have the knowledge and maturity to do so wisely.

62. Conformity and uniformity among students are of somewhat less value than creativity and inventiveness.

63. Education should be directed toward preparation.

64. The teacher may use fear of supernatural consequences of immoral acts as an aid in the development of healthy moral living among students.

65. Educational aims as well as content should be continually refashioned for a particular society in a particular place and at a particular time.

66. Since one of the principal problems of teaching is keeping the experiences of the students moving along subject matter lines with which the teacher already has familiarity, the teacher needs to know both the subject matter and the peculiar needs and capacities of the students.

67. In order for the student to make a moral choice in a given situation he needs to know what is truly right and what is truly wrong in relation to that specific situation before he chooses.

68. Good teaching proceeds on the assumption that reason is a measure of all things, that individuality must be subordinated to universality, and that percepts are less significant than concepts.

69. Schools should indoctrinate the students in the ideals of democracy.

70. On controversial questions which arise in the classroom, the teacher should permit free presentation and discussion by students of relevant viewpoints.

71. Students profit most from teachers who know their subject, express information objectively, and who keep themselves and their personal feelings out of the picture.

72. Moral values, like all other values, are best learned when the learner tries out his value judgments in practice and undergoes the consequences.

73. The content of the curriculum should be limited by (a) what it is safe for the learner to experience in view of his nature, weakened as it is by original sin, and (b) what will aid him in the achievement of his supernatural destiny.

74. The more concrete the knowledge, the more valid and certain it is.

75. Learning is the unfolding of the self to self-consciousness.

76. Within the classroom, the teacher should have the sole right to decide what controversial issues may be discussed by the students.

77. In all important respects, the subject matter taught by the teacher should use the students' experiences and interests as a starting point.

78. The subject matter of any course should be selected by the teacher and students.

79. The basic purpose of teaching is vigorous inquiry into past and present experience for the purpose of intelligently directing the course of future experience.

80. Liberal education means liberating intelligence for capable self-direction in using the world's knowledge, more or less regardless of how certain that knowledge.

81. Intellectual discipline includes reflection over what has been done, extraction of the net meanings, and projection of ideas as ways of dealing with further experiences.

82. A person improves his thinking by connecting whatever he does with the consequence of doing it.

83. It is the function of the teacher to analyze, to systematize, and to present the subject of study in such a manner that the unfolding order of the subject will exactly correspond to the unfolding order of the mind of the student.

84. There are certain areas in education such as the revealed truths of religion, which are not tested or validated by experience and therefore are not to be considered from an attitude of experimental criticism.

85. Minimum standards of achievement, in the form of requirements to be met equally by all students, must be demanded at every level of education.

86. Teaching implies knowledge, knowledge is truth. The truth is everywhere the same. Hence, education is everywhere the same.

87. A student is educated to the extent that he perceives wider choices among alternatives, increases his accuracy in predicting the consequences of his behavior, and knows better what he really wants.

88. Students should be taught that critically tested human experience is the best authority available.

89. The learner's purposes determine (a) what is relevant subject matter, (b) the order in which it is learned, and (c) its significance for future occasions.

90. If you cannot use the subject you are studying, it has little value.

91. The teacher utilizes his background of information, criticizes society and projects ideals.

92. The teacher should encourage and assist students in their judging of the materials, values, and results of the instruction.

93. Intellectual discipline is not achieved through merely acquiring information, but comes from actively inquiring into problems seen as significant.

94. If growth is to take place, the teacher may be obliged to coerce the indolent student, even though coercion may involve tedious memory work.

95. There are some aims in education that are inherently right and good and should be followed under all circumstances.

96. Orderly behavior in life is best achieved by the student's realizing evaluating, and accepting responsibility for the consequence of his acts.

97. Good teaching will awaken the student to his selfhood and to his unity with a greater self or world mind.

98. Indoctrination stops inquiry. Without continuous inquiry, the mind is closed.

99. Learning is a process of mastering objective knowledge and developing skills by drill, trial and error, memorization, and logical deduction.

