Introducing Problem Solving through Literature at the Elementary Level

Margaret S. Harbert
University of Massachusetts Boston

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INTRODUCING PROBLEM SOLVING THROUGH LITERATURE AT THE ELEMENTARY LEVEL

A Master's Thesis

by

MARGARET S. HARBERT

Submitted to the Office of Graduate Studies and Research of the University of Massachusetts at Boston in partial fulfillment of the requirements for the degree of

Master of Arts

September, 1989

Graduate Program in Critical and Creative Thinking
INTRODUCING PROBLEM SOLVING THROUGH LITERATURE AT THE ELEMENTARY LEVEL

A Master's Thesis Presented

by

MARGARET S. HARBERT

Approved as to style and content by:

Steven Schwartz, Chairperson of Committee

John Murray, Member

Hilary Hopkins, Member

Patricia Davidson, Program Director
Critical and Creative Thinking Department
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ABSTRACT
INTRODUCING PROBLEM SOLVING THROUGH LITERATURE AT THE ELEMENTARY LEVEL
August, 1989

MARGARET S. HARBERT, B.A., UNIVERSITY OF MASSACHUSETTS, AMHERST
M. A., UNIVERSITY OF MASSACHUSETTS, BOSTON
Directed by: Professor Steven Schwartz

There has been much publicity the past few years regarding students' lack of basic skills, their inability to think clearly, and their poor use of problem solving strategies. To focus on this need, the following program has been designed to help elementary teachers introduce problem solving in an organized manner adding very little, if any, extra material to the curriculum. The program aims to help students solve problems, critically, creatively, and systematically.

Problem solving was chosen as the target area since the skills and strategies used are closely related to those used in reading comprehension, answering questions logically, and general good thinking. The basic approach stems from E. Paul Torrance's, "Future Problem Solving Process", (Torrance, 1972); however, it has been modified to incorporate eight stages, thus making problem solving
easier for teachers to introduce to elementary students. In order for such a program to succeed, it was assumed the following criteria would have to be met: 1) Students would have a definite starting point. 2) The problem could fit into the curriculum with a minimum amount of modification. 3) Problems would move from the concrete to the abstract, from the well-defined to the complex.

In order for teachers to utilize this thesis easily, the format and lesson plans are included, as is a description of a two day workshop used to introduce the program to the instructors. The rationale behind the program, a selected review of current literature in this area and a presentation of the general strategies used for effective problem solving are presented. The first lesson in each stage reveals how the program can be integrated into the present curriculum without adding substantial new material. The second lesson for each stage reveals how the program can be adapted to teach problem solving within the realm of a specific teaching unit. Both lessons contain the same goals, objectives, and strategies; therefore, with the completion of either set of lessons, instructors should feel comfortable teaching in this manner and students should be on their way to becoming independent problem solvers.
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CHAPTER I

Introduction

There has been much publicity in the past few years regarding students' lack of basic skills, their inability to think clearly, and their use of poor problem solving techniques. It is my contention that if problem solving is presented in a viable model, one which allows teachers to infuse these skills into their everyday curriculum, the above problems would be greatly reduced. Moreover, creativity, independence, and confidence would emerge as students seek strategies to define, solve and evaluate problems.

According to the National Assessment for Educational Progress, 1979-1980, many students have poorly developed problem solving strategies and weak critical thinking skills. Our complex democracy depends on these skills; therefore, educators should feel compelled to help strengthen students in these areas. If educators are not presently meeting the need, then new strategies and/or models must be developed to help teachers integrate instruction in the necessary skills. This proposal uses the Future Problem Solving model (Torrance, 1978), but infuses it into the curriculum in such a manner that instructors do not have to add extensive material to their courses. Instead they adjust the format so that the students are
actively solving problems found within the bounds of the present curriculum.

Raymond Nickerson claims that high school graduates not only lack problem solving skills, but lack the skills necessary for college success in general (Nickerson, 1984). Rather than lower college programs’ standards, it would seem more prudent academically to help elementary and secondary students attain their true potential. Knowledge and application of problem finding and problem solving techniques can only help toward this goal.

Current approaches to problem solving are varied. No one way is necessarily ideal for all audiences in all situations, nor is any one method wrong in all situations. Quite often a combination of approaches is the most appropriate; however, much depends upon the instructor’s competence with the approach, the match with the student needs and the ultimate goal of the instruction. If the objective is merely to solve given, clearly defined problems requiring one word answers or one predetermined answer, then work on well-defined problems is satisfactory preparation. However, if the goal is to generate divergent thinking and evaluative skills, which seem to be needed, then additional work is required with ill-defined problems or real life situations where the problems are not so neatly packaged or well-defined. Many correct answers may be found and it is up to the students to evaluate possible solutions for acceptability, relevancy and fit.

It is appropriate at this point to define "problem" as it will be used in this thesis. Problems have certain characteristics: givens,
goals and allowable procedures. Givens involve the initial state of the problem with its conditions, objects and information: the original problem. Goals involve what is desired, the change expected from the initial state: the final solution. Procedures involve the sequence of operations that will solve or transform the problem to the goal state: the steps to used to achieve the goal.

The problems chosen will stress each of the three characteristics, but not necessarily in one problem. In the first four lessons, the problems will have well-defined given statements where the students can focus on achieving the goal or the solution. As the students become proficient at developing skills and strategies, more complex situations will be introduced. The problems will then have ill-defined initial statements and/or goal statements. The students will have to define the problem, solve it according to the way in which they have defined it. The problems may be "nested" or stacked within one another, so the students have to determine the underlying or most significant problem that is to be addressed. Strategies used to attain the goal, whether the problems have well-defined or ill-defined initial goal statements, are important; therefore, the processes used in overcoming obstacles will become part of the problem solving schema. The emphasis in the lessons will be on defining the problem and determining an appropriate, creative solution. However, it seems almost impossible to attain the goal of true problem solving without having students become aware of the process or processes used to reach it, especially if students are taught
consciously to reflect upon what has happened at the end of each lesson.

Educators, mathematicians, and people in industry and business concerned with improving students' problem solving ability have been developing ways in which this can be done efficiently, systematically and/or creatively. Since there are so many approaches, only a few of the ones especially adaptable to the elementary situation will be reviewed.

Treffinger's Creative Learning Model (Feldhusen and Treffinger, 1985) is an example of a systematic program used in teaching creative thinking and problem solving. Students are introduced to creative problem solving techniques through a series of three carefully designed levels. In Level I the students deal with cognitive and affective dimensions of learning, thereby providing the students with the skills and attitudes needed for later levels. In Level II, students become involved in more complex methods and systems for problem solving. They are given problems which require weeks or months of research and planning to solve using higher order thinking skills. In Level III, students develop confidence in dealing with real life problems and challenges, rather than practicing problems merely for the sake of practicing.

