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ABSTRACT
                This manual provides a set of tasks for use in the
microteaching context of a Teaching Laboratory to be used in teaching
pupils an approach to problem solving. The introduction describes the
contents and functioning of the Teaching Laboratory and the way in
which the manual should be used. Details of five lessons are then
given. The first lesson is unstructured, the only requirement being
that it should be relevant to the curriculum. It is followed by a
description of the evaluation methods, the different aspects of the
learning situation, and those of teaching problem solving. Lesson 2
presents the problem; lesson 3 formulates hypotheses; lesson 4
verifies hypotheses; and lesson 5 applies the generalization. In the
description of each lesson the instructional objectives and methods
are detailed, and an evaluation guide and listening guide are also
included for each. (MBM)

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TEACHING FOR PROBLEM-

SOLVING: A TEACHING

LABORATORY MANUAL

(Preliminary edition)

Thomas B. Gregory

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The Research and Development Center for Teacher Education

The University of Texas at Austin

Foreword

Microteaching is one of the brightest innovations spawned
in teacher education. Its attractiveness may be attributed to a
number of interests and concerns. Some see microteaching, as it
was developed at Stanford, as a substitute for a more regular,
extended practice of teaching prior to a fifth-year internship.
Others believe it an appropriate substitute for student teaching.
Some view it as useful in the early induction of candidates into
teaching. Still others look to it as a viable component in different
elements of the teacher education program. However seen, micro-
teaching seems to require only a few critical elements.

An indispensable element of microteaching, would seem to
be the skill or task or set of skills or tasks upon which the
teacher candidate focuses in this teaching exercise. The Stanford
model includes a number of technical skills of teaching, e.g.,
establishing set, reinforcement, varying the stimulus. Quite likely,
this list of skills is widely adopted and used in many programs.
Major reasons seem obvious. This set of skills was the first developed.
Too, attention to these skills appears productive in changing
teacher candidates' behaviors. The attractiveness of microteaching

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and the availability of the early set of skills should not inhibit,
on the other hand, development of alternative conceptions and
programs. Indeed, development of many sets of skills or tasks
useful in the microteaching setting should be fostered.

This manual, Teaching for Problem-Solving, is one set of
tasks developed for use in the microteaching context. These tasks
direct candidates' attention to a rather specific system of teaching.
In keeping with other work in the Texas Research and Development
Center, this set is concerned with pedagogic tasks with which
teachers must engage if they are to teach pupils an approach to
problem-solving. This manual has been used in a major research
project conducted by its author. Research results indicate that
beginning teacher candidates working with these tasks in the
Teaching Laboratory do change their teaching behaviors. The
author nevertheless believes the tasks may be even more useful
to candidates after they have attended to some more general and
possibly basic tasks, e.g., clarifying objectives, questioning,
explaining. For example, the tasks might be very useful in special
methods courses in social studies, mathematics, and science. They
might have less applicability in special methods courses in art,
music, business, and physical education. That usefulness may

vary as a function of the teaching field is now only a hypothesis worthy of examination. The manual, in this experimental version, is issued that teacher educators may use it, may react to it, and may experiment with it.

Dr. Thomas B. Gregory, the author of this manual, is now Assistant Professor of Secondary Education, School of Education, Indiana University. An experienced teacher in Ohio schools, he was one of several key individuals who participated in the early development of the Teaching Laboratory at The University of Texas at Austin and who contributed to the manual used experimentally in that Laboratory. This experience served him well in preparing this new manual.

The author would appreciate hearing from those who examine and/or use the manual. This type of feedback is important to planned revision and experimentation. Permission to reproduce the manual should be requested from the Research and Development Center for Teacher Education, The University of Texas at Austin.

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TEACHING FOR PROBLEM-SOLVING:
A TEACHING LABORATORY MANUAL
(Preliminary edition)

Thomas B. Gregory

Rationale for the Teaching Laboratory. Most teacher education

programs are comprised of three basic phases: 1) courses in Educational

Psychology, in Curriculum and Methods, and in the History and Philosophies

of Education; 2) observations in the schools; and 3) student teaching.

The rationale for such a program is fairly obvious. Courses attempt to

give the student the prerequisite knowledge necessary for teaching; ob-

servations allow him to relate this knowledge to real situations; and

student teaching permits him to gain experience at applying his newly

acquired professional knowledges and skills. The paradigm has been

widely accepted if not embraced.

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Such a traditional program is not enough. At least one
additional phase is desirable, one consisting of a series of laboratory
components. These components collectively will be referred to as the
Teaching Laboratory, the purpose of which is to bring at least a
modicum of reality and specificity to the pre-student teaching phases
of the teacher education program (Broudy, 1964; Davis and Gregory, 1968).
Think of a continuum such as that in Figure 1.

	College Courses	Obser- vations	Teaching Labora- tory	Student Teaching	First Year of Teaching	
Little Reality						Reality
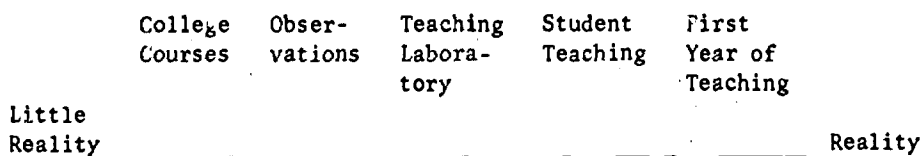
Figure 1

The Teaching Laboratory is viewed as a vechicle for encouraping the
early relation and application of knowledges. Also, it is seen as an
intermediate agent enhancing the probabilities of transfer fo knowledge
and skills learned in the college classroom to the public school class-
room by reducing their perceived dissimilarities.

Basic Description of the Teaching Laboratory. The Teaching
Laboratory (TL) is a small room equipped with the basic classroom

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furnishings, including desks, a blackboard, an overhead projector, and
easy access to other standard audio-visual equipment. It also contains
audio or video recording equipment with which to record the TL lessons
taught by candidates. These records provide accurate and realistic
feedback to teacher candidates using the Laboratory.

In addition, the Teacher Laboratory also contains from four
to eight "students." They may be real students recruited from the
public schools or other teacher candidates role-playing students of a
given age and ability level. The latter has proven to be an expedient
if not desirable alternative, at least in the case of secondary teacher
candidates.

The Teacher Candidate's Role in the Teaching Laboratory. In
the Teaching Laboratory, one is required, among other tasks, to incor-
porate specific teaching strategies into short TL lessons or "teaches."
TL lessons will range from five to twenty minutes in length. When
not teaching, a subject may be acting as an observer or student for
another candidates' teach. In all cases candidates are observers and
evaluators, writing comments on teaches made by their colleagues and
possibly by themselves.

Since role-playing students may be an additional responsibility,
the use of some simple procedures may make the assumption of a specific

role easier. An example may be useful in making this point:

> Situation Requirement: Be an average tenth grader in
> English. For a start, think back to your own tenth
> grade English class. Think of your teacher, your class-
> mates, and your collective attitudes toward your teacher,
> each other, English, and school in general. Did the
> class easily volunteer information or was it reticent?
> Was your class really average, or did most of the
> students in it go on to college? It is possible for
> you to role-play yourself, or another student, or a
> composite of other students. Assume the role that
> seems most natural and exemplary to you. Your task may
> be complicated by the fact that you have never had the
> subject being taught. In such a case, you may consider
> yourself a student with learning problems. Use what-
> ever other devices you find helpful. Do attempt to
> avoid stereotyped behavior, since it may encourage
> stereotyped reactions from your "teacher."

