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CREATIVE PROBLEM SOLVING IN PRESERVICE
TEACHER EDUCATION: AN EXPLORATORY STUDY

DISSERTATION

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

by

Phyllis Saltzman Levy, B.S., M.A.

* * * * *

The Ohio State University
1979

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To Barry—without whose patience and support
this dissertation would not have been completed.
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Julie, Lisa, Dave, and Frank, the teachers who facilitated my making empirical sense of my ponderings.
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Teachers teach differently from one another. Such a statement can be agreed upon by most professional educators. The differences are the interesting part of working with and observing teachers. One of these differences has to do with the way the teacher interacts with or reacts to students involved in the problem solving process.

THE ALGORITHM AND CREATIVE PROBLEM SOLVING*

In the "conventional model of schools," teachers know about certain procedures for problem solving. These procedures work. One such procedure is that for multiplication of numbers. This procedure is an algorithm. The goal of the conventional teacher is to train the student to carry out the procedures.

Consumers use known algorithms to solve problems. Teacher-consumers teach known algorithms to students. Thus, these individuals function in the realm of known knowledge. Computers can also be used to solve problems using known algorithms. The complementary realm of knowledge, that of the unknown, can only be explored by the human mind. It seems that schools ought to attend to this second realm, since computers can

*This section is based on an interview and conversation with Professor Karl Kornacker of The Ohio State University.
work with known algorithms more efficiently, more quickly, and more cheaply than can children (and since computers cannot work within the second realm). Such schools would treat children as if they all had the capacity to invent new algorithms. Such schools would nurture those who had the capacity to create algorithms suitable for working on classes of problems yet unsolved. This would maximize the opportunities for those few special children to learn to know their own abilities and to ponder problems. It is believed by this researcher that nurturing those students who could possibly make the quality of life better for great numbers of others is a valuable direction for schools to take.

Creative problem solving is the capacity of the person to use both the conscious and the other-than-conscious, to both "let" and "make" the solution come, to use both the left and right brain functions maximally, to use both her/his environment and herself/himself as a source, to tolerate both the chaos of confusion and the ecstasy of solution. This capacity and the individual's use of this capacity can result in a procedure which works to resolve a class of problems. The process of creative problem solving cannot be defined apart from the nature of the person. The product of creative problem solving can stand alone, exclusive of the creator.

Creativity in problem solving is analogous to artistic creativity. By artistic creativity two things are meant; 1) a process that yields an empirical product, and 2) a process that does not necessarily yield a product. In the first case, the product is the focus. In the latter case, the process is the focus. Creativity in problem solving is more
closely related to this first aspect because of the nature of problem solving which infers by definition a problem resolved. The algorithm used by the creative problem solver must lead to a solution that works to solve a class of problems. Conventional schools recognize artistic creativity, but scientific creativity, social creativity, and numerous other expressions of creativity are recognized only as "extra-curricular" activities. Some problems will take a longer time to solve than others and therefore might appear to be only process. In these situations, the human mind must be able to project the possibility of solution to comprehend the existence of an algorithm. This futuristic orientation will allow the problem solver to include such problems-in-process as potentially being resolved.

Creative problem solving requires pondering, mulling over the information, a transaction with the knowledge and with the environment. It involves both a conscious and subconscious trial and error search. From this pondering, the individual chooses the best answer. The selection involves aesthetics. In the conventional school model, students rarely have the opportunity to find out what they can accomplish by pondering since the school structure tends to deal only with the conscious and with known algorithms. The tendency in schools is to take quick, little steps in solving problems. Pondering would provide students with experience in contemplating over several days.

There is no procedure (algorithm) for what the student does in the process of creative problem solving (inventing algorithms). This procedure is necessarily unique for each individual in each situation.
But there can be an algorithm for what the teacher is doing to increase the opportunities for and capacity of the student to engage in creative problem solving. Thus, a goal for teachers might be to identify an algorithm (algorithms) for stimulating students to work on problems for which there are no algorithms. This is a goal of this dissertation. Several questions need consideration when pondering this problem: the first is answered in this dissertation, the others are contextual questions which warrant consideration and will not be answered directly in this dissertation. What does the teacher do to develop the student's capacity to work on a problem for which there is no algorithm? What kind of school structure of learning environment can be developed to help facilitate this process? How can the teaching algorithm be evaluated? This is, how can one test the teaching algorithm to determine if it "works?" What can be expected to result from this teaching algorithm?

![Diagram](image)

**Figure 1**  
PRELIMINARY PROCESS MODEL FOR TEACHING CREATIVE PROBLEM SOLVING: PART ONE

In the above model, the teacher is successful if the student gets to know her/his own problem solving processes, finds the solution to the problem, or actually identifies an algorithm.
In order to better understand what a teacher who had the capacity to create such stimulating algorithms would be like, in the next two sections of this chapter, the teacher who consumes knowledge will be contrasted with the teacher who produces knowledge.

TEACHER AS CONSUMER

Certain teachers might be called "consumers" of knowledge (Mooney in Pinar, 1975, pp. 175-207). Consumers of knowledge might view their teaching in these ways:

I am to be quite impersonal, to leave myself out....
I am to look for truths which exist on their own account, independent of me....
I am to observe [or "teach"], but not to participate....
I am not to be influenced by what I value....
I am not to be concerned with what is 'good,' only with what is 'true.'...
[The information will speak for itself.]
I am to depend on logic and testable demonstration, not on feelings and imagination....
I am to use procedures approved by scientists [the Board of Education, and the administrators,], not my own unproven ways of doing things....
...my experience has little worth compared to the accumulated and tested experience of science [and the experts]....
[I select problems to study and teach based on the 'curriculum,' not in relation to what I or my students need to know]....
I must avoid making mistakes....
My job... [as a teacher] is, therefore, to achieve that separation from nature which allows me most clearly to see nature's truth so that I... [and my students] can fit ourselves to that which has to be outside of me and man (pp. 177-180).*

Teachers governed by a philosophy such as that outlined by the above statements fit nicely into institutions which reflect this

*Italics omitted for purposes of this paper.
philosophy. Mooney writes that such schools are based on the following psychological reasoning:

A subject exists before a particular child comes to it and will continue to exist after the child has gone. A child exists before he comes to a particular subject and will exist after he has left it, whether he has learned the subject or not. The two, subject and child, are in separate systems and are independent of each other. They have no necessary connections.

The subject has its own conceptual order—geometry, for example. This order is necessary for the subject, is the subject, as a matter of fact. A student who learns geometry learns this order. When the student has fitted his mind with this order, then he knows the subject. He can be tested by conceptual order, and, if he gives responses which are 'right' within the system, then he is developing a 'disciplined' mind in the subject.

It is the conceptual order of the subjects which makes it possible to stabilize the schools. The children are forever changing, coming by the thousands, staying awhile, and passing on through. This changing amorphous mass can be controlled by making the subjects a center of the system. Let the students come and be pitted against the stabilizing core of the subjects. Hire as teachers those who know a subject well and let them teach that subject. Group the students in convenient numbers and send them to a given teacher to 'get that subject.'

If a student doesn't 'get a subject,' mark him down, for, of the two things, the subject and the student, it is the student who is in error and needs to be disciplined to fit the discipline. The 'subject' is the basic, elementary construction to which the student is to adjust. The subject is the creator; the child the created (p. 182).

And not only is the teacher part of the system described above, the teacher most likely was a 'product' of such a system.

The center of value, of right, or organization, of psychological action is 'out there' in the subjects. The job of the student is to learn how to behave from positions in systems outside himself. The job of the teacher is to see that the students most quickly and easily fit themselves to these outside existences and controls (pp. 182-3).
Schools described by this reasoning encourage the teacher to act as a consumer of knowledge both during her/his time as student and during her/his time as teacher. The teacher-consumer could live happily-ever-after in a school based on this philosophy.

CREATIVE PROBLEM SOLVERS:
THOSE WHO ARE ABLE TO INVENT NEW ALGORITHMS

It is assumed that a teacher must be a creative problem solver to develop a stimulating algorithm for maximizing the opportunities for a student to do creative problem solving. Such a teacher-producer would view their teaching in these ways:

Whatever I realize of the universe, I realize from where I am, and no other being realizes life from where I am. This is my uniqueness, my being....

[I am] joined into...all other beings, into the whole universe. I am an intimate inclusion within all. This is my universality, my belonging....

...I am constantly spending energy, which, as it leaves me, calls for my constant seeking of renewal by fresh inclusions, taken from the universe into me. This gives my life a forward thrust....

...I may be able to find a structured form that, fitting to the structure of my emptiness, grasped and taken into me, fits and fills my need....

I am not only a being with belonging in the universe, and a becoming out of these, but also a fitter, fitting the universe and me in a reflexive transformation (Mooney in Pinar, pp. 190-191).

The view presented by these statements is quite different from that of the teacher-consumer. The implications for teaching which can be drawn from this difference will form much of that which is to follow in this dissertation.
To highlight the distinction between the way the teacher-consumer orders her/his environment and the way the teacher-producer orders her/his environment, one might consider the changes an individual would make if evolving from the former to the latter:

1. A change in the kinds of judgements required.
2. An increase in the range of judgements required.
3. A shift in the focus of attention from the characteristics of the product to the characteristics of the production process.
4. A reverse flow in the dynamics of thought, being from product to person in consumption and from person to product in production.
5. A recognition of the fundamental and initiating status of the self...[in the teaching process] (Mooney in Pinar, pp. 189-190).

It should be noted that the creative problem solver does "use" existing knowledge. The shift from the consumer view to the producer view does not imply an abandonment of knowledge; it does imply a change of view and type of engagement with existing knowledge.

The terms process, product, and algorithm have a specific relationship. A process is what a person does. A product (output) is what is accomplished by the doing. An algorithm is a specified process which works to resolve a class of problems. The teacher-consumer responds to all types of input in the same way, regardless of the nature of the input. The teacher-producer uses an algorithm which is responsive to the variation in the input: that is, the teacher-producer interacts with the student according to the needs of the student at that particular time. Both use algorithms, yet the algorithms are of very different types. The algorithms dictate the teacher's response to her/his students. The output of the first type is a trained student. The output of the second type is, ideally, a creative problem solver.
THE PROBLEM

The question for the preservice teacher becomes: How do I learn about this creative problem solving process so that I can increase the opportunities for such a process to happen for children with whom I am working? If the basic components of a learning environment are indeed in transaction as indicated by the producer's view of teaching, the direction of energy flow indicated in Figure 1 also would move in reverse.

The students' processes illuminate the teachers' processes

The problem stimulates the student

TEACHER   STUDENT   PROBLEMS

PRELIMINARY PROCESS MODEL FOR TEACHING CREATIVE PROBLEM SOLVING: PART TWO

It seems that the preservice teacher might most effectively learn about such creative problem solving by interacting with a child involved in the process since the process is within the child and can therefore be best studied there. This type of learning might only occur if both the preservice teacher and the child have the capacity to view the environment as producers. This study will attempt to investigate this learning process.

The conventional method for preservice teachers to learn about children, learning, and teaching is their consumption of the knowledge product presented by the teacher educator:
An alternative method for preservice teachers to learn about children, learning, and teaching is their production of the knowledge product by making sense of the components of their environment. The results of this study might be used by the teacher educator-producer when exploring ways to increase opportunities for and capacities of her/his preservice teaching students to solve teaching problems creatively:

(Note: When the people in this process hold the producer view, and when the links between the people are characterized as being new algorithms, the energy flow moves in all directions.)
In the effort to find out about 1) the learning of the preservice teacher about this process and 2) what sense for her/his teaching the preservice teacher makes from these new data, the teacher educator-researcher will observe and interview the preservice teacher as s/he goes through this learning process. By doing this, the "Alternative Process Model of Teacher Education" will be put into practice.

The need for people with the capacity to solve problems is evident after an empirical examination of our earth: human suffering, injustice, and other classes of problems exist.

Man's trouble is great enough to cause him to rethink the place he wants to give himself. He has examples of how splittings between groups of men, when taken to be absolute have led straight into the jaws of death. His feelers are out for a deeper unity which takes the splits and puts them under control so that instead of being causes of death they are enriching differentiations of a healthy whole (Mooney in Pinar, p. 198).

In cultural tradition, there is a symbol around which hope centers when the going gets rough. This is the symbol of creation....(p. 198).

What is needed now is not only the happenstance of a few creative men in the total population, but a direct and widespread honoring of conditions for cultivating creativity among people generally. People are threatened now, whole nations at a time, so that what is called for now is emergent greatness among people, whole nations at a time (p. 199).

The commitment to making a better world and the trust that the more people having the capacity to invent new algorithms the greater the likelihood that solutions to existing problems will be found both underly this dissertation.

Several assumptions related to the teacher-producer are held by this researcher:
1. Creative problem solving is of extreme import and ought to be part of the school curriculum.

2. It is possible for teachers to develop a stimulating teaching algorithm which would maximize the opportunities for creative problem solving in the classroom.

3. It is possible for teacher educators to develop a stimulating teaching algorithm which would maximize the opportunities for creative problem solving (relevant to teaching) in the preservice teacher preparation program.

4. The learning and teaching processes undertaken by the teacher are the teacher's own and are unique.

5. Any learning experience has different meaning for different individuals; that is, teachers come to the experience with different skills, knowledge, and attitudes. And one teacher at different times in her/his development also comes to the experience with different abilities.

6. The teacher fits experience into her/his own construct structure (Kelly, 1963).

7. Producer-learning and producer-teaching proceed in an orderly manner, absorb the learner or teacher intensely, and involve intrinsic reward (Huizinga, 1950).

8. Both choice and structure are essential components of producer-learning and producer-teaching.

9. The process of teaching from the producer view includes both activity and reflection.

10. Creation has a rhythmic quality including states of balance and imbalance. Imbalance or disequilibrium is needed to begin creation.

11. The teacher-producer is a person who sees significant classroom events differently and who therefore has a different sort of transaction with knowledge and students than does the teacher-consumer.
PARTS OF THE DISSERTATION

Chapter one has been an introduction of the problem. Chapter two will review the work of those who have grappled with this or related problems (such as the research on creativity and problem solving). Chapter three will be a theoretical examination of the problem. Chapter four will describe the methodology for the case studies. Chapter five will provide an analysis of the data. Chapter six will include implications and directions for further research resulting from the study.
Chapter One introduced the problem: Can an algorithm be developed for stimulating students to work on problems for which there are no known algorithms? and How does the preservice teacher learn about the creative problem solving process so that opportunities for such a process to occur in the classroom might be maximized? In the creative problem solving process, it makes sense to understand what others have thought about related to one's problem before proceeding to attempt to solve the problem. Hence, the necessity of this chapter.

Chapter Two will attempt to answer the questions: What is meant by the creative problem solving process? and What implications does this meaning have for the classroom teacher? The first part of the chapter will focus on (1) creativity, i.e., theory, practice and research; and (2) problem solving, i.e., use of known algorithms as well as invention and use of previously unknown algorithms. The second part of the chapter will focus on implications of creative problem-solving for the classroom teacher. Based on this literature review, nothing has appeared relevant to the preservice education of teachers and their personal and professional understanding of creative problem solving. Thus, knowledge related to (but not specific to) the problem of this dissertation will be reviewed in this chapter.
Creative problem solving is a process. Sometimes, a communicable product results. Mooney provides a theoretical perspective for understanding this process:

The important thing is how the creative person handles himself in relation to (a) the extension of his experiencing, (b) the focusing of his experiencing, (c) the management of his actions during his experiencing, and (d) the derivation of significance from his experiencing.

The creative person seeks to extend his experiencing through holding himself open for increasing inclusions. This is evidenced by an inclination to take life as an adventure and a becoming, a curiosity and willingness to understand what is going on in oneself and in related aspects of the environment, a desire to get out to the edges of conscious realization and to feel a way into the unknown, an interest in new ideas and fresh perspectives, a spirit of play and experimentation.

The creative person seeks to focus his experiencing through self-differentiation and self-realization. This is evidenced by a willingness to be different in things that make a difference, an honoring of his own fulfillment even when it runs counter to common expectations of others, a persistent inquiry into the meaning of his own life, a feeling that his individual life has independent roots, an insistence on expression for self-clarification, a feeling the world is, in important part, his own creation.

The creative person seeks to manage his actions during his experiencing through disciplining himself to serve the extension and focusing of his experience. This is evidenced by an insistence on mastering his materials and tools of work so well that these become a part of his own way of living, an insistence on the privilege of controlling his own work schedule, a willingness to stick with baffling problems over an extended period of time, a capacity to be consumed by his work, a seriousness in selecting work to do which is personally and deeply valuable to him.

The creative person seeks to derive significance from his experiencing through dependence upon esthetic formings. This is evidenced by an insistence on harmony of form and function, a trusting of feeling to guide his way through an experience, a searching for the simplest structural forms to catch up a whole field of relations at once, an ability to think in terms of patterns of form, a
sensing of profound order in nature and a searching for that order in himself and in the universe, a testing of a solution by the way in which it seems to fall into place without forcing, a deliberate nourishing of and from unconscious sources, a sensitive awareness to positive and declarative modes of thought (Mooney, 1954, pp. 545-6).

In the above passage, Mooney has succinctly described the complex phenomenon of creative problem solving by telling what the problem solver does. The process seems to occur in both a conscious and other-than-conscious manner, and the evidence of this process is a product which might or might not reflect the process. Thus, we fall back on describing what the person does: Mooney writes that the person (a) experiences her/his environment and self in the most open manner possible, (b) makes sense of these data (that is, what s/he discovers in "a"), (c) uses her/his own brain as an instrument to accomplish "a" and "b," and (d) makes sense of the experience described in "a," "b," and "c" to achieve a harmony of form and function. This extension, focusing, management, derivation of significance pattern is an ongoing process continuing throughout the life of the creative person. Numerous other authors have written descriptions of what creative problem solvers do (Sampstead, 1962, pp. 333-9; Melton, 1967; Van Norren, 1976; Torrance, 1977, p. 24; Parnes, 1977; Fearn, 1976). These descriptions mesh well with the Mooney description.

A. Creativity

Those who write theory relevant to creativity provide "the eyeglasses" to use to focus and understand what one sees when looking
at the reality of creativity.

1. **Theory**

Perhaps it would be most helpful to begin by defining the term "creativity."

...creative thinking...[is] a natural human process in which a person becomes aware of a problem, difficulty, or gap in information for which he has no learned response; searches for others; formulates hypotheses about possible solutions; evaluates these possible solutions and tests them; modifies them and retests them; and communicates the results to others (Torrance and Torrance, 1973, p. 6).

...there is a man (a creative system), using his mind (a creative system) to effect (create) a fitting (a creation) between what is forming in him (being created) and what is forming in his field of focus (being created), thereby to realize creation-on-the-make within his knowing (Mooney, 1967b, p. 13).

Both of these definitions describe what occurs in the **person** who is involved in the creative act. This is sensible since creativity does not exist without the person. The first definition helps the reader to understand creativity in terms of the western way of thinking; that is, conscious behaviors are emphasized, product-orientation is clear, and the process is defined as a linear pattern. The second definition is focused more on an eastern way of thinking (although it includes the western way); that is, the beyond-conscious is implied, process-orientation is clear, and creation is viewed as a happening ("creation-on-the-make") rather than a linear progression.

Further elaboration of this role of the subconscious might be useful:
In the subconscious... half-formed ideas appear as symbols, manipulated according to the rules of emotion rather than logic. Here also, 'mental blocks' are raised that blind the conscious mind to emotionally unacceptable possibilities. An idea that is eventually recognized by the conscious mind as a solution to a long-standing problem may even originate in the troubled pantomime of a nightmare... (Douglas, 1977, part 2, p. 285)

This subconscious activity seems to be a crucial component of creative problem solving. It will be discussed at greater length in the section of this chapter dealing with the "unknown."

It seems appropriate to state the convictions and hypotheses about creativity available in the literature:

...convictions.

1. Creativity is a process that may or may not result in a product; but in any case, product is not a test of creative value or an indicator of creative behavior.
2. Creativity does not occur in a vacuum. It is the use, the management, the manipulation of knowns.
3. Neither the creative process nor the creative product results from magic. Both can largely be explained in terms of creator behaviors.
4. The creative process relates to an intellectual factor, if at all, only by a criterion of sophistication, not by a criterion of essence.
5. None of the above convictions discount inspiration, insight, or seemingly fantastic gifts of 'creative geniuses.' (Fearn, 1976, p. 55)

These convictions "fit" the assumptions proposed in Chapter I of this dissertation. Hypotheses about creativity are stated:

...(i) creative efficiency in people can be markedly increased if they understand the psychological process by which they operate;
(ii) in creative process the emotional component is more important than the intellectual, the irrational more important than the rational;
(iii) it is these emotional, irrational elements which can and must be understood in order to increase the probability of success in a problem-solving situation (Gordon, 1961, pp. 6-7)
These statements of the convictions and hypotheses underlying the work of these authors aid the reader in gaining a clearer understanding of creativity. Allusion is made to both the logical, verbal functions of the left brain and the holistic, geometric functions of the right brain.

A tremendous amount of work is currently being done concerning the functioning of the brain.

The conclusions being drawn from these experiments and research projects are that the left hemisphere of the brain, which controls the right side of the body, specializes in logical-analytical thinking and verbalization. These include talking, reading, writing, mathematical calculation, and most of the functions that involve linguistic and numeric processes.

The other side of the brain, the right side... cannot verbalize what it knows. It houses spatial perception, holistic understanding, perceptual insight, tactile sensation, musical ability, visualization, and some intuitive ability (summary of work written by Sperry as noted in Garrett, 1976, pp. 239-240).

An understanding of such a differentiation is most helpful when pondering the phenomenon of creativity. One may conclude:

The creative process is the transformation of a creative impulse through the use of techniques and sign manipulation into a communicable product. All parts of the brain are called upon to work together.... (Garrett, 1976, p. 241).

Thus, as it is necessary to include both the western-way and the eastern-way in understanding the creative process, it is also necessary to understand both left and right brain functions.

It seems clear that one must define creativity in terms of the person involved in the creative process. The conscious and other-than-conscious, product and process, and linear and geometric represent extreme positions on continua: creativity is defined as a function of
each continuum in relation to the functions of the other continua. Convictions and hypotheses about creativity are evident in the literature, sometimes stated explicitly sometimes not.

Next, the behaviors, skills, abilities, psychological states, and common difficulties of the creation person will be discussed resulting in a portrait of the "creative-one."*

The creative person demonstrates certain behaviors. These behaviors have the prerequisite condition of familiarity with the self:

- People who undertake a lifetime of creative production are required to become conscious of themselves as the source for their creation... [and]...have to know themselves accordingly (Mooney, 1963B, p. 46).