In order for a problematic situation to be real or relevant to the problem solver, Treffinger feels it should contain three criteria: interest, influence, and imagination. The students should be interested in or want to do something about the situation. There should be the possibility that the problem solver can really influence
the problem and/or solution in some manner. Lastly, the person assigning the problem has to be open to new solutions, not merely waiting for the students to come up with a predetermined solution. If the problem meets these criteria, the students will feel an "ownership" or a dedication to the problem which will provide the motivation to deal with the situation until a satisfactory, perhaps even a creative answer is found. By the use of this gradual and systematic approach, Treffinger encourages creative thinking and problem solving (Feldhusen and Treffinger, 1985).

At the other end of the spectrum is an approach that uses complex problems from the start of the instruction. Students are given a contemporary or future problem situation. They determine the underlying problem, brainstorm possible solutions, evaluate solutions, implement the solution, then produce a design, product or service based upon the original problem and sell it. E. Paul Torrance's, "Future Problem Solving Process", as this particular model is called, has been widely used by people concerned with complex problem solving (Torrance, 1972).

Bridging the gap between the two polar strategies are various modified forms of instruction. Strategies, such as those cited in Sternberg's "Practical Intelligence in the Real World: The Role of Tacit Knowledge" (Sternberg, 1985a) combine certain elements of both approaches. Sternberg recommends use of complex problems that are real life issues, for those are the problems students face. The emphasis on real life situations produces ill-defined situations
because life's problems are not always well-defined, neither are the solutions.

Since many people, both teachers and students, appear to need the structure of well-defined problems and well-defined steps or actions in order to grow in confidence as problem solvers, it is our contention that a useful approach to problem solving for elementary schools incorporate both the well-defined and the ill-defined situations. The instruction should start out with well-defined problems requiring definite answers and procedures, then move along a continuum to complex problems with many solutions. This instruction should be done in a sequential manner so the less experienced instructor will be receptive to teaching problem solving and confident that the intended result will ensue. This approach should also meet the needs of students with different learning styles since many students need the initial structure offered from well-defined problems to be successful. Students who are capable of handling a situation with less structure and who already have a sense of divergent thinking and evaluation will blossom under the complex problem situation. However, since most classrooms are blessed with both types of students, it is necessary to cater to both their needs. Combining the approaches helps to meet this need.

Factors influencing problem solving instruction must be attended to before attempting to address such a program successfully. Developing an appropriate environment, providing teacher modeling, and developing the relevant personality traits in students are integral parts in teaching "problem solving".
Developing an atmosphere that is safe, where teachers and students feel willing to take risks, is essential for accomplishing active problem solving. The physical characteristics of the room should be inviting, but more importantly, a feeling of mutual risk taking and the acceptance of failure as part of the learning process must be present. Students, as well as instructors, will need time to accept the fact that problems may not have definite answers or that there may be a number of correct answers to complex problems. The environment should, therefore, encourage a tolerance for ambiguity.

(See Chapter IV). Teacher modeling is equally important, for the instructor must not only provide opportunities for the students to problem solve but must demonstrate a valuing of effective problem solving and the specific target strategies. (See Chapter IV). By modeling the behavior and thinking desired from the students, the instructors are reiterating the importance of the methods or techniques used and showing the interaction of the intellective and affective components in the process.

Personality traits are important. Cultivating some of the following characteristics helps one to become a better problem solver: playfulness, curiosity, tolerance of ambiguity, adventuresomeness, a capacity to work with others, resourcefulness, a sense of humor, risk taking and confidence (Gallo, 1987). The same traits also help to make instructors more creative in working with their students. According to Gallo, the two traits most sorely needed are flexibility and perseverance. Students can be observed using these attitudes automatically when playing video games such as
Atari or Nintendo. When students play such video games, they experience feelings of self-esteem and peer prestige which motivate them to pursue the ultimate goal. Their success is primarily due to the games' set up. Players are rewarded for small increments of success which inspire them to continue the quest of unraveling a complex problem. Because of the enthusiasm and perseverance students exhibit in playing a game that is essentially problem solving, it would be a desirable goal to cultivate these same traits in academic areas in order to produce avid, creative problem solvers.

A repertoire of specific strategies is also imperative to good problem solving. Strategies for fact finding, problem finding, idea finding, solution finding and acceptance finding need to be taught. The Osborn and Parnes (Parnes, 1981) model is probably one of the most explicit in revealing how divergent thinking, followed by convergent thinking in each strategy, helps guide a person through the creative process. Their use of divergent and convergent thinking in each strategy makes it a popular and effective creative problem solving model.

Our experiences with the critical and creative thinking skills program in Shrewsbury, Massachusetts, initiated some years ago, made it apparent that the program must be one with which the teachers feel comfortable. Granted, this will not be accomplished all at once, however, designing the program with the teacher's comfort and, therefore, receptivity in mind, can only help.

In order for the program to be used effectively, it should have a starting point which fits into the present curriculum with a
minimum amount of trouble. Experienced teachers, comfortable with developmental approaches, tend to prefer approaches that move from the concrete to the abstract, that move from the well-defined to the ill-defined. In addition to the systematic element there must be enough flexibility to handle the complexity of contemporary as well as future problems (Harbert, 1989). To meet these needs I propose a program which will use literature as a vehicle for integrating problem solving instruction into the fourth grade reading curriculum.

The choice of literature as the vehicle through which to teach problem solving came about from literature's richness in problem solving possibilities. It has innumerable characters, an extensive variety of settings and situations, and a wealth of problem solving strategies. Literary selections may be chosen for a host of reasons: to fit students' needs, curriculum requirements, reading level, ability to stimulate creativity or for pure enjoyment. The variety of literature available, drama, poetry and folk tales, offers inexhaustible avenues for problem solving. Finally, the same strategies used for problem solving can enhance reading comprehension. Therefore, since teachers are constantly seeking effective ways to teach reading comprehension and since learning to solve problems effectively uses many of the same strategies used in reading comprehension, it follows that using the vehicle of literature for problem solving is a logical choice.

To summarize, the problem solving program developed proposes to use problem solving strategies effectively and in a manner inviting for teachers using everyday required curriculum.
Chapter II presents the statement of the problem, Chapter III reviews some of the models used in teaching problem solving, the rationale behind each and adaptations to make it appropriate for elementary students. Chapter IV presents the curriculum unit introducing and describing the stages. Chapter V reveals lesson plans which integrate problem solving into an already existing curriculum, with an alternative lesson which uses a familiar story that could be used as a problem solving unit. Chapter VI presents a two day workshop which should be used to help teachers become acquainted with the program. It also suggests helpful hints in case something goes wrong and what to do if it does. Chapter VII serves as a conclusion to the introduction of problem solving in the elementary grades. It stresses the importance of reflective thought in the desire for transfer of problem solving skills to occur.
CHAPTER II
Statement of the Problem

This chapter addresses the issues around problem solving and the documentation of students’ lack of problem solving. The issues raised will be followed by a discussion of why students need creative problem solving, how this instructional goal will be addressed and why the study of literature is an appropriate vehicle for the instruction. Specific considerations which must be dealt with before a program can actually be effective will also be noted.