The Manual. This manual is designed to introduce teacher
candidates to some of the important teaching strategies identified
by educational and psychological research. Teaching is, in part,
a psychomotor task in much the same sense that driging, acting,
typing, and playing a musical instrument are. Obviously, learning
any of these involves acquiring the necessary cognitive skills.
But in addition, none of these tasks can be adequately learned without
mastering their physical requirements.

This is generally best accomplished through actual practice
on the task or on a closely related physical activity. This manual's

prime purpose is to guide teacher candidates to acquire widely
accepted teaching behaviors through practicing them in a situation
related to that found in a real classroom.

The rest of this manual will speak to the reader as a
teacher candidate.

LESSON ONE

AN UNSTRUCTURED TEACH

The requirements for this first teach are quite simple.

You are to teach a short lesson eight to ten minutes in length on

some curriculum-relevant topic in the TL.

Just as jumping into the water is a prerequisite to learning

how to swim, getting some first hand experience in the Teaching

Laboartory is a prerequisite to learning and effectively applying

specific strategies to later teaches. It is not atypical for you

to be anxious or nervous on this first teach. On the contrary, you

should be concerned if you are not; small amounts of anxiety are quite

helpful in motivating one to perform tasks more effectively. There

are at least three characteristics of this first teach that may

contribute to your nervousness. The specific purpose of this teach

is to help you overcome them.

First, it is not unusual for beginning teacher candidates

to be concerned about many matters of great personal importance to

them. Some examples are what to do with one's hands, how to move

about the room in a casual manner, how to anticipate the students'

reaction to one's lesson, and how to avoid one's undersirable speech

mannerisms. Such problems diseppear with experience, but can be

disconcerting to a beginner. Recognition of this should facilitate

the reduction of any anxiety associated with these matters.

Second, teaching in general and especially TL teaching can
be termed an ego-involvement situation (Sherif and Cantril, 1947).
You come to teaching with a well-established conception of your-
self and your own personal competencies. For instance, you would
not be here if you did not think you could be a good teacher. In
the Teaching Laboratory, you are confronted with the necessity to
"prove" to yourself that your assessment of your own competence is
correct; you are, in other words, ego-involved. This first teach
gives you an opportunity to begin receiving meaningful feedback to
use in assessing how realistic your self-concept is in regard to
your ability as a teacher.

Third, any time one performs (in a behavioral rather than
a theatrical sense), he is unconsciously aware that he is being
evaluated. For example, think of the number of unsolicited clarifying
statements (e.g., giving examples, paraphrasing, asking for agree-
ment, interjecting qualifying statements) made in everyday conversation
to insure that others will accurately understand one's position on
matters. This unconscious awareness surfaces to a conscious awareness
in the Teaching Laboratory since one's performance is being formally
evaluated. It is compounded by the additional awareness that part

of that evaluation is being made by one's peers. Since all place

high value on their peer status, any threat to it is anxiety producing.

As you teach in the Laboratory you probably will find your colleagues

quite supportive and the threat to status and the anxiety accompanying

it greatly reduced. Since this teach is not formally evaluated, it

gives you an opportunity to begin coping with whatever anxieties you

may have. You also have the opportunity to make some important first

steps in terms of a self-evaluation of your teaching behavior.

Some teacher candidates come to this course with the feeling

that they "just have to teach," that no other recourse is open to

them, that not to teach would be a great personal failure. The

anxiety produced by the thought of failure results in a very high level

of motivation--in some cases, too high. That is, for some, anxiety

is so great that it impairs performance and must be reduced to facil-

itate acceptable performance in the Teaching Laboratory. If you find

yourself in this position, consultation with your instructor may

produce the means for alleviating your individual concerns.

To repeat, your task for this first teach is to prepare and

teach a ten-minute lesson in your subject area. Your only require-

ment is that it be curriculum relevant. That is, choose a topic that

would legitimately be taught in a public school classroom. At first,

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you may feel that ten minutes is not enough time to adequately teach
anything. This is not the case. Most long lessons are really made
up of many short segments connected by transitions. Roughly plan in
outline form a 50-minute lesson by setting down the procedure you
might follow. Examine each of the major outline headings and you
will find that most can be treated in ten minutes or less. In fact,
if your outline has five or more headings, some must be. Select any-
one of these as the topic of your first teach. It can be the beginning,
middle, or end of the larger lesson. By analogy, you are being asked
to think of a theme topic, but are required only to prepare one
paragraph of the total paper.

In this lesson, you may encounter a "clean slate" problem--
the largely falacious idea that you must always teach everyone and
everything "from the beginning." An examination of several textbooks
in just one area of one of your teaching fields will produce vast
differences in the ordering of topics. Such an exercise reveals that
each field has many possible starting points for instruction. Never-
theless, some topics do require cetain prerequisite knowledge. If
your TL lesson topic requires such prerequisite knowledge, the
necessary information can be "taught" by giving your students a
prepared handout contaiining the necessary information. Admittedly,

some topics are inappropriate to the Teaching Laboratory, but they are
far fewer than one might imagine.

The time limit on this first TL lesson is not crucial. It
can be as short as five minutes if you like. You may find it helpful
to receive a signal after eight or nine minutes so that you can smoothly
bring your teach to a close. Assume that at ten minutes the bell has
rung, and your students will have to leave for their next class and
you must conclude your lesson as quickly as possible.

So that you will better understand the criteria used in
evaluating each teach, they are stated in behavioral terms. Since
this first teach has very little structure and is not formally
evaluated, it does not require the several instructional objectives
necessary for subsequent, more structured teaches.

INSTRUCTIONAL OBJECTIVES FOR FIRST TEACH

1. The student will be able to teach a ten minute lesson on some
curriculum-relevant topic in the Teaching Laboratory.

EVALUATION

One of a teacher's most difficult and important tasks is
making fair, accurate evaluations of his students' performances.
Anytime one is asked to describe everything he knows about another
human being by one letter or a numeral, he tries, in effect, to dic-
hotomize human experience. The task is both impossible and misleading.
Yet, teachers continuously are required to do both. In the Teaching
Laboratory, you will gain a great deal of direct experience in
evaluating your colleagues' teaches. Hopefully this guided experience
will improve indirectly your ability to evaluate the performances of
your future students.

In general, the criteria upon which judgments will be made
should be clear. This principle, easily understood, is less easy to
implement. The best method presently available for dealing with this
problem is by stating the criteria for acceptable performance in terms
of observable behavior (See Mager, 1962). Such instructional objectives
attempt to communicate concisely and accurately by avoiding the use
of terms having many different interpretations (e.g., to know, to
understand, to appreciate, tec.).

A well-written instructional objective satisfies four
requirements necessary for the unambiguous communication of the
criteria used in evaluation. Of those listed, the last three are
taken from Mager (1962, p. 12).

1. The objective identifies who must perform the act. In the case
    of the tasks in this manual, the who is you, the teacher candidate.

2. The objective identifies the terminal behavior that is considered
    evidence that the desired learning has taken place and the ob-
    jective has been accomplished. With respect to the tasks in this
    manual, the terminal behaviors are those of individuals who teach
    and are usually stated in terms of teaching behavior.

3. The objective attempts to define the desired behavior further by
    describing the important conditions under which the behavior will
    be expected to occur. The conditions under which you will perform
    the tasks in this manual are those present in the Teaching Laboratory
    (e.g., small number of students or colleagues, time limit, etc.).
    They are reasonably constant and, thus, are not repeated for each
    objective in every task.