"Behaviors involved in being intimate with the self include curiosity, imagination, and originality (Fearn, 1976, p. 60)." Once this familiarity is found, fluency and flexibility are the behaviors which are apparent:

[Fluency]...is rather like rummaging through one's space to make conscious all of the possibilities, no matter how remote, that surround a question or problem.

Flexibility is the production of ideas from sets or perspectives that are different from those ordinarily associated with a problem (Fearn, 1976, pp. 56-57).

Moreover,

A second designation at the behavior level includes those behaviors required for doing things with, or manipulating the collected data. These include the behaviors involved in the prerequisite discipline, as well as elaboration and managing of chaos (Fearn, 1976, p. 58).

*"Creative-one" will be a term used in this dissertation. It is an efficient term for a person with the capacity to do creative problem solving who functions in a whole and integrated fashion.
Familiarity with the self as source for and instrument in creativity, fluency (rummaging), flexibility (production of new orders for ideas), and ability to effectively manipulate the data are all behaviors which can be observed in the creative-one.

Ross L. Mooney developed a list of indices of creative behaviors (1952). To accomplish this he:

...read with care the expressions of acknowledged creative persons.... As I read, I selected passages which seemed to me to be particularly revealing; made up brief statements in which I tried to catch up the meanings; put these statements on cards, one statement to a card; kept reading until I got no new ideas; picked out cards which seemed best to represent the whole range of meanings; put these into a list which I called "A Preliminary Listing of Indices of Creative Behavior;" and then classified the items (Mooney, 1955A, p. 15).

This "Classification of Items In 'A Preliminary Listing of Indices of Creative Behavior'" is included as Appendix A in this dissertation.

The skills of creative thinking..."require practice and can be enhanced by teaching (Torrance and Torrance, 1973, p. 7)." These include:

...the skills of becoming aware of problems and gaps in information, defining these problems and gaps, retrieving and combining information from previous experiences and accumulated knowledge, producing possible alternative solutions, developing criteria to evaluate these solutions, using these criteria to judge these solutions, testing the most promising solutions, deciding upon the best solution [and] working out plans and details for implementing the solution.... (Torrance and Torrance, 1973, p. 7).

It must be noted that the first of these listed skills, the "becoming aware" skill seems highly grounded in the other-than-conscious and might involve a great amount of "mulling" time. The behaviors listed above occur, to a great extent, in this pondering stage. The balance
of these skills are primarily conscious, although any of them might include original formings and fittings of ideas.

In addition to those behaviors and skills, abilities of the creative person have been listed:

1. Constructive discontent with things as they are;
2. Ability to observe and understand the environment both internally and externally;
3. Active curiosity for all things, old and new;
4. Mental organization or the ability to file and catalog all kinds of data for retrieval;
5. Improved reasoning power to separate relevant from irrelevant; to associate disparate elements into wholes; and to analyze complexities into manageable parts;
6. Creative and practical imagination to apply past experience and learning to current needs;
7. A sense of proportion, to logically determine magnitude, priority, and degree;
8. Willingness to demonstrate that ideas are worthwhile by getting out and trying or testing them; learning from mistakes (Samstead, 1962, pp. 333-9 as quoted in Weiss, 1977, pp. 6-9).

This list of abilities and attitudes might be considered a list of personality characteristics necessary before one can enter the realm of creating new algorithms. The specificity of this list goes beyond "familiarity with the self" which is listed above, although this list and the previous lists appear to be congruent.

"Interrelated psychological states" of the inventor have been identified:

1.a. **Detachment**: The feeling which the inventor described as being 'removed...sort of cut off...I've got to take a real look...from way out....'

1.b. **Involvement**: The closeness implied by, 'How would I feel if I were a spring? I find myself very mixed up with this spring. I can't get away from my own springiness.'

2. **Deferment**: The sense that it was difficult though necessary to discipline himself against premature attempt at solution....
3. **Speculation:** The recurrent ability to let the mind run free.

4. **Autonomy of Object:** The feeling described...[by].
   
   "I have the feeling that this thing is on its own, completely outside me....the people you've put in a play just go on by themselves (Gordon, 1961, pp.18-19)"

And

[5] ...the ability to tolerate and use the irrelevant was of fundamental importance for a solution....

[6] ...the ability to play, to sustain a childlike willingness to suspend adult disbelief....* (Gordon, 1961, p. 30).

These descriptions of psychological states illuminate further the other-than-conscious realm of creative problem solving.

Moreover, a listing of the common difficulties of the creative problem solver will help to complete this portrait:

1. Difficulty in finding words to describe original images....
2. Inability to let the imagination 'go,' to laugh, to play with new ideas and materials....
3. A tendency to analyze rather than synthesize....
4. Syntheses made too quickly before all of the facts have been taken in....
5. Difficulty in freeing oneself from an earlier image....
6. Fear of going too far-out in the imagination....
7. Too great a flood of ideas....
8. Preoccupation with worry (Torrance, 1977, pp. 31-33, italics omitted).

Such difficulties in producing original ideas act to block the problem solving process but also aid the reader in understanding what the

*"[The three mechanisms for play are]...(1) play with words, with meanings and definitions; (2) play in pushing a fundamental law or a basic scientific concept 'out of phase;' and (3) play with metaphor (Gordon, 1961, p. 30)."
creative problem solver must cope with. These problems are different from those encountered by persons working with known algorithms.

Thus, we have a portrait of the creative-one when in interaction with a problem (see Figure 5). The creative-one exists in an environment. The person is in the constant process of extension, experiencing, focusing of experiencing, management of actions during experiencing, and deriving the significance of experiencing (Mooney, 1954, pp. 545-6). The conscious skills used in these processes are those listed by Torrance and Torrance (1973, p. 7). The abilities and attitudes, such as discontent and curiosity (Samstead in Weiss, 1977, p. 6-9) keep the processes in motion. Possible blockages in the person's environment, such as difficulty in finding words (Torrance, 1977, pp. 31-33), might stop the flow of creative interest and energy. These processes, abilities, and blockages help to describe the creative-one's outward trip into the environment. There is also an inward trip. Familiarity with the self (Mooney, 1963B, p. 46 and Fearn, 1976, pp. 56-7) is a prerequisite for this inner trip. The psychological states the individual might experience, such as detachment or involvement (Gordon, 1961, pp. 18-19) aid in expressing what happens in this other-than-conscious inner search. Fluency (rummaging through one's space) and flexibility (reordering ideas) are involved. When the person begins to manipulate the data, the outward trip begins again (Fearn, 1976, pp. 56-58).

In other words:

One great route is from an inner reaching; another is through outer. In the former, one knows himself to be participant-creator in what is moving through him; in the latter, one knows himself to be seeing creation
moving through another being. The former is, at times, called 'mystic,' though the knowing, then, is very real, natural, and compelling. The latter is, at times, called 'scientific,' becoming real in that dimension.... the two come to be realized as in a union when one knows creation.' Inner modes of knowing fit the outer, and we are whole again (Mooney, 1967A, p. 275).

This extension, focusing, management, derivation of significance process of both outward and inner trips by the creative-one describe what the creative problem solver does when creating potentially new algorithms. Moreover:

The creative flow in individuals is not likely to be continuous. It is more likely to be pulsating. Quiescence for awhile may mean the gathering of strength and direction for a fresh productive spurt, or it may mean something has died (Mooney, 1957A, p. 17).

This variation in the rhythm of the flow is what infuses life into the system, continuously reaffirming the life within the creative-one.

2. Practice and Research

It seems appropriate to discuss the practical aspects of creativity at this point. Research results, trends, and developmental stages of the creative person will be included in this section. E. Paul Torrance is the outstanding individual in the empirical exploration of the phenomenon of creativity.

One of Torrance's associates, Joe Khatena, summarized the results of the research on creativity:

The avalanche of creativity research will not stop in spite of aversive criticism, and the thunder of the past 25 years has produced: (1) sound though diverse theories and definitions some of which have led to the construction of measures that are finding greater acceptance through use, proper study and refinement; (2) Important
Possible Blocks

Possible Blocks

1. Difficulty finding words
2. Inability to play
3. Analysis rather than synthesis
4. Synthesis too soon
5. "Getting stuck"
6. Fear
7. Too many ideas
8. Preoccupation with worry

Familiarity with Self
Psychological States:
1. Detachment and Involvement
2. Deferment
3. Speculation
4. Autonomy of Object
5. Tolerance
6. Play

Using the Skills:
1. Become aware of problems
2. Define problems
3. Combine information to use
4. Produce alternative solutions
5. Evaluate solutions
6. Test promising solutions
7. Choose best solutions
8. Plan for implementation

Abilities:
1. Constructive discontent
2. Observation
3. Curiosity
4. Organization of mind
5. Reasoning
6. Imagination
7. Sense of Proportion
8. Willingness to check

Extension

Focus ing

Managing

Derivation of Significance

Using the Skills:
1. Become aware of problems
2. Define problems
3. Combine information to use
4. Produce alternative solutions
5. Evaluate solutions
6. Test promising solutions
7. Choose best solutions
8. Plan for implementation

Sources of listings which combine to make this portrait are: Mooney (basic design); Fearn, 1976; Gordon, 1961; Mooney, 1954; Torrance, 1977; Torrance and Torrance, 1973; Samstead in Weiss, 1977. Specific references are provided in the paragraphs which precede the "Portrait."

Figure 5

PORTRAIT OF THE CREATIVE-ONE WHEN PROBLEM SOLVING
deliberate application in education, business and every-day living of the many; (3) the integration of creativity in the school curriculum and methodology relative to instructional materials in almost every subject matter field, and in creative ways of learning respectively in the United States (and abroad); and emphasis of creativity in such current educational movements as career education involving realistic problem-solving, futurism and creative problem-solving, special education programs for the gifted and talented and the like; (4) the greater use of such measures for the identification of the creatively gifted students and to a lesser extent for the appraisal of the consequences of educational programs that are creatively oriented; (5) better understanding to some extent of the creative-behavioral correlates of people of different ethnosocial groups in the United States and to a lesser extent abroad; and including children who are disabled, disturbed, or disadvantaged; (6) sounder basis for the accelerated-productive education of the gifted and talented; (7) recognition of creativity by the American Psychological Association as a respectable field of inquiry within the larger context of personality; (8) and recognition by the U.S. Office of Education of creative and productive thinking abilities and performance as important facts of the gifted and talented relative to identification and educational programming (Khatena, 1976, pp. 2-3).

These eight developments, many of which are relevant to education, show the clear effect of research which has been done on creativity.*

Torrance (1977) gives a historical perspective to the study of creativity by discussing the trends in the last ten years:

Perhaps the most visible of the retooling efforts has been the production of curriculum and instructional materials designed to facilitate creative thinking.... All of these programs...have been used rather widely... and experimental evaluations have been favorable (p. 10).

Today's advertising [in professional periodicals] rarely uses the term 'creative' and instead describes various kinds of thinking, problem-solving, and imaginative kinds of activities (p. 11).

*Torrance and Torrance, (1973) synthesize 142 experimental studies in creativity and find varying degrees of success with varying types of intervention.
This is a change in the words used in advertising and indicates a change in the language of creative problem solving.

In almost all of the [career education] curricula thus far produced, there is a great emphasis upon seeing implications, producing alternatives, predicting trends, predicting the consequences of decisions, elaborating alternatives, asking questions, decision making, obtaining new information, recognizing and understanding one's own potentialities, changing one's own characteristics, and the like (p. 11).

In 1960, there were no commercially available tests for identifying creative talent among school children. Today, several such tests are available commercially.... Perhaps the most widely used test battery is the Torrance Tests of Creative Thinking. Considerable reliability, validity, and normative data have now accumulated on these tests. The prevailing evidence indicates that the performance of high school students on these tests is related significantly to adult achievements as determined 12 years later. The relationships between performance on these tests and tests of intelligence continues to be generally positive but low (p. 13).

During the past 100 years, a variety of procedures have been developed for measuring some of the creative thinking abilities. Most of these measures have been used only in research, and only now are tests of creative thinking abilities becoming available for use in schools. It should be made explicit at this point that the weight of evidence indicates that creative thinking is not a unitary ability, but that a number of abilities are involved. According to the most extensive research in the field, the abilities involved are sensitivity to problems, fluency..., flexibility..., originality (the ability to produce ideas that are off the beaten track), elaboration (the ability to fill in details), and redefinition (the ability to define or perceive in a way different from the usual, established, or intended way, etc.) (p. 17).

The trends Torrance discusses--1) development of curricular and instructional materials, 2) change in the language of advertising, 3) emphasis on skills of creativity in career education, 4) development of tests to identify creative talent, and 5) development of procedures for testing creative thinking abilities--give the reader insight into what
the field was like **before** 10 years ago and the specific changes that have occurred in that time. Moreover, such a historical perspective might provide the reader with an understanding of what one may reasonably expect in the way of change in the next ten years.

Much thought has been given to the developmental stages of the creative-one, particularly the school age child:

Findings concerning the stages of creative development during the elementary years have been amazingly consistent, considering the variety of measures, samples of subjects, and periods in history involved. In the United States, most of the creative thinking abilities as measured by tests show growth from the first through third grades, a sharp drop at about the beginning of the fourth, a rise during the fifth and sixth, and another decline at about the beginning of the seventh grade (Torrance, 1977, p. 23).

Rosenfield and Houtz (1977) find that gifted children do not appear to slump in the fourth grade and hypothesize that this is due to their normal operation which is often two years ahead of their peers. The findings of the studies reviewed by Torrance and that done by Rosenfield and Houtz must be understood in context. It seems possible that the institutions of elementary education in the United States have a greater effect on the development of creative problem solvers than has been accredited. These results might be evaluated by asking questions other than those which have previously been asked: How would an American child perform on these tests if s/he had not attended school? How would such a child perform in a country other than the United States? That is, does our culture influence (impede or accelerate) a child's creative development? How would such a child perform on these tests if s/he had attended a "school" which focused its energies on maximizing the
opportunities for and capacities of the creative problem solver to invent new algorithms?

In summary, much work has been done in both the theoretical and practical aspects of exploring creativity. Generally, creativity theory centers on the creative-one, describing what this person does. The research has made attempts to measure the work of these persons and to describe their developmental stages (at least through age 13). Enough is now known about creativity to discuss it with a common language. Although this language is still in the process of forming, common ground has been established and can thus proceed from here.

B. Problem Solving

Problem solving means different things to different people. The meanings range from using known algorithms to using unknown algorithms.

<table>
<thead>
<tr>
<th>SOLVING PROBLEMS</th>
<th>USING KNOWN ALGORITHMS</th>
<th>OTHER ALGORITHMS</th>
</tr>
</thead>
</table>
| EG. An adult putting together a three dimensional wooden puzzle that only fits together in one way. | EG. An adolescent using an inquiry learning approach to find relations among numerical sequences. | EG. An adolescent pondering the problem "Can animals reason?"

Figure 6
TYPES OF PROBLEM SOLVING

Problem solving has been defined in the literature as:

...the capacity for deliberate guidance of action by forethought....[In which] choices of action can be deliberately made to enhance the possibility of suitable fittings when the act is carried out (Mooney, 1963c, p. 320).
And:

...the capacity to act as if an act were carried out before, in fact, it is undertaken. It uses past experience, product of prior learning, to predict what may happen if and when certain acts are carried out in conditions given (Mooney, 1967A, p. 278).

Such a capacity to choose action with almost a priori wisdom reflects an understanding of what both the eastern way of thinking and the western way of thinking have to offer:

Eastern philosophies and techniques can teach us 'busy' Americans so much about how to relax, meditate, and to let the flow happen, let the data co-mingle without trying, let the connections take place 'subconsciously,' that is, without being consciously aware.

Western philosophy, on the other hand, can teach us procedures like deliberately deferring judgment, brain-storming, checklisting, using mephological analyses, etc. for making the data interrelate in new and valuable ways, and for increasing the probability of more and deeper 'ahas (Parnes, 1977, p. 7).'

Thus, by taking advantage of both the 'letting' and 'making' of the solution, the problem solver maximizes her/his capacity to solve problems.

In the following sections, the literature in the known realm will be reviewed. This will be followed by a review of that which has been written about invention and use of previously unknown algorithms.

1. **Use of Known Algorithms**

Much research has been done based on children's solving of problems by using known algorithms. Since this is not the focus of this study, only two examples of this type of research will be reviewed. The interest here is in describing what research involving invention and use of previously unknown algorithms is not.

Olton and Johnson (1976) used an experimental design to try to investigate the incubation period problem solvers seem to need. The
problem they selected was called 'The Farm Problem' and involved an equal geometric division of a figure into four parts.

Divide this area into four parts which have the same size and shape.

Answer:

Figure 7
THE FARM PROBLEM
( Olten and Johnson, 1976)

They interrupted the work of the experimental groups and gave them varying treatments during their waiting time. None of the groups solved the problem any quicker than the control group which was allotted no incubation time. It must be noted that the problem had a single correct answer, that the problem was selected by the researchers, that the investment of the subjects in solving this problem might be questionable. These authors accounted for their negative findings by proposing two hypotheses; 1) that the motivational, temporal, and cognitive factors in this study do not reflect real life conditions, or 2) that the existence of the phenomenon of incubation ought to be seriously questioned. They conclude that more research is needed.

The second experiment using known algorithms involved the training of teachers to have a positive attitude toward creativity. Baroody, Brumley, Hocevar, and Ripple (1976) used a pre-and post-test design to measure the change in attitudes of teachers involved in a one half day inservice program. The authors knew the desired outcome before they began their study. And, this desired outcome was achieved.
Some studies involving known algorithms and problem solving might indeed further our knowledge of the problem solving process, but only as far as that problem solving process can move within the known realm. Once the problem solver enters the unknown realm, this information is no longer valid because an entirely different event is occurring. The behaviors, skills, abilities, psychological states, and possible problems of the person are different. The process seems to be different. The outcome is different. Evaluation of the outcome is different; that is, when working in the known realm, there are often externally identifiable correct responses; when working in the unknown realm, the "correctness" of the solution has to do with whether or not it "works" to solve a class of problems, and this might not be determinable (or even comprehendable) by the contemporaries of the problem solver. Thus, studies investigating problem solving as it deals in the known realm are useful, but their limitations with regard to creative problem solving must be recognized.

2. Invention and Use of Previously Unknown Algorithms

One's ability to solve a problem depends on his ability to achieve a frame of reference which is larger than the problem. One can then gain control; otherwise the problem remains larger than the mind of the investigator (Mooney, 1963B, p. 45).

In reviewing the research involving unknown algorithms, not only is the subject to be evaluated in terms of the above quote—the researcher conducting the study must achieve a frame of reference larger than the study itself. Having this broadness of vision seems to free the researcher to accept that which the subject creates, regardless of its uniqueness.

One of the most significant books in this field was edited by Brewster Ghiselin, The Creative Process: A Symposium (1952). It is a
collection of thirty-eight personal accounts of the creative process by such creators as Einstein, Poincaré, Van Gogh, and Wordsworth. Ghiselin introduces the book with a general statement about the creative process; many of his comments have direct bearing on the way a person invents and uses previously unknown algorithms:

What force causes the person to begin creating?

At the beginning of his struggle for realization his originality may achieve no more striking manifestation than an extreme dissatisfaction with established order (p. 13).

It is not Goethe who creates Faust, but Faust which creates Goethe (p. 13).

Once this disequilibrium is felt, how does the person proceed?

The first need is...to transcend the old order. Before any new order can be defined, the absolute power of the established, the hold upon us of what we know and are, must be broken....[And] in order to invent, one must yield to the indeterminate within him, or, more precisely, to certain ill-defined impulses which seem to be of the very texture of the ungoverned fullness which John Livingston Lowé calls 'the surging chaos of the unexpressed (p. 14).'

Creation begins typically with a vague, even a confused excitement, some sort of yearning, hunch, or other preverbal intimation of approaching or potential resolution (p. 14).

Having transcended the old order and having felt the emotional tension of getting ready, then what happens?

Production by a process of purely conscious calculation seems never to occur.... Not only Shelley, Blake, Ernst, Henry James and many other artists of great note or of little have described some considerable part of their invention as entirely spontaneous and involuntary--that is, an automatic. Invention automatic in this sense is claimed also by a variety of intellectual workers, such as Spencer, Nietzsche, Sir W. Rowan Hamilton, C. F. Gauss (p. 15).
The automatic functioning in invention is, rather than an inferior or suspect substitute (or an exalted one), an extension of activity beyond the limited scope of that which is shaped by insight, the conscious activity, which is an observant adjustment of exactly appreciated means to known ends (p. 17).

Can an example of this automatic, other-than-conscious activity be provided?

[Henri Poincaré observed] 'Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning, I had established the existence of a class of Fuchsian functions, those which came from the hypergeometric series; I had only to write out the results, which took but a few hours (Poincaré quoted in Ghiselin, p. 16).'

How does the creative-one continue this process?

Even when an artist has found his way, the opposition between the new and the old persists, for the unrealized continues to draw him.... He is drawn by the unrealized toward realization (p. 18).

...it is evident in both art and science the inventor is to some degree incited and guided by a sense of value in the end sought, something very much like an intimation of usefulness (p. 20).

The fact is that the mind in creation and in preparation for it nearly always requires some management. Most creative workers pick up what they know about this by trial and error, by causal observation of themselves and others, and from such comment as they may chance upon.... The larger objects of management are two: discovering the clue that suggests the development to be sought, that intimates the creative end to be reached, and assuring a certain and economical movement toward that end (p. 21).

Having felt disequilibrium, transcended the old order, experienced emotional tension, proceeded automatically in an other-than-conscious fashion, been guided by a need for realization and a sense of value in that realization, and managed one's own mind, how does one remain open
to her/his environment so that the forming and fitting of the ideas might continue?

It is essential to remember that the creative end is never in full sight at the beginning and that it is brought wholly into view only when the process of creation is completed. It is not to be found by scrutiny of the conscious scene, because it is never there. Yet the necessary step is not retirement altogether from the conscious scene, into a meaningless blackout...What is necessary is to be able to look into the wings where the action is not yet organized, and to feel the importance of what is happening off stage (p. 21).

It is perhaps hard to see how there should be any fixity at all in so fluid a medium. Yet the fact is that there is a great deal of stability, so much that often it interferes with life. It may be that the threat of dissolution is so great that men have developed their conservatism as a necessary guard against the dispersal of the order they live by. Whatever the cause, the tendency to distrust the widest and freest ranging of the mind is so strong that the changes necessary for the development of human life could not be attained without the efforts of the more daring and ingenious of mankind (pp. 23-24).

The person must guard against entering a "meaningless blackout" and against "distrust of the widest and freest ranging of the mind."

Ghiselin writes that patience (p. 26), will power (p. 27), planning (p. 27), and use of conscious activity such as observation and experimentation (p. 28) are also crucial to the creative process. This summary of what the creative process seems to be for these (quoted in Ghiselin's book) individuals is most helpful in the effort to understand what one does when inventing previously unknown algorithms.