As mentioned in the introduction, the National Assessment for Educational Progress, 1979-1980, determined that students have poor problem solving strategies and weak critical thinking skills. Even though this was not specifically aimed at the results of fourth graders, there is an apparent need in this area. To put it on a more personal level, the students in the school where I teach also have been found to have poor problem solving strategies and weak critical thinking skills. This may not seem surprising. However, for the past four years our school has been involved in a thinking skills program which has become nationally known. Why, then, aren’t our students scoring better? Several factors contributing to the low scores have been identified and strategies have been taken to strengthen the program and to rectify the deficits (Harbert, 1989).
The thinking skills program used in Coolidge School in Shrewsbury, Massachusetts was developed by the teachers using the direct teaching model by Barry Beyer where individual skills are modeled, taught and used (Beyer, 1985). The emphasis is threefold: modeling the skill, teaching the skill, and using it in the curriculum areas so as to insure that the students are truly familiar with the skill. It was assumed that after the presentation of a skill, the students could and would use that skill. Transfer, as such, did not happen. The students have the skills, can explain exactly how to use them and can determine under what conditions these skills would be useful, but they do not use them automatically. They think of them as being necessary only for "thinking skills" lessons.

The second problem stems from the fact that they think of the skills in their pure state: compare/contrast, cause/effect, sequencing, et cetera. They do not think about combining them for a more complex task. Finally, students have demonstrated a marked improvement in flexibility, fluency, elaboration and originality; however, they lack the critical aspect necessary for becoming good thinkers. They can not look at a problem and determine the "best" answer, even when given sufficient support for the apparent goal. They appear to be some of the most creative, divergent thinkers imaginable, but they are not tested on creativity, they are tested primarily on critical thinking and problem solving. Therefore, strides must be taken to teach what is being tested and to take a look at the value of what is being tested.
The difference between divergent and convergent thinking must be addressed. Divergent thinking allows the person to think of multiple, creative ways of solving a problem. Convergent thinking involves critically thinking about the multitude of answers in order to pick the best solution based upon given or generated criteria. Being able to combine divergent and convergent thinking is paramount to problem solving, for the larger base of answers from which to select, the better and more creative will be the response.

There is also a need to assess the type of thinking required on state and standard tests. The need to change and/or supplement what is valued must be recognized before states will respond. This will take time, not only to recognize the value of creativity and divergent thinking, but to develop a means of reliably testing such abilities.

One of the ways in which these needs can be met in the curriculum, regardless of the testing involved, is through an explicit critical and creative problem solving program. The skills and strategies experienced in creative problem solving, divergent and convergent thinking, are the same skills and strategies needed to become good thinkers. (They are also the skills mentioned in the introduction as necessary for good comprehension in reading). Problem solving requires the student to step back and determine what is known or has been given in order to find a solution. This same reflective strategy is needed in everyday learning.

At the elementary level, instruction in problem solving through literature is somewhat unique; however, literature should be
considered a valuable avenue for problem solving development for the advantages are many:

1) Literature is filled with people in various situations solving numbers of intriguing problems, thus students can immediately identify with the characters and situations.

2) Problems presented in literature range from the concrete to the abstract, from the well-defined to the ill-defined.

3) Choosing a variety of literary sources to provide problem variety not only supplements the reading program, but gives the students exposure to a greater variety of literary styles.

4) Whether a character solves a problem successfully or not, the well articulated record of the character's process in literature provides rich opportunities for finding, analyzing and evaluating problem solving methods and for understanding how traits and social environments affect human beings as they go about solving complex problems.

On a practical level, however, perhaps the most important reason for choosing literature as the curriculum area of focus versus science or social studies, is the attitudes teachers have about the value and importance of instruction in literature and reading. Language arts, the area within which literature falls, is one area of the curriculum that most teachers feel compelled to do well. Also, and not unimportant, is the fact that many experienced teachers feel confident in teaching this curriculum. Integrating problem solving into this area will appeal to teachers' comfort and sense of efficiency.
Robert Glaser's philosophy is important to note when talking about teacher comfort and receptivity, for he feels that thinking skills should be developed or taught within the context of the existing curriculum (Glaser, 1984) rather than as a separate unit or subject. Therefore, problem solving, a series of thinking skills, should likewise fit into the existing curriculum. Since teachers are already being asked to condense the material they cover in some orderly fashion, adding problem solving to the curriculum as another subject would be a serious drawback. Changing the format and emphasis of the existing material in a manner which would be comfortable for the teachers so they would use the program, would seem much more prudent and effective.

A number of other factors influencing learning such as aspects of the emotional and physical environment, teacher modeling, personal traits and specific strategies need to be considered if effective problem solving is to take place. While some of these appear obvious, they are worth making explicit since they are needlessly often overlooked.

A) The environment in the classroom should be conducive to thinking and risktaking. If the instructor is trying to encourage creative thinking and problem solving, then there must be room in the curriculum for experimenting with ideas. (See Chapter V). There must be time allocated for dealing with ambiguity, resolving differences, creating challenges to be tested, and supporting answers whether they are found to be correct or incorrect. Once the students are positive that it is all right to be wrong and that it is all right to
change answers, solutions, opinions and feelings when facts dictate a change, they will be much more willing to accept the challenge of problem solving.

B) Teacher modeling makes a tremendous difference in the rate at which students accept the challenge to be creative and daring in their responses. Watching the instructor take risks and strive for creativity acts as a catalyst in getting the students to be creative. Watching the instructor support ideas, even though wild, stimulates a similar response from the students. The teacher who models the divergent and convergent thinking on a daily basis can expect students who enthusiastically imitate the behaviors. (See Chapter V).

C) Marilyn Adams in *Odyssey: A Curriculum for Thinking* (Adams, 1986) makes several observations about environmental factors within the classroom that need to be attended to before the actual teaching of thinking skills and/or problem solving can be effective.

1. There has to be a nonthreatening and supportive atmosphere where students are not stifled by failure.

2. The teachers must express a willingness to explore ideas and concepts.

3. The teachers must be willing to admit to mistakes or admit when a concept does not make sense.

4. Students need positive reinforcement not only for the product or ultimate goal statement, but for the process.

5. Students need to know that teachers respect students' opinions and feelings even when they differ from their own.
6. All students need to be included in discussions, even quiet ones.

7. Have students reveal evidence of thinking by asking questions of the instructor and each other.

8. Have the students assume the role of teacher, instructor or evaluator, thereby forcing the student to have it clear enough in his own mind to explain to another.

9. Encourage students to think, for even incorrect thinking, is better than a correct guess.

10. Help students understand that many questions have more than one answer. Thinking about a problem may produce an alternate answer.

11. Allow students "wait time", time to think before giving them the correct answer.

12. Keep students actively and productively on task. Active learning keeps the interest level high.

13. Have students try to transfer knowledge from the learning situation to another area where the same task may be applied. Even though these factors may seem obvious to some teachers, they are not to most. These factors are often the very ones which are omitted due to insufficient time, lack of measurable testing means or lower priority than finishing the curriculum. Having all students participate in discussions and effectively using "wait time" so that everyone has a chance to think adds minutes to the lessons, but these are the very techniques that can make the difference in thinking versus parroting. These are also the techniques that some
teachers feel uncomfortable using because they admit to the possibility that mistakes may and will be made. The students will need much positive reinforcement and encouragement to reach their goal the first few times. Once they become used to exploring possibilities and understand that the means is often as important, if not more important, than the end product, then they should be willing to take risks for the sake of solving problems critically and creatively.