4. The objective specifies the criteria of acceptable performance
    by describing how well the learner must perform to be considered
    acceptable. This requirement is difficult if not undesirable
    to fulfill with respect to the tasks of this manual. Teaching
    strategies are best considered as being inappropriate or
    appropriate to specific situations rather than being "good" or
    "bad." Consequently, the instructional objectives stated in this

manual have rather imprecise criteria for <u>acceptable</u> performance
in general but more stringent criteria for appropriate performance
in the specific situations created by each individual's teach.

Grades you assign to your colleagues should be based on how
well they <u>appropriately</u> have fulfilled the instructional objectives
specified for that teach. While teacher candidates are encouraged
to select topics that will allow them to apply all the required strategies
of a specific task, finding one is sometimes difficult. You should
consider this in evaluating the appropriateness with which a specific
teaching strategy has been used. The instructional objectives for a
task attempt to operationally define appropriateness for each of the
task's teaching strategies. This should enhance the agreement of
individual evaluators.

Since grades are extremely limited in their ability to
describe human behavior and in no way suggest ways of improving it,
you and your colleagues will find more detailed feedback of great value
in your attempts to improve your teaching. Thus, you will find it
useful to supplement your grades to each of your colleagues with written
comments conveying your reactions to their teaches.

Common sense is a good guide to what to write and how to
present it. First, comments can refer to the specific criteria upon

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which grades for a teach are based, or they can refer to the many

other behaviors not being evaluated but still   crucial importance

to effective teaching. Both are of value when they point the way to

improved teaching behavior.

Second, everyone likes to hear about their strengths, but

they also are interested in knowing their weaknesses. More precisely,

they are interested in knowing how to overcome them. Therefore,

coupling identifications of weaknesses with constructive suggestions

for improvement is a highly desirable practice both in the Teaching

Laboratory and later in teaching. Strive for a healthy balance in

your criticism (i.e., identify about as many strength as weaknesses)

and your suggestions will not only be accepted by colleagues but sought

as well.

Third, avoid resorting to negative affect (e.g., "you did a

bad job of . . ." or "that wasn't really teaching . . ."), or sarcasm

(e.g., really now, did you mean to do that). One seldom slips into

this mode of communication, but even small amounts of it can be very

damaging to interpersonal relationships.

Fourth, work for quantity as well as quality in writing

comments. Deciding which points will be most relevant to a colleague

is often difficult. Writing many comments enhances the possibility

that you will hit upon a point of particular relevance to his present
stage of development as a teacher.

Writing comments can be a nuisance, but it also can aid
in development of the abilities to discriminate important aspects
of the whole, to diagnose weaknesses, and to prescribe alternatives,
all of which are important attributes of effective teaching.

In summary, teachers need to be good evaluators. The Teaching
Laboartory offers you extensive experience in evaluating the performance
of both your colleagues and yourself. Written comments are valuable
when they are both constructive, and substantive. Comments are of
most educational worth when they suggest directions in which to change
behavior and the means through which to do it.

THE LEARNING SITUATION

Hopefully, the product of all teaching is learning.
Regrettably, a teacher sometimes finds himself working in situations
where little learning seems to be occurring despite his teaching
efforts. The first question he may ask is "Why?" to which a multitude
of "experts," lay and professional, will proffer a diversity of answers.
Some will seem to conflict. Others may be reconciled with varying
degrees of difficulty. A few may even constructively suggest solutions.
All will probably be partially correct since learning is a complex
problem.

Teacher candidates are sometimes confronted with what appear
to be "cookbook" solutions to problems found in general learning
situations. These "recipes" are the product of years of teaching
experience and are not without value, but they seldom explain "why."
In addition, the complexity of the learning process makes generalizations
difficult, causing such solutions usually to be amended with numerous
qualifying statements describing the circumstances under which a
procedure is appropriate. Unfortunately, such descriptors can induce
confusion as well as enhance clarity.

Teachers thus find themselves in the position of having
to be able to select the most relevant suggestions of those avail-
able, synthesize these into an accurate explanation of the problem,

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and develop means for remedying the situation. The undertaking is a

formidable task. The classroom teacher, already burdened with numerous

other responsibilities, is often the only person with sufficient

knowledge of the specific situation to accomplish the task. The following

learning model is proposed as a construct to both aid the development

of explanations of why learning problems occur and suggest strategies

for their remediation.

On the basis of existing research, three distinct, though

closely related, variables emerge which must all be adequately sat-

isfied if learning is to take place. They involve 1) the developmental

status the individual brings to the learning situation, 2) the degree

of incongruity experienced by the individual in the learning situation,

and 3) the individual's conception of his own competence to deal with

the learning situation with which he is confronted. An examination

of learning situations where one of the variables is not satisfied

may aid an understanding of the three variables and why each is

essential to a productive learning situation.

The first variable involves the developmental status and

prior learning of the individual. It is important that the learning

situation fit the structure of his cognitive maps (ways of thinking),

or what Piaget (1968) calls "schemata." For example, a teacher can

place a tall, narrow glass and a short, wide glass of equal volume in

front of a six-year-old child. The teacher first fills the short

glass to the brim with water and then pours it from there into the

tall glass, filling it to the brim. To the question, "Which glass

holds more water?" the child, focusing on the heighth variable, will

answer "The tall one." Some children, focusing on the width variable,

will answer "Th- wide one." Further pouring and questioning does not

change the answer; the child is unable to see the fallacy in his answer

because he has no concept of the conservation of matter, or more

specifically, the conservation of volume. Because of his prior learning,

he does not sense the incongruity raised by his answer and will not

until he has "restructured his cognitive maps" or "transformed his

schemata" or "learned."

The second variable is closely related to the concept of in-

congruity mentioned in the first. Learning requires the arousal of

curiosity which is stimulated by an encounter with incongruity. A

teacher might ask a group of seventh graders "Why is it that an airplane

weighing many times the weight of a car can fly, but the car can't?"

"Because the airplane has wings." If he allows this answer to stand,

no curiosity is aroused, but if he probes "How do wings make an air-

plane fly?" and follows with related ques ions, he is well

on his way to fulfilling the requirements of the second variable, the encounter with incongruity.

The third and final variable, like the first, is internal, but it is primarily affective rather than cognitive in nature. It centers around what is usually termed self-confidence, or what White (1952, 1959) has termed "effectance" or "competence motivation." Consider an otherwise able student who is having trouble with algebra. He may continually be confronted with situations where the first two variables are satisfied, but the third is lacking. He has come to consider himself a weak algebra student and the problems he encounters seem overwhelming for his capabilities.

His dilemma becomes a self-fulfilling prophecy (Rosenthal, 1968) unless his teacher is able to diagnose the actual problem and guide him slowly through the process of solving the equation, encouraging him along the way and showing him "that it really isn't as hard as he thinks it is." High school dropouts are immediately defeated when presented with a two or three hundred page textbook, but see the same material as realistically within their grasp when it is given to them in ten or 15-page sections.

In summary, learning is a function of at least three variables: 1) the prior learning of the individual; 2) the degree to which the individual is aware of an incongruity; and 3) the individual's conception of his competence to deal with the situation. Learning problems occur when any one of the variables is inadequately satisfied. There

are many reasons why satisfaction of all three is difficult, but one
of extreme importance is the uniqueness of the learning act for each
individual. Trying to deal with learning (a largely individual process)
by teaching a class (a group process) is extremely difficult.

You may find the three-variable concept of the learning model
a useful construct in planning your TL teaches. The instructional
objectives for each teach implicitly require this type of planning.
Planning instruction by cons⁻iously attempting to satisfy the three
variables in the learning situation cannot hamper your attainment of
the instructional objectives for a teach. On the contrary, it should
aid your achievement of them. In addition, you may find the model a
useful guide for instructional planning in situations lacking the
structure of TL teaches (e.g., student teaching,and, later, actual
teaching).