One study conducted on a much smaller scale than Ghiselin's, but using a similar format resulted in a collection of creative problem solving events involving children in mathematics:
It seems that for most young children, especially preschool children, the possibilities of no solution, no available proof, or no possible answer do not exist. Children give the impression that in terms of their experience and in terms of their view of the world every problem has a solution.... When faced with a problem, the majority of young children are very willing and eager to attempt to solve it. They show endless enthusiasm and almost never fail to supply a solution (Liedtke, 1977, p. 333).

It is a major interest of this researcher to encourage teachers to think about ways to support and develop what Liedtke writes exists in young children so that they may, as they mature, do the work of the kind that the Ghiselin men and women accomplished.

The synectics movement to a large degree involved invention and use of unknown algorithms.

Synectics theory applies to the integration of diverse individuals into a problem-stating, problem-solving group. It is an operational theory for the conscious use of the preconscious psychological mechanisms present in man's creative activity (Gordon, 1961, p. 3).

The movement worked on problems of all sorts; groups of individuals worked together. One of their well-articulated techniques is the use of analogy:

As a special extension of metaphor we make considerable conscious use of analogy, i.e., comparisons between things with like functions and different forms. Personification and anthropomorphization.... are key directions for analogy. For example: 'How would it feel if it were human and could feel?' 'How would I feel if I were it?' (p. 31).

The synectics groups emphasized making the strange familiar and making the familiar strange (p. 35). To accomplish this, use of analogy took four forms: 1) personal analogy -- for example, becoming the object under discussion; 2) direct analogy -- for example, finding an
object in nature that does what the manufactured object ideally would do; 3) symbolic analogy -- for example, imagining an object like the Indian rope trick and designing an object that could be manufactured which could accomplish the same task; and 4) fantasy analogy -- for example, imagining how an object would work ideally and than proceeding to invent the ideal (pp. 37-49).

As the synectics movement has developed, they have come to an operational understanding of the other-than-conscious part of the human mind:

During the problem-solving process, the preconscious, when evoked by interest and emotional commitment, goes searching for relevant suggestive data. Its criteria for relevance do not seem logical because often the data that are presented do not appear to the conscious mind to be connected even distantly with the problem at hand. For this and other reasons people gradually build in a censor to protect the conscious mind from the overt interrupting thought from the unconscious by way of the preconscious. (The figure below is a representation.)

![Diagram of conscious, preconscious, and unconscious minds]

(Prince, 1970, p. 82)

[The censor]...is not infallible. Given desire on the part of the person to solve a problem, and given time and pressure, chances are good that some helpful message will get through (p. 83).

If a person has developed sensitivity to the proddings of the unconscious, if his censor is easily bypassed or penetrated, he is able to behave more creatively and use more of his potential (p. 84).
...nearly all of us begin life highly creative but soon after the start of our formal education, the censor begins to build up and creative potential becomes harder to reach. By age eight or nine, logical, analytical thinking has taken over (p. 85).

This understanding of the role of the "censor" allows the individual in the creative problem solving process to insist that her/his mind penetrate this censor, thus making available a wealth of previously unavailable information. One of the outcomes of this dissertation might be to alter the loss of creativity experienced after the child enters the schools by raising the awareness of teachers about what they do to foster this loss.

The synectics movement has also operationalized an insistence on patience and completeness:

...our rigid analytical training...makes us feel that the only good idea is a perfect idea--that only ideas presented in final, acceptable form are worthy of exploration. As a result, unformed ideas with possible potential never receive the energy necessary to build them to greatness. This artificial insistence on completeness all too often means that the only ideas which are really considered are the superficial ones--those which can be quickly completed and made more defensible. Such defense-oriented thinking relies heavily on the already known and already accepted and it works against speculation with the half-known or unknown intuitive thought. This prevents the emergence of fresh, innovative, daring ideas (Prince, 1970, pp. 31-32).

This warning to beware of the seeming need for completeness too early in the problem solving process shows much wisdom. A new idea is often like a human fetus; it needs to mature before it can be exposed to what is outside of the nurturing womb. Those of us who are fortunate enough to be in touch with creative problem solvers sometimes need to act as a
nurturing womb, until the problem solver has developed the idea sufficiently to expose it. This is particularly true of classroom teachers.

The contributions of the synectics movement which have most relevance to this dissertation are its use of analogy as a means to an end, its operational understanding of the conscious and the other-than-conscious, and its insistence on patience and completeness.
Ghiselin, Liedtke, Gordon, and Prince have made efforts to understand the way individuals invent and use previously unknown algorithms by (directly or indirectly) observing people involved in such a process. Their conclusions are most helpful when attempting to make sense of this process for the classroom teacher.

From the theoretical and practical discussion of creativity and from the discussion of problem solving on terms of the known and the unknown, one might form an extended definition of creative problem solving:

Creative problem solving is the capacity of the person to use both the conscious and the other-than-conscious, to both "let" and "make" the solutions come, to use both the left and right brain functions maximally, to use both her/his environment and herself/himself as a source, to tolerate both the chaos of confusion and the ecstasy of solution. This capacity and the individual's use of this capacity can result in a procedure which works to resolve a class of problems. The process of creative problem solving cannot be defined apart from the nature of the person. The product of creative problem solving can stand alone, exclusive of the creator.
Moreover:

... problem-solving grants the power to the problem-solving creature not only to solve problems which have been possible to it heretofore but to solve any number of problems. It is the process of problem-solving, itself, which is now the possession of the creature and not just the capacity to reach solutions for given content.

Successful operation depends, however on the problem-solving creature being conscious of his having a process to operate and of his role in feeding into that process what it takes to meet valid environmental circumstances. He can solve different problems according to what he pays mind to; he can succeed or fail according to what he pays mind to. He is knowingly confronted with the opportunity and responsibility of operating a 'mind (Mooney, 1963C, p. 328).

II. IMPLICATIONS FOR THE CLASSROOM TEACHER

The literature offers much in the way of what all of this information on creativity and problem solving means for the classroom teacher. With reference to these implications, it seems appropriate to begin with what the conventional school is and proceed to describe the ideal school.

In conventional schools:

... the trouble tends to be that, in our haste and ignorance, we do not fully operate the creative feedback chain; we do not get what we need at each level to fit what's there for feeding back. Teachers 'teach' without knowing all they should of how their teaching fits with the learner's frame. Principals operate without knowing all they should of what fits the teacher's need; the superintendent operates without knowing all he should of what fits the need of the principals. Each loss along the way distorts the message that should be coming through the chain, and what then returns in the feedback to the point of origin is more unfitted still. Thus, fractures form; life drains away (Mooney, 1966B, p. 177).
The "splits" resulting from the breakdown of the creative system as it might ideally appear in the school system might make the schools an ill-suited environment for the creative person, either the student or the teacher.

The conventional concept of teaching involves, exclusively, knowledge transfer:

There is a tradition that one teacher by somehow syringing facts and ideas into the center of the protoplasm that is the child [is teaching].... To educate [in the conventional sense], we have to make plans as to what we should do; having made those plans, we get all wrapped up in making those plans succeed. We decide that there are facts in arithmetic, that the child must have those facts in order to live in today's society, and that we must make the child possess those facts. So we try to syringe them into the center of his being. Up to a certain point, there is a sense in this desire; but beyond this point there is tragedy for everyone concerned (Mooney, 1953 C, p. 15).

Such a metaphor of syringing information into the core of the child might be carried one step further. If a foreign substance were injected into the core of a living being, or even a living seed, the procedure would most likely kill the life. Educators must heed the biological warning inherent in this comparison, as it may be considered proof of what the conventional school process does to the creative capacity in children:

Short-sighted in the pressures of complexity and time, our temptation is to show to students only what the product is, as ready-formed. As the student gets it, it then comes as something set and dead; it is difficult to 'learn' and holds its place in experience only through the efforts made to re-member it for the test that's coming in. Once the test is given, forgetting does the rest. The students are creative creatures in the way they're made, and, as creative creatures do, what they cannot use in creatings of their own, they lose. They slough off the extra weight (Mooney, 1966 B, p. 176).
This is not to say that knowledge transfer is unimportant. It is to say that knowledge transfer is only part of the necessary process, and that emotional and imaginative elements complete the whole (Prince, 1970, p. 86).

A clear goal of the education system is student learning:

Learning...works to extend the value of perception's working. It records and orders what has come as consequence of man's action as he transacts, across his borders, to effect a fitting union with his world.... It forms conceptual structures to serve as means by which to guide a man to more meaningful involvement in creation's making (Mooney, 1967, p. 278).

George Kelly (1963) bases his Theory of Personality on such conceptual structures. In this process of learning, the student is in direct transaction with traditional content disciplines:

As the student comes to each discipline, he can be led to see that what he confronts is something men are making that he, in turn, is to use as a further making-force.

Those who 'learn' a discipline can have it 'really learned' only when it becomes, for them, a resource to use in what they create, in turn (Mooney, 1966A, pp. 175-176).

Once 'learning' is understood to be a continuous process of life-forming, the relation between teaching and learning can be described:

Teaching-learning is then seen as a communicative chain which works back and forth between the teacher and the learner in a give-and-take by which the teacher, learning what the learner has to bring, provides the fitting thing that can be used, within the learner, to form new forms in him. The testing comes in what the learner forms, and the testing of the teaching comes in how well the teacher fits the stuff he forms to what the student has for use. (Mooney, 1966B, p. 176).
this process of continual forming and fitting infuses life into the creative systems involved in this chain. Such a process can be illustrated pictorially:

![Diagram](image)

Figure 8
A MODEL FOR THE TEACHER AT WORK
(Mooney, 1967C, Figure 4)

The teacher and the student are each independent creative systems, each constantly in transaction between self and environment. These two systems merge at the common medium in their environment, curriculum. Each makes sense of data collected in the common ground, and fits the data into her/his own conceptual structure. Each receives infusion of life from the other in this way.

Having reviewed some of the literature on what schools are, what learning is, and what the teaching-learning transaction is ideally, it seems appropriate to review what teachers should be:

[Teachers ought to be persons]...who have the capacity for helping others realize their creative potential.... (1) have an appetite for life, (2) are curious about how the mind works and how people grow, and (3) like to help others think through their experiences (Mooney, 1957A, p. 19).

Based on the research into creativity to date, Torrance (1977) made these recommendations for teachers: 1) make "deliberate efforts to improve quality and quantity of creative thinking (p. 25)," 2) encourage development in the skills of creativity, 3) "reward creative development," 4) respect unusual questions, unusual ideas, unusual solutions to problems, 5) "show children that their ideas have value (p. 26)," 6) provide opportunities for self-initiated learning, 7) "give purpose to creative writing," 8) "provide experiences which make children more sensitive to experimental stimuli," 9) "develop a constructive attitude toward the information taught (p. 27)," 10) "provide adequate warm-up for creative activities," 11) "provide unevaluated (off-the-record) practice," 12) "make it clear that [originality in thinking]... is expected and will be rewarded (p. 28)."

Before a lesson, the major function of the activities to be planned is to heighten anticipation and create the desire to know. During the lesson, the major purpose of the learning activities to be planned is to help students dig deeper, examine information from different viewpoints, become deeply involved in the problems raised, puzzle over perplexing information, make and correct guesses, and have fun. Activities at the end of the lesson should be designed to keep the creative thinking processes going and to stimulate further efforts to obtain information and to draw insights from such information. (Torrance, 1977, p. 29).
All of the recommendations made in the literature are helpful in that they specifically direct the interested teacher, however:

It should be made clear that no teaching and no disciplined approach to creative problem solving will guarantee creativity. They only increase the probability that creativity will occur (Torrance and Torrance, 1973, p. 7).

Finally, it seems appropriate to state more generalized advice to classroom teachers. The teacher ought:

1. To evaluate the effect of the school on individual students;
2. To be spokesman for the creative need of individuals;
3. To induce changes in school outlook and practices when these changes are needed to match the creative needs of students;
4. To know individual students..., to help them shape their needs and potentialities toward creative resolution.... (Mooney, 1960, p. 31).

And:

The identification of creative behavior in others will be found to depend in large part on realizing creative qualities in [the teacher's] own behavior. The primary source for... knowing will thereby come to be in his own experience, with hypothesizing and testing to check for harmonies with the experiencing of others (Mooney, 1954, p. 547).

That is, attention must be paid by the teacher to her/his own creative process in order to fully understand and support the creative process in students.

Perhaps the singularly most significant thing a teacher can do for a student who is involved in creative problem solving is to respect the fragility of the forming idea and help the student to develop such a respect:
New ideas, like all new creatures, are tender and fragile; they are dependent on the personal care of the one giving them birth. To take a new idea away from its creator too soon is likely to injure him in a way he will resent as a personal insult; it is also likely to endanger the life of the idea.

By the same token, not to take a man's ideas after they have matured is often as damaging....

A person who is creating needs friends who care about him as a person and creator. With social support, he can afford to be open and vulnerable at this point of creation. Otherwise he will tend to close up (Mooney, 1957 A, p. 17).

Such a nurturing of previously unknown algorithms and of the person inventing such an algorithm might help the person to preserve and extend life.

Thus, the literature has much to say about creativity in the classroom. Yet, this is a field which is still in the process of forming. So, it seems appropriate to conclude with a list of questions which might be used to evaluate classroom teaching:

Is the communication vital? Does the teacher come to life in his expression? Is his life renewed by his participation? Is his response freshly formed in resonance with what the students offer? Is he open to the students’ sending? Does he watch and listen for cues up-coming? Does he have a target in the inner world of the students’ forming as he shapes up his expression? Is he open to different minds among them, seeking avenues to each in reciprocating meaning? Is he testing to find students' openings? Does he know what they are closed to? where they lack an integration? what blocks they have in their expression? how each can best make clear his form of knowing? what past experience has offered by way of grounds on which to build his further knowing? his stage of maturation as a self-teaching person?....

What about students for their end of the communication? Are the free to offer their expression? Are
they trying? Are they open to the efforts of the teacher? Are they reaching for connections? Do they come to life when in the classroom setting? Do they put themselves into what they do when seeking meaning? Are their questions vital? Are their questions and expressions relevant in the sequential order? Are they targeting their offerings to meet the forms emerging in the teacher's growing composition? Do they sense their minds are growing?
The question is, is the curriculum, in fact, so ordered? What is the connected way of growing in between the courses offered? What forms the basic union for the student as he moves from course to course, seeking integration of himself as he opens out into varied fields of knowing? What is the discipline that disciplines the courses into a union fitted to the growing of a person? What does the teacher do, who, seeking a way to make his contribution to integration, designs his course accordingly? What is the question that is common to each and all teachers such that, asking it and working toward an answer, the teachers form a community of mind, needing one another, communicating back and forth to effect development within themselves and in the total such that, doing so, they provide a fertile field for growth and integration of the student? What is the fitting question that, integrating and growing teachers, also integrates and grows the students? (Mooney, 1976B, pp. 9-12).
The classroom teacher has the responsibility to arrange the students' learning environment in a way which will maximize the opportunities for the students to reach their own creative potentials. To understand this responsibility, one must consider several aspects of the problem:

1. What is teaching?
2. What is learning?
3. How are teaching and creative problem solving related?

WHAT IS TEACHING?

Teaching is both an art and a science (Mooney, 1961, pp. 48-49) in the sense that it requires the most complete awareness of self and the most complete awareness of environment by the teacher.

Figure 9
TEACHING

49
Teaching is a set of processes occurring in the context of a relationship between two individuals, a "teacher" and a "student," in which the effort is to help the student to gain a more comprehensive understanding of herself/himself and her/his environment. In this effort, the teacher also gains a clearer understanding of these elements. For both individuals, the path from the "in" to the "out" and back "in" again becomes more and more clearly delineated as it is traveled again and again. Teaching is the teacher supporting the student while the student works at understanding these elements. Or, to use the journey metaphor again, the teacher holds the student's hand as the student finds her/his way along this path. At some points in teaching, the teacher might be the most efficient source of knowledge for the student, at other times, the teacher will only be able to offer encouragement.

When teaching, the teacher does four things: 1) the teacher tries to re-create in her/his own mind the student's concept of the problem and 2) by doing this helps the student to clarify her/his own concept of the problem, 3) the teacher tries to keep the student's thinking in motion, and 4) the teacher tries to keep the interaction between teacher and student orderly.

1) The teacher tries to re-create in her/his own mind the student's concept of the problem.

The teacher asks questions and the student answers the questions.

![Figure 10](image.png)

**Figure 10**

RE-CREATION OF STUDENT IDEA
The ideal is to maximize the overlap: this might happen if the teacher is able to ask the right questions and the student is able to effectively communicate her/his concept of the problem.

In Figure 2, the circles are wavy since the problems they represent are not expected to be clearly defined while the teaching is on-going.

The following is an example of a teacher trying to understand what the student is thinking and is transcribed from a videotaped pilot study* done for this dissertation:

1 TEACHER: I want you to think of a problem that you
2 would be interested in solving that has not already
3 been solved, that we don't have procedures to solve.

4 STUDENT: How about to find out if animals reason?

5 T: Have you thought about that a lot? Have you
6 thought about how you would solve it?

7 S: No.

8 T: What have you thought about the problem?

9 S: Well, not a lot. I just sort of imagine myself
10 with all of these animals, sitting and talking.

11 T: When you imagine that they can talk, do
12 you imagine a Doctor Doolittle thing or do you
13 imagine that they are communicating to
14 you in other ways?

15 S: Other ways.

*See Chapter IV for description of pilot studies.
T: Like?
S: Like, the gorillas, they have sign language.
T: You're talking about science.
S: Yeah, you know how the dolphins have telepathy?
T: No I don't.
S: Well, they have these radio waves that go out and some people can tell what they are.
T: But that's science again. That's something we already found out through science.
S: But I want to find out if they can reason. I think they can.... To solve the problem I would read up on science that people know as fact....
T: Is that the first thing?
S: Yeah.... And I would probably see if I could live with animals. You know, like that lady who lived with the gorillas for awhile. And so that they would have me become, they would think I was one of them. And then I would learn more about them that way. That way I would learn more of their habits.
T: First you would look from the outside through the eyes of the scientist and you'd look from the outside getting ideas about the habits. Then you'd look from inside and try and become one and try and understand their habits and learn about their habits as one—as a gorilla or as a dolphin or whatever. Right?
S: Um hum. And I might try to be like a gorilla.
T: You would turn into a gorilla in your brain?
S: Well, first I would become one and I would know myself that I wasn't. But they would think I was. Then I would become one myself....
T: OK. I have a question. So they would perceive you as one and then you would eventually start to think of yourself as one, but would you actually
S: I would stay the same physically. I'm gradually looking from the outside to the inside.

The progression of this conversation can be matched with the progression indicated by Figure 2. In the beginning (lines 1-10) the teacher has no understanding of the student's concept of the problem. As the teacher questions (beginning on lines 11, 16, 29, 38, 47, 52), she is trying to gain a better understanding of what the student is talking about. As the conversation developed beyond this transcribed portion, the overlap was maximized to the point where the teacher was satisfied that she had recreated the student's conception of the problem and the student seemed satisfied. The teacher was trying to see the picture of the problem that the student saw from the student's point of view.

2) By doing this, the teacher helps the student to clarify her/his own concept of the problem.

Referring again to the transcribed conversation, the student indicated that she was not clear about her conceptualization of how she would solve the problem (lines 7 and 9). As the questioning progressed, she developed a better understanding of how she would solve the problem (beginning on lines 15, 17, 25, 30, 45, 49, 57). She indicated after the videotape was completed that she had indeed never thought these thoughts before: while watching the videotape she wrote, "You made me start thinking about some things that I had never thought about before."

Thus, by making deductions from the transcript and attending to what the student said after the conversation ended, it seems that the teaching helped the student to clarify her own concept of the problem.
3) **The teacher tries to keep the student's thinking in motion.**

Returning again to the journey metaphor, this statement might be restated as the teacher helping the student to move on after having reached a stop sign or a road block. Certainly, in some situations, the student can cope with such blocks with no help. Yet, when the student is stopped, the teacher who is teaching gets the student's mind going again (or asks many questions, one of which works).

Several teaching patterns seem to work to move students beyond the road blocks. First, there is the **clarify/summarize/question pattern** illustrated in the following transcribed passage from a second pilot study:

1  **TEACHER:** [In response to student comment] You said, first
2                      you'd deal with sources. Are you talking about going to
3                      the library and finding out about organizations?
4  **STUDENT:** Um hum.
5  **T:** So you look for what their source was, and what else
6        would you.... What I'm interested in is not what the
7        final paper would look like but what are the
8        jiffy plan steps? I mean, if you were going about
9        solving this problem, step one would be what?

The question beginning on line 2 serves to clarify the student's comment. The uncompleted statement beginning on line 5 is a summary, stating that which has already been made clear. The questions beginning on line 6 act to propel the student on to new information. This pattern clarifies for both the teacher and the student what is being said, clarifies what has been fully examined (i.e. where the development of the idea stands), and gives direction to further exploration of the topic. In addition to using this pattern herself/himself, the teacher supports the student in clarifying, summarizing, and questioning herself/himself.
Second, the teacher might use examples to keep the student's thinking in motion. Referring to the second pilot study:

TEACHER: How do you figure out ways to deal with it? I mean, how do I start thinking about it? It's like if I said how do you run, you could tell me—well, you would say, well you get the right shoes on, the correct clothes on, lean forward, you put your right leg out, and your left arm and then.... You know, you could tell me step by step. Now tell me the same kind of "step by step" to do what you do with your brain.

Using examples such as that used in the above quote aids the student by reminding her/him about something s/he already knows and can communicate, and reminding the student how it feels to know this so that s/he can transfer this knowledge and these success feelings to the current, new problem under consideration.

Third, the teacher might use imaging, or pretending, to keep the student progressing on the thought journey. The following is an example quoted from the second pilot study:

TEACHER: How about we'll image. Just close your eyes, and I'll close my eyes, too. And imagine yourself there, in bed, you know getting ready to go to sleep. And you decide to think about, you know, it's the right time to think about this death thing. Can you just jabber a bit? Tell me what you're thinking.

Imaging facilitates the teacher in freeing the student from the current time and place in which there might be blocking forces such as emotional tension. The student can be "placed" in a safe environment and then be freed to further develop the concept being discussed. Imaging also might establish the feeling desired by the teacher, in this case the feeling of solving a problem, the feeling of pondering, so that the student can then incorporate that feeling in her/his current situation to help her/him solve the problem.
Fourth, the teacher may offer both verbal and non-verbal support to the student such as the nodding of the head, eye contact, leaning back in one's chair, facing the student "head on," and saying phrases like "Take your time," "Good," "Interesting point," and "Um hum." All of these send the message to the student to continue, that what s/he is doing is good. Each of these four teaching techniques, the clarify/summarize/question pattern, use of examples, imaging, and use of supportive gestures and words, may be used by the teacher to help the student keep her/his thought flowing in a communicable form.