Creating a receptive environment and teacher modeling are most effective in fostering desirable traits, but it must be remembered that students come with some specific personality traits which constitute creativity and problem solving more easily than others. Much can be done to foster desirable attributes by creating situations in which the desirable traits can develop. Students who realize they have the skills and strategies as well as the freedom to develop a solution will quickly develop a positive attitude toward problem solving, whether in the classroom, during homework or in everyday living. Skills and strategies, then, become an important part of the problem solving schema.

Arthur Costa's Teaching for Intelligent Behaviors (Costa, 1986) is a handy reference for goals, objectives and strategies needed in critical and creative thinking as well as in critical and creative problem solving. For instance, he claims that there are four categories of instructional strategies that students need in critical and creative thinking: imitative, meditative, generative and collaborative. The imitative strategies involve direct instruction, drill
and practice, mastery learning, mnemonics and rehearsal. Meditative strategies include concept attainment and development, open ended discussion, clarification, inquiry and discovery. Strategies designed to generate responses are brainstorming, lateral thinking, mind mapping and synectics or making the familiar strange by the use of analogies and metaphors. Lastly are the collaborative strategies such as cooperative learning, role playing, simulations, pair problem solving and class meetings. Many of these will be described in more detail in Chapter IV. It is sufficient at this point to say that being fluent in the use of various strategies and when to use them appropriately produces a confidence that is a necessary component in developing positive attributes and receptive environments.
Chapter three offers a review of a number of models of teaching problem solving that can be easily adapted to elementary students as well as the rationale behind them.

We begin with Barry Beyer's (Beyer, 1985) five-stage framework for teaching thinking skills, skills which are needed to solve problems. He uses a direct teaching approach in which the teacher models the skill, introduces the skill, and explains the procedure and rules for using the skill. A chart reveals the steps that have been used in working with the skill, then the students apply the skill to other situations and reflect upon what happened while they were using the skill. Once the students have mastered a number of these thinking skills such as compare/contrast, cause/effect, discovering attributes, making generalizations and sequencing, they are assumed to be ready to think and solve problems by using their "thinking skills". One of the merits of Beyer's program for problem solving lies in its organizational format. The teacher knows exactly what to present and the students know what is expected. Beyer's framework can act as a good springboard, for it provides a knowledge base in skills necessary for good problem solving.
In contrast, Polya, a noted mathematician, presents a four stage problem solving method (Polya, 1957). Although Polya limits his work to mathematics, his approach to problem solving is broad enough to be used in other areas. The four stages provide an ideal organizational framework for students when there is one specific answer to a problem.

1. understand the problem
2. devise a plan
3. carry out the plan
4. look back

Polya's stages are important to problem solving because they show how closely problem solving is related to memory and language comprehension. Each stage of Polya's method is used in every problem, but the importance of each level is determined by the particular problem and the user's experience. See Figure #1.

A more open ended approach is presented in the Osborn/Parnes Creative Problem Solving Model which comprises five stages: fact-finding, problem-finding, idea-finding, solution-finding (evaluation), and acceptance-finding (implementation). See Figure #2.
### Polya's Stages

<table>
<thead>
<tr>
<th>Information Processing</th>
<th>Translation</th>
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<tbody>
<tr>
<td>1. Understand the problem</td>
<td>Encode the Problem in working memory</td>
</tr>
<tr>
<td>2. Devise a plan</td>
<td>Search Long-term Memory for Plan or Production</td>
</tr>
<tr>
<td>System</td>
<td></td>
</tr>
<tr>
<td>3. Carry out the Plan</td>
<td>Execute the Production</td>
</tr>
<tr>
<td>System</td>
<td></td>
</tr>
<tr>
<td>4. Look back</td>
<td>Evaluate the Results</td>
</tr>
</tbody>
</table>

**Figure #1: Polya's Stages**

**Creative Problem Solving Model**

- **Divergent Thinking**
  - Mess
  - Fact
  - Problem
  - Idea
  - Solution
  - Acceptance
  - Finding
  - Finding
  - Finding
  - Finding
  - Finding
  - New Challenge
  - Action

**Figure #2: The Osborn/Parnes Creative Problem Solving Model**
The emphasis in this model is problem finding which helps students realize that problems may not appear in neat little packages, rather the problem may have to be sought out and defined. An interesting feature of this model is its use of divergent and convergent thinking at every stage. The divergent component stimulates the imagination generating creativity at every level. The convergent component encourages the evaluative element to surface (Parnes, 1981). See Figure #2.

Parnes and Osborn also introduce the idea that the creative person may not work in a linear fashion, rather may move back and forth from one stage to another at any time (Parnes, 1981). See Figure #3.

Figure #3: Osborn/Parne's Alternative to Linear Problem Solving

While there is value in this model, young children would fare better by introducing the concept of problem solving in a sequential manner. They need to be taught to seek all options before jumping
to closure. Prematurely jumping to closure is easy to do using this model.

Treffinger and Feldhusen's hierarchical model is included since their program is one in which two methodologies, creative problem solving and the pedagogy of concrete to abstract are combined (Treffinger and Feldhusen, 1985). In Level I the students are introduced to the basic skills that will be needed at the higher levels: brainstorming ideas, listing attributes of a particular object, developing a fluency of ideas. In Level II the students practice more complex problems. These are contrived to help the students succeed in realistic and/or futuristic problems. Level III presents the goal for problem solving: competency in dealing with real life situations. Treffinger's definition of such "real" problems are those in which the students have a personal concern or involvement. Treffinger also claims that problems at this level should meet three criteria: interest, influence and imagination. The students must be interested in the topic and they must feel their decisions could really make a difference. Lastly, the problem must be one in which the students are allowed to use their imaginations (divergent thinking), then evaluate their solutions and select the best course of action or solution to the problem (convergent thinking). Treffinger feels that many instructors use a model similar to his but they do not include the three criteria in their selection of problems for the students. Rather, they choose a problem for which they feel there is a "correct" answer. The students strive to find the instructor's solution rather
than one of their own, thus lose enthusiasm which would produce more creative solutions.

Figure #4: Treffinger and Feldhusen's Model

E. Paul Torrance approaches problem solving somewhat differently than those people already mentioned. His work stems from Parnes and Osborne's, however, he added a complex problem solving domain. He believes that students do not learn to solve problems by tackling well-defined mini-problems. He believes students should be presented with the situation in much the same fashion that the problems would actually be encountered. Students should be given a contemporary or future problem situation. From the information given, they must determine the underlying problem, brainstorm, evaluate and implement a solution, then produce a design, product or service. His emphasis is on solving a complex situation for a reason.
Robert Sternberg also recommends using complex real life problems early on in the instruction of problem solving. He suggests that formal knowledge in problem solving will not be as effective as finding solutions to everyday problems in the context in which they occur. He stresses that most problems are not well defined, but must be defined from a situation, be it pleasant or unpleasant. Most everyday problems are complicated and do not have one right or wrong answer; moreover, whatever the solution chosen, it produces a definite consequence. For example, a college teacher faces a problem with the class. College teachers are taught ways in which to control classroom activity, methods of being effective for the largest number of students, and how to generate interest in the subject. However, only through experience in the classroom are these skills really learned, then transferred to new situations (Sternberg, 1985a).