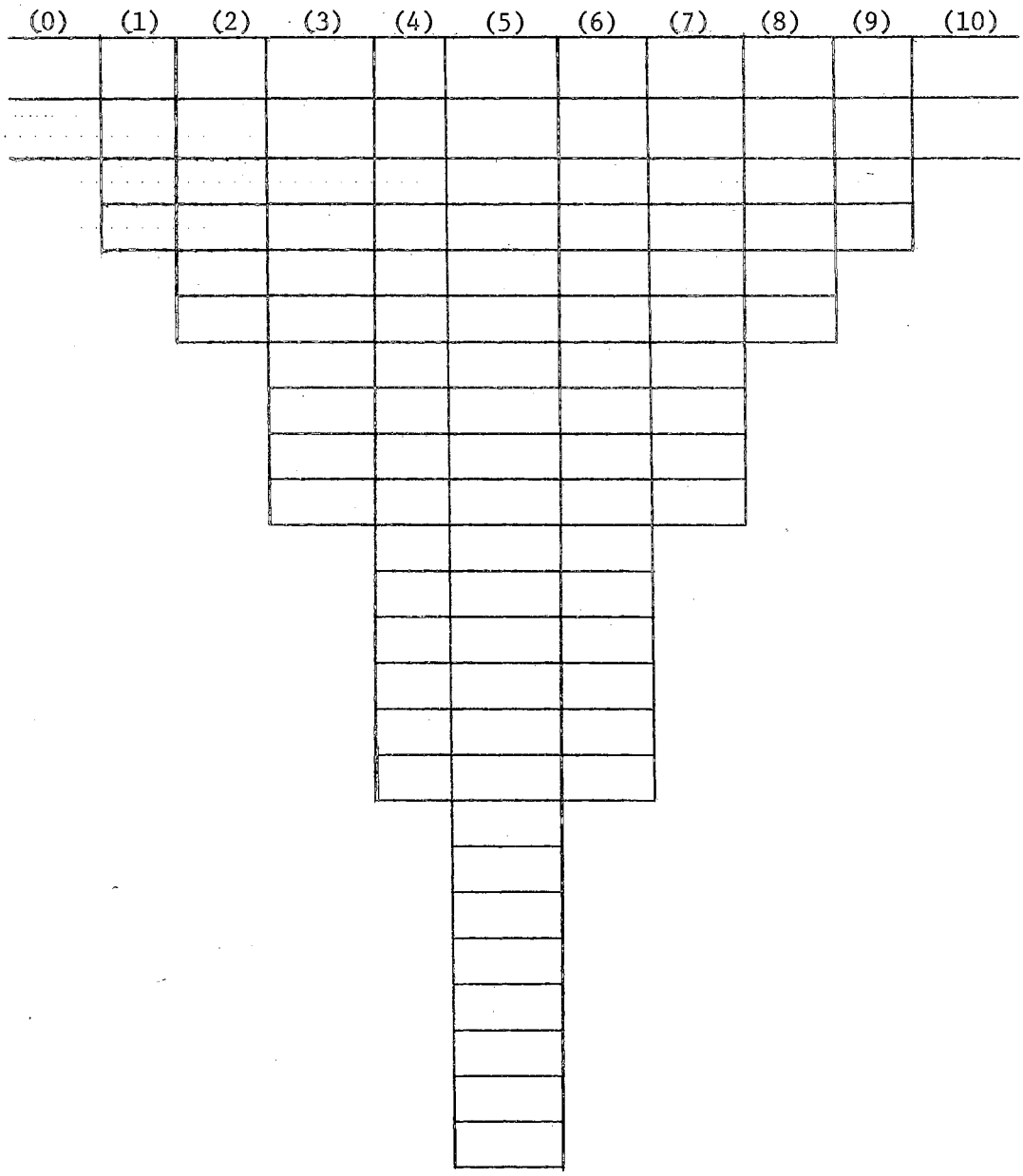
100. When a student is judged to be doing failing work, with material within his range of intellectual competence, such a judgment means also that the teacher has failed.