Your first teach was important for othe.: reasons than those
previously expressed. It was, first of all, an unconscious statement
of your previous definition of teaching, and of your concept of the
role of a teacher. If your lesson is typical, your _implicit_ definition
of teaching might be something like "a human information-giver standing
at the front of a group of students who occasionally writes on a
blackboard, often refers to his notes, and always observes the unwritten
rules of propriety and decorum." Assuredly, that is not the kind of
teacher you want to be, nor is it an accurate picture of the teacher
you are capable of being right now. It _is_ a composite of the majority
of teachers we have had, altered considerably by the situational
variables of the Teaching Laboratory.

This manual is an attempt to give you more than just past
experiences with teachers from which to build your concept of a
teacher. When the Teaching Laboratory operates properly, it fulfills
all three variables of the learning situation for a teacher candidate.
If it did so on your first teach, you may now be experiencing some
incongruity; start attempting to reconcile it.

PROBLEM-SOLVING

Your next five teaches will focus upon various aspects of
the teaching of problem-solving. Problem-solving has been described
and defined by many and, with few exceptions, one finds a surprisingly
high amount of agreement between their formulations. In attempting a
synthesis of their various views, Gagne(1966, p. 132) defines problem-
solving as ". . . an inferred change in human capability that results
in the acquisition of a generalizable rule which is novel to the
individual, which cannot have been established by direct recall, and
which can manifest itself in applicability to the solution of a class
of problems."

Paraphrasing this definition so that its relationship to the
learning model is made obvious results in an inferred change in an
individual's capabilities that is the direct result of attempting to
reconcile the incongruity present in a learning situation. This cap-
ability cannot have been a part of his developmental status prior to
confrontation with the learning situation. The reconciliation of the
incongruity is not adequately accomplished until the individual is able
to apply his new capability to an entire class of similar problems.
Ability to do this is self-perceived as a manifestation of the
acquisition of new competence.

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Historical Background. Problem-solving is no new concept.

Plato and Aristotle both defined the act in much the same way as it

is today. Dewey's philosophical writings and pedagogical practices

gave renewed importance to the process by making it the focus of most

if not all learning. Misinterpretations of Dewey's work led to many

unfortunate excesses especially in the child-centered wing of progressive

education. These acts subsequently tarnished the reputations of many

schools successfully using his approaches or variations of them. Largely

as a reaction to these excesses, a much more essentialistic philosophy

stressing "efficient, rigorous" expository techniques came into the

fore in the nineteen forties and early fifties and accelerated the already

waning prominence of teaching for problem-solving.

Sputnik caused a complete reappraisal of the American educational

system. This new and public examination resulted in a renewed emphasis

on the teaching of process as a legitimate part of the content of courses

(Bruner, 1960; Parker and Rubin, 1966). Numerous national curriculum

projects began developing "new" ways of teaching specific subjects. If

any one quality could possibly characterize all of them in their diversity

it would be their attention to the teaching of process, including problem-

solving (Goodlad, et al., 1966).

Philosophical Rationale. John Gardner, past secretary of the

Department of Health, Education, and Welfare, once said "Too often we

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give our children cut flowers when we ought to be teaching them to grow
their own." The philosophy behind teaching for problem-solving centers
around this position. Knowledge is never increased by simply learning
that knowledge which already exists. Rather, it is increased by using
it to generate new knowledge. Agreement is general on this point.
Disagreement arises with respect to the means employed.

Some, including the essentialists, feel that knowledge will
be generated naturally, that teaching the known culture is sufficient
(Bestor, 1953, 1955; Lynd, 1953; Smith, 1949, 1956; Ric⁁over, 1959,
1962, 1963). If a principle can be learned expositorally in one-tenth
the time of discovering it, to learn it by the latter is ludicrous, 'and
would, thereby, deprive the student of nine other principles that could
be learned in the time necessary to "discover" one.

Others feel that this position is only part of the story, that
students must not only learn how to know, but how to think or transform
information (Piaget, 1968). To become a scientist, musician, or
mathematician, one must think like a scientist, musician, or mathematician
(Bruner, 1960; Combs, 1962). To do this effectively, one must teach
students how to think in a particular discipline rather than leaving
its development to chance. This manual adopts the latter position.

Research on Problem-Solving. Most problem-solving is taught
inductively or by what is referred to as the "discovery" method. Examples

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include those of Guthrie (1967), Laughlin and Doherty (1967),

Klausmeier, et al. (1963), Worthen (1968), Ray (1961), Scandura

(1966c), and Kersh (1958, 1962). In examining their results, few

trends emerge, leading one to agree with Bellack (1956) who suggests

that the advantages of a particular teaching technique cannot be

easily generalized beyond the specific context of a study.

Bruner (1961) cites four advantages to discovery learning

which represent an excellent synthesis of the conclusions drawn from

the research. When used appropriately, the discovery method increases

intellectual potency (the expectation of success or what this manual

terms "competence"), intrinsic motivation, the learning of the

heuristics of discovery (the strategies used in solving problems), and

the amount of information actually retained. Perhaps the crucial

factor here is appropriateness; various teaching techniques are usually

best viewed as being appropriate or inappropriate to specific situations.

When it is used appropriately, problem-solving can be a powerful

teaching strategy. Problem-solving is not a panacea for all educational

ills; it is one very important additional technique every teacher will

find useful.

Problem-solving is generally seen as having four rather

distinct phases. The first is the statement of the problem. Before

one can begin solving a problem, one must have a very clear idea of

just what the problem is. What are its characteristics and limits?
What are the relevant aspects of the total evironment?

The second phase is the formulatiจn of the hypothesis. Once
the nature of the problem is well defined, the natural consequent is
to begin searching for a solution. At this point, one either formally
or informally begins hypothesizing or guessing possible solutions for
the problem.

Once hypotheses are suggested, verification of the hypotheses
is then in order. Several of the hypotheses may be partial explanations
of the principle necessary for solving the problem. One will most
likely be or seem best. Verification of the correct guess may proceed
in any fashion from blind trial and error to a rigorously controlled
experimental situation (which is really only another kind of trial-and-
error situation).

Once a tentative principle or solution rule is arrived at,
a second type of verification, checking for transfer to new but similar
situations is necessary. If the solution is in fact a valid identifi-
cation of the crucial principle, it should be generalizable. Satisfaction
of this phase of the problem-solving situation terminates the process
allowing the individual to direct his attention to other activities.

Each of these four phases will be the focus for one of the
following four teaches where the instructional tasks involved in

teaching each phase will be dealt with in more detail.

Teaching as a Role. Each person encounters several different
social situations each day of his life, and he behaves differently
in each. His behavior at a religious service differs greatly from
that behavior at a party as it does when meeting a stranger as opposed
to a close friend. On a more subtle level, your behavior as a student
at the first meeting of a class probably differs from that of three
weeks later. At the former, you are likely to be reluctant to say
much and would rather get the feel of things first.

In this same sense teaching requires a different behavior.
In fact, different kinds of teaching require different behaviors or
roles. Applying the learning model to problem-solving results in a
teaching role that changes with each phase of the problem-solving
task. Appropriate roles for each phase will be discussed in more
detail as they become pertinent.