Sternberg has come up with a year long program entitled "Intelligence Applied" designed to teach problem solving effectively. Although it is a five-part program geared for high school students, it is noteworthy because it emphasizes that problems should be developed from everyday situations, thereby giving students a reason for finding a logical and/or creative solution. It recognizes that problems are not clear-cut and that whatever solution the person or group decides upon, the solution will lead to some consequence (Sternberg, 1985b).

One example of a program in creative problem solving using complex problems from a content area is that designed by Kermit Barry (Barry, 1989). Kermit Barry, educator and principal of Belville
High in Belville, Michigan, has had a program involving problem solving in social studies for over forty years. Even though the subject matter and age level of his students are different from those in this paper, his creative problem solving program is worthy of explanation. Barry uses the required text for his school, but supplements it with various materials and activities. The students must increase their knowledge base with various memorized pieces of information, must read and digest various documents related to the topic and present some type of solution to a problem. The solution may be in the form of a cabinet meeting, a bill of their own design, or a mock trial, depending on the unit being studied. Barry states an ill-defined problem, provides curriculum criteria and motivation, but the students design their own service, product, design or event.

Barry's program includes five steps:

1. Developing a knowledge base through text and outside readings
2. Dividing into cooperative learning groups
3. Defining the problem
4. Generating ideas and solutions to the problem defined
5. Presenting the solution to class

Barry has been using this approach for around forty years. He claims the value lies in the fact that students have to become active learners and active problem solvers. They have to look up their own material to develop a knowledge base, in addition to meeting the criteria he has set up. They have to define and solve an underlying
problem from the situation he has proposed. They have to develop and present a logical solution to the class based upon the definition of the problem they have chosen. In order to be confident and answer questions from their peers, the students must have analyzed and internalized the material connected with their topic. They feel a particular ownership in the problem and solution they have presented.

Although there have been no actual tests provided concerning success, Barry reports that the measure of its worth has become apparent over the years. Students who were underachievers have become contributing, enthusiastic members in his class. Many students have transferred the techniques learned for problem solving and the feeling of success gained from his class to other subject areas. Years after graduating, students have returned to him to express their thanks and appreciation for not only a course that created interest in solving problems in politics, social studies and current events, but for a course that awakened them to the fact that they, themselves, had the means of solving their own, everyday problems. When such transfer occurs, even years later, it makes Barry's program appear to be quite successful.

The program we are going to offer will be a combination of elements chosen from programs by Treffinger, Parnes, Sternberg, Barry and Torrance. It offers problem solving strategies which can be used by all students. The strategies are implemented in stages for teacher receptivity and student adaptability. It encourages the traits
and characteristics considered essential for good problem solving, and will be accomplished in an environment conducive to creativity.
CHAPTER IV
Curriculum Unit

Chapter four, the curriculum unit, includes the goals of the unit, and an overview of the sequence of instruction. Lesson plans follow in chapter IV. The general goals for the program include goals both for the teachers and the students. The goals for the teacher include:

1. encourage teachers to be receptive to critical and creative problem solving instruction
2. help teachers become good problem solvers by providing an organized program and teacher instruction via workshops
3. provide models so as to enable teachers to introduce problem solving in a sequential manner and to foster organizational skills
4. help teachers value creative as well as critical problem solving within the realm of teaching
5. provide hands on material to encourage active participation of all students

The goals for the students include:

1. directly improve students' problem solving ability by use in different subject areas
2. transfer problem solving ability to new situations
3. utilization of critical and creative skills to effectively deal with practical/everyday situations
4. a striving for self-actualization, initiation and motivation to solve problems
5. a development of cooperative learning styles
6. experience active learning situations where they are truly involved in the learning experience
7. experience with hands on materials

The target audience used in developing the materials for this thesis were fourth grade students from a predominantly white, middle class community. The students were heterogeneously grouped in terms of academic performance: top, middle, and bottom with about a year's difference in academic growth from top to bottom. There were several bilingual students in each class with varying degrees of English fluency. Several students went to the school psychologist or to private psychiatrists for various reasons. All students appeared responsive to teacher suggestions and positive reinforcement. The students had been exposed to a critical and creative "thinking skills" program for the past four years where they had learned to work in small groups, to follow a set of directions and to share in group decisions. Most students performed lower than expected in problem solving in math, yet scored relatively higher in computational skills on the California Achievement Tests. They scored lower than the Shrewsbury town averages on the Massachusetts Educational Assessment Program, especially in problem solving and transfer of knowledge, thereby substantiating
the need for better problem solving instruction. While these testing devices may not be perfect, they serve as a norm throughout the state and the results need to be taken into account when planning future programs.

The stages of implementation were developed due to my experience in teaching for thinking skills over the past four years. Problem solving in stages seems most helpful in the introduction of problem solving. Once the teachers and students have experienced the total program, there may be stages or parts which will be used frequently and stages which may be used only in certain situations. This will become obvious as the program is introduced. For teachers to be receptive enough to try to incorporate critical and creative problem solving into the present elementary curriculum, they need to believe it will work. The lessons will show the teachers how to integrate problem solving into the curriculum sequentially and efficiently. After going through the eight stages, the students will be ready to handle problem situations with considerable independence. The lessons start with well-defined problems with either definite initial statements and/or definite goal statements. They follow a continuum ending with ill-defined situations where problems are nested and have many possible processes and solutions for obtaining these goals. By going through the entire process from stage one to eight, it is felt that teachers as well as students should be able and ready to attempt contemporary or future complex problem solving on their own.
A primary goal in problem solving is to have successful strategies transfer to other areas. Although such transfer is difficult to achieve, it may be approached through low road transfer, high road transfer or a combination of both. (Perkins and Salomon, 1989) define low road transfer as occurring when the students practice a particular strategy over and over in different contexts. The repeated practice enables the students to draw upon the experience when similar situations arise. High road transfer occurs when students analyze what, how and why they are utilizing certain strategies so they can apply these principles to situations at a later date. Combining both roads of transfer would involve having the students reflect upon a number of different tasks, asking how, what and why they attempted to accomplish the task in each situation.

Going through the eight step problem solving process as an introduction to problem solving will not provide the practice necessary for low road transfer to occur. Teachers presumably cannot provide practice with the variety of experiences necessary for transfer to occur. To help compensate for this lack, there is a period of reflective thought at the end of the lesson. By allowing the students and instructor time to analyze what, how and why they made a particular decision, the teacher, with training and practice, can help the students understand the concept being taught so they may apply it to another situation.

Since the program will be introduced in stages of implementation, the steps used for each lesson should be listed on charts and displayed prominently in the classroom. They should be
large enough that students may refer to them at any time during the lessons. They will help in the organization and utilization of the program.

To reiterate the point that the attributes of literature can be integrated with creative problem solving instruction, a reading objective as well as a problem solving objective will be included for each activity. Many of the skills will become more automatic if the teachers try to use them in other subject areas.