GNC SCALE

THESE STATEMENTS ARE:

LEAST LIKE THE IDEAL TEACHER

MOST LIKE THE IDEAL TEACHER



GNC Scale

The following numbers represent those statements which are oriented toward the rationalistic or classical philosophy.

1 - 2 - 3 - 6 - 7 - 8 - 11 - 12 - 15 - 16 - 17 - 19 -

21 - 23 - 24 - 26 - 27 - 28 - 30 - 31 - 34 - 36 - 44 -

46 - 47 - 48 - 49 - 51 - 52 - 54 - 56 - 61 - 63 - 64 -

67 - 68 - 69 - 71 - 73 - 74 - 75 - 76 - 83 - 84 - 85 -

86 - 94 - 95 - 97 - 99

# APPENDIX B

## OTIS MENTAL ABILITY TEST

# OTIS QUICK-SCORING MENTAL ABILITY TESTS

## GAMMA TEST: FORM AM

This is a test to see how well you can think. It contains questions of different kinds. Here are four sample questions. Five answers are given under each question. Read each question and decide which of the five answers below it is the right answer.

Sample a: Which one of the five things below is soft?

(1) glass (2) stone (3) cotton (4) iron (5) ice

The right answer, of course, is cotton.

Sample b: A robbin is a kind of

(6) plant (7) bird (8) worm (9) fish (10) flower

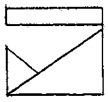
The answer is bird.

Sample c: Which one of the five numbers below is larger than 55?

(11) 53 (12) 48 (13) 29 (14) 57 (15) 16

The answer, of course, is 57.

Sample d: Which figure includes the most angles?

(16)  (17)  (18)  (19)  (20) 

The answer is (20).

The test contains 80 questions. You are not expected to be able to answer all of them, but do the best you can. You will be allowed half an hour after the examiner tells you to begin. No questions about the test will be answered by the examiner after the test begins. Lay your pencil down.

Do not turn this booklet until
you are told to begin.

# APPENDIX C

## SUB-TEST OF DIVERGENT THINKING

Name: _____

THINGS CATEGORIES TEST -- Fi - 3 IF

This is a test to see how many things you can think of that are alike in some way.

Below are two examples of things that are always red or that are red more often than any other color. Look at these examples. Then go ahead and write in the blanks more things that are always red or that are red more often than any other color. You may use one word or several words to describe each thing.

Bricks

Cherries

_____

_____

Your score will be the number of correct things that you write.

You will have 3 minutes for each page. When you have finished Page 1, STOP. Please do not go on to Page 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

Name_____

PLOT TITLES -- 0 - 1 OS

In this test you will be given two plots of stories and you are to write as many appropriate titles as you can for each plot. The titles must have some clear relation to the plot.

The titles may be clever or not. The only requirement is that they be clearly related to the plot.

There will be numbered lines to write on. Use one line for each title. When the signal is given (not yet), turn the page and write as many titles as you can for the plot at the top of the page.

You will have 3 minutes for each page.

If you have questions, ask them now.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.



This test was prepared under U. S. Government Contract N6onr-23810.

# SYMBOL PRODUCTION -- 0 - 2 OY

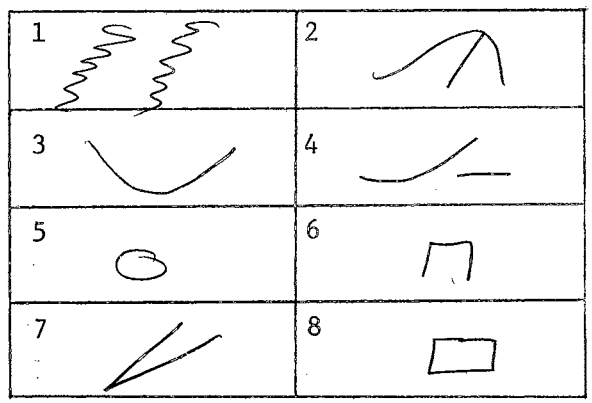
This is a test of your ability to devise a set of symbols to represent some situation. Symbols are brief representations of ideas; these ideas may be concrete, such as objects, or more abstract, such as actions. In the test, activities and objects will be given and your task will be to set down symbols of your own design to represent the activities and objects. Look at the examples below:

Ring (1) the bell (2)

Open (3) the door (4)

Look (5) into the room (6)

Close (7) the window (8)




The words underlined above are numbered and symbols were drawn in the corresponding numbered squares at the right-hand of the page.