LESSON TWO

CREATING INCONGRUITY: PRESENTING THE PROBLEM

In general, this task involves setting the stage. For
problem-solving to be a useful instructional strategy, students and
teachers must get started on the right foot. Specifically, this task
involves at least five instructional tasks that are necessary for
adequate satisfaction of the three variables of the learning model.
They are: 1) finding an appropriate problem for students to solve;
2) analyzing the task with which the students will be confronted in
solving the problem; 3) assessing the present developmental status
(entering behavior) of the students; 4) teaching missing capabilities
prerequisite to an ability to solve the problem; and 5) confronting
the students with sufficient incongruity to stimulate problem-solving
behavior.

Problem-finding. It is, first of all, necessary for you
to find a problem of appropriate difficulty for the developmental
status of your students. In effect, you are being asked to be
creative. This is sometimes difficult so do not be reluctant to
seek assistance. Such aid can range from getting the suggestions
of a classmate to participation in a formal brainstorming situation.

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The latter has been found to be quite effective in stimulating

creativity (Parnes, 1961; Parnes and Meadow, 1959).

Brainstorming may be described briefly as a group of people

firing ideas at each other for a period of time, say five to ten

minutes, during which the emphasis is on quantity rather than quality;

no idea is too silly or ridiculous. Persistence is important since

the quantity and quality of ideas usually increases in the last half

of the session.

Analyzing the Task. Once an appropriate problem has been

found, it is advantageous to perform a rather thorough task analysis.

Problem-solving generally is accomplished by the student acquiring

the principle or generalization which explains an entire set of

situations of which the problem solved is just one. Acquisition of

the principle may be primarily a cognitive task as would most likely

be true in mathematics and the sciences. It might be highly affective

as in the arts, or it may be a psychomotor task as in physical education.

It may combine fairly equal cognitive and affective components as

might be true of the social studies, or components of all three

as is the case of the task you are learning--teaching.

In general, task analysis involves starting with the

principle to be acquired and working backward step by step until

one has a complete picture of the relevant learning processes

involved in getting a student from where he is (entering behavior)

to the instructional objective of acquisition of the principle

(Gagne, 1962). Satisfying prerequisites is extremely important

if the learner is to be capable of functioning independently at the

desired higher learning level. Several taxonomies and hierarchical

constructs can be of great assistance in performing a task analysis

once you have determined the nature of its cognitive, affective,

and psychomotor components.

For primarily cognitive tasks,Gagne's hierarchy (1965)

is useful. He identifies seven different behaviors involved in

"learning." The last four of these are applicable to normal school

situations. The highest category is the use of strategies (e.g.,

problem-solving). In order to "solve," one must have command of

all the generalizations essential to attacking the problem (i.e.,

the prerequisite category, use of principles). Before one can use

principles, one must be able to classify information in those ways

essential to the acquisition of a principle (i.e., the prerequisite

category, use of class concepts). To form class concepts one needs

to be able to perform appropriate acts in a specific order (i.e.,

the prerequisite category, behavior chains or sequences). Whenever

the principles, concepts, and behavior chains essential to the

instructional objective (strategy) are apparent, this type of

task analysis can be most informing. Topics in highly structured

disciplines such as mathematics and the sciences most often fit

this description.

The Bloom (1956) and Sanders (1966) taxonomies are

helpful in a wide variety of learning situations. Their hierarchies

are applicable to situations where students are asked to transform

cognitive information with which they are presented. If the instructional

objective requires that the students produce a plan of attack

(synthesis) as might be the case in verifying hypotheses, they must

first be able to determine the crucial qualities of the problem

situation (analysis) to be successful at the synthesis level. To

do this they must be able to apply information learned in other

contexts. Application requires that they be able to comprehend

(interpret) the relationships between previous situations and the

present one. Lastly, one must have a knowledge of those facts that

are prerequisite to transformations of information involving them.

The Krathwohl Taxonomy (1964) deals specifically with

affective tasks be describing a hierarchy based on the degrees

of involvement a student can experience in learning situations.

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This Taxonomy identifies receiving (attending passively to incoming

information) as its lowest level of involvement. Subsequent levels

of the hierarchy are responding (actively attending), valuing (finding

worth in the situation), organization (interpreting the relative

importance of the values held), and characterization by a value or

value complex (acting consistently with those values held).

No related Taxonomy exists for psychomotor tasks.
In sufficient knowledge of this area makes such a formulation

premature. A psychomotor task analysis is probably best performed

by attempting to list the motor skills prerequisite to adequate

fulfillment of the instructional objectives.

Piaget (1968) and Bruner (1964) both identify the importance

of concrete referents as a prerequisite for abstract thought. Before

one can use material symbolically (e.g., using language to describe

reality), one must be able to use material iconically (e.g., using

pictures or objects to describe reality). A prerequisite to iconic

representations is an enactive representation (concrete experience

with the actual object or act).

Regardless of the type of task analysis performed, iden-

tification of all the important prerequisite behaviors is essential.

When a student lacks a prerequisite, he finds himself in the position

of having to resort to artificial means for solving a problem (e.g.,
rote learning, blind trial and error, etc.). Satisfaction of prereq-
uisites allows him to function independently in the new situation.

Assessing Entering Behavior. Once the capabilities pre-
requisite to a successful encounter with the learning situation have
been determined through the task analysis, the next task is to determine
whether or not your students possess these capabilities. Capabilities
may be cognitive in nature, such as a knowledge of the Bill of Rights,
the ability to translate a story problem into an algebraic equation,
or the ability to extrapolate present events into the future. They
may be affective in nature, such as the harboring of an unconscious
prejudice, or belief in specific values. Or they may be psychomotor
in nature, such as the ability to touch specific keys on the type-
writer without looking at them, the ability to dribble a basketball
left-handed, or the ability to play an A-flat arpeggio at a specific
tempo.

A lack of a prerequisite ability may be caused by at least
three factors. One is obviously that the student just has not learned
something to which he was previously exposed. Second, the ability
may be missing because of his socio-cultural background. Millions of
"disadvantaged" (and probably thousands of overlyadvantaged) students

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have trouble in our middle-class oriented school system because we
assume the presence of certain middle-class entering behaviors they
do not possess. Third, a student may not have reached a stage of
development necessary for the acquisition of certain abilities. While
this problem is especially important at the elementary level, develop-
ment does not stop there. For example, the attitudes arising from
post-pubescent heterosexual relationships may be essential to certain
topics you wish to teach.

Note that intelligence is not included in this list.
Research indicates that teacher expectation is a powerful factor in
the level of achievement reached by students (Rosenthal, 1968; Rosenthal
and Jacobson, 1968). In most cases, the fairest, most realistic
attitude to take is that students have the innate capacity to do the
work and that any deficiency in capabilities is a result of the
environmental factors discussed above and may be remedied if all
the missing skills prerequisite to a task can be identified and enough
time is available to teach them. Identification of missing prereq-
uisites is important at this point because it is usually anticlimactic
to stumble upon one in the "heat" of problem-solving activity and
have to digress from it long enough to remedy the situation.

Teaching Missing Prerequisites. If missing prerequisites
are identified, teaching them before the students are confronted with

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the problem is most important. The studies of Scandura (1966a,

1966b, 1966c), Scandura and Behr (1966), Amster (1966), and Gagne

(1962, 1964) all indicate that a student's premature entrance into

a problem-solving situation results in his being generally ineffective

in handling the problem in any productive manner. As a result, little

learning takes place. If the problem selected is fairly appropriate

to the capabilities of the students, teaching prerequisites should

be a simple matter. If gross deficiencies are apparent, confrontation

with the problem would best be postponed until a later more appropriate

time.