Rationale for the program:

E. Paul Torrance's six step creative problem solving model listed below has been modified into eight stages of implementation that make it more useful for the teacher who is inexperienced in problem solving. The intent is not to change his model, rather to change its implementation.

E. Paul Torrance's Model
Recognize and state underlying problem
Produce possible solutions
Develop criteria for judging solutions
Evaluate and select solution
Implement solution
Sell solution

Problem Solving Model for Elementary Students
Stage 1 Understand some problems have multiple solutions
Stage 2 Evaluate solutions
Stage 3 Recognize and state the problem or multiple representations of the problem
Stage 4 Establish or generate criteria for the solutions
Stage 5 Find and evaluate solution in terms of criteria
Stage 6 Communicate and/or implement the solution in terms of how the problem was defined
Stage 7 Evaluate and reflect on entire process
Stage 8 Transfer (on own) to new problem

The rationale for such a change involves the following observations:

1. Using the stages of implementation enables teachers and students to generate creative problem solving situations from the already existing material.

2. Using stages of implementation gives students a specific starting point, a definite organizational pattern to follow and a guide for evaluating problems, plans, solutions and products. This will help young students organize themselves.

3. Using a continuum gives the teacher as well as the students a way to detect specific weaknesses or areas where help may be needed.

Some general strategies that teachers can employ which will make the goal for problem solving easier to attain follow:

Two strategies that have proven effective in classrooms both involve the teacher's rhythm of responses. The first, wait time, should be an integral part of all teaching, not just problem solving. Wait time is a strategy for teachers which allows students time to think. The average teacher waits less than three seconds for a
student to answer before asking someone else, (Costa, 1986). By waiting longer, the teacher invites the students to organize their thoughts and to think before answering, thereby, generating more thoughtful, as well as more creative, answers. It also gives the slower thinker a chance to organize and share his/her thoughts.

The flip side of this type of wait time is to allow time after the student has answered before asking another question. By allowing students time to reflect upon what has just been said rather than immediately going on to a new idea, the students will tend to elaborate upon the concept.

The second strategy involving time which produces more creative and effective answers is to pick the fifth or sixth student who volunteers, not the first. The delay gives time for organization and creativity to blossom, students start to realize that the thought behind the answer is really more important than the answer.

Mary Budd Rowe has a list of eight ways in which classroom performance is enhanced when wait-time is used. If the teacher waits three seconds between teacher questioning and student answering, the following behaviors will be noticeable:

1. Average length of student responses increases
2. Students initiate more responses
3. More students succeed in answering more questions more of the time
4. More alternative explanations are offered by the students
5. Students make more and better connections between evidence and conclusions
6. Teachers are more flexible in their responses to students
7. Teachers' questions show more variability
8. Teachers' expectations improve in regard to performance of students usually rated as relatively weak

There are certain phrases that inhibit wait time because they imply "the correct" answer has been given:

"Think" "Great answer!"
"Why?" "You're absolutely correct!"
"Yes...but..." "Don't you think that...?"

Instead, there are several phrases that enhance wait time:

"If that's so, then why...?"
"I don't understand what you mean. Try telling me again."
"What evidence are you using?"
"I'm not sure I can agree with that, because..."
"I think that... What do you think?"

When working with the students, wait time becomes easier if the teacher sits with the students at their level, if the teacher avoids eye contact while conversing so that students are talking to each other rather than just to the teacher and if the teacher makes observations instead of asking questions. This takes practice. One way in which to make this change in style easier is to have peers observe each others, noting how many times wait time is used, how many times an observation is made rather than a question being asked or how many times students are asked to restate a problem
and/or answer so that others will understand. (See teacher response
sheet, page 105).

While the use wait time helps establish the pattern of
generating thoughtful, organized and creative answers, teachers must
also help students develop a sense of risktaking or an acceptance of
failure. Risktaking is an important pattern in building the confidence
needed to become "creative" or, somewhat different. It takes an
inner strength to be able to suggest new ideas. It takes even more
strength to accept the fact that the ideas generated may fail or that
perfectly good ideas will be rejected because the teacher or public is
not ready to accept them. Students who find their first efforts
reinforced enthusiastically are provided with the motivation to
continue thinking creatively as well as critically, (Harbert, 1989).
Chapter V has details on how to make this happen in the classroom.

Breaking into small groups is another strategy that works well
for problem solving, short answers, preparation for essay tests, and
generating ideas. This cooperative learning style provides an
opportunity for all students to participate. It allows students to gain
confidence and to become active learners by testing their ideas in a
microcosmic situation, making failure or taking a risk less
threatening. It gives the members a chance to "piggy-back" or use
others' ideas as a stepping stone to a new idea. It is also an
evaluative tool, for each small group presents only its best answer(s)
to the large group.

Small group interaction is a central issue for this program, but
it is not a standard procedure in many schools, so this type of active
learning may have to be taught before the problem solving program can be used successfully. It is through the insights of others and the rallying of ideas in a group situation that students form new ideas and critically analyze the options suggested. Although this may occur in a large classroom situation, there will be many passive learners while a few bright or interested students carry the majority of the thinking. If transfer is to occur, all students must be involved, active learners sharing ideas and solving problems in many situations.

Team reading or paired teams, where two or three students read in a small group is another deviation from the traditional teaching of reading. This strategy may let vocabulary errors go undetected for a day or two, but the benefits of such a strategy minimize the drawbacks. If the instructor allows the students to read together, then answer comprehension question(s) together with the stipulation that the students must be able to support the ideas, the students have entered the realm of analysis (McTighe and Lyman, 1988). If the paired teams regroup, having to defend their answers to another person or team, it forces the students to go back and find evidence to support the answers. When the students go back to answering questions independently, they will have the confidence of knowing others agree with the answer as well as an idea of what is needed to support their ideas. If the students can read the material well enough to define the problem or question and support answers with evidence from the text, then most of the vocabulary will undoubtedly be picked up in the process and the
emphasis will fall where it should: on thinking and comprehension. See Figure #5.

<table>
<thead>
<tr>
<th>Team A</th>
<th>Team B</th>
<th>Team C</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>A</td>
<td>B</td>
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<td>Team A</td>
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</tbody>
</table>

Independent Responses/Contributors to Class Discussion

9:10 A B C A B C

Figure #5: Paired Reading Teams

Problems for this program have been chosen for directness of approach and solution. For instance, if the students were reading "Jack and the Beanstalk", the following problem may be posed: Jack and his mother have no money and no food, how can they get food? Children who have read the story will have the obvious answer, but should be encouraged to find another solution to the problem. This first situation or question involves a well-defined problem which has obvious solutions. The students are given a chart with the steps listed as a guide. They solve the problem in small groups according to the process indicated by the chart. Then the small groups come together to share their results with the large group. During the discussion they will find that some groups approached the problem
differently, yet all obtained an acceptable or "correct" answer. Thus, they come to realize that there may be more than one approach to a problem; moreover, there may be more than one "correct" answer. They will apply this knowledge as they approach the next stage of problem solving.