4) The teacher tries to keep the interaction between the teacher and the student orderly.

The conversation between teacher and student is more than a series of unconnected statements or groups of statements made by the two individuals. It is a pattern of groups of statements connected by conscious teacher effort. At appropriate times in the conversation, the teacher makes summarizing remarks, reinforcing remarks, and transition remarks (The teacher also supports the students in making summarizing and transitional remarks). These serve to give form to the conversation as a whole so that both individuals feel that they are moving in a structured manner and are achieving a desirable product.

The following are three quotations from the first pilot study which illustrate a summarizing remark (beginning line 1), a reinforcing remark (line 5), and a transition remark (beginning line 6):

1 TEACHER: So you reflect on the day that you've had and
2 you plan for the next day. Your creative thinking is the
3 reflection because you're creating new things that
4 didn't happen and planning is pretty creative....

5 T: OK. That's good. Very interesting....
T: OK. I'm going to push you now. Can you think of another problem?

It might be noted that these types of statements could be classified in the categories identified under question 3 (keeping student thought in motion). This is correct. The position of the statement within the context of the conversation reveals the function of the statement more clearly than does a transcription of the statement in isolation. Particularly, what the statement "causes" the student to do clarifies the function of the statement.

By trying to recreate in her/his own mind the student's concept of the problem, by helping the student to clarify her/his own conception of the problem, by trying to keep the student's thinking in motion, and by trying to give order to the conversation, the teacher teaches. Each of these skills might be taught to a preservice teacher, perhaps beginning with an experience like that described in Chapters IV and V of this dissertation.

Thus, teaching is a set of definable processes which when used by the teacher serve to "bring the Image into focus." These processes can be operationalized and taught to preservice teachers. Preservice teachers can also learn how to focus by having "focusing" experiences and opportunities to reflect on those experiences. Four case studies in which preservice teachers had "focusing" experiences are described in Chapter V of this dissertation.*

*One technique for validating this stimulating teaching algorithm is to compare it to the verbalization of great teachers about their own teaching process. Such a description is included as Appendix B of this dissertation. Appendix B is the note written to me by Professor James K. Duncan when he first read that I was interested in elaborating a stimulating teaching algorithm. This description helps to confirm the validity of the stimulating teaching algorithm.
WHAT IS LEARNING?

It is beyond the scope of this dissertation to attempt to present a comprehensive definition of learning. However, it is necessary to relate the concept of learning to what has been said about teaching in the preceding portion of this chapter since teaching and learning are often paired conceptually.

It will be recalled that the student's concept of the problem was expressed in Figure 10 as a wavy circular shape. This shape is meant to represent the student's unclear, unfinished understanding of her/his own problem. The effort to resolve the problem is the focus of the learning effort. It is believed that learning does not take place if no "problem" exists. Some need, disharmony, confusion, or disequilibrium within the learner must precede learning. In the context of this study, learning is the process by which an individual effects the resolution of the problem.*

If the student begins with a notion of what the problem is, however unclear that notion might be, the student then begins to clarify, add to, or change that notion until the student is satisfied. Satisfaction might mean identification of a process for solving the problem, finding

*This may be contrasted to a standard psychological definition: "The following definition may be offered provisionally: Learning is the process by which an activity originates or is changed through reacting to an encountered situation, provided that the characteristics of the change in activity cannot be explained on the basis of native response tendencies, maturation, or temporary states of the organism (e.g., fatigue, drugs, etc.) (Hilgard, 1956, p. 3)."
the solution, or actually identification of an algorithm, depending on the student's needs. When satisfaction occurs, the learning process is likely to be finished. The teacher has two functions in this learning process. S/He can help the student through this clarification/addition/change process using the teaching techniques identified in the first portion of this chapter. Moreover, s/he can extend the student's criteria for feeling satisfied, thereby improving the final quality of what is learned.

The only change in the student's concept of the problem which will not be considered learning for purposes of this dissertation is the complete obliteratiob of the wavy circular shape, that is, the destruction of the student's concept of the problem either by the student herself/himself or by an external destroyer. Furthermore, for purposes of this dissertation, the destruction of a student's concept of the problem by a person other than the student will not be considered teaching.

Learning is a fitting process, the fitting of selected parts of one's environment into one's own conceptual structure (Kelly, 1963). What fits is learned, what does not fit is not learned.

If his [the person's] thoughts bring with them a feeling of expansion, a fresh togetherness of things not heretofore thought of together, of harmonious form, etc., then he knows to go on; if they bring feelings of blockage, frustration, diffusions, etc., then he knows to pause or try a new line (Mooney, 1957A, p. 17).

In this quotation, Mooney describes this process of making sense of elements in one's experience, that is, of fitting. The learner is
continuously selecting, ordering, and fitting resulting in a finer formation of her/his notion of the problem (indicated by the wavy circular shape becoming a clearer and clearer image).

HOW ARE TEACHING AND CREATIVE PROBLEM SOLVING RELATED?

The creative problem solving act is the student's own process, that is, such activity is sustained by the student using personal abilities. The most that a teacher can do is to support and challenge the student while the student is involved in problem solving. The forms which this support take are identified in the first section of this chapter and include: 1) trying to understand (re-create) the student's concept of the problem; 2) helping the student to clarify her/his own concept of the problem; 3) keeping the student's thinking in motion by using a clarify/summarize/question pattern, using examples, using imaging, and offering verbal and non-verbal encouragement (support); and 4) keeping the interaction between the teacher and student orderly by making summarizing remarks, reinforcing remarks, and transition statements. The process of creative problem solving occurs within the student; the teacher "holds the student's hand" while on this "journey."

There are several necessary preconditions for this "hand holding" process to be able to occur. First is an atmosphere of trust. There must be a mutual viewing by the teacher and the student of each other as human beings (e.g., each having the right to NOT answer a question, the right of privacy, and the right of ownership). Such a condition
might be established immediately, but it is more likely a result of a relationship which has grown over time. Or perhaps, if the teacher is trusted by a third person who the student sees as trustworthy (such as a sibling or friend), trust will be transferred. Trust must be present before the student will be willing to risk her/his premature and still vulnerable findings. A second pre-condition is a sense that the teacher has a genuine interest in the student and, to some degree, an interest in the problem itself. The teacher has to provide "signals" to the student informing the student that the teacher wants to hear about what the student is thinking. That the teacher is naturally interested in the student and the student's creative problem solving activity by definition of the chosen profession (i.e., the profession of teaching) is a false assumption. It occurs to some observers of large numbers of teachers that unfortunately many are not motivated by such a genuine interest in student learning. A third precondition is that the teacher has extensive personal experience with creative problem solving herself/himself. The teacher must know how the chaos of an influx of unorganized ideas feels. The teacher must know how it feels to form the solution. The teacher must know the feeling of coming to a block, and know the feeling of transcending the block. The teacher must know the tempo, rhythm and timing of creative problem solving. If these preconditions are met, the teacher will know what the student is experiencing and will have a better sense of how, when and why support is appropriate.
CHAPTER IV
METHODOLOGY

When the focus of attention shifts from theory as used by the practitioner to theory as framed by professional theorists, a shift occurs in grounds of relevance: i.e., for the practitioner, the question is what do I need to do; for the theorist, the question is what do I need to understand (Mooney, 1978, pp. 4-56).

In Chapter III, the effort was to understand. This chapter details what a preservice teacher might do to learn about the "way" of teaching discussed in Chapter III.

Such a discussion will serve two purposes: 1) it will "ground" the theory, that is, show clear direction based on the theory for teacher educators and preservice teachers, and 2) it will detail the methodology to be used in the four case studies related to this dissertation.

However, before proceeding to such a discussion, an ethical question must be addressed—Is the interest of this researcher to mass produce little Phyllis's? The answer is no. In no way is this dissertation intended to be a statement of "truth" separate from the person writing it. The interest is to analyze and communicate the nature of the teaching process from a particular perspective (elaborated upon in the first three chapters). The receiver of the communication then makes decisions as to her/his own teaching. The communication serves to increase the preservice teacher's knowledge about the
processes of teaching. The assumption is that the more information a person has, the better the quality of decision s/he will be able to make. This method for "teaching" the theory has as its goal better clarification of the preservice teacher's own conceptualization of teaching (i.e., their own theory) and in no way is it meant to be used to manufacture duplicates of Phyllis.

If the theory in Chapter III is seen as the product, and the preservice teacher's own theory of teaching is seen as an alternative product, then this chapter is the process of how one gets to the alternative product. Of necessity, the process must be consistent with the product. As the reader will soon determine, the "get information about the student's structure of the problem/student self-clarification of the problem/student thinking kept in motion/ordering process" is the structure of the methodology used by the teacher educator.

Figure 11 illustrates the methodology. Three people were involved in each case study, the researcher, the preservice teacher, and the student. The spiral began with the researcher since she established the learning situation for the preservice teacher. The catalyst was the prototype videotape made during the pilot study: the pilot study consisted of a teacher* and a student talking about creative problem solving in an effort to begin to understand the student's problem solving process. The spiral ended with the researcher since she was

*The researcher was the teacher in the pilot studies.
the person who endeavored to make sense of the complete process in the writing of the dissertation. Of course, if the preservice teacher found the encounter personally or professionally significant s/he might continue to think about it until s/he came to some resolution. Thus, there was an expected outcome (the researcher's) and several possible other outcomes (the preservice teachers' and the students').
As the process developed, the preservice teacher began to identify more clearly her/his own teaching methodology. That which the preservice teacher thought about and the methodology itself became more and more specific to the needs and abilities of that individual teacher. The preservice teacher ideally gained increasing clarity about some aspects of her/his own theory of teaching. The core of the methodology was the researcher's theory of the stimulating teaching algorithm as described in Chapter III.

Learning involves an individual in transaction with a problem who finally makes sense of the problem by identifying a process which will lead to resolution or by reaching the resolution (product) itself. The researcher was the individual in transaction with what she saw on the pilot study videotape and in subsequent data collected in the case studies who make sense of the data by writing this dissertation. The dissertation is a product which describes in detail a process, the stimulating teaching algorithm.

![Diagram showing the relationship between the researcher, data, and transaction](image-url)
The preservice teacher was the individual in transaction with what s/he saw on the pilot study videotape and in subsequent data from the case study experience who made sense of the data by making application of it to teaching. This application to teaching is process-oriented.

![Diagram of the preservice teacher making sense of data](image)

**Figure 13**
THE PRESERVICE TEACHER

The student was the individual in transaction with the chosen problem who made sense of the data by identifying a process to solve the problem. This happened as a direct result of use of the stimulating teaching algorithm.

![Diagram of the student making sense of data](image)

**Figure 14**
THE STUDENT
Thus, each of the actors involved in this methodology was involved in the same activity. The differences were the degree of specificity of and the nature of the problem (for the student, anything was all right; for the preservice teacher, the choice was made to think about teaching; for the researcher, the choice was made to think about this one problem related to teaching) and the way the individual made sense of the transaction (for the student, the process to use in solving the problem; for the preservice teacher, the process to use in teaching; for the researcher, the dissertation).

I. The first loop of the spiral involved the viewing of the pilot study tape by the preservice teacher. A trusting relationship between the researcher and preservice teacher was assumed. The content of the tapes formed the basis of discussion for the second and third loops. The researcher was not involved in this activity except as the creator of the situation in which the preservice teacher viewed the videotape and as the creator of the videotape.

II. The second loop involved the preservice teacher's effort to communicate to the researcher what s/he saw on the videotape. By having to communicate in words to the researcher, the preservice teacher began to make sense of the tapes for herself/himself.

III. The third loop involved the preservice teacher in planning how to work with a student to maximize the opportunities for creative problem solving in a situation similar to that viewed on the prototype videotape. A step-by-step plan, delineating the questions to be used by the teacher resulted from this. The researcher's function at this
time was to keep the teacher's thinking in motion, using the clarifying/summarizing/questioning pattern, using examples, using imaging, and/or providing support as described in Chapter III.

IV. The fourth loop involved the teacher in interaction with a student, executing her/his plan. This interaction was videotape recorded for analysis. The researcher was not involved in this activity except as the creator of the situation in which the teacher encountered the student (and visa versa) and in being present at this encounter.

After the "teach," the videotape was available to the researcher for analysis, previous to any discussion with the teacher. The effort was made to find out: 1) What did the teacher do?, 2) What did the student do?, and 3) What was the transaction between the two?

V. The fifth and final loop for purposes of these case studies, involved the teacher's effort to communicate to the researcher her/his reflections on the "teach." The preservice teacher was given the choice to 1) watch and listen to the tape before this discussion or 2) not watch and listen to the tape. Several questions were asked by the researcher:

1. What did you do?
2. Why did you do it?
3. What would you keep?
4. What would you change?
5. How did what happened previous to the "teach" (i.e. loops I-III) affect what you did?
6. What will you do in your classroom teaching to maximize opportunities for students to do creative problem solving?
This discussion was videotape recorded for reference.

After the discussion, the tape was available to the researcher for analysis. The effort was made to find out: 1) What did the researcher do?, 2) What did the teacher do?, and 3) What was the transaction between the two?

The end product of this spiraling process was the researcher's dissertation. Through this process her basic assumptions and thoughts were challenged, clarified, and analyzed: these will be communicated to the education profession in the form of this dissertation. An additional product that was predictable was the beginning of the teacher's own construction of a personal theory of teaching creative problem solving. From such a theory, the teacher would be able to make teaching decisions when with students.

Replication of this process was done four times, in each case a preservice teacher was paired with a student. Selection of teachers and students was based upon: 1) the person's capacity to solve problems creatively as defined in this dissertation, 2) the person's interest in the project, and 3) the person's availability to participate at a specified time.

The case studies were arranged to allow the children to "teach" the preservice teachers:

This reversal in the roles could not come about until we unatched our connection to the teacher-student roles as such, and related each child on a one-to-one, person-to-person ground—in which case the child felt held at a deeper level than otherwise occurred, and freed in his response to show us how his mind worked to make meaning of his world (Mooney, 1978, p. 1-4).
Designing a field experience for the preservice teacher in which it is the teacher's assigned task to learn from the student while actively teaching (rather than observing or assisting) is a rare effort. It was felt that this was the best source for the preservice teacher's learning about how to teach, provided that the teacher educator supported this activity (i.e., by showing the prototype videotape as a model). The underlying assumption is that the preservice teacher is an able person who has the capacity to do self-teaching if placed in a nurturing environment.

The subjective bias of the researcher in interpreting the data has been reduced by quoting the original source, that is, the preservice teacher, as often as possible. Chapter V is an analysis of the four case studies. Each case study analysis has a conversational quality about it, a conversation between what existed independent of this research (the quotations) and what sense the researcher made of reality (the comments). The variance and commonalities among the case studies enriched the data available for interpretation in the study, and successive repetition acted as a form of case study replication.

Two pilot studies were done to better understand the complexity of the phenomenon being investigated. Each involved a student with this researcher as the teacher. Videotape recordings were made of both pilot studies. One of these videotapes served as the prototype videotape viewed by the preservice teachers because the student in the

*The next 3 paragraphs were developed with the help of Professor James K. Duncan.
other videotape wanted no one to view the tape. The pilot studies helped provide concrete examples of dimensions of the stimulating teaching algorithm as described in Chapter III.

The validity of this study can be checked from any of several postures. First the data in this study are in some measure confirmed in the literature. Second is the match between what was written in this dissertation and personal accounts of others such as that written by James K. Duncan and included as Appendix B. Third is the repetition of process at many levels within the study; what the student did was similar to what the teacher did and was similar to what the researcher did. Another repetition which increased the validity of the study was that the researcher was asking the preservice teacher to work with a student which is the process carried out by the researcher in the prototype videotape.

Chapter V describes what the preservice teachers did when directed by the plan developed in this chapter.
CHAPTER V
THE CASE STUDIES: THEORY INTO PRACTICE

The methodology described in Chapter IV was used in four case studies. A description of each of these case studies is included in this chapter. Following these is a comparison of the work of the four preservice teachers.

The preservice teachers differed in a number of characteristics. Two were physical education students, one was in art education, and one was in social studies education. Two were female and two were male. One was a beginning professional education student, one was finished with student teaching, and the other two were at middle points in their professional preparation. All had been students of this researcher in one of the last five quarters.

The students involved in loop IV (See Chapter IV) were also very different. One was in sixth grade, one was in seventh grade, and two were in eighth grade. Two were female and two were male. Three had been students of this researcher between 1974 and 1976, and one was a sibling of a previous student.

Two settings were used during each case study, a decision made based upon equipment available in each room. The first room was familiar to the teachers, the second was not. Both were classrooms. The creation of the prototype videotape, the "teach (loop IV)," and
the discussion of the "teach (loop V)" all took place in the same setting; that is, all videotaped teaching was done at the same location.

CASE STUDY A

This case study is easily divided into two parts: first Teacher A made sense of the new information (loops I, II, III, Figure 11, Chapter IV); second, Teacher A made sense of her own teaching (loops IV, V).

Teacher A watched a videotape of a teacher (this researcher) and a child discussing creative problem solving, the prototype videotape. As she watched, she recorded what she saw. Her resulting notes were ordered in the form of a lesson plan. Some of what she saw stimulated her to invent her own methods which she also recorded. Thus, Teacher A combined loop I and II.

In the ensuing discussion, Teacher A asked specific questions and commented on the videotaped "teach," talked about her teaching plan, and discussed her concerns about the impending "teach." An example of a specific question is "When you [the teacher] asked 'When is your most productive time?, was that something you wanted to know or was that to help him?" This question seemed to indicate a need to understand the teacher's (in the videotape) intent so that Teacher A could formulate her own intent and resulting procedure. Moreover, Teacher A made comments about what she saw the teacher on the videotape do, thus, possibly revealing what she learned:
Now these are the things I've got written down that you did. First, you always ask for him to 'let you in.' [saying] 'I don't understand, so explain.' 'To become part of his thoughts.' And to explain, always explain.

Teacher A seemed to be beginning to understand how to learn from a student in the process of "teaching" that student. That is, her identity as a teacher shifted from "giver of knowledge" to "conductor of the learning process." This shift is a major interest of this researcher in her work of educating preservice teachers. Teacher A said:

I thought your last question was a good question -- 'Is there anything else that I didn't let you say?' because a lot of times, you know, the teacher wants to understand something so they stop the student in the middle of this great thought.

Teacher A seemed to be collecting "good" ideas that might be of use to her.

Comments she made about her teaching plan include:

Let me see what I have down. First, I want to say, 'Do you have a problem that doesn't have a solution that you wonder about?'

And then 'How would you solve it?' or 'Could you solve it?' Well, 'How would you solve it?' because they might not be able to solve it.

Teacher A seemed to be having a discussion with herself, proposing alternatives, selecting, and evaluating the selection.

OK. Then you ask 'How do you know when you are finished or have succeeded?' And I thought maybe I would say 'What has to be accomplished before you feel satisfied?'
And then I would ask her 'What can a teacher do to create a problem solving environment?'

Maybe I could ask her, too, what methods work best for her in a classroom. Would she rather have an open discussion? And does that work for everybody in the room?

Or would she rather write things down and not share them? Or post them on the board?

Again, teacher A was generating multiple possibilities by thinking of various classroom methods. By talking about her lesson plan, Teacher A was testing ideas, comparing these ideas to both her ever-developing new ideas ('"new" since watching the videotape) and to the researcher's ideas. This testing process, supported by the researcher, seemed to result in greater security on the part of Teacher A.

In addition to specific questions and comments about her teaching plan, Teacher A discussed her concerns:

The thing I'm worried about most right now is for her to say 'Gee, I don't know.'

The only thing I was worried about was I may let her go by and not say something and you [the researcher] sit there going 'Oh, I have such a question I would love to ask.'

I'm worried that we're going to sit here. And all of a sudden I'm going to look at her and she's going to look at me.... [and no one will talk].

Silence was clearly Teacher A's greatest concern. To support her in this concern, the researcher made statements indicating that she (the researcher) was interested in what Teacher A did more than what Student A did, that Teacher A clearly had a different teaching style from the researcher, that this difference was valued, that Teacher A was welcome to use any ideas she recorded from the videotape, that any
method Teacher A chose was fine, and that there was no problem if the equipment ran and there was silence.

Having made sense of the new information which was presented to her on the videotape, Teacher A taught the lesson to Student A. After the "teach," she made these notes:

My goal was to give Student A a clear understanding of her question. I think we were both nervous. I wanted to make Student A feel more at ease.

At times I wanted to move her from one topic to another. I would ask her if she was finished, but tried to keep from forcing her away from anything. When Student A started talking about her school problems, I became worried. I really wanted to look at you [the researcher] for guidance, but decided I shouldn't. It may have made Student A think she was doing something wrong.

Throughout the taping [of Teacher A's teaching], Student A seemed somewhat insecure in her ideas. I wanted to maximize her security. I told her her ideas were good, to go on, to keep talking, etc. I was afraid our topics were not right for your [the researcher's] work. I tried to keep from being too much like you [the researcher]....

I worked very hard at being a listener. I wanted Student A to feel that what she said was very important to me. I wanted her to say everything that came into her mind. The ending of the tape worried me. I did not want to stop until Student A was ready, but even as we ended the tape, I felt that I had only scratched the surface of Student A's idea bank. I wish we would have had more warm-up time. I felt only half finished.

At this point, Teacher A was clearly more concerned about her student than about her survival as a teacher. Her emphasis seemed to be on the desire to be a good listener and on her student's security.

In the discussion that concluded the case study (loop V), Teacher A elaborated upon the above notes. She seemed to by trying to make sense of the original videotape (loop I), the teaching experience (loop IV), and what she would do in her future teaching. Examples of
Teacher A's effort to make clearer sense of the videotape include:

When I saw your tape, I thought...everything was so good. I thought 'My Lord!' I thought that...one of the main things was to let her know that I listened to everything she said. That's important.

The first way I acted like the researcher from what I learned in class was to make Student A a winner. That's something that I want to keep when I teach. Mostly mannerisms. Now I like the way sometimes you clarify...like you'll say 'Well, is this what you mean?' And if they say yes then you know where they are; and if they say no, you can say 'Explain it.'

You talk more than I talk. Because I thought 'Oh gee, Phyllis would have said this and Phyllis would have said this.' I was quiet more. And I didn't sum up as much because I didn't want to interrupt her, unless I thought that those were really important points.

A lot helped me, the tape you had. And then after, when I met her, I decided what worked for the student in the videotape might not work for her.... I adapted what I learned from the student in the videotape.

From the videotape I picked up good ideas, like helping the student if the student got bogged down in words, trying to summarize what they said, so that they know you are listening to what they said.