The symbols you see above are merely examples of the kind you might make. For instance, you might want to symbolize "ring" by marks like  because they remind you of sound waves. There are many ways of representing things, but the way which you choose should be understandable. Your symbols should get ideas across to other people. Usually, it is some important property of the thing symbolized that is used. In devising a symbol, ask yourself the question "Can I point out very quickly to someone else why I chose this symbol?" Use as few lines as possible in drawing a symbol. A detailed picture is more than a symbol and is not what is called for.

In the test itself you will be given statements of activities similar to those above. You are to write symbols of your own. You are not to use letters, numbers, or the symbols of the example above in your answers. Do not draw stick-figures or cartoon figures performing actions, but try to symbolize the actions themselves.

Work as rapidly as you can; do not spend too much time on any one symbol. If you have difficulty in thinking of a symbol, leave it and return later if you have time. Your score will depend on the number of good symbols you give.

You will be allowed 5 minutes for each page. There are two pages.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO



This test was prepared under U. S. Government Contract N6onr-23810.

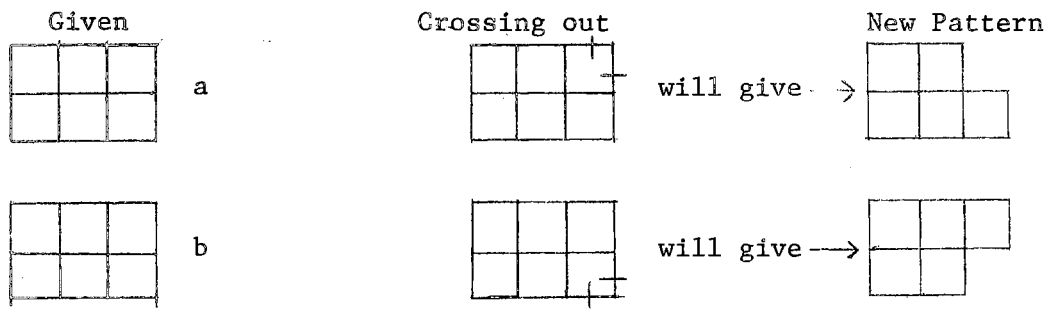
NAME _____

MATCH PROBLEMS V-Xa-2 (FAF)

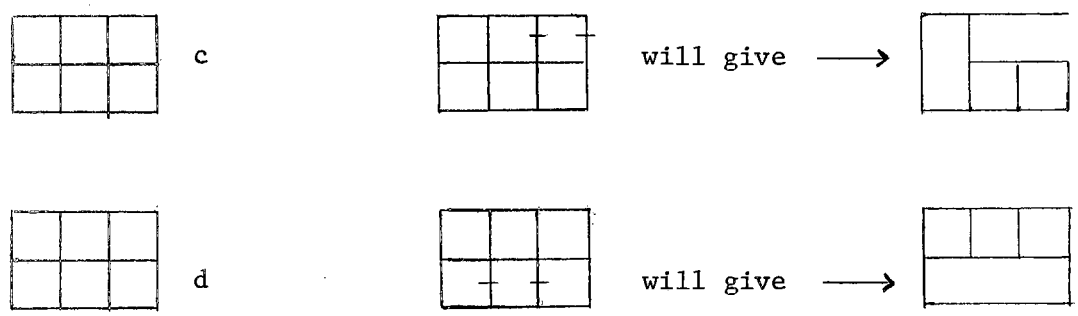
In this test you will see a drawing of matches with no heads. The matches are laid out in squares. You are to cross out some of the matches so that the matches left make a new pattern of squares. Then you are to cross out different matches to make another pattern.