The eight stages included should be copied onto a large chart or the board to help students focus on the objective for each stage. Reviewing the steps necessary to get to the next stage helps reinforce the patterns and strategies needed for good problem solving. The example included in each stage is suggested to help clarify the focus of instruction. After each lesson has been completed, the students should share what they have done and explain how they came up with the solution. This reflective thinking time helps others to see and understand differences in thinking. It also gives insight into faulty reasoning and logic. Although it may seem easy to cut out this step, it is precisely this thinking about thinking that will help transfer problem solving skills to other situations.

There are many techniques available to help make using the strategies for problem solving easier to incorporate and understand. Within each lesson there will be one or two strategies mentioned that are particularly important to that aspect of problem solving. Each strategy will have questions and/or techniques the teacher can use in helping the students to understand and employ the concept.

Careful and clever use of the strategies and techniques suggested in the lessons will make problem solving in literature an intriguing part of the curriculum.
The Problem Solving Model

Stage 1  Focus of Instruction: Understand some problems have multiple solutions

Brainstorm ideas related to the problem
Brainstorm plans related to the solution
Solve the problem
Share and/or reflect

Before going into the problem solving stages, it may be necessary for teachers to review some of the strategies that follow in order to help the students move from stage to stage easily. Some students will automatically use these strategies as they try to solve the problems; however, for those students who don't, discussing them may open avenues that would otherwise be unknown. Even for the students who use them automatically, it is important to use their appropriate names, so they can be used more effectively during moments of reflective thought. Although it is not necessary that the students be familiar with all these strategies before they begin problem solving, it is effective to point them out and discuss them as they are encountered and/or used in the program. It must be remembered that the techniques are means to solutions, not ends in themselves.

Brainstorming is one of these necessary skills for Stage 1. Students must learn to share their thoughts in order to work together effectively. In brainstorming every idea is accepted. Judgment is deferred until a later time when the ideas will be
tailored into acceptable solutions. Deferring judgment encourages the fluency of answers, especially in students who may be hesitant or slow to answer.

If the class has not done much brainstorming, they could sharpen the skill with additional problems such as the one from "Jack and the Beanstalk" in stage one on page 69. What other things could Jack have done with the cow instead of trading it for a handful of beans? What things could Jack do for his mother to make up for his mistake in selling the cow? What else could he have done with the beans? All answers should be accepted at this time, for a seemingly wild idea with a few minor changes, may turn into a terrific solution or product.

In the first few problem solving activities risktaking should emerge. With encouragement, the students start to be spontaneous and free-flowing with ideas. They begin to see that there may be many possibilities; moreover, that if an answer is not accepted, it is not a matter of being right or wrong, it is merely a detour until another idea is generated. Once brainstorming, risktaking and fluency of ideas become positive, automatic components of the problem solving process, creativity should occur.

The elaboration of an idea occurs much more readily if students have a working knowledge of strategies to help them. Visualization, forced-relationships, metaphorical associations and attribute listing are just a few, but an important few of the strategies students must be able to use effectively.
Visualization is a strategy which attempts to have one picture in one's mind an object, a scene or a story. Picturing the details and/or sequence of events often helps one "see" a solution or develop more creative ideas based upon what is visualized.

The concept of forced-relationships involves the forcing together of two entirely different ideas, then finding similarities. For example, students may compare the giant in "Jack and the Beanstalk" with a chair. They both can be strong, appearances can be varied, both can be comfortable or hot and sticky on which to sit. Students use the similarities as a springboard for further elaboration.

Metaphors have long been used in comparisons because of the visual images produced; therefore, metaphorical analysis becomes a dependable technique in developing creativity. The giant is a table creates an entirely different image than the giant is a sponge. Asking the students why those particular metaphors were selected can often evoke even more thought provoking analogies.

Attribute listing is another technique from which the creative person can leap. Simply by listing the attributes of a particular object, the brain starts to generate other attributes which may be farfetched, but when tailored, form an appropriate solution. Listing the attributes of a spoon may conjure up the following list: shiny, concave, convex, skinny, pretty, decorated, plain, silver, spotted, dirty, large, small, hard, cold. While still generating ideas, the person may look at the list and suddenly latch onto the word concave. From the word "concave", an entire story may develop. Once again, these techniques do not have to be taught prior to stage one, but may be
introduced whenever students happen to use them or whenever the teacher feels they are necessary for proper execution of the stage. The worksheet on page 46, Figure #6, will help students organize their approach for determining multiple solutions.
Name __________________________

Multiple Solutions

Check off each statement in the correct box after you have read the statement. Some may have more than one answer. Be certain to check the things that apply to your problem and solution.

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

1. Read the problem. Make certain you understand the problem.

2. Could there be more than one answer to the problem?

3. If the solution or answer requires more than one answer, did you try any of these techniques?
   a. Brainstorming
   b. Attribute listing
   c. Metaphors
   d. Visualization
   e. Forced-relationships
   f. Elaboration

Figure #6: Worksheet on Multiple Solutions
Stage 2  Focus of Instruction: Evaluate solution
            Review solutions
            Evaluate solutions
            Select best solution in terms of information given
            Share and/or reflect

In the second stage the problem is a little more complicated. Students discover that various ideas can and will be tried, but they need to select their best idea based upon their understanding of the problem. They brainstorm ideas, evaluate ideas and pick the most likely to succeed. They try it and check to see if the solution answers the original problem. The idea of evaluating becomes important because it changes the focus from divergent thinking to convergent thinking needed in good problem solving.

In the story of "Little Red Riding Hood", Little Red Riding Hood faces a problem. The wolf asks her a question. Should she talk to him, a stranger? The problem is well-defined: Should Little Red Riding Hood or anyone talk to strangers? Whatever the decision, students will have to evaluate the alternatives before picking the best solution. Evaluation of ideas in relationship to the problem becomes the important element in the second stage of implementation.

A skill necessary for Stage 2 is evaluating. Students are usually good at deciding which solution they like best (opinion), but they must come to realize that they should be able to support their choice with facts or evidence. Most fourth grade students are too
young to evaluate a solution with reasoning terms such as those Richard Mayer presents: logic, inductive, deductive, conditional, and linear reasoning (Mayer, 1983). However, students can be taught the following techniques for evaluating an answer:

1) make certain an answer fits the original question
2) look for evidence within the definition of the problem for choosing that particular solution
3) use past experience to decide if the solution has a chance of working
4) cite evidence from the text which will support the solution
5) make a decision on fact rather than opinion

For some students a graphic representation of a strategy may be more effective. A chart such as the one which follows may help the students pinpoint a good solution quickly. It may also help them cover aspects of the problem they would have otherwise have forgotten. Instead of limiting their solutions to one area, the chart helps them to focus their attention on many areas. The chart for stage two should be presented as a reference. The students will also benefit from using the worksheet on page 49, Figure #7, which helps them organize their thoughts for evaluating a solution.
Evaluating Solutions

1. Read through the problem to make sure you know what is asked.
2. Write down each possible answer on the back of this paper.
3. Check off the five best answers.
4. Circle the answer you think makes the best solution.
3. Read through the list of reminders. Check each box that applies to your best solution to help decide if it really answers the problem.