Before the videotape I didn't know what I would do. I kept thinking 'What does she want?' I was really worried about what kind of lesson plan I would make. I thought you would give me a set of books and say...'Make a lesson plan.'

I just watched the tape and wrote down what I thought was important. And wrote down what you did that I thought would be good to do.

Teacher A apparently did use the teacher (this researcher) in the videotape as a model (she emphasized listening, student success,
clarification). It must be noted that throughout the case study, the researcher verbally and non-verbally supported Teacher A's own way of teaching, emphasizing an interest in the difference between Teacher A and the teacher on the videotape.

Examples of Teacher A's effort to make sense of her own teaching experience include:

I could just see myself scratching the surface but not getting down deep enough. Maybe if I knew her better or we had more warm-up.

I wish I could have done more. I wish I would have been able to have given her the answer to her problem.

I was really happy she didn't always agree with me. She said 'Well, not all of the time.' [Teacher A laughed]

I wanted to do what I wish my teachers would have done for me. I knew how I felt when teachers put me on the spot. So I wanted...to make her want to give everything she had. I thought she did.

In school, you have a lesson plan -- things aren't supposed to go out of order. So I thought she wasn't going to say something about magic or astrology. I didn't expect her to say [ 'I have a school problem.' ]

I didn't smile like you. I probably should have.

I wasn't at all scared with Student A. Maybe it's just kids. I'm not afraid of kids if they're little.

I told her what she was saying wasn't stupid and that I understood what she said. And that her problems were important.

I tried to be real personable for her. I tried to make her feel less like a student and more like a person I'm interested in and want to talk to. So I thought that helped.
I knew she had a lot more to say. Maybe if I knew how to, I felt I could have brought more out of her. I just tried everything I knew. I didn't want to bombard her with more and more questions because she seemed done. I looked at her and she looked like she was done.

I wish I could have made her feel good enough to talk about the problem about school right at the beginning.

I'd keep the setting....because we were close together....And I would keep the way I acted toward her especially listening to what she said....I'd keep the beginning question and I'd keep the ending question, but on the beginning question I think I'd try to help her a little bit more...because I think it's a really hard question. So maybe I could explain it more....I was afraid she was afraid she was doing the wrong thing.

I'd keep the time, the length, because she was done. And I was done too.

I'd keep her. It's great to have a student who comes in and is willing to subject themself to something like that....She'd be a great student to have.

I would sit up....I would like to speak louder....I wish I'd had more experience. I wish I would have been able to go deeper.

Such reflective thinking about one's own teaching is a pleasure to witness. Teacher A invested a great deal of thinking in this reflective process. She seemed generally pleased with what she had accomplished and interested in improving. She clearly valued the student as a person-in-process rather than a receptable for content.

About the ways in which she intended to apply this case study experience to her future teaching, Teacher A said:

I think I would like to know how I can help them [her future students]. And if I can help them with methodology, than that's what I would do.
I think Student A came up with the best solution, to give the students time to write or talk to each other. However they want to do it. And also to work one-to-one with a kid. Because I didn't even know her, and in 15 minutes I knew her, I knew a little bit about her. I know teachers that don't know that much about me that I had for a whole year.

I want my kids to be able to think, not just write down and listen. When I give a question, I want more than one answer coming back to me. I really don't think there are right and wrong [answers in my content area].

These statements reveal a sincere commitment to students and their thinking process. Teacher A was able to take the advice of Student A, an ability not always seen among teachers. Probably, these statements only reflect a small fraction of the thinking Teacher A will do to make sense of this experience for her future thinking because of her nature as a creative-one.

CASE STUDY B

At the onset of this study, Teacher B was very reserved. She seemed to understand what was being modeled in the videotape with almost no trouble. Her major investments of time and energy were in making and teaching the teaching plan and in applying this experience to her future teaching.

She had very few questions about what she saw on the videotape: these involved how the teacher on the videotape had planned. Teacher B almost immediately began to wonder aloud about her own teaching plan:

I'm trying to think of other ways to go about doing [teaching] it. Because I don't know if I've really tried to do it before. I'm sure I have, but I really wasn't conscious of what it was.
She seemed to be unthreatened by the concept of creative problem solving and by the "letting the student teach the teacher" mode.

When I think of creativity or thinking that way, I think of using 3-dimensional forms.... The way I would go about doing this would be figuring out some kind of 3-dimensional, some kind of visual thing to work on.

Teacher B is conscious of her own creative problem solving process and is attempting to apply that process directly to the "teach."

This is different from directing her energy into imitating the teacher on the videotape's style, procedure, and form.

Coming up with questions for him [Student B] to answer to get at the answer I want; that's my thing. You know, like, not knowing what he's going to say, you can't really prepare anything. I'm not sure I would be able to follow up on things as easily as you [the teacher in the videotape] did. Because I think you've had a lot of practice at it.

Teacher B then asked questions about Student B. Teacher B spoke very little during loop II. She indicated much apprehension about the impending "teach."

I don't know. I'm just real curious as to how I think, too.

I just want to review these things [notes]... I like to try things out before I do them. You know what I mean. I feel like trying how I would do it out. Would that be OK to do?

I like feeling confident. I am able to cope with things that happen that I don't expect, but still, I like to be able to have a grip on what's happening. If I would practice it, at least I would have an idea.

You're saying anything goes, right? I can do anything?
Teacher B seemingly needed reassurance to know that the researcher was interested in Teacher B's own style rather than the imitation of the teacher in the videotape.

All of this grappling with making sense of the requested task for herself resulted in a "teach" which was quite different from the original videotape. Teacher B developed exercises for Student B which were based on three dimensional items. The first involved his (Student B's) selection of a provocative photograph, generation of questions about the photograph, identification of alternative solutions to the imagined situations, and discussion of the consequences of the situation. The second exercise involved Teacher B's manipulation of large bolts and screws, conducted in silence, and Student B's subsequent discussion of what he was thinking about while he watched. Teacher B also took time to talk about various art (her field of interest) materials and contemporary art. By doing this she focused Student B's thinking into a specific content area. Teacher B made an effort to personalize the conversation to Student B by asking questions about creative problem solving in drama; drama is of high interest to Student B. Finally, Teacher B did use the prototype procedure used in the videotape, asking the student to identify an unsolved problem of interest and then asking the student to tell how he would solve the problem. Throughout all of these experiences, Teacher B concentrated on questioning Student B about how his thinking progressed. All of these exercises had the same function -- to give Student B a first-hand experience in creative problem solving and to help him
analyze what he thought and exactly what his process was. The exercises differed (from each other and from the prototype videotape) in form: involving photographs, three dimensional metal objects, problems specific to art, problems specific to drama, and general abstract problems selected by the student.

Loops I, II, III, and IV seemed to function as a warm-up for Teacher B. In loop V, discussion about her "teach," she began to talk freely without prodding from the researcher. About the effect that loops I, II, and III had on her learning process, Teacher B said:

After looking at what you [teacher on the prototype videotape] did, I just felt I'd have to work it out the way I could handle it. Because I don't think I could have done it the way you did it.... At the end, I did ask him a question that you had asked.... I think it didn't go as well as when you did it.

[After loops I and II] I panicked [Teacher B laughed]. I went home and dug out all the things I had on creativity and read them all over again. I wrote [several quarters ago] this long paper on what the art teacher could do to promote creativity in the classroom.... It helped just because it helped me to review. It didn't really actually help me when I was trying to figure out what to do with Student B.... In fact, that's [the books and paper] where I got some of the ideas to do the things that I did with the pictures and the objects. I also picked up on another teacher that I had had. So I went home and I tried to work it into the way I would feel comfortable doing it.

Then I tried to make sure that that would get at what I wanted. I just went over it in my mind.

Teacher B seemed to be testing out her plan at this point, trying to identify the "gaps" as this term was used in reference to learning in Chapter III.
And it seemed like it did [ work ]. And then I was lying in bed that night and I started thinking about some of the things I had to do the next day and I started thinking of some other questions that were even better than what I had planned out.

Teacher B took time to mull over her plan and identified alternative procedures to achieve her goal more efficiently.

When I went over [ using contemporary art with Student B as a discussion starter ] it seemed like it would really get at how does a person go about thinking creatively. When you look at this art work, how do you go about making sense of it in your mind.

[ After practicing, Teacher B found ] ... it didn't really work. It worked better than it did with Student B.... I asked a lot more questions [ in the practice lesson ] and was a lot more specific about what I wanted.

[ About her choice of photographs for use in the "teach" ] I chose these certain ones because I thought they left a lot to think about.... Those are the ones that to me brought a lot of thought.

I tried to keep [ the lesson ] in the same idea [ form ] that you [ the teacher in the prototype videotape ] did.... I think I would have probably done a whole completely different thing from you if I hadn't even seen the tape.

[ About loop II ] I wanted to ask you if I could do it in my own way. It did help to ask questions.

Maybe I could have done it better if I hadn't had the time [ to make the lesson plan ].

You [ the researcher ] had said that you wanted me to get answers from him rather than me being, having all the answers, or teaching him something. I was to...get answers from him. It was com- fortable. I liked it, for a change. It seems that that's how it [ schools ] really should be, but it isn't.
Teacher B used the preparation time to shape her own teaching plan using her own style. She took advantage of the time she had to test her plan against her own thinking and in a practice lesson.

About the "teach" itself, Teacher B said:

I was aiming to, I don't think I was very good at keeping him going. I think it's a real tricky thing to do, to pick up on what other people say and to keep it going.

This process is what was referred to in Chapter III as keeping the student's thinking in motion.

You [the researcher] could have given me a whole outline of what to do. But I don't think that's what you wanted.

We [Teacher B and the researcher] know different things.... Especially with teaching, you have to do it your own way.

When he said he didn't like contemporary art, it really threw me.

This was in direct contradiction to the way Teacher B had made sense of contemporary art during her planning. She was able to cope with this contradiction and keep her own and Student B's thinking in motion.

When I showed him the photographs, my idea was asking as many questions that he could [bring] to mind about what he wanted to know about the action or event.... He kind of didn't ask as many as I thought he was going to....

He only came up with one solution. And my ideal was that he would come up with several different solutions.

Teacher B is identifying specific discrepancies between her expectations and what actually happened when teaching Student B.
This is where I had trouble. I wanted to ask him how he came to this solution.... But I don't think I knew how to do all that.

I have trouble doing that [ finding language to express her ideas ].... Like trying to get what I want out of the person and trying to explain things.

[ In each of the exercises ] I was getting at one thing. I was getting at one question -- trying to figure out how he [ Student B ] is thinking creatively.

[ Teacher B began with questions in one exercise because ] I wanted him to keep an open mind about all the different possibilities. And I didn't want him to think there was any one set thing that it had to be.

If I got to know him more [ Teacher B could get him to do more what she wanted ].

I'd try it all over again [ Teacher B liked what she did. ]

[ If she could change the lesson ] I would go over it again to figure out why these things didn't work.... I'd try to list some things that I should do.... I just don't think that he was talking enough.

When comparing Student B to herself and her own reaction to the exercises, Teacher B was disappointed. However, she seemed able to use those discrepancies to improve her own teaching, always having in mind trying to understand the student's concept of the problem (as described in Chapter 111).

Teacher B made numerous statements which indicated that she was making sense of the experience for her future teaching.

From Student B, I got the idea that leaving a classroom very open for creative thinking to happen [ was valuable ]. From this other person [ with whom Teacher B had practiced the
lesson], I got the idea that you need to close everything else out but still be open.

After what Student B said, you know, I asked him what you [the researcher] had done in your classroom....and he said well, you were really open. After what he said, I have a more open mind to trying.

I seemed to pick up on the feelings and emotions that were running through. Maybe psyching your kids up for doing a project..., creating an atmosphere where they would be more open [would be good].

The way you talk [to your students], the tone of your voice, what you say, what the room looks like, how it's arranged. ...what visuals or what senses are appealed to [stimulate creative problem solving].

I'd try to figure out how my kids were thinking. If you knew...what would make them think creatively -- like maybe doing some kind of exercises, something that would help them to be more aware of what's going on and how they are thinking. And I'd turn around and try to create more of those situations.

I think it's a very important thing [how to teach creative problem solving] and it deserves a lot of thought and a lot of figuring out.

Teacher B stated that she was just beginning to make sense of her experience and would likely think of other ideas later. She clearly applied her own creative problem solving process to this "teach" and to her reflections about the "teach."
CASE STUDY C

Teacher C approached this experience without apprehension and with expectation for great personal learning.

Before even viewing the prototype videotape, he did some careful thinking about his teaching plan:

Now I wrote down some things here earlier....
Ideas that I had right away before....
[viewing the tape]. I wanted to see what I got from the tape first and then remember what it was. Before I even realized what I was doing, I wanted to clarify values....
This is another saying of mine I wanted to 'empathize but not sympathize.' Anything he [Student C] felt bad about, I wanted to let him know I understood.... I like to set goals.... If you talk about goals...that's something like a picture [of the whole].... if we set a goal, we're focused in on something.... And then evaluate.

Thus, he wanted to do some values clarification, some empathizing with Student C, some goal setting, and some evaluation regardless of what other things were expected of him by the researcher.

Teacher C was very attentive when watching the prototype videotape; several sections he watched twice. Following the viewing, he was specific about what he thought was interesting and what he would have done differently.

One thing I think I would have done there [when the student in the videotape talked about writing papers], I would have asked him 'Why are we writing papers?... Here I'd try to get him to think divergently.

One thing I think I would have done...if I'd picked it up, maybe I would have done it earlier -- I'd ask him 'Would it bug you to fail if you picked a problem that didn't have a solution?'
He also had many questions about the student in the videotape, although he had comparatively few questions about Student C whom he had not yet met. Previous to this case study, Teacher C had developed a clear personal philosophy of teaching which pervaded the conversation (loop II). For example:

A lot of college students don't realize that you've got to take a little bit of everything you get [from instructors] and make it a balance for yourself. And maybe what's good for me is too much for you. I can go too far on value's clarification. I can go too far on positive reinforcement. I need a bit of firmness. And I tend to joke around too much and have too much fun.

Teacher C particularly noticed the extent of the questioning done by the teacher in the prototype videotape and the choice of language by this teacher:

I liked the word you [the teacher in the videotape] used too when you talked about what 'warms you up' instead of what 'motivates' you. And the way you said what 'pushes' you... instead of what 'forces' you to do something.

He added these words to the list of questions he had acquired from watching the prototype videotape for use in his "teach."

Teacher C's "teach" had much the same form and flavor as the "teach" on the prototype videotape. He asked many of the same questions and used many of the same teaching methods (such as asking for clarification of Student C's problem -- see Chapter III). He developed some new discussion areas such as decision making. Overall, his "teach" had the "look" of that on the prototype tape.

Careful reflection followed the "teach." Teacher C made several comments about the effect loops I, II, and III had on him:
After that, [loop I] I decided, well, mainly what you were looking for was just asking questions.

Teacher C used the planning time (loop III) in a unique way:

I feel like I started [teaching] before the camera started. I sat upstairs in your office and I just thought through some things that I wrote down on this paper. Mostly like an outline. I decided I wanted to go through some values clarification. I felt like if anybody else watched the tape [of Teacher C teaching], that was the big thing that I did [e.g. value's clarification].... I decided I'd go through that, explain what we were going to do,...and give him some criteria for success so that Student C would know what I wanted him to do.... And [Teacher C would] go through the process of asking...him [Student C] how...he pushed himself.

I wanted to personalize it so that we'd have some rapport.

I took off and went down to the Oval [a park area in the center of the Ohio State University campus]. And just kind of ran around and thought about that. And I took a piece of paper and a pencil with me.

It seems that Teacher C used this jogging time to mull over what he had planned. He specified after loops I and II that he would need to have this time allotment.

[When jogging and doing this thinking] I just really felt like I was doing something constructive and I was really super-enjoying myself. And I felt like we were going to get something accomplished.... I went out and just ran and tried to get my blood circulating.

I knew there were certain things that I needed to do like value's clarification and asking a bunch of questions. So I knew what I wanted to do but how I wanted to do it and exactly what I was going to say, I wasn't sure of.
But I knew I would come up with it.... I just had a real confidence that it would come out. I never once thought about pressure. I was concerned -- I wanted it to go better -- I think I wanted it to be just like your's [ the teacher's in the prototype videotape ].

About the "teach" itself, Teacher C said:

After seeing your [ the teacher in the videotape's ] tape, I think I tried to do pretty much exactly what you did.

That [ asking questions ] was fun. It was easy.

I got frustrated.... halfway through it because when you [ the teacher in the videotape ] worked... it went zip right through it. It really seemed abstract with Student C. I could never focus... and get 'go' lights like you did with the student in the videotape.

I don't think I really ever hit on the question... except for the 'space' [ response from Student C ]. So I was glad, I thought I got one [ good response ] out of three.... [ If doing the 'teach' over ] I'd try to get him to say more problems that didn't have answers.

One thing I wanted to say to kind of put Student C at ease and make him feel good was I said 'Phyllis has really been bragging [ about ] you. You must be something special.'

I wanted to put him at ease by saying 'Well, I'm kind of new at this... and if I goof, correct me.'

Teacher C was clearly concerned about Student C's comfort and lack of anxiety about this experience.

I know what I had to focus on was your [ the researcher's ] relationship with him [ Student C ]. That's something that
was good. That was something that opened him up.

There was something else that we had in common — his mom being a phys. ed. teacher and me being in phys. ed.

I just tried to find out what he was interested in. What sports, what he did at school, something about his sister.

Another concern held by Teacher C was establishment of rapport with Student C. He used several, carefully planned discussion questions to gain rapport.

He [Student C] told me about some girl in his class that was kind of scatterbrained, Chris.... We were talking about thinking in pictures, so I said 'What if we were teaching Chris?' So that he didn't have to think of something abstract.... It was easier for him to talk about.

This effort to personalize and make the discussion concrete was very effective in Teacher C's opinion.

I just used a lot of positive reinforcement to whatever he said and a lot of guided exploration, I just wanted to key him in or I wanted to lock him in.... I wanted him to be comfortable, but I wanted him to be real sure about exactly how he felt.

I think I am satisfied [with what was accomplished]. I realize it could have been better; there was room for improvement.... It was good [for the first time meeting Student C and teaching him this way].

I tried to use the right balance of everything I've learned so far....positive reinforcement... I wanted us to be friends, and good friends, but I still wanted that line.... I wanted to be able to demand some things of him.

I was completely open with him from the start.

I would keep the structure of what I did.... I had four or five steps where I went through
[1.] the rapport,[2.] the divergent thinking in terms of creative problem solving. And one thing I liked to say, too, is 'Help me think through this.' ....I'm just a friend sitting down and thinking through this with [the student].... Number 3 was 'What is problem solving? What are some of the things you have problems about?'.... And then [4.] how he motivated himself. And then, the fifth thing was what I was talking about before -- rebuilding.... I went over a summary.... I looked at my notes.... And I wrote down the key things that we'd talked about. The big thing I think we got was creative problem solving for [outer] space.

He [Student C] gave me what he thought a teacher should do for his class.

Although Student C provided Teacher C with concrete teaching suggestions, Teacher C did not mention these suggestions when discussing what a classroom teacher could do to maximize opportunities for students to do creative problem solving.

I was kind of tired. I felt a little bit drained. I didn't want to be unloading all over him [so Teacher C minimized positive reinforcement].

[If teaching this lesson again] I don't know that I'd change that much. Of course, if it wasn't Student C, there's a chance it would be completely different.

Teacher C, with this comment, demonstrates an awareness that the person is the core of the lesson rather than the content (as core).

Instead of listening and being able to say what he [Student C] said, I knew what type of thing I wanted to hear and what I was listening for was the way he said it.

I did discover some things [Teacher C] uncovered [them. Like] ....what to listen for and what kind of things worked.... I think a lot of times when I dealt with people before I wasn't listening,
and I liked to hear myself talk.... And I felt like pearls of wisdom were going to come out and people's minds would be changed.... And that helped me to realize it's not what I say, it's what they say and how I [see it]....

Teacher C did seem to learn a great deal from this teaching experience (loop IV). In light of the high quality of reflection evident in these stated learnings, one might find Teacher C's application of these to his future teaching particularly insignificant.

Teacher C related this case study experience to his future teaching:

I think it [creative problem solving] fits in [a classroom setting] with a balance with all the other things that need to be done...like making sure they learn the things that they have to learn.

This statement seems more indicative of the consumer view of teaching (as described in Chapter I) than the producer view which might be anticipated from a creative problem solver. If additional work was done with Teacher C, clarification of this issue might be worthy of pursuit.

I feel much more comfortable teaching science with this type of style than I do with phys. ed. [In physical education] it's really tough to get kids into [the lesson]. I mean your lesson plan has to be super flexible.

Since the prototype videotape dealt in the affective and cognitive domains, as did Teacher C's "teach," perhaps he had trouble making application of this form to the psychomotor realm. This is a second issue worthy of future pursuit with Teacher C.
I can think about that [the "teach"] in other situations when I'm dealing with kids. And if I come to something I'm stumped on, I can go out and think 'Well, what did I do with Student C?'

[In the future] I think I'll listen more. [This experience]...gave me some things to think about [like]... What to do with the information I listened to.

Teacher C was very open and verbal when discussing his opinions and what he had seen. He seems to need greater support from the teacher educator to make sense of the experience for his future teaching than was given in this case study. An assumption of this case study was that if provided with the opportunity and support to make sense of a problem, the creative problem solver could do this almost independently, supported only by questions and reinforcement. This seems to be an incorrect or a partially incorrect assumption for working with Teacher C. The need for additional support techniques seems to be indicated in this situation.

CASE STUDY D

Viewing the prototype videotape and talking about it provided Teacher D with an idea of what was wanted by the researcher. Teacher D turned off the prototype tape about two thirds of the way through because he was too tired to watch any more of it.
I think I got data from watching the tape and from talking to you [the researcher]. And then I put it all together.

During the discussion about the prototype videotape, Teacher D made the attempt to understand the process of the student in the tape:

He's [the student in the videotape] alert to all of your questions. He's trying to answer everything. I think that he's actually making things up when he's talking to you.... I think that what was happening was, as you asked him, he realized about all of the things that he had been doing before.

Teacher D was very interested in understanding his own process of taking advantage of his other-than-conscious resources. This interest seems to have allowed him to understand that this ability to reach into inner, unknown resources is often used by students in the learning situation (as discussed in Chapter III). The above quotation indicates that Teacher D was applying this awareness to this laboratory experience (of viewing the prototype tape).

Another direction that Teacher D took the discussion (Loop II) was toward what he was to do when he taught Student D:

So, my job is to have this girl materialize.... her creativeness. Like, to put into words that we could write down, the ways that she uses to creatively solve problems. Right?

How old is she [Student D]?

[In the first part of the lesson, Teacher D must] establish a relationship.

What will the setting be like?

Will it just be her and me?