Look at the example

CROSS OUT 2 MATCHES.
LEAVE ANY NUMBER OF SQUARES.
EVERY MATCH LEFT MUST BE PART OF SOME SQUARE.




These two answers are correct, but both use the same rule. This rule is to cross out two corner matches. Only one of these answers would count. You must use different rules to get the new patterns that will count. Now look at the answers below.




Neither one of these answers is correct. Some of the matches left are not parts of squares in the new pattern. You must cross out the correct number of matches so that each match left is part of some square.

In the test you will see many patterns on which to work. Use a different rule for each answer. In each of your answers, every match left must be part of some square.

You will be told when to begin work and when to stop work on each page. You will have 5 minutes for each page. There are two pages. Work as rapidly as you can.

If you have questions, ask them now.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.



Prepared under U. S. Government Contracts N6onr-23810 and O.E. SAE-8384.

Name_____

OBJECT NAMING -- Xs - 3 FSS

In this test you will be given the name of a class of objects. Your task is to write down, in the time allowed, the names of as many objects in the class as you can.

EXAMPLE: You are given a class defined as MINERAL

You might write down Uranium
Gold

Write as quickly as you can, but be sure that the names you write belong in the class of objects or things given. Make your letters as legible as possible.

You will have 2 minutes to complete each page, there are two pages.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO



This test was prepared under U. S. Government Contract N6onr-23810.

Name_____

GESTALT TRANSFORMATION -- Re - 1 SR

In each of the following items you will be presented with a problem which may be solved by using a part of one of the objects given as choices. The solution may be one requiring ingenuity. Place an X through the letter corresponding to the object which you think has a part which would best solve the problem.

For example:

To start a fire

A. - a fountain pen
B. - an onion
C. - a pocket watch
D. - a light bulb
E. - a bowling ball

The correct answer is "C" and an X has been marked on "C." This is correct because you could use the crystal from a pocket watch as a burning glass to start a fire.

You will have 10 minutes to complete this test.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.



This test was prepared under U. S. Government Contract N6onr-23810.

# APPENDIX D

# FORMULAE

# STATISTICAL EQUATIONS

These basic equations were modified to be usable with the normal sub-routine package of the IBM 360 computer at Oklahoma State University.

1. t - test for paired groups. (55)

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\Sigma d^2}{N(N-1)}}}$$

2. Multiple Regression. (52)

$$Y_i = \mu + B_1X_1 + B_2X_2 + B_3X_3 + \cdots\cdots B_KX_K + e_i$$

3. Analysis of Variance. (55)

$$SS_t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$SS_g = (\Sigma X_1)^2 + (\Sigma X_2)^2 + \cdots\cdots (\Sigma X_K)^2 - \frac{(\Sigma X)^2}{N}$$

$$SS_w = [SS_t - SS_g]$$

$$F = \frac{\text{Group Variance Estimate}}{\text{Within Variance Estimate}}$$

# APPENDIX E

## SUB-TEST SCORES

Scores of the Sub-tests of Divergent Thinking

(arranged by student number)