Presenting the Problem. Once the previous four requirements

have been met, the stage is set for the presentation of the problem

(i.e., the confrontation with incongruity). An incongruity is

curiosity-arousing. Berlyne (1954) and Festinger (1964) identify

two factors determining the strength of the conflict causing the

incongruity. The first is the degree of disagreement between two

existing events. Take for example a situation in which a student

believes strongly in some principle, be it the law of gravity, his

own lack of prejudice, that Bach's music is unenjoyable to him, or

any other well-established value or fact he holds to be true.

Information in conflict with this belief, be it a strip of paper

defying gravity as an air stream is directed over it, a personal decision based on a prejudice, or a recording of the Swingle Singers, creates a curiosity-arousing incongruity. The amount of curiosity aroused is in part a product of the amount of conflict between these two events.

The second factor determining the degree of curiosity aroused is the relative strength of the two events. If one belief or the other can be easily rejected, little curiosity is aroused. If, however, both must be held tenaciously, great conflict can be created and with it activity aimed at reducing the incongruity. This is your final objective on this teach--to arouse sufficient curiosity to stimulate problem-solving behavior.

You are not required to go beyond this point for this task. Time requirements will probably prohibit actual entry into the problem-solving situation. If the assessment of entering behavior, the teaching of missing prerequisites, and the presentation of the problem takes less time than anticipated, you may elect to end your teach at that point or enter into problem-solving activity. The former is undoubtedly more appropriate if an adequate satisfaction of the incongruity cannot be accomplished in the time remaining.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes
    in length.

2. The teacher candidate will select a problem appropriate to the
    developmental status of his students. Appropriateness of the
    problem will be judged on the basis of its relevance to the
    students and how well the entering behavior of the students
    fulfills the prerequisites of the problem.

3. The teacher candidate will perform a thorough task analysis on
    the problem he has selected. Thoroughness will be judged as
    sufficient when it is apparent that his assessment of entering
    behavior indicates a knowledge of the behaviors prerequisite
    to the problem being presented.

4. The teacher candidate will identify the prerequisite behaviors
    that are not a part of the entering behavior of his students.

5. The teacher candidate will teach those prerequisite behaviors
    that are not a part of the entering behavior of his students.
    Adequacy will be judged by each of his students in terms of his
    conception of his ability to solve the problem after expending
    a reasonable amount of time and energy.

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6. The teacher candidate will present the problem in a manner
    appropriate to the arousal of an optimum level of curiosity
    from his students. The criterion for evaluation will be each
    student's estimate of the curiosity the incongruity arouses
    in him.

EVALUATION GUIDE: LESSON TWO, PRESENTING THE PROBLEM

Teacher's Name_____ Degree of Fulfillment

Your Name_____

	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
Instructional Objectives for This Teach					
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. Problem was appropriate to students' developmental status.	4	3	2	1	*
3. Task analysis was sufficiently thorough.	4	3	2	1	*
4. Your missing prerequisite behaviors were identified.	4	3	2	1	*
5. Your missing prerequisite behaviors were taught (learned).	4	3	2	1	*
6. Presentation of the problem aroused your curiosity.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade

4	3	2	1	0
A	B	C	D	F

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LESSON TWO LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to ycur instructor <u>before</u> you are
to teach LESSON THREE.

This guide is designed to aid you ir. structuring your tape
listening to better enable this feedback component of the TI.
to be of optimum benefit to you.

	Tallies	Total
1. Make a mark each time a student is <u>able</u> to answer a question you ask.		
2. Make a mark each time a student is <u>unable</u> to answer a question you ask.		
3. Make a mark each time a student asks you for further information.		
4. Make a mark each time you reinforce a student's contribution.		
5. Make a mark each time you do not reinforce a student's contribution.		
6. Make a mark each time you use some distracting mannerism (e.g., "uh," overuse of a specific word or phrase, etc.).		

In terms of the above information and that which you received on
your comment sheets, what aspects of your teaching do <u>you</u> see a
need to improve? How do you intend to attack these problems?

LESSON THREE

ATTACKING INCONGRUITY: FORMULATING HYPOTHESES

Once the requirements for Lesson Two have been satisfied,
students are ready, hopefully eager to begin problem-solving
activity. The task for Lesson Three is to accomplish the second
phase of the problem-solving sequence, the formulation of hypotheses.
The brainstorming technique is suggested as a productive strategy
for accomplishing this phase. Brainstorming may be approached in
one of two basic ways. A variation of one of these methods will
most likely be appropriate for your particular topic.

Low Internal Evaluation Situation. For highly creative
situations where there are no "right" answers, where your prime
interest is in reducing convergent thinking and conventionality,
an appropriate approach is to encourage students to suggest possible
solutions as quickly as they occur to them. Quantity is emphasized
with little or no regard given to quality. The rationale upon
which this approach is based is that as more and more different
ideas are suggested by the group, individuals are led to look at
the problem from new frames of reference. These, in turn, produce
more unique contributions. In a sense, the process becomes cyclical

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in that old ideas continually generate new ones.

Research supports this rationale. Parnes (1961) and
Parnes and Meadow (1959) found that this approach yielded a greater
quantity of hypotheses, and that the hypotheses were, on the average,
higher in quality than those obtained in a non-brainstorming situation.
In addition, the quality of the hypotheses formulated was highest in
the last half of the brainstorming session.

Three teaching strategies (or roles) are implied by these
findings. When using this approach, a teacher must first reduce the
amount of internal evaluation being made by students. Removing
inhibitions might be another way of describing this strategy. Low
internal evaluations can be accomplished in part through pre-brainstorming
instructions that encourage this kind of behavior by directing students
to postpone any evaluation of the efficacy of their various suggestions
until a large pool of tentative hypotheses has been established.

Second, a teacher must be highly supportive and reinforcing
to maintain the low-risk environment necessary for high student
involvement. Bellack, et al (1966) describe instruction as a game
in which the teacher sets the rules of play and has the right to
change them at any time. Students quickly learn that the real rules
of the game implied by a teacher's actions and reactions sometimes

contradict the rules he has set previously. Avoid rejecting answers
as being silly or off-base if you have said previously that any
idea is acceptable. In general, be sure that your actions are
consistent with your instructions.

Since the quality of the hypotheses increases with time,
it is also important to encourage persistence. Edison once remarked
that the creative process involves a great deal more perspiration
than inspiration. Research agrees with this view. The teacher's
task is to keep ideas flowing by using the exhortations, prompts,
and hints that are a part of guided discovery.

High Internal Evaluation Situation. For topics having a
"right" answer, there may be advantage in having students attack a
problem more directly. This goal can be accomplished in part by
encouraging students to evaluate the efficacy of a hypothesis before
offering it to the group. Guilford (1968) maintains that this sort
of active evaluation is useful in situations where low-quality
answers are detrimental to the problem-solving process. Your task
is to identify the optimum level of internal evaluation for your
topic. The optimum level is achieved when evaluation acts as a
detriment to low quality answers but not to those of high quality.
Once you have established what that level is, plan your instruction
to foster it.

The three teaching strategies suggested for low internal
evaluation situations are equally important here. Structuring the
amount of internal evaluation desired is a necessary first step.
Setting the ground rules for the search might be another way of
describing the use of this strategy in a high internal evaluation
situation.

Support and positive reinforcement are also important.
A flat "no" response to a student's contribution is seldom necessary
even in a situation having "right" answers. Questioning or probing
a student further can usually bring _him_ to see the fallacy in his
contribution and _he_ will then supply the "no." This approach is
consistent with the desire to have students become more critical of
their own contributions as well as those of others.