What will you [the researcher] be doing?
I think I know what you want. I'm just trying to get ideas of how I'm going to bring it out of this girl. So she can say it in a way so that you and I could understand it.

I think that once she starts talking, then I will identify with whatever she's saying. And then I'll probably get involved; forget about everything that's around us; just get into the conversation. And then she'll feel like she's talking to someone that identifies with the things she's saying. It will be even good for me because I'll be talking to somebody who identifies with the way I feel.

Teacher D is "learning" about teaching as learning is described in Chapter III. He is formulating his concept of the problem (which is what he will do to teach Student D) and is seeking the gaps in this concept so that he can fill them. His questions indicate this gap-filling effort. The final statement in the above series of statements seems to indicate his reviewing his concept of the problem to make sure no gaps remain. He continues:

She doesn't know what's going on?

Then Teacher D indicates all the gaps are filled:

I don't have any [more] questions. I've just got to get it together in my head.

Teacher D seems to have completed his data seeking effort at this point.

About the planning time (loop III) Teacher D said:

I think I needed the time to get my system working. Because, like I said, I got this data from you but that didn't mean that I understood it. And then once I collected
the data, it went in [to his head], and was processed, and the answer came out. And then I knew what you [the researcher] wanted. So that was when I tried writing the questions [to use when teaching] down the half hour before I came here [to teach]. Then I knew I.... [had made sense of the data].

What I usually do, like I'm like a computer--I program myself.... So when I come here [to teach], I'm prepared. I just let my brain take over and the words come out.

I only worked [planning] at a conscious level for about half an hour....right after I left here [after discussing the prototype videotape]. It [the viewing and discussion] was recent, right? I had just talked about it, had just watched the tape, and I couldn't help thinking about it.... [During this one half hour] I was thinking about the way I was going to go about it.... [He then assigned the work to his unconscious.]

Before I came here [to teach], I had... another [conscious] half hour.... [He wrote down] questions. I guess, by that time, I had been working [unconsciously] on it long enough to be able to write something.... And I just started writing things down.... Then I knew that I had been [unconsciously] thinking about it. Because of the questions that I was writing.

The conscious use of his unconscious capacity is an interesting dimension of what Teacher D said. In his teaching of Student D, too, he talked about this and asked her if she used a similar process. The level of consciousness about the other-than-conscious capacities that Teacher D had developed was markedly different from the level of Student D. When asked about this difference, Teacher D said:
For at least the last 15 years I've been acting this way, without realizing what I was doing. Since I talked to you [the researcher], I started thinking about it. [Before] I was afraid to think about it... Until you started talking to me, then I realized what I had, what I was doing.

He is referring to a conversation six weeks prior to the case study in which his capacity to use his other-than-conscious resources was noted. He has clearly thought this through and applied it to his daily life.

When teaching Student D, Teacher D immediately began asking questions on process (e.g., "Like, when you're going to solve a problem, any kind of problem..., how do you go about it?") without beginning at a concrete level (like asking Student D to select a problem). This seemed to be a problem; Student D did not appear to be comfortable or to be able to respond to Teacher D's questions. Furthermore, when Teacher D did introduce a specific problem, he chose it rather than allowing her to select a problem of interest. Teacher D was able to use the environment of the teaching experience; the first concrete problem he introduced dealt with the repair of a broken stool he found in the classroom. He provided Student D with a great deal of support and positive reinforcement throughout the lesson.

Teacher D, in the discussion following the "teach," made numerous comments about the experience:

I thought she, [Student D] was very receptive.... She's very quick. I was surprised. Surprised is not the word, I was impressed.... She was very sharp.

After I got here, I wasn't sure what would happen. I hadn't taken a whole lot of time before [Teacher
D taught] to think about it. I just decided to go over there [to the teaching place] and go to it.

When I saw her looking at the camera and you, I knew that I had to get rid of that before we could actually start working.

It was a bit hard trying to get things out of her because she was so shy.... She always talked very softly. It took some effort to make her feel comfortable. I was trying to help her. I wanted to help her to forget about the camera and about you [the researcher] sitting there. Because that was what was upsetting her. At one point I actually achieved that. Like, when I had the stool up here. I got her involved in it. And some other times. I think when I asked her how would she teach me [she forgot about the camera and the researcher].

Then I started to get into some questions. I wanted to get some answers. As I was sitting... I wanted to give her a problem. I hadn't thought of a problem yet [before arriving on the scene].... I saw that stool over there, and I just picked it up. And boom, boom, boom.... And by talking to her and listening to what she was saying, I knew that she was being a creative problem solver.... She had a solution.... At that moment I thought that I had really succeeded because she forgot about that [the camera and the researcher] and she got herself involved.

[About using his environment to teach, Teacher D said] I don't know. It's something I do all the time.... Because people understand better when they see things.

And then I asked her what went through your [her] mind, because I wanted her to tell me. I knew what went through mine [his mind]. But I wanted her to think about it and try to put it into words. Which is what you [the researcher] wanted.

I was looking at her eyes and the expressions on her face and I was just, like, putting myself in her place. And I could see something develop.... I'm sure that she said that [solution to the stool problem] but she didn't think about it. That's why I asked her later, 'Did you think about the
triangle first and then solve the problem?'
She said she did, but I don't think she did....
She solved the problem before she even thought
about the triangle [and its relation to the
legs of the stool].

It appears that Teacher D is using the teaching algorithm proposed
in Chapter III. He was trying to understand the student's concept
of the problem and to take her beyond that (i.e., keep her thinking
in motion).

It may not be concluded from this that the case study experience
"taught" Teacher D how to use the algorithm; he may well have been
using it previous to the experience. But it seems reasonable to
conclude that at least the case study experience gave Teacher D
practice at using the algorithm and gave him an opportunity to talk
about it, receive encouragement, and proceed in his self-teaching
effort.

Teacher D continued to talk about the "teach:"

[In the "teach,"] I brought up environmental
conditions because I'm affected by it....
When I was writing some of those questions, I
thought about the way [environment affected
me].... I guess that's why I brought it out.
I wanted to see if she felt the same way.

[If repeating the lesson] I'd keep everything.

[Changing the lesson] I'd probably hide the
camera.

I realize that it was the first time that we'd
met. And she's only 14.... And shy.... I'd
probably try to meet her at least an hour or two the
day before.... [And] I'd hide you [the researcher]
behind a window or something.
Clearly, Teacher D perceived Student D's silence as shyness and fear of this researcher and the camera. In contrast to this perception, Student D's silence might be interpreted as not understanding what was being asked in Teacher D's questions: this hypothesis is based on her expressive response to all of the concrete questions asked by Teacher D.

Teacher D applied this experience to his future teaching. He specifically mentioned that he would alter his normal problem solving style (that is, leaving all conscious work until the last possible moment) when planning a lesson for a group of children, because planning to teach seemed to him to take more conscious time.

[When teaching his students] I would probably do what we [In the case study] just did.... I would feed the data into my students.... I wouldn't give them a written problem. I would get some material, something they could touch and see. And then let them solve it.

[For example, in soccer] I would have them do some drills first.... That's the data.... I would have them start without the cones. I would have them run with the ball and have them pass it back and forth. And later I would have the cones. And then I put there a real guy.... Just to stand there so they'd get the image of a person being there. And then I'd have them find for themselves the solution [to how to do a wall pass]. Then put them in a real game. And have them [deal with]... the situation by themselves.

I would teach them about some physics. For every action there's a reaction. So I would do this. I would draw. I would get a piece of paper and I would explain [using visual images].

Most of the things I'd do follow these patterns.
Thus, Teacher D has identified a receive data/practice/find solution pattern for his students as well as emphasizing the use of visual images to support verbal explanations.

Teacher D was involved in a great many other activities during this case study. When asked about whether or not he thought his being tired affected the quality of his performance he said it had not, and the only change he thought he would have made had he had more time would have been his doing some library research. This researcher disagrees with Teacher D. It is felt that had he had more time and energy to devote to this project, his performance would have been even more unique. Perhaps the "outside" activity commitment level of the preservice teacher ought to be considered when encouraging her/him to participate in this type of perservice learning activity. Timing is an element which needs consideration when providing creative problem solvers with opportunities to do their work.

COMPARISON OF FOUR CASE STUDIES

In order to provide an efficient means for comparing these case studies, Figure 15 has been developed. It is based upon questions which serve as effective bases for comparison.

This experience did seem to serve as a way for each of these preservice teachers to begin to learn how to use the algorithm proposed in Chapter III. Teachers B and D seemed to have an understanding of the algorithm, perhaps because it was natural to them, before beginning the case study. For them the case study experience seemed to provide
practice at using the algorithm, an opportunity to talk about it, and an opportunity to clarify in verbal language what they had been doing at a non-language level previously. Teacher A identified the algorithm and used parts of it. It is questionable whether Teacher C identified the algorithm.
### Figure 15
**COMPARISON OF FOUR CASE STUDIES**

<table>
<thead>
<tr>
<th>Comparison Questions</th>
<th>Teacher A</th>
<th>Teacher B</th>
<th>Teacher C</th>
<th>Teacher D</th>
</tr>
</thead>
<tbody>
<tr>
<td>What did the teacher do prior to watching the prototype tape?</td>
<td>Wondered what content she would have to teach and what would be the source of the content.</td>
<td>---------------</td>
<td>Prepared notes related to what he would teach Student C.</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>Watched and took notes. Used it as a model.</td>
<td>Watched and took notes. Had no problems, understanding and this seemed to be a natural process for her.</td>
<td>Watched and took notes. Watched several parts twice. Used it as a model.</td>
<td>Watched 2/3 of tape and took notes.</td>
</tr>
<tr>
<td>What was the teacher's response to the prototype tape (loop I)?</td>
<td>Asked specific questions about prototype &quot;teach&quot; and shared her teaching plan.</td>
<td>Asked how the teacher had planned. Immediately began to wonder about what she would create as a plan.</td>
<td>Talked about what he would have done differently. Asked questions about student in videotape. Discussed personal philosophy of teaching.</td>
<td>Most interested in the creative process of the student in the videotape. Tried to understand what he was expected to do in IV. Asked questions about Student D. Filled in the &quot;gaps&quot; of his concept of the &quot;teach.&quot;</td>
</tr>
<tr>
<td>Comparison Questions</td>
<td>Teacher A</td>
<td>Teacher B</td>
<td>Teacher C</td>
<td>Teacher D</td>
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<tr>
<td>What was the teacher's response to having planning time (loop III)?</td>
<td>Was incorporated into loop I work. Developed a specific plan.</td>
<td>Did research. Practiced. Selected instructional materials. Tried to find the &quot;gaps.&quot; Developed a specific plan.</td>
<td>Asked questions about Student C. Reviewed notes from 1. Went jogging which acted as &quot;mulling&quot; time. Really enjoyed this! Developed a specific plan.</td>
<td>Used unconscious resources. Did not develop a specific plan.</td>
</tr>
<tr>
<td>What was the teacher's response to teaching (loop IV)?</td>
<td>Used questions collected in I. Was apparently a bit nervous.</td>
<td>Used 3-dimensional items. Used I as model only in last portion.</td>
<td>Used questions and phrases collected in I. Saw emphasis as being the asking of questions. Thought this was fun.</td>
<td>Saw this as an opportunity to have a conversation with another creative problem solver. Centered on the student's process of creative problem solving.</td>
</tr>
<tr>
<td>What was the teacher's response to discussing the teaching (loop V)?</td>
<td>Was enthusiastic.</td>
<td>Was enthusiastic.</td>
<td>Was enthusiastic. Discussed personal philosophy of teaching.</td>
<td>Was enthusiastic. Discussed personal style of creative problem solving. Talked a lot about his other-than-conscious activity.</td>
</tr>
<tr>
<td>Comparison Questions</td>
<td>Teacher A</td>
<td>Teacher B</td>
<td>Teacher C</td>
<td>Teacher D</td>
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<tr>
<td><strong>What was the teacher's response to the student?</strong></td>
<td>Wanted to make her feel like a &quot;person.&quot; Enjoyed working with her.</td>
<td>Based part of the lesson on his interests and problems he invented. Saw him as her teacher.</td>
<td>Enjoyed working with him.</td>
<td>Saw her as shy and afraid of the camera and the researcher. Found her receptive. Was impressed with her.</td>
</tr>
<tr>
<td><strong>What was the teacher's perception of the researcher's relation to the student?</strong></td>
<td>Perceived it as positive. Used it in discussion to establish rapport.</td>
<td>Perceived it as positive. Used it in discussion to establish rapport.</td>
<td>Perceived it as negative, that Student D would be ill at ease with the researcher present.</td>
<td></td>
</tr>
<tr>
<td><strong>How did the teacher's identity as a teacher develop?</strong></td>
<td>Shifted from &quot;giver of knowledge&quot; to &quot;conductor of the learning process.&quot;</td>
<td>Felt comfortable letting the student provide the answers.</td>
<td>Realized person was core of a lesson rather than content.</td>
<td>Classroom-like practice was provided to reinforce the identity as a teacher he had already formed.</td>
</tr>
<tr>
<td><strong>To what extent did the teacher adopt the algorithm?</strong></td>
<td>Wanted to make her student a &quot;winner.&quot; Used clarification and summarizing.</td>
<td>Kept her student's thinking in motion. Tried to understand her student's concept of the problem.</td>
<td>Used questioning process.</td>
<td>Tried to understand his student's concept of the problem. Offered consistent support to Student D. Kept his student's thinking in motion. Used clarification and summarizing.</td>
</tr>
<tr>
<td>Comparison Questions</td>
<td>Teacher A</td>
<td>Teacher B</td>
<td>Teacher C</td>
<td>Teacher D</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Did the teacher use additional resources?</td>
<td>Used none.</td>
<td>Used books and a previously written paper to prepare. Used 3-dimensional materials brought from home to teach.</td>
<td>Used none.</td>
<td>Used the stool found in the classroom where IV occurred.</td>
</tr>
<tr>
<td>What was the source of the problems discussed in IV?</td>
<td>Student A.</td>
<td>3-dimensional items, content area of Teacher B, Student B.</td>
<td>Student C.</td>
<td>Teacher D and the teaching environment.</td>
</tr>
<tr>
<td>What was the source of the teaching ideas discussed in V?</td>
<td>Student A and Teacher A.</td>
<td>Student B and the student with whom she practiced the &quot;teach.&quot;</td>
<td>Teacher C (Teacher C did not use suggestions which had been provided by Student C).</td>
<td>Teacher D (Teacher D did not ask Student D for teaching ideas).</td>
</tr>
<tr>
<td>Did the teacher choose to review her/his taped &quot;teach?&quot;?</td>
<td>Watched tape.</td>
<td>Watched tape. Was very frustrated by the technology of this part of the experience.</td>
<td>Watched tape.</td>
<td>Watched tape.</td>
</tr>
<tr>
<td>Comparison Questions</td>
<td>Teacher A</td>
<td>Teacher B</td>
<td>Teacher C</td>
<td>Teacher D</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------</td>
<td>----------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>What was the teacher's greatest concern before the &quot;teach?&quot;</td>
<td>Was concerned about silence.</td>
<td>Wanted to invent good questions for Student B. Wanted to know about Student B. Apparently did not feel confident.</td>
<td>Wanted to use value's clarification. Wanted to establish rapport with Student C. Was concerned about Student C's comfort.</td>
<td>Wanted to understand the &quot;data&quot; (I and II)&quot; to apply them to his teach.</td>
</tr>
<tr>
<td>What was the teacher's greatest concern after the &quot;teach?&quot;</td>
<td></td>
<td>Found discrepancies between what she expected Student B to say and what he said.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What was the teacher's goal in teaching?</td>
<td>Directed her teaching to her student's clear understanding of the question.</td>
<td>Interested in keeping the student's thinking in motion.</td>
<td>Interested in helping Student C to clarify his values.</td>
<td>Wanted to have a conversation with another creative problem solver so that he could test out some of his hypotheses about the process.</td>
</tr>
<tr>
<td>Comparison Questions</td>
<td>Teacher A</td>
<td>Teacher B</td>
<td>Teacher C</td>
<td>Teacher D</td>
</tr>
<tr>
<td>----------------------</td>
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<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>What will the teacher do in her/his future teaching?</td>
<td>Provide students with time to write and talk to each other.</td>
<td>Encourage &quot;openness&quot; in her classroom. Use variation of stimulus. Try to understand students' concepts of problems. Do creativity exercises.</td>
<td>Would listen more. Would fit creative problem solving into curriculum in &quot;balance&quot; with required content.</td>
<td>Would use a receive data/practice/find solution pattern for students. Would use visual images to support verbal explanations.</td>
</tr>
<tr>
<td>How did the teacher perceive herself/himself as different from the teacher in the prototype tape?</td>
<td>Talked less. Did not sum up as much. Smiled less.</td>
<td>Used 3-dimensional exercises.</td>
<td>Tried to be like the teacher in the prototype tape.</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER VI
IMPLICATIONS AND DIRECTIONS FOR FURTHER RESEARCH

In this chapter a summary of this dissertation study will be followed by implications and directions for further research. These may be categorized into several areas: (1) what the classroom teacher does to maximize the opportunities for students to do creative problem solving, (2) teacher education, (3) curriculum and schools, (4) creative problem solving and the algorithm, and (5) theory and methodology.

SUMMARY

The question investigated in this study was: How does the classroom teacher maximize the opportunities for students to work on problems for which there are no known algorithms? A review of the work and thoughts of those who have previously grappled with this or related problems was completed. Theoretical inquiry and case study methodology were the sources of the data. A stimulating teaching algorithm was identified and an examination of its application and implications was made (much of this is included in the balance of Chapter VI). Directions for further research to illuminate the "Alternative Process Model of Teacher Education" proposed in the dissertation were indicated (also included in the balance of this chapter).
WHAT THE CLASSROOM TEACHER DOES TO MAXIMIZE
THE OPPORTUNITIES FOR STUDENTS TO DO CREATIVE PROBLEM SOLVING

Once the three preconditions, trustworthiness, genuine interest, and personal experience in creative problem solving, are met by the teacher, the teacher can do specific things in the classroom to maximize the opportunities for students to do creative problem solving. Such a list might begin with items such as those enumerated below. However, it must be noted that it is appropriate for such a list to be expanded or adapted by each teacher according to what works. Within the classroom:

1. The teacher ought to arrange the furniture to provide for various types of learning environments such as tables around which groups of students might work together, study carrels for individual study, and soft lounge chairs for comfort.

2. The teacher ought to officially open the "student to teacher" communication route by providing for a place where a student might sign up to request a private chat.

3. The teacher ought to continually use student evaluation of the classroom situation to assess and readjust classroom procedures.

4. The teacher ought to share her/his own creative problem solving efforts.

5. The teacher ought to enlist the help of the student(s) in creative problem solving efforts.

6. The teacher ought to create assignments which encourage the student to develop new algorithms after having surveyed the field.

7. The teacher ought to use an appropriate amount of class time to guide the student in doing reflective thinking until s/he is able to do such reflective thinking independently.

8. The teacher ought to attend to the teaching of skills necessary to the student so that the student can begin to
pursue independently (such as reading skills, researching skills, note-taking skills, organizing skills, communicating skills).

9. The teacher ought to provide study materials and resources with the classroom which are relevant to the student's interests and expressed problem areas.

10. The teacher ought to provide time within the "normal curriculum" for students to identify problems of interest and for students to pursue their expressed problems.

11. The teacher ought to schedule her/his own time to provide for a large amount of time to talk to individual students about their expressed problems.

12. The teacher ought to encourage students to talk to each other about their creative problem solving activities.

13. The student ought to provide class time for such student-student conversation (see item 12).

14. The teacher ought to provide class time for formal voluntary presentations by students to share the product of their ponderings or to report progress in their problem solving efforts.

15. When such sharing (see item 14) takes place, the teacher ought to encourage formal questioning by the audience of the presenter, always fostering the constructive nature of such questioning.

16. The teacher ought to encourage students to display or publish the products of their ponderings.

17. The teacher ought to provide the student with help in securing the study materials and resources necessary for the solving of the problem (e.g., obtaining from the school's library filmstrips requested for a single student's viewing).

18. The teacher ought to use multiple instructional strategies to insure provision for the student's learning modes (e.g., use of learning centers, simulations, independent projects, audio-visual materials).

19. The teacher ought to encourage an interdisciplinary approach to problems, encouraging the student to employ
knowledge and skills from all appropriate content areas.

20. The teacher ought to emphasize language as an effective mode for communication about the problem and might thus encourage the student to develop her/his language skill (e.g., skill in choosing efficient vocabulary to write the problem question).

21. The teacher ought to provide the student with models of problem solving strategies and styles (e.g., see Gihselin, 1952).

22. The teacher ought to encourage the student to work on the problem while not in class.

23. The teacher ought to encourage the student to work in class on the problem which has heretofore been "extra-curricular (e.g., to extend an interest in military history, in outer space, in magic)."

24. The teacher ought to provide study materials and resources which might stimulate a student's interest in a problem, eventually resulting in the student's selection of the problem to pursue.

The list is in no way comprehensive. It is meant to be exemplary of specific items a classroom teacher can use to maximize creative problem solving within her/his class. The above items are skills, knowledges, and attitudes which could be taught to preservice teachers by the teacher educator. Moreover, it is crucial that the preservice teacher be given the time and support outlined in this dissertation to pursue her/his own development to teaching style and teaching methodology.

Teaching succeeds where learning succeeds; learning succeeds where growth succeeds; growth succeeds where life succeeds; life succeeds where it increases (Mooney, 1978, pp. 55-58).
In Chapter I a question was posed: How does the preservice teacher learn about this creative problem solving process so that s/he can increase the opportunities for such a process to happen for children with whom s/he is working? From these case studies what conjectures might be made about how the preservice teacher learns about this process and what seems to be associated with successful learning:

1. Independently or with the help of a teacher educator (who uses the stimulating teaching algorithm proposed in Chapter III) the preservice teacher becomes aware of how s/he solves problems creatively; that is, s/he must be able to verbalize her/his personal creative problem solving process.

2. The provision of models, either using prototype videotapes or some other format, is a way that some preservice teachers will learn the process.

3. Preservice teachers ought to be "taught" how to learn from their students. This learning might be applied to respond to the stated question.

4. Guided field experiences, such as that provided by the methodology described in Chapter IV, will allow some preservice teachers to learn the process.

5. Since preservice preparation for secondary teachers is so highly content-centered (see description of "consumer" in Chapter 1), perhaps particular attention to creative problem solving ought to be paid in the special methods classes: there might be need for this in preservice preparation of elementary teachers.
6. Perhaps, preservice teachers who can be identified as creative problem solvers ought to be offered an opportunity for an alternative experience to the conventional methods course so that they could find company with others like themselves. The need for conversation with someone who understands teaching (and life) in the unique way in which they understand teaching is like hunger. In this type of environment, these teachers might be able to reach their potential within the teacher preparation institution (an event which rarely occurs currently).