| IF | | OS | | OY | | FAF | | Faf | |
|---|---|---|---|---|---|---|---|---|---|
| 17 | 30 | 12 | 20 | 17 | 25 | 16 | 14 | 12 | 9 |
| 23 | 19 | 22 | 35 | 24 | 41 | 16 | 13 | 13 | 11 |
| 19 | 22 | 17 | 17 | 25 | 21 | 14 | 11 | 8 | 7 |
| 14 | 10 | 9 | 12 | 29 | 13 | 23 | 13 | 9 | 8 |
| 16 | 24 | 12 | 47 | 27 | 32 | 19 | 11 | 14 | 16 |
| 18 | 12 | 7 | 15 | 29 | 29 | 11 | 24 | 7 | 7 |
| 23 | 13 | 28 | 20 | 28 | 26 | 27 | 14 | 7 | 16 |
| 22 | 20 | 24 | 20 | 28 | 25 | 17 | 22 | 12 | 15 |
| 24 | 14 | 7 | 5 | 29 | 21 | 16 | 8 | 18 | 13 |
| 16 | 18 | 17 | 15 | 19 | 12 | 13 | 17 | 4 | 5 |
| 15 | 17 | 12 | 15 | 35 | 29 | 16 | 16 | 16 | 7 |
| 21 | 21 | 22 | 20 | 35 | 22 | 18 | 11 | 18 | 6 |
| 14 | 12 | 30 | 12 | 32 | 32 | 20 | 10 | 11 | 12 |
| 14 | 14 | 27 | 10 | 29 | 8 | 8 | 12 | 6 | 3 |
| 12 | 19 | 12 | 15 | 32 | 30 | 17 | 10 | 8 | 10 |
| 25 | 14 | 40 | 15 | 18 | 22 | 16 | 11 | 17 | 11 |
| 13 | 17 | 10 | 15 | 14 | 26 | 13 | 21 | 5 | 10 |
| 18 | 20 | 20 | 15 | 26 | 38 | 15 | 20 | 10 | 10 |
| 18 | 18 | 15 | 5 | 27 | 22 | 14 | 13 | 6 | 14 |
| 16 | 16 | 25 | 20 | 17 | 33 | 8 | 13 | 2 | 13 |
| 18 | 22 | 19 | 35 | 15 | 23 | 16 | 18 | 7 | 11 |
| 21 | 15 | 12 | 10 | 29 | 22 | 20 | 18 | 3 | 12 |
| 22 | 20 | 15 | 22 | 14 | 21 | 11 | 13 | 4 | 10 |
| 18 | 17 | 32 | 25 | 13 | 19 | 15 | 20 | 5 | 9 |
| 11 | 16 | 7 | 5 | 9 | 22 | 6 | 9 | 3 | 9 |
| 14 | 22 | 40 | 12 | 24 | 31 | 22 | 16 | 8 | 15 |
| 24 | 13 | 17 | 35 | 10 | 21 | 19 | 21 | 9 | 15 |
| 21 | 10 | 17 | 45 | 22 | 34 | 16 | 16 | 5 | 13 |
| 16 | 21 | 16 | 30 | 17 | 21 | 15 | 20 | 5 | 14 |
| 15 | 12 | 17 | 10 | 24 | 21 | 7 | 10 | 5 | 11 |
| 20 | 17 | 10 | 30 | 23 | 18 | 12 | 15 | 15 | 14 |
| 12 | 14 | 15 | 12 | 12 | 22 | 14 | 12 | 10 | 11 |
| 15 | 18 | 5 | 20 | 16 | 24 | 14 | 19 | 8 | 5 |
| 18 | 25 | 15 | 34 | 25 | 19 | 13 | 19 | 9 | 10 |
| 19 | 24 | 14 | 15 | 35 | 18 | 9 | 14 | 21 | 7 |

VITA

Richard Lee Fox

Candidate for the Degree of

Doctor of Education

Thesis: AN ANALYSIS OF RELATIONSHIPS AMONG CONSISTENCY OF BELIEFS, DIVERGENT THINKING, AND MENTAL ABILITY OF ELEMENTARY EDUCATION STUDENT TEACHERS IN SCIENCE

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Personal Data: Born in Peru, Indiana, April 27, 1927, the son of Nelson A. and Ruth M. Fox.

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Professional Experience: Served in the United States Army, 1944-1947; taught science courses at Winchester High School; Winchester, Indiana, 1953-1955; taught biology at Delphi-Deer Creek Consolidated High School, Delphi, Indiana, 1955-1957; employed as biology teacher, Waukegan Township, High School, Waukegan, Illinois, 1957-1959; employed as biology teacher, then department head, then assistant chairman of Science Division, Richwoods Community High School, Peoria Heights, Illinois, 1959-1966; served as a graduate assistant at Oklahoma State University, Stillwater, Oklahoma, 1966-1967; employed as chairman of the division of life sciences, Rock Valley College, Rockford, Illinois, 1967-1969, also served half-time as director of institutional research, 1968-1969, then as full time director of institutional research, 1969-to date.

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