Encouraging persistence is also very important. With
one exception, this strategy may be approached in much the same
manner as it is in the low internal evaluation situation. When
students are expected to be critical of their contributions it is
necessary to allow time for thinking. When students are silent
because they are apparently taking time to consider the situation
carefully, exhortations to contribute are inappropriate. Any silence
of more than a few seconds duration will undoubtedly make you feel

uneasy. You will probably feel a strong urge to say something just
to fill the gap in the conversation. Remember though that silence
has much the same effect upon your students. Because it does,
the use of silence can be a powerful strategy for both allowing
students time to think and as another method of eliciting responses
from them. Exhortations, prompts, and hints are of course still
in order whenever you judge your students' silence to be the result
of a lack of ideas. Attempt to get the students to develop several
alternative hypotheses. The availability of attractive alternatives
will add interest to subsequent verification procedures.

The Teaching Task. If you did not take Lesson Two any
further than the statement of the problem, Lesson Three can easily
build upon it. You may wish to begin by spending a minute or two
reviewing the prerequisite entering behaviors and restating the
problem. If the topic of Lesson Two was completed, you will need
to use these opening minutes for presenting your new problem.
Because of time limitations, assume that entering behavior has been
assessed and missing prerequisites have been taught. After you
have set the ground rules for the search, have students suggest
hypotheses. Use those teaching strategies appropriate for collecting
hypotheses for your topic. Do not be overly concerned if the

"correct" hypothesis is not suggested. There will be ample opportunity

to elicit it at the beginning of Lesson Four should the need arise.

Once a reasonable number of hypotheses have been formulated, you

have satisfied the requirements for this teach. If you would like

to continue with this topic in Lesson Four, bring your lesson to

a close short of attempting to verify the correct hypothesis. A

quick review of the hypotheses suggested may provide a smooth close

to your lesson. Should time permit and if you would prefer to use

a new topic for your next lesson, you may begin the verification of

hypotheses phase.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes
    in length.

2.. The teacher candidate will concisely review the previous lesson
    and restate the problem in the first two or three minutes of the
    lesson.

3. The teacher candidate will adequately set the grou rules for
    the search for hypotheses. The instructions will be appropriate
    to the nature of the topic. Both criteria will be considered
    as achieved if the teacher candidate's subsequent actions are
    consistent with his instructions.

4. The teacher candidate will be supportive and positively rein-
    forcing of students' contributions, and will avoid negative
    affect.

5. The teacher candidate will make appropriate use of silence in
    his lesson. Appropriateness will be considered satisfied when
    time is allowed for thinking whenever a need for this is the
    apparent cause of silence.

6. The teacher candidate will encourage students to be persistent
    through the use of appropriate means such as exhortations,
    prompts, and hints whenever necessary. A necessity will be
    defined as an extended duration of silence that is apparently
    not the result of students taking time to think.

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EVALUATION GUIDE: LESSON THREE, FORMUATING HYPOTHESES

Teacher's Name_____   Degree of Fulfillment

Your Name_____

Instructional Objectives for This Teach	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. A concise review of Lesson Two was given.	4	3	2	1	*
3. Teaching behavior was consistent with stated ground rules.	4	3	2	1	*
4. Positive reinforcement was appropriately utilized.	4	3	2	1	*
5. Strategy of silence was utilized whenever appropriate.	4	3	2	1	*
6. Persistence was encouraged whenever appropriate.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade

4	3	2	1	0
A	B	C	D	F

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LESSON THREE LISTENING GUIDE

NAME_____   SECTION_____

Complete and return this form to your instructor before you are to
teach LESSON FOUR.

This guide is designed to aid you in structuring your tape listening
to better enable this feedback component of the TL to be of optimum
benefit to you.

	Tallies	Total
1. Make a mark for each student who actively participates in the lesson.		
2. Make a mark each time a student formulates a hypothesis (i.e., makes a guess or suggests a possible solution).		
3. Make a mark each time you reinforce a student's contribution.		
4. Make a mark each time you do not reinforce a student's contribution.		
5. Make a mark each time you use some distracting mannerism (e.g., "uh," overuse of a specific word or phrase, etc.).		

With an "X," estimate the percentage of total talking that was done
by students.

Direct Teaching	0	25	50	75	100	Indirect Teaching

In terms of the above information and that which you received on your
comment sheets, what aspects of your teaching do you see a need to
improve? How do you intend to attack these problems?

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LESSON FOUR

OVERCOMING INCONGRUITY: VERIFYING HYPOTHESES

At this point, your students are hopefully confronted with
many possible explanations for the incongruity they have encountered.
Your main task on this teach is to help them verify the correct or
best hypothesis.   In such a situation a useful teaching strategy may
be to not teach.   Staying out of the discussion as much as possible,
allows students to make their own mistakes and find their own solu-
tion.   One of your instructional objectives is to have your students
make a formal statement of the principle that reconciles the incongruity.

The point during the lesson at which the correct or best
hypothesis is verified, seems to make little difference.   Drama
suggests that the climax come shortly befc 'e the end and you may wish
to guide the verification process toward this outcome by having students
work with some of the incorrect hypotheses first.   There is, however,
nothing wrong with verifying the correct hypotheris at the outset.   If
one alternative is clearly more feasible than the others, students
may view a delay in verification of it as a phony attempt to avoid
the obvious.   In this case, early verification of the correct hypothesis
is advisable.   One can then examine the other hypotheses to determine
'why they are unacceptable or less appropriate.

Verification procedures are usually best dicated by the nature of the discipline involved as well as the topic. One reason for teaching problem-solving is to get students thinking like scientists, mathematicians, linguists, artists, historians, etc. Encourage students to use the methodology of your discipline. Too little attention to process has been a past characteristic of the teaching of most disciplines even at the undergraduate level. You may therefore be uncertain of what your discipline's methodology encompasses. Your TL instructor and major professors can be of assistance in this case.

The Teaching Task. If you did not take Lesson Three any further than the formulation or hypotheses, Lesson Four can easily build upon it. You may find it best to spend a minute or two reviewing the hypotheses suggested during the last lesson and asking if the students have thought of any additional ones. If Lesson Three included some verification it may be possible to start at that point with this lesson. If a new topic is desirable, spend those first minutes presenting the new problem and suggesting some possible hypotheses to the students. Verification procedures may then be started. When sufficient verification has been accomplished, have students compose a formal statement of the principle involved.

Accomplishment of these tasks satisfies the requirements for this
lesson. Bring your lesson to a close. You may again opt to
continue, if time permits, by beginning to check for transfer of
the principle to new situations.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes
    in length.
2. The teacher candidate will review the hypotheses formulated in
    Lesson Three.
3. The teacher candidate will encourage use of the investigative
    methodology of the discipline he is teaching. The time available
    is acknowledged to be a serious limitation to the achievement of
    this objective and will be considered in judging its attainment.
4. The teacher candidate will guide the students' verification
    procedures in an indirect manner, allowing students to largely
    control the procedure.
5. The teacher candidate will direct the students to compose a formal
    statement of the principle reconciling the incongruity.

EVALUATION GUIDE: LESSON FOUR, VERIFYING HYPOTHESES

Teacher's Name_____

Your Name_____

	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
Degree of Fulfillment					

Instructional Objectives for This Teach

	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. Hypotheses formulated in Lesson Three were reviewed.	4	3	2	1	*
3. Use of discipline's investigative methodology was encour.	4	3	2	1	*
4. Students largely controlled the verification procedure.	4	3	2	1 ·	*
5. Students composed a formal statement of the principle.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade

| 4	3	2	1	0
A	B	C	D	F

LESSON FOUR LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor before you are to
teach LFSSON FIVE.