It is hypothesized that regular field experiences might be destructive to the development of these teachers; because of their extreme sensitivity and seriousness they often do not fit in the usual places. They need special "tutoring" by special "tutors" to be able to make this fit.

The stimulating teaching algorithm developed in Chapter III has application to teacher education as a model of a procedure for solving teaching problems. Of course, further research is necessary with reference to student success and satisfaction before any wholesale adoption of the algorithm would be reasonable. But based upon the results of this study, the algorithm seems certain enough to present to preservice and inservice teachers as a viable and vital alternative available to them for use.

There are numerous possibilities for use of this algorithm in teacher education. It could be used as the basis for field experience as it was in this study. It could be used as a basis for the skill development of preservice teachers and incorporated into the microteaching format. It could be used as a form by teacher
educators for their own teaching.

A stimulating teaching algorithm has been proposed. At this time, this researcher cannot make the statement that this algorithm will be useful to all teachers in all situations. Many teachers do not themselves have the capacity to do creative problem solving and would be ill at ease if asked to teach this way. (That is, only a teacher-in-process, a teacher-producer, has a need to develop and/or use such a teaching algorithm. A teacher who "knows all the answers" has and uses "known content algorithms" is in no way seeking or receptive to anything else). It is hypothesized that some teacher-producers have styles of creative problem solving so different from this researcher's that this algorithm would be of no use to them. Thus, when considering the use of this algorithm in teacher education, notation of this variation among teachers is critical. Ideally, the availability of this algorithm to teachers should be on a voluntary rather than mandatory basis.

This researcher was able to make use of the algorithm in the education of preservice teachers in the form of the case studies. She used the algorithm as she taught the teachers and gave them a model of the algorithm in the prototype videotape. The case studies in Chapter V served to "check" the teaching algorithm proposed in Chapter III. These case studies provided: 1) the opportunity for this researcher to understand the portions of the algorithm which did not come clear to the receiver of the communication, the preservice teacher, 2) the opportunity to observe preservice teachers
attempting to maximize the opportunities for students to do creative problem solving, 3) the opportunity for this researcher to talk about and clarify her own understanding of the teaching algorithm, 4) the opportunity to observe the differences among the preservice teachers in the way they responded to the lesson (i.e., the methodology), 6) the opportunity to observe preservice teacher engaged in making sense of an algorithm new to them, and 7) the opportunity to make sense of all of this new data in terms of this dissertation. As a result of this reflective process, the dissertation question has been answered and grounded in empirical realities.

As becomes clear upon examination of Chapter V this learning experience for preservice teachers was a success. They learned a great deal and they had fun doing it. If creative problem solving by children in schools is valued, it seems appropriate to give preservice teachers field experiences with excellent child creative problem solvers so that the teachers can learn from the students. Once sense has been made of the creative problem solving process then the preservice teacher will be prepared to teach children who have no previous experience in creative problem solving. In other words, this particular type of experience with self-teaching (for elaboration refer to "teaching quotient," p. 143f.) children might serve to develop the preservice teacher's understanding of what these children do naturally and independently so that the teacher can develop curricular and instructional materials for use with other children. Certainly, this type of field experience should not be the only type had by the preservice teacher. But it is worthy of attention and application in existing preservice teacher education programs.
An unexpected result of this study was what seemed to be the development of a new professional identity in the preservice teachers. These case studies seemed to help the preservice teachers think of themselves as self-fulfilling teachers. The experience served to help them apply creative problem solving, which they had heretofore used in their non-teaching lives, to their teaching lives. Teaching became a transactive process with students rather than a one-way "fill-it-up" communication. This new positive personal construction of teaching and self which occurred in each of the preservice teachers was supported by their having someone to talk to about this construction. It was a special experience for all involved.

The focus of the case studies was on the education of the individual intending to become a teacher rather than development of curriculum and instruction for teacher education programs in institutions. Certainly, a translation from the former to the latter could be made. Specific identification of institutional descriptors would be necessary in order to plan, execute, and evaluate a comprehensive teacher education program within an institutional setting.

The case study recordings were analyzed to try to understand the sense the preservice teacher made of the stimulating teaching algorithm. The presentation of the algorithm came in two forms: first, the algorithm was used by this researcher in her teaching of the preservice teachers; second, the prototype videotape was an example of the algorithm being used in teaching a child. From both.
of these, the preservice teacher began to form a concept of the algorithm and its application. The documentation of this process is included as Chapter V of this dissertation.

In addition to analyzing these data in terms of the formation of the concept of the stimulating teaching algorithm, these same data could be analyzed looking for other patterns. The answering of the following questions would be a direction which further research in teacher education might take:

1. Why did the researcher teach each of the preservice teachers differently? What cues did they give to tell her to communicate the same information in varying forms?

2. How might a teacher educator teach a predominantly right-brained teacher to express what s/he is thinking about in a logical, verbal form (e.g., to explain instructions and information more clearly)?

3. How can a teacher educator teach a preservice teacher to comfortably operate in either left-brain or right-brain fashion depending on the needs of the student? Can the teacher educator teach the preservice teacher to communicate the same concept in both fashions? Can the teacher educator teach preservice teachers to teach their students these processes?

4. How can the teacher educator help the preservice teacher who has the capacity to be a teacher-producer (but is not) become a teacher-producer?

5. What direct instructional techniques were used by the teacher educator (this researcher) in these case study tapes? Does a pattern emerge? Is the pattern teachable to other teacher educators?

Thus, the audiotapes and videotapes recorded in these case studies might serve as the data base for further inquiry.
This study focused on the preservice teacher. An obvious avenue for further exploration would be to do a similar study focused on inservice teachers. Appropriate questions are:

1. By observing successful inservice teachers, those who have maximized opportunities for their students to do creative problem solving, can the stimulating teaching algorithm they use be identified? How are their algorithms alike or different from that proposed in this dissertation? If different, can the different algorithms be integrated?

2. Can inservice teachers gain the same success and satisfaction from a learning experience like the case study experience in this dissertation as did preservice teachers?

3. Can teacher-consumers be taught to leave space for creative problem solving to happen in their classrooms? Can they be trained to use the stimulating teaching algorithm?

Figure 16 illustrates the teacher education process used in the case studies with preservice teachers and proposed for inservice teacher education. It represents a focused area of a teacher education program rather than a comprehensive program. Of course, one might carefully consider the model and make sense of it for a comprehensive program. This model is appropriate if those involved are interested in maximizing opportunities for students and teachers to do creative problem solving.
"If satisfied" indicates that the teacher has been able to make sense of the new information and to make application of it for her/his teaching, feels like s/he has been successful, and is desirous of more of this type of learning. Children are only involved in this model as the recipients of the practice. Teachers are the sole actors in all other capacities.

This model for a focused area of teacher education served to illustrate what has been suggested in a verbal, linear fashion in the preceding paragraphs.
CURRICULUM AND SCHOOLS

The stimulating teaching algorithm has application to curriculum and schools. If employed by teachers, the probability of students being able to work on problems for which there have been no previously identified algorithms is made greater. Such an emphasis would change the form of curriculum by shifting the degree to which the curriculum is knowledge-producing as opposed to knowledge-consuming in nature. The school environment would have to be changed to be responsive to such curricular developments (e.g., computer terminals might be necessary in all buildings and textbooks would not be necessary for all students).

Curriculum and schools form the context in which teaching and learning occur. It must be noted that the focus of this dissertation is neither curriculum nor schools and that these two phenomena deserve much closer and more complete attention than can be paid in this study.

Teaching and curriculum ought to interact so that each vitalizes the other, that is, infuses it with life-like qualities. This vitalization ought to be able to take place in a school.

The focus for the stimulating teaching algorithm is the learning of the student. In the schools, the child ought to be honored for her/his capacity to move from pondering to product and back again (Mooney, 10/17/78).
Figure 17
THE CAPACITY TO MOVE FROM PONDERING TO PRODUCT

The process is the creative problem solving process. The product is an algorithm invented by the child as a result of pondering (also called creative problem solving). The teaching algorithm described in this dissertation would honor such a process. In fact, a basic assumption of the algorithm is that moving from pondering to product and back again is valuable.

A long list of questions about how this algorithm would fit in schools was posed at the end of Chapter II. Many of them have been answered: Communication in the proposed teaching algorithm is vital, that is, it is life-centered. In this algorithm, the teacher comes to life as a creative-one and self-renewal occurs in the teaching process (as defined by the algorithm). The teacher's response is freshly formed in resonance with the student's communicated response. The algorithm insists that the teacher be open to the student's sendings. The teacher, who acts much like the conductor of an
orchestra of communication, watches and listens for cues up-coming. The focus of the teacher is the student's Inner world. Because of the way teaching is defined in this algorithm, the teacher is open to differences among the students. Teaching involves testing to find the student's openings, paths by which the teacher and student can more fully understand each other's mind-formations. In this process, the teacher discovers: some of what the student is closed to, where the "gaps" in their mind-formations are, the blocks the student has to expressing herself/himself, but the student can best clarify and communicate her/his knowings, the collective past experience of the student as a basis on which to build new mind-formations, and the student's stage of maturation as a self-teaching person.

The questions involving what students do when "taught" by use of this stimulating algorithm have not been answered in this dissertation, and this is an appropriate direction for further inquiry. Also, the questions related to curriculum are beyond the scope of this dissertation.

In order for this stimulating teaching algorithm to survive in the schools as they are currently operated, support systems for those using the algorithm must be developed. This algorithm by definition "protects" the student's idea while it is in the forming stage. Not only is the conceptualization of the student not interfered with, it is nurtured by the teacher using this algorithm.
In relation to schools in general, such a support system is necessary for the teacher who is involved in identification of stimulating algorithms. Moreover, such a support system must be considered for the teacher educator involved in such a process. If the school system could provide safety and nurturance for individuals' attempting to find algorithms for problems to which there are no known algorithms, the probability of the success of their work is greatly increased. Development and maintenance of a support system for all human beings in the school system seems like a direction worthy of pursuit.

Perhaps, the reason that "conventional schools" tend to stifle the capacity of the creative problem solver is that algorithm-creation (process) comes before the existence of the algorithm (product). In order to plan, in the traditional sense of the word "plan," the algorithm is needed before the learning experience. Thus, the teacher can set up certain conditions and provide supports for the students involved in creative problem solving, but the teacher cannot plan for creative problem solving to happen within the student. Many individuals would chose not to get involved in creative problem solving rather than to relinquish some of their control of what goes on in the school. It seems appropriate that this type of "consumer-power" ought to be exchanged for the notion of "producer-power" in schools. The opportunity for children to ponder may be crucial for the vitalization of schools. A specific research question worthy of investigation and related to this
dissertation is What specifically do schools do that destroys the child's capacity to work on problems for which there are no algorithms? (as described in Liedke, 1977).

Another direction for research relevant to curriculum and schools came clear as a result of this dissertation study. The students involved in the pilot studies differed in their "teachability." One was able to propel herself almost without the teacher. Another needed careful and thorough application of the stimulating teaching algorithm described in Chapter III. That is, the two students differed as to their need for teacher support. The possibility of a new statistic emerges from this understanding -- the TEACHABILITY QUOTIENT. Such a number would clue the teacher into the student's ability to support her/his own learning independently. The statistic would indicate the students' emerging places on a continuum extending from "self-teaching" to "needing teacher support in the learning process." In classrooms, students who were self-teaching could then be allowed to get on about their business without interference. The stimulating teaching algorithm would be useful in the teaching of those who were not self-teachers. The "goal" at the end of the school experience would be to have all students be self-teachers. Therefore, for any one student, the statistic should change as s/he grew. The "teachability quotient" would be invented for and used by classroom teachers; the IQ is very useful to researchers of the classroom but sometimes serves to block the learning process rather than to facilitate it in
classrooms. Obviously, this teachability quotient needs better definition and further investigation. This statistic's power and use might be much greater for purposes of the classroom teacher interested in creative problem solving than is the current I.Q. statistic.

Much research is needed in the areas of curriculum and schools to better understand the work begun in this study. It must be research that has at its core a respect for the creative—one who is in process. Quantitative and qualitative methods will be necessary to complete the picture begun in this investigation.

CREATIVE PROBLEM SOLVING AND THE ALGORITHM

The dissertation was a practical model of what the theory espoused. It was an intense effort in one person (the researcher) to do creative problem solving; the dissertation was about creative problem solving. It resulted in the invention and use of an algorithm; it discussed invention and use of algorithms. The case study methodology used what the theory proposed. The researcher made sense of the phenomenon of creative problem solving in teaching; the dissertation was about making sense of a transaction between an individual and her/his environment.

This dissertation has described a stimulating teaching algorithm for use by classroom teachers when interested in maximizing the opportunities for their students to do creative problem solving. In Chapter I several questions were posed about the creation of such
an algorithm. As a check of the success of this dissertation, it seems appropriate to see if the answers to these questions have been found:

What does the teacher do to develop the student's capacity to work on a problem for which there is no algorithm?

Chapter III, V and VI addressed this question.

What kind of school structure of learning environment can be developed to help facilitate this process?

This question is worthy of further inquiry. "Curriculum and Schools" in Chapter VI is a beginning for such future research.

How can the teaching algorithm be evaluated?

For each teacher and child, sense must be made of the algorithm. If it "works" to stimulate the student to work on problems for which there are no algorithms, the teaching algorithm is a success. Specific methods for evaluation, perhaps best called "the evaluating algorithm," might be developed by further research.

What can be expected to result from this teaching algorithm?

Again, further research is warranted. Data collected in the case studies of this dissertation might be reanalyzed focusing on the student rather than the teacher. Such a reanalysis might result in an answer to this question.

Analysis of the data in this study was related to the creative problem solving process of the preservice teacher. It has already been noted that the data collected in this study has the potential to be analyzed for additional purposes. One such purpose related to creative problem solving and the algorithm would be to identify what the children involved in the tapes do when in this process and what patterns emerge from this activity.
Investigation of the creative problem solving process as it relates to discovering previously unknown algorithms has been revealed as a problem worthy of study by this dissertation. Only a small portion of the needed work is contained in this study. Yet, this dissertation does represent a beginning; and that in and of itself is significant. Directions for such further research include:

1. Research to find out what the brain processes are like when the person is involved in algorithm formation.

2. Research to identify the best kind of learning environments to nurture algorithm generation.

3. Research to identify the environments that can be created by parents to encourage creative problem solving by their children.

4. Research to find out if algorithms are a realistic notion for use in social activities like education (as opposed to their current proven use in mathematics).

5. Research to identify genetic factors which contribute to the person's capacity to do creative problem solving.

6. Research to determine if the person's capacity to do creative problem solving is totally dependent on environment.

THEORY AND METHODOLOGY

As a theorist, it seems appropriate to reflect upon one's work in qualitative terms. Descriptive theory can serve two purposes:

...for the practitioner, the question is what do I need to do; for the theorists, the question is what do I need to understand (Mooney, 1978, pp. 4-56).

Chapter VI attempts to respond to the first of these tasks: Chapter III attempts to respond to the second, that is, provision of a...
broad understanding for the theorist.

In the process of evaluation of theory, one might address several specific qualities: 1) the provision of a context of relations within the theory, 2) the integrative power of the theory, and 3) the refinements introduced by the theory (Mooney, 1978, p. 4-36). The context of relations between teacher and student is examined in this dissertation. The uniqueness of this context of relations is that the emphasis is on what the student can teach the teacher and on how the two can interact in the most freeing and growing way. This kind of interaction is the basis for the integrative power of the theory. The "consumer" observing the teacher-student relationship sees a split between the teacher and student, a stagnant set of behaviors by the teacher (who is "never" changed or illuminated by students), and a dehumanized posture for the student (who is seen as an ever-expanding receptacle for predetermined content). The "producer" observing the teacher-student relationship sees an integration between the teacher and student, an open set of behaviors by the teacher based on inquiry and desire to nurture, and a human posture for the student (for whom content is provided). The relationship is seen as a whole, the parts of which complement and nurture each other. Moreover, this:

...theory doesn't set aside what has gone before as conceptual ground to build upon; rather it absorbs basic premises that have come in sequence heretofore.... What impresses us is the holistic nature of the universe and the progressive differentiations that can come from any organism as a point or origin, that unit being source from which whole has relevance (Mooney, 1978, p. 4-40).
The theory presented in this dissertation is integrated both in its content (the teacher-student relationship) and in its relation as a small part to the universe as a whole. That is, both the form and the fit of this dissertation reveal integration.

The attempt in this dissertation was to focus one portion of the model presented in Chapter 1.

Thus, refinement of the relationship between the teacher and student was provided. The theoretical propositions presented in Chapter III were grounded in the case studies of Chapter V. In order to further refine this model, research is needed: (1) What is the nature of the transactive relationship between teacher educator and preservice teacher? (2) between teacher educator and inservice teacher? And (3) within what institutional context can this model survive and (5) flourish? Finally, (6) What is the relation of the teacher educator to the student and (7) to the problems on which the student works? Such research would help to re-form this model, to ground it
in reality.

As a developer of research methodology, reflection upon one's developed methodology is necessary. It must be noted that the creative problem solver who attempts to find new algorithms is the same as the researcher who finds new methodologies to investigate a problem. The methodology of this study was particularly authentic. First, the researcher, in the formation of this dissertation was involved in the creative problem solving act described by the dissertation. Second, the researcher performed the task requested of those teachers involved in the case studies. Third, the process observed between student and teacher was the same process undertaken by the researcher and her committee. Such a replication of process at all levels of the study increases its authenticity. Finally, throughout the study and even now as this product is produced, the study is seen as a growing, developing, changeable entity which functions as a beginning for the researcher's professional work rather than an ending. Such a producer-view of this dissertation product is consistent with the producer-view valued throughout the study.

This form of methodology, as described by the above four characteristics, seems to have a place for further research in education. The complexity of the educational process (teaching and learning) is mind-boggling. Traditional quantitative methods provide substantive information about the process and about the context in which it occurs. Traditional qualitative methods serve to describe "chunks" of this context such as teacher attitude or developmental
stages. Both are useful and necessary. Both add to our knowledge about the educational process. What is missing is an integration of quantitative methods, qualitative methods, and other methods previously unexploited (such as research carried out by the classroom teacher using both quantitative and qualitative techniques in the effort to become a more effective teacher). Research that has binding threads throughout, joining all aspects of the study, as this dissertation has attempted to do, might result in greater understanding of the whole of the educative process.

My interest is in delivering this dissertation into the hands of the people who have the teaching to do; to those who teach educational researchers; to those who teach educational theorists; to those who teach inservice teachers; to those who teach preservice teachers; and of course, perhaps most critically important, to those who teach the children.
APPENDIX A

CLASSIFICATION OF ITEMS

In

"A PRELIMINARY LISTING of INDICES OF CREATIVE BEHAVIOR"

October 6, 1953

by

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CLASSIFICATION OF ITEMS
in
"A PRELIMINARY LISTING OF INDICES OF CREATIVE BEHAVIOR"

Introduction

While working on the creation of the items to go into the "preliminary listing," I tried, psychologically, to stay on the level of specific expressions. I did not want to work from a pre-designed system downward toward specifics, having found that when I work in that direction I have relative difficulty in creating vitalized specifics. I prefer to saturate myself with the specifics, stay on that level as long as I can, and let the items be arranged in the list as they follow according to a "feeling of vitality," and then to turn generalizer, trying to find out later what it may be that has been composed into the list.

The function of the classification, for me, was therefore to try to discover what may have been implicit in the specifics by way of a larger pattern which had somehow come to be operative in my mind without my knowing it. I therefore worked on the classification in the spirit of discovering "the dimensions of the field" which might be there at the level of previously unrealized assumption.

Having the classification now prepared, I want to use it as a means of checking out with others on the relevance of this perspective for their own ways of gestalting the field. Do the classifications make vital sense? What seems to have been left out? What is out of balance? If this system is suitably inductive of the specifics, what then is that further and deeper system of which this classification is a specific? Etc. I know that those who are interested in classification problems are perhaps a scarce and strange breed, but if there are a half dozen who find something intriguing in this particular problem and who care to serve as critics, I will feel myself rich indeed. Or, if there is anyone who would like to go through the whole exercise quite on his own, I would be most happy to supply such a person with a set of cards (one item to a card) to facilitate his own sorting. He gets the oak-leaf cluster.

The reader will notice that I have arrived at four "dimensions" for Part I of the list: (1) openness for the reception and extension of experience,* (2) movement toward differentiation and realization of self, (3) disciplined management of means to significant experience,

*For this concept, I am Indebted to Carl Rogers who has given vitality to the term, "openness," in these connections.
and (4) esthetic ordering of the forms of experience. The first dimension recognizes the creator as existing in an environmental field, both internal and external, to which he opens himself for experiencing. The second dimension recognizes the necessity of the creator differentiating himself within that field and establishing the position from which his experience is coming to be organized. The third dimension recognizes action as occurring in the self-environment field and the management of actional or operational behaviors as being requisite to the forming of significant experiences as life moves along. The fourth dimension recognizes the necessity of composing experience into formings of meaning to the creator, these formings having an esthetic quality.

In Part II of the list, I repeated two of these dimensions. I am still puzzled as to why I did not arrive at all four dimensions in Part II as I did in Part I. Perhaps someone can enlighten me on this point. Reaction to anything will be appreciated.

October 6, 1953

Ross L. Mooney
CLASSIFICATION OF ITEMS
in
"A PRELIMINARY LISTING OF INDICES OF CREATIVE BEHAVIOR"

ITEMS IN PART I - SELF-ORIENTATION

1. **Openness for the reception and extension of experience**: direct and spontaneous experiencing: openness to self, environment, life, growth and emergence, the unknown, and ideas.

**Direct and spontaneous experiencing**

75. He likes to feel things and perceive things directly.
76. When he gives himself to a new experience, he opens himself like a child to its immediate effects.
77. He can become childishly enthusiastic about an apparently simple thing.
78. At times he has experienced a heightened awareness, a capacity to see more, hear more, sense more than is usual for him.
82. He likes his experiences to have a sensuous quality as well as an intellectual quality.
83. He feels most sure of himself in experiences where the sensuous and intellectual qualities harmonize in support of a common perception.
181. He has retained a spirit of play.
182. He likes to share with children in their spontaneity and innocence.

**Openness to self**

18. He sometimes has a very vivid sense of his own being.
19. He is aware of his own vitality.
20. He likes to feel wide awake in every pore of his being.
86. He opens his internal life to his conscious awareness.
87. His own internal feelings and ideas can stimulate him as much as outside events.