This guide is designed to aid you in structuring your tape listening
to better enable this feedback component of the TL to be of optimum
benefit to you.

		Tallies	Total
1.	Make a mark for each hypothesis for which some verification is attempted.		
2.	Make a mark each time a student suggests a procedure for verifying a hypothesis or in some manner indicates that he feels he has at least partial control over the direction of the lesson.		
3.	Make a mark each time it is evident that your students are thinking as a person in your discipline would (i.e., using the investigative methodology of your discipline).		
4.	Make a mark each time it is necessary for you to give direction or redirection to your students' verification process.		
5.	Make a mark each time your students ask you for further information.		

With an "X," estimate the percentage of total talking that was done by
students.
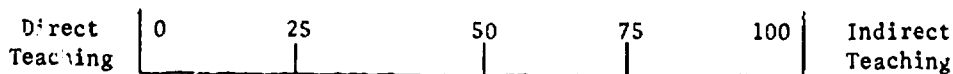
Direct Teaching	0	25	50	75	100	Indirect Teaching

In terms of the above information and that which you received on your
comment sheets, what aspects of your teaching do you see a need to
improve? How do you intend to attack these problems?

LESSON FIVE

ELIMINATING THE INCONGRUITY: APPLYING THE GENERALIZATION

Your task on this teach is to use two basic strategies.
The first involves assessing how much your students have learned.
Traditional testing procedures are only one (often quite inappropriate)
method of accomplishing this. The second strategy involves helping
students to better grasp the problem-solving processes they have used
by having them verbally introspect them.

The final phase of the problem-solving sequence may be
viewed as being another type of verification procedure. Often an
individual is not completely confident that he has mastered a learning
situation until he has proven to himself that he can apply the principle
in new situations. In situations where a learner does not feel he needs
this mastery, checking for transfer is nevertheless a crucial instructional
strategy for the assessment of learning.

But the learning of the principle is only one of the two
major objectives teaching through problem-solving seeks to attain.
The second is, of course, the acquisition of the process abilities
(i.e., the heuristics or investigative techniques) of a discipline.

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The first step in this acquisition was to have students, perhaps

unconsciously, use your discipline's investigative methodology. A

second step is required if students are to have gained any meaningful

command of your discipline. You must make certain that they are

consciously aware of the processes they have used as one way of

better insuring their ability (power) to use these tools again

(Berman, 1968). Verbal introspection of the problem-solving process

is an effective means for accomplishing this awareness.

Checking for Transfer. In solving their problem, your students

have probably been concerned with one isolated instance in which the

principle they are acquiring holds. However, the true test of their

command of the principle is their ability to generalize it to new

situations in which it also operates. In other words, checking for

transfer is an important step in the problem-solving process.

Several avenues are available for accomplishing this.

Perhaps the most obvious is to present the students with new situations

and have them explain how or why the principle applies. A second is

to present the students with a situation where the principle appears

to apply but in fact does not. The explanation of how or why is a

good deal more demanding here and may only be useful in cases where

students understand the principle that does explain the situation. A

third method is to have the students identify the new situations in
which the principle operates. Again, explanations of how and why
are helpful in assuring that all students understand the generalization.

Introspecting the Processes Used. One may conceptualize this
teaching strategy as another means of insuring transfer. The difference
is that the interest, in this case, is in the transference of processes.
A problem-solving approach is ludicrous if students only acquire the
principle they seek. As mentioned earlier, simply telling them the
principle is a great deal more efficient. The value of the problem-
solving approach lies in its ability to teach process, to give students
the tools necessary to extend knowledge beyond its present limits.

In much the same sense that a carpenter cannot use a tool he
does not own, your students cannot use a process unless they are aware
of it. Admittedly, awareness of a process does not assure an ability
to use it anymore than ownership of a chest of tools makes one a
carpenter. It is, however, an essential first step.

Awareness can be accomplished simply by having students talk
through the procedures they have followed in arriving at a formal
identification of the principle that answers the questions that aroused
their curiosity. Your ability to use effective questioning strategies
will aid this recapitulation considerably. Why did the students formulate

the hypotheses they did rather than others? How did they formulate them?
Why did they choose to evaluate that hypothesis first? How did they
verify the hypotheses? Why that method rather than this? These are
only some general examples of questions that may lead students to verbalize
the crucial procedures they have unconsciously used. In terms of the
learning model, you are taking this opportunity to show students how
sophisticated their thinking really is as a way of building competence.

The Teaching Task. You may find a restatement of the principle
and some minor review of Lesson Four as an effective opening for this
lesson. An assessment of learning through checking for transfer seems
a logical next step. Use whatever means you deem most appropriate for
accomplishing this. Remember that a formal test situation will likely
stifle whatever realism you have succeeded in instilling in the learning
situation.

Once you are satisfied that students have command of the
principle, introspection is in order. Decide what the most pertinent
procedures used by the students were, and plan your questioning to elicit
them. Praise is important, but students should also be led to an
awareness of their inappropriate procedures so that they may avoid using
them in subsequent similar situations. Remember also that a major
goal in this phase of the problem-solving sequence is to increase your

student's concepts of their own competences. Assume the kind of
supportive role that will facilitate the attainment of this objective.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes
    in length.

2. The teacher candidate will make a concise review of the previous
    lesson.

3. The teacher candidate will assess learning by checking his students'
    ability to transfer the principle to new situations.

4. The teacher candidate will check for transfer by using means
    appropriate to his topic and discipline.

5. The teac her candidate will lead his students to verbally introspect
    the problem-solving act. This objective will be deemed satisfied
    when the students feel they are aware of the procedures they have
    used.

6. The teacher candidate will foster competence by assuming a supportive
    role. This objective will be deemed satisfied if the students feel
    more capable of dealing with problems in that discipline as a result
    of their problem-solving experience.

EVALUATION GUIDE: LESSON FIVE, CHECKING FOR TRANSFER

Teacher's Name _____   Degree of Fulfillment

Your Name _____

	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
Instructional Objectives for This Teach					
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. A concise review of previous lesson was made.	4	3	2	1	*
3. Learning was assessed by checking for transfer.	4	3	2	1	*
4. Transfer was checked by means appropriate to the topic.	4	3	2	1	*
5. Students introspected the problem-solving process.	4	3	2	1	*
6. The lesson increased your conception of your competence.	4	3	2	1	*

On the back of this form, identify the
areas in which this teacher is strong
and weak. Give your suggestions for
improvement. In writing your comments,
remember to a) be specific, b) be
constructive, and c) write as extensively
as you can.

Over-all Grade				
4	3	2	1	0
A	B	C	D	F

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LESSON FIVE LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor **before** you are to
teach LESSON SIX.

This guide is designed to aid you in structuring your tape listening
to better enable this feedback component of the TL to be of optimum
benefit to you.

	Tallies	Total
1. Make a mark each time a student displays an ability to transfer the principle to a new situation.		
2. Make a mark each time you encourage students to transfer the principle.		
3. Make a mark each time you reinforce a student's contribution.		
4. How well were students able to verbalize (introspect) the learning process they had experienced?		

This has been a first attempt at teaching problem-solving and your
success to this point should therefore be viewed in relation to
your abilities before this first attempt.

In effect, you too have been involved in problem-solving behavior in
attempting to teach these tasks and it may now be of some value for
you to introspect the processes you have used. How many of them were
intuitive? How can you make intuitive processes more purposive?
Enumerate your successes, however modest you may feel they are. More
importantly, identify those areas in which you feel you must improve
and prescribe the means you see as necessary to achieve that improve-
ment. Use the back of this sheet if additional space is necessary.

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