**Openness to environment**

5. He insists on having things interesting.
22. He is willing to open his mind outwardly to the play of the environment on his senses.
24. He has experienced a sense of belonging to something larger than himself.
25. He is aware of a universe.
27. He feels his kinship with all mankind.
28. He feels that he belongs to all mankind as much as he belongs to his own particular times and places.
79. He is highly perceptive of some aspects of his environment.
154. At times he feels as if he were discovering the world anew.
Openness to life
17. He takes life as an adventure.
21. He does not fear death of his body nearly as much as he fears the death of his spirit, the disappearance of his appetite for life.
31. The problem of a happy life after death concerns him less than the problems of finding consummation in his life now.
138. He has a dual sense of life, one as participant in it, the other as observer of it.
139. He seeks to increase his capacity to participate fully and observe clearly.

Openness to growth and emergence
13. He values his own growth and development.
14. He is willing to risk suffering for the sake of possible growth.
15. He senses his life as a becoming.
16. He looks forward to realizing life anew as it emerges.
26. He seeks increasing universality.
29. He feels that his life lacks completeness and he wants to complete it as fully as he can.
30. He seeks a consummation.
60. He feels that there are forms within him demanding to be born.
74. He likes to feed on experiences which whet his appetite for still deeper experiences.
150. He cultivates deeper values.

Openness to the unknown
23. He is attracted to the mystery of life.
59. He feels there are powers to tap within him which he has not yet tapped.
61. He sometimes feels as if his life were in suspense, waiting for some unknown thing to happen.
62. He senses forces within him that extend beyond his awareness.
132. He seeks to get out to the edge of his conscious realizations and feel his way into the unknown.
133. He knows that the unknown may turn up the disagreeable and ugly as well as the satisfying and beautiful.
134. He respects the unknown.
135. He is more impressed with what he doesn't know than with what he does know.
136. He senses mystery in some things which seem so obvious to others.
137. He senses the unknown as existing both within himself and within "the world out there."
180. He has not lost his sense of wonder and delight.
Openness to ideas

88. There are times when he likes to day dream, curiously watching for whatever occurs in his mind.
89. He feels that his ideas "come to him."
90. He gets some of his best ideas when apparently thinking of nothing at all.
108. He cultivates the germinal idea, the budding conception.
109. A trivial coincidence may set off in him a large and penetrating insight.
128. He is alert to new perspectives, knowing that so much depends on the angle from which his problem is grasped.
145. New ideas and bold conceptions intrigue him.
146. He sometimes seems willing to entertain "crack-pot" ideas.
147. He is not ashamed to start in learning something at a childish beginning level if he feels it will help him.
156. He cherishes the "ah ha" moments when he gets a sudden insight into the nature of things.
157. He is quick with suggestions.
158. Sometimes he experiences a flood of suggestions, far more than he can immediately capture for use.

2. Movement toward the differentiation and realization of self: reaching beyond conformity, asserting independence, realizing uniqueness, creating self and world.

Reaching beyond conformity
1. He seeks to give some aspects of his environment a fresh form, a new structure and meaning.
2. He dares to be different in things that make a difference to him.
3. He will try things which would not occur to others to try.
4. He distrusts pat formulas for the control of his behavior.
6. He dislikes doing the same things the same way all the time.
7. He dislikes the shackles of habit when they prevent a fresh realization.
8. He is inclined to see things in terms of their potentials.
9. He likes to find ways of converting necessities to advantages.
10. He feels something lacking in the average and ordinary situation.
11. He wants to go beyond the typical.
12. He wants to transcend the established order.
151. He sometimes wonders whether he belongs to the immediate life around him as others seem to belong.

Asserting independence

40. He feels that his life somehow has its own independent roots.
63. He feels a need to honor his own internal necessities.
64. His central interests are more than other interests; they are yearnings.
66. Even though others may not understand him, he feels committed to the honoring of his own fulfillment.
69. He is aware of the responsibility involved in his own freedom of choice.
70. He is conscious that what he takes as absolute is still something affected by his own choice.
71. He depends heavily on his own experience.
72. He feels he has to check out the most important truths by the way they fit into his own experience.
73. He uses the experience of others as a check on his own, not as a substitute.

Realizing uniqueness
36. He feels that his life has a potential meaning, not only for himself but for the world.
37. He wants to know what the meaning of his life might be.
38. He seeks self-realization.
41. He feels that the composition of his being is somehow unique.
42. He feels that he may have a special contribution to give to the world.
85. He takes note of his own behavior and tries to understand it.
91. He is frequently surprised at himself for what he contains.
95. He searches for new ways of using materials to express what is new and unique with him.
140. He is sometimes capable of observing himself almost as though he were someone else.
153. Those things which he has accepted as old and familiar sometimes appear to him to be strange and distant.
152. He sometimes wonders just who he is.

Creating self and world
32. He gets his greatest enjoyment from his own creating.
33. He wants to give his life expression, form, objectification.
34. He wants to make his own revelation of reality.
35. He seeks to create his own version of the world.
68. He feels that the world he knows is, in important part, his own creation.

3. Disciplined management of means to significant experience:
   selection of vital work, concentration of effort, conservation of energy, control of work, management of materials, self-management.

Selection of vital work
43. He is conscious of the temporary quality of his own life and of the enduring quality of life in the large.
44. He sees many problems to work on, much work to do.
45. He feels his life is far too short to permit him to do all he want to do or might do.
46. He is conscious of the necessity of selecting what he will do and of the importance of that decision.
47. He is concerned with discovering the work which is most natural for him to do, most inclusive and challenging to all his capacities.
48. He takes his chosen work as a primary and necessary means of fulfilling his life.

Concentration of effort
49. He is able to bring to his work a concentration of his whole personality.
50. He can become quite intense in his feeling and expression.
51. Sometimes he seems to be consumed by his work.
52. He feels his problem intensely.
53. He likes the discipline of concentration.
54. He enjoys periods of hard work.
55. To complete some task important to him, he will sometimes drive himself to the point of exhaustion.
56. He will stick with baffling problems over an extended period of time.
57. He dislikes to waste his energy.
58. He dislikes indolence in himself and in others.
59. While working at one task, he is often imaginatively forming the next task he wants to do.
60. In some of the more obvious and systematic phases of his work, he is likely to be painstaking, disciplined and insistent.

Conservation of energy
120. He is sensitive to the level of his available energy and to the rhythms of his energy flow.
121. He knows the importance of becoming refreshed.
122. He gives his attention to learning effective relaxation.
123. When his thinking grows clogged and dull, he will cease intellectual activity and turn to something else more sensuous and free.
124. On coming to a puzzling and significant problem, he will saturate himself with all he can learn about it, then relax to get his cues for further work from suggestions which arise later from the levels of his unconscious activity.

Control of work
98. When he has completed a piece of work, he likes to be freed of it.
113. He is sensitive to what will spoil the development of his growing ideas.
114. He intensely dislikes distractions when he feels he is about to reach a clarification.
116. When he comes to critical phases of his work, he insists on freedom to control his own time schedule.
127. When he gets stuck in his work on a problem, he is likely to feel that he must be asking the wrong questions.
144. He is quick to sense the "atmosphere" of situations to which his work is relevant.
Management of materials
92. He enjoys playing with the materials he uses in his work.
93. He is sensitive to the qualities and limitations of his materials.
94. He likes to know his materials so well they "become a part of him."

Self-management
39. He is willing to face himself.
65. When internal tensions occur, he gives his attention to their resolution.
115. He tends to become moody and irritable when things get cloudy and confused inside.
117. He takes account of his moods and his state of being.
118. He develops a sensitivity to those moods which promise productive returns for his work.
119. He seeks to learn ways of promoting productivity in himself.
178. He is sometimes severe with himself, scolding and chastizing himself for his own foolishness or ineptitude.
179. He is also capable of laughing at his own blunders.

4. Esthetic ordering of the forms of experience: reflective turn of mind, sensitivity to harmonies of relationships; feeling way through; structuring toward simplicity and unity; sensing of analogies; concern for vital forms; autonomy of ideas; acceptance and productive use of the unconscious; awareness of values, purposes, assumptions; positive concrete, vivid, relative thought.

Reflective turn of mind
80. He is sensitive to occurrences which strike him as significant.
81. When something strikes him as significant, he wants to know why it has struck him that way, what has made it significant.
99. He likes to meditate and mull things over.
100. He is a reflective thinker.
101. He likes to use his mind.
102. He is interested in discovering how his mind works.
103. He senses the importance of ideas.
155. He is continually forming hypotheses and devising ways of testing them.
168. He likes to try to see behind apparent contradictions and paradoxes.

Sensitivity to harmonies of relationships
96. He insists on a harmony of form and function, means and ends.
104. In the realm of ideas, he has experienced the beautiful and the esthetically satisfying.

Feeling way through
84. He trusts his feeling to guide him through an experience, sensing its form and flow.
112. He moves toward solutions by progressively feeling his way through rather than forcing his way through.

131. He is willing to begin work on a problem he can only dimly sense and not yet express.

167. In judging the relevance of ideas, he seems to depend on a "feeling of fit," a sense of harmony, belongingness, appropriateness.

173. His thinking is marked by intuitive leaps.

174. Rather than being afraid of his intuitions, he cultivates them.

175. He depends on intuitive and reflective thought to bring him to his initial and most significant hypotheses.

176. He undertakes to use systematic thinking and logical formulations only after he has hypotheses to test.

Structuring toward simplicity and unity

159. In choosing among many suggestions, he seeks the one which does the most to include and release all the rest.

160. In solving problems, he searches for the simplest structural form with which to catch up a whole field of relations at once.

161. In the progression of his life, he seeks the ever more simple-and-complete.

163. In trying to understand events, feelings, ideas, he seeks to find a structure for them.

164. He has the power of seeing relations amid a multitude of differences.

165. He wants to know how things fit together.

Sensing of analogies

162. He is intrigued with the problem of how living things form and become.

166. He enjoys the quick analogy, the sudden suggestion of a comparability between things not heretofore related.

Concern for vital forms

169. He is intrigued with the problem of how living things form and become.

170. He intuitively senses a profound order in nature and seeks to uncover that order in himself and in the universe.

171. Vital forms attract him more than static forms.

172. His thinking has an "organic" quality.

Autonomy of ideas

110. As his ideas form, he senses that they seem to grow out of their own roots, as if independent of him.

111. He is most confident of his solutions when they seem to fall into place of their own accord, without his forcing them.

130. In an important sense, he feels that he does not know what his problem is until he reaches the point of its resolution.
Acceptance and productive use of unconscious workings

125. He has learned that the work which goes on in him at unconscious levels is as important in the solving of his problems as what he does consciously.
126. He seeks to harmonize his conscious and unconscious workings.

Awareness of values, purposes, assumptions

67. He is aware that the truth he sees is shaped according to his values.
141. He pushes to uncover the assumptions which he has been taking for granted without being aware of it.
142. He gives much attention to getting and keeping his purposes clear and relevant.
148. He is sensitive to his values as they enter to structure his thought.
149. He seeks to make his values explicit.

Positive, concrete, vivid, relative thought

105. His thinking has a positive, declarative quality.
106. Though he may be dealing in abstractions, his ideas still contain a quality of concreteness.
107. His imagery tends to be vivid.
143. He is conscious of the relativity of things, their interdependence and mutual transformation through time.
ITEMS IN PART II - ORIENTATION TO OTHERS

1. **Openness for the reception and extension of experience with others:**
   openness in feeling toward others, openness in the feeling of others toward him, protection of a system of openness in interpersonal relations, openness to learning about human nature.

**Openness in feeling toward others**

184. He likes people.
168. He is open and direct in his dealings with people.
189. He tries to make it easy for others to understand him.
200. He is sensitive to people's needs for personal security.
201. He is sensitive to people's needs for personal security.
239. He likes to be of help to others in the discovery of themselves.
258. He is willing to ask others to help him clarify his own problems.
259. He enjoys sharing with people who have become as sensitively aware of their existence as he has become aware of his.
260. He loves humanity and wishes to better mankind.
262. His love is non-possessive.

**Openness in the feeling of others toward him**

190. People feel at ease in talking with him.
192. People find themselves telling him their personal problems.
232. People feel that he trusts them and that they can trust him.
236. He brings out the good in people in their relations with him.

**Protection of a system of openness in interpersonal relations**

222. He is sensitive to acts which increase dependency of himself on others or of others on himself.
223. When he accepts the dependency of others, he expects to help them become more independent.
224. He is aware that his own psychological independence and freedom is dependent on others having a similar psychological independence and freedom.
225. He implicitly expects others to honor his own integrity.
228. He will not let others run over him in the things of deepest value to him.
231. He can be aroused to deep anger.

**Openness to learning about human nature**

183. He is a keen observer of human nature.
165. He has always been interested in people.
186. He wants to know what makes people behave the way they do.
187. It is important to him that he understand the people with whom he deals.
194. He searches for the way things look from another person's point of view.
202. He is quick to note underlying emotions.
203. He habitually watches for people's impelling motives and guiding purposes.
204. He watches for the roles people give to themselves and to each other.
205. He is alert to changes in roles as they occur.

2. Disciplined management of means to significant experience with people: skills used in dealing with others, concepts underlying his dealings with others, self-management.

Skills used in dealing with others
191. He knows how to listen.
193. He seems to listen to what lies behind their words.
195. He seems able to participate with others in their own experiences.
196. He seems to understand a great deal without being told.
197. He is thoughtful in what he says.
198. As he speaks he seems to be taking others into account.
206. He has made a habit of role-playing, within himself, while watching or listening to others.
208. He "feels out" the values that hold the lives of others together.
209. He searches for a "center" in each person's being.
213. He readily contacts people in widely varying stations of life.
221. He challenges others to achieve their own independence and freedom.
227. He sees the potential evil in people as well as the potential good.
233. He readily allays suspicion.
235. He readily reveals his motives to others.
261. He shows his love and affection.

Concepts underlying his dealings with others
207. He treats others as persons beyond the roles they take.
210. He seeks to understand individuals in the light of their own composition and history.
211. He takes each person to be uniquely valuable in his own right.
212. He is wary of categorical descriptions of people.
214. He is sensitive to the effects which people have on one another.
215. In selecting people who are to work together, he is sensitive to choosing those who would have a constructive effect on each other.
216. When people clash with one another, he is disturbed until he can see some common ground on which they might feel secure.
217. In conflict situations, he operates on the premise that there is a fitting place for everyone if suitable places can only be visualized and effectively worked for.
218. He feels an elemental urgency in human beings to find ways of helping themselves.
219. He acts on the assumption that each person is interested in enriching his own life.
230. He will take action when foreseeing his own or other people's degradation.
234. His own motives in dealing with people are uncomplicated.
229. He is sensitive to abuse and injustice in people's dealings with people.
237. He acts on the assumption that people want to do the good and fulfilling thing.
238. He is openly aware that in making this assumption he is acting on faith.
263. While treating others as persons, he also sees them as samples of mankind.
266. He seems guided by a desire to treat others as he would treat himself.

**Self-management**

199. He seems to listen to his own words as if from someone else's point of view.
220. He seeks his own psychological independence and freedom.
226. He has found it necessary to be honest with himself.
240. He has found his work with others to be important means of achieving perspective on himself.
241. He seeks a clear perspective on his own life.
242. He is sensitive to discrepancies between the way he actually behaves and the way he wants to behave.
243. He has met serious problems in his own life.
244. He has discovered potential evil in himself.
245. He has felt fear, hate, jealousy, meanness, etc. in his own being.
246. He has been humbled before his own internal struggles.
247. He has experienced failure.
248. He seeks to openly recognize his own limitations and imperfections.
249. He appreciates and consciously recognized the favorable and hopeful aspects of his life.
250. He seeks to include both his negative and positive tendencies as realistic aspects of himself.
251. He has felt the narrow margin between integration and disintegration.
252. He knows that the achievement of integration is a continuing struggle.
253. He has found a way of accepting the struggle of life as inherently worthwhile.
254. He has learned not to expect too much of himself or others.
255. He has developed a philosophy of life.
256. He is more interested in wisdom than in knowledge for its own sake.
257. He seeks to use knowledge to produce wisdom.
264. He seeks to see himself more and more in the light of all mankind.
265. He seeks to universalize and objectify both himself and others.
One technique for validating this stimulating teaching algorithm is to compare it to the verbalization of great teachers about their own teaching process. Such a description is included as Appendix B of this dissertation. Appendix B is the note written to me by Professor James K. Duncan when he first read that I was interested in elaborating a stimulating teaching algorithm. This description seems to confirm the accuracy of the stimulating teaching algorithm.

Phyllis -

A lot of my own professional work is done in the area you propose to investigate as a subject of inquiry. Each Ph.D. dissertation should be a piece of original work -- that is, solving a problem that has not been solved before. I am, therefore, in the role of the teacher in your study -- the student being the candidate for the Ph.D.

I have not studied this subject as you propose to study it but I have a wealth of good and bad personal experiences I can draw upon which may be useful to you if I share my learning from these in the form of propositions that I believe have been confirmed in my experience (I'm arguing from an N of 1 😊).

In order to help another generate algorithms for solving problems the teacher should be able:

1. To comprehend (in the broadest sense of that term) the problem in the same way the learner does. This involves
cognitive as well as affective comprehension (students, for example, have feelings about statistics as well as some level of knowledge about statistics. Both affect the way they solve the problem at hand).

2. Get the learner to "tell It like It is." That is, he must get the learner to reveal the nature of the problem and his (the learner's) own relationship to it as fully as the learner can. The first question I ask myself is do I understand the problem as posed by the learner. It is usually true that the learner does not fully understand the problem and because this is the case I, of course, cannot fully understand the problem as the learner sees it. And, this is important, I usually understand some unresolved aspects of the problem and learner's relation to it that he or she does not yet understand. (It is tempting to move in and explain to the learner what I know that I think he does not know -- much as I am doing here. This is a right course of action only if I believe I have a good understanding of the learner and his or her problem and feel that what I have to say can be fitted by the learner into the problem area as he or she sees it).

3. Explain to the learner what the problem is from the learner's view. (Explain is used in the broad sense of the term). In my own work I ask him or her to
correct me where I have misunderstood. This is a period of give-and-take -- an interpersonal transaction for purposes of clarification.

4. To "own" the problem in the same sense that the learner "owns" the problem. This is a very complex issue. If the learner feels the problem is trivial I should feel the problem is trivial. If the learner feels the problem is very significant I should feel the problem is very significant. It is a matter of empathy with the learner in the problem solving process. I may myself not be frightened by the effect of orthodox research standards of the graduate school but I should fully understand the feelings of fright that the learner may have. It is in these as well as the cognitive senses that I must "own" the problem. Very often I do not have the knowledge about the problem that the student has but insofar as he or she shares that with me I "own" the problem in the same sense as he or she does. A final illustration; I must share in his or her belief about the power of the method (e.g., ethnographic, interview, experimental design, etc.) if I am to "own" the problem in his or her sense.

When I come to "own" the problem as the learner does I must become highly self-conscious about my
working relationships with the learner. I will for example worry about the problem on my way home from work. I'll generate solutions to "give" to the learner. (I make most of my mistakes here). I must realize that every effort of mine to take the problem over as my own robs the learner.

5. **To preserve the learner's right to "own" his or her own problem.** Although I feel free to suggest or admonish, I have to do so only when I believe the learner can readily assimilate the suggestions or admonitions and adopt them as his or her solution. (We have a fine example of that in what I am doing right now in response to the problem area you have posed. I could have chosen not to share these ideas with you).

6. **To help the learner analyze the problem and his own relations to the problem.** As you know I tend to go to the blackboard, define terms, use logical processes -- both inductive and deductive. I am helpful to some students when I do this and not so helpful to others. In addition, I tend to rely upon principles I consider fundamental, e.g., principles of measurement, definition, probability, etc. Much more could be said here.
7. **To help the learner see what resources are available**
to **him** -- his own especially but also the resources of others and of materials.

8. **To help the learner synthesize.** Most problem solvers have difficulty maintaining perspective and seeing the larger view especially after analytical examination of an aspect of a problem. If I do it right I ask the learner to synthesize. In my hurry to get the problem solved I often do the synthesizing myself. This does not work well for me. It is strange to me that people can follow my analyses and in large measures adopt the analyses as their own but cannot do the same with my syntheses. I think this is important but don't know why.

9. **To give the learner all the time he needs and simultaneously maintain some social pressure for solutions.** Creative behavior cannot be hurried. I maintain social pressure mainly because both the **learner** and I understand that I "own" the problem too. I have a stake in its successful resolution. If the learner fails -- we both fail. If the learner succeeds we both succeed.

10. **To serve as critic to the learner both with regard to the processes being employed and the solutions being reached.** In Ph.D. dissertation work this becomes increasingly important as each piece of
the algorithm is "polished" and "put in place" in the overall mosaic. The important part of this has to do with the level of humanness exhibited by the critic. Criticism should be "tough" but unless humane is worse than useless. If I truly "own" the problem in the sense that the learner does the criticism is easier to accept. The teacher's role here is a difficult one to play. I do it best when I hold in mind the strengths and weaknesses of the solution as I see them.

Some additional reflections on this process from my own experience.

I am disappointed when some of my pet ideas do not appear in the developing solutions. I have to be careful that doesn't show. I should assume that the learner decided on good grounds that these ideas were not a part of his solutions. I err more often here than I like to think.

The learner and the problem are constantly changing (and I am too). Every session begins in a new "place" -- not usually disconnected from the old "place" although sometimes it is hard to see the relations between the two. At some stages the growth of confidence in the learner is vitally important. Uninterrupted growth in confidence is a bad sign.

If I am satisfied with the progress I am making in solving the problem it is likely to signal trouble. If I am satisfied with the
progress the learner is making it is a good sign.

I think, in general, the teacher should have the feeling that
he or she is a few steps behind the learner much of but not all of
the time. In a healthy transactive interchange of thoughts and
feelings the pair should be moving ahead together building upon the
strengths that each can provide. In my own work, as I lead I feel
increasingly that the problem is in me not the learners. I have
suggested the dangers here.

I have a propensity to talk too much. This is coupled with a
kind of reification of words. A sense that problems can be solved with
words. I know better. Words are tools to guide experience and ex-
perience solves the problem not the words.

To use one of Ross Mooney's expressions I am guided by the
quality of the "fittings" I make in this process. If the fitting
doesn't feel right, I sense an error and seek the reason. If the
"fitting" feels right I presume I am doing what can be done to enhance
the learner's capacities to create the algorithms. In this latter
case, I am often-times misled because I confuse my satisfactions with
the satisfactions of the learner. My sense of goodness of fit is not
his or her sense of goodness of fit. A better guide is his or her
sense of the fitness of things.

Hope these rough comments prove useful to you but will not be
upset if they don't.

Kelly


____. "Classification of Items In 'A Preliminary Listing of Indices of Creative Behavior'." Columbus, Ohio: Bureau of Educational Research, The Ohio State University, 1953B, 10 pp. (Mimeographed).