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Maybe</th>
<th>Considerations</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>1. Does your answer fit the problem?</td>
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<td></td>
<td>2. Can you find evidence in the text to support your answer?</td>
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<td></td>
<td>3. Can you use past experience to prove your solution works?</td>
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<td></td>
<td></td>
<td></td>
<td>4. Is your answer fact or opinion?</td>
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</table>

Figure #7: Worksheet on Evaluating Solutions
Stage 3 Focus of Instruction: Recognize and state the problem or multiple representations of the problem
Read the problem
Brainstorm ideas related to the problem
Establish underlying problem
Share and/or reflect

Stage three shifts the emphasis to understanding and determining the underlying problem in a situation. The solution then becomes dependent upon the students' interpretation of the problem. Defining a problem or determining an underlying issue will be a strategy that takes practice. Students must be able to determine the type of question being asked: fact-finding, judgmental or creative. In a fact-finding question, students merely recall what has been stated, taught or is remembered from previous knowledge. In a judgmental question, students are required to compare two or more bodies of information and obtain an answer which they can support for a definite reason. In a creative answer, students must draw upon previous knowledge and decide how that knowledge can be tailored, merged, or manipulated for application in a new situation. The "What-if..." question would be an excellent stimulus for such creativity. Students must be good at fact-finding or recall in order to have an appropriate knowledge base in the problem solving area, but they must be able to determine when a situation calls for active participation in the answer or solution.
Teachers must also be aware of what, as well as how, they are asking questions and problems (Dillon, 1982). Due to the complex nature of defining an ill-defined problem, ill-defined problems are intentionally introduced after well-defined problems.

Based upon evidence from working with students in thinking skills, students appear to need practice in using questioning levels and solving problems that are apparent before they attempt to narrow a situation and define a problem. They seem to be able to generate ideas and solutions to a problem which has a well-defined given statement requiring one or multiple solutions. However, they have difficulty supporting a judgment or a creative answer with facts from the story (Harbert, 1989).

In the story, *Mr. Popper's Penguins*, Mr. Popper receives penguins from Antarctica. How will he keep them? What if he wants to keep all of them? There are many possibilities, but students must come up with the underlying problem before they can solve the problem. They must convince the audience their solution will work, given their interpretation of the problem. The worksheet which follows may help in determining the problem.
Worksheet for Determining the Problem

Check off as reviewed

1. Read the problem. Restate it in your own words.

2. List possible problems connected with the situation solution?

3. Choose the problem you think is most likely the real problem, the one which caused other things to happen.

4. Make certain you know what kind of problem is being solved: fact-finding, judgmental, creative.
   a. Do you need a fact to solve the problem?
   b. Do you need to find support in order to convince others to agree with your solution?
   c. Do you need a fresh idea, one which would not usually be thought of with the problem?

Figure #8: Worksheet on Determining Problems
Stage 4  Focus of instruction: establish and/or generate criteria for the solution

Understand the problem
Establish criteria
Share and/or reflect

Stage four requires that the students establish criteria for the solution. First they must decide what type of problem or question is being asked: fact-finding, judgmental or creative in order to know what type of answer is expected (Dillon, 1982). Then they must decide if criteria or limitations are given which must be taken into consideration. For instance, if the answer has to be a one word group consensus, the approach will be much different than if the answer must be a model, a product or a design. The teacher may also help them in determining their own criteria.
Establishing Criteria

Has the teacher given criteria which must be met in order to solve the problem? If so, what is it? Circle the criteria you need to keep in mind.

1. Does your solution really solve the problem?
2. Could you really make this solution work?
3. Is there an easier way to solve the problem?
4. Did you try multiple solutions before selecting this one?
5. Did you use more than one source of information?

What criteria have you set for yourself? You may use the categories above or you may think of your own.

Criteria #1
Criteria #2
Criteria #3
Criteria #4
Criteria #5

Figure #9: Worksheet on Establishing Criteria
Stage 5  Focus of Instruction: Find and evaluate solution in terms of criteria

  Recognize and state underlying problem
  Determine criteria
  Evaluate solutions in terms of criteria
  Share and/or reflect

Stage five reveals the need to use the criteria dictated as a factor in the solution to the problem. If the instructor has left the criteria open-ended, then the group must establish its own criteria for the problem before creating a solution. Out of the many solutions generated, the one meeting the criteria to the greatest extent should be used. A chart such as the one in Figure #10 may be introduced as a visual tool to help in making the decisions.
Name______________________

Determining Solution in Terms of Criteria

Write your best solutions in the column listed possible solutions. Look at the criteria you were given and decide if your solution met the criteria. Check off each criterion met. Which solution fits the criteria given the best?

<table>
<thead>
<tr>
<th>Possible Solutions</th>
<th>Does it meet criteria #1?</th>
<th>Does it meet criteria #2?</th>
<th>Does it meet criteria #3?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>partly</td>
<td>no</td>
</tr>
<tr>
<td>#1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
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<td>#5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions to think about before making your final decision:

1. Does your solution solve the problem?
2. Do you like your solution? Does it meet the requirements?
3. Is it a fact, a judgment or a creative solution?

Figure #10: Worksheet on Determining Solution in Terms of Criteria
Stage 6 Focus of instruction: Communication and implementation of solution

Recognize and state underlying problem
Evaluate solutions in relation to the criteria
Evaluate solution for fit and originality
Communicate and/or implement solution with others

The emphasis in stage six is on communicating the solution. In stage six the students must convince the audience of the solution's worth in terms of how they have interpreted the problem and in terms of the criteria given. In order to do this they must keep in mind some of the following questions: Does it answer the original problem? Does it fall within the realm of the criteria listed? Is it practical, creative or both? Is it an appropriate solution in terms of the audience to which it is presented? A puppet show for five year olds would need to be much different than a puppet show for teenagers or a group of computer experts.
Organizing Presentation of Solution

1. Reread the problem. Does your solution solve the situation given?
2. Reread the criteria given and/or criteria you chose. Does your solution meet these criteria?
3. If you are presenting the solution alone, have you rehearsed your answer? Do you have all the materials you need?
4. If you are presenting the solution in a group, is everyone prepared?
5. If the presentation is both oral and written, have you done both parts?
6. Is your solution appropriate for the audience which will hear it?

Figure #11: Worksheet on Organizing Presentation of Solution
Stage 7 Focus of instruction: Evaluate and reflect on entire process

- Recognize and state the underlying problem
- Brainstorm solutions and criteria
- Evaluate solutions in terms of criteria
- Communication and/or implementation of solution
- Share, reflect, evaluate process

There are numerous ways in which problem solving may be evaluated. Four of the possibilities follow:

1. Have students create a story which contains a problem that is solved within the context of the story. In order to solve the problem they have created, they are forced into analyzing what they are developing. They have to determine the underlying problem in a situation, establish any criteria pertinent to the problem or story, develop a solution which would be acceptable to the teacher and implement the solution (create the story). After completing their product, the students would share their stories and decide if the problem(s) created within the story had really been solved. They would discuss techniques used in the solution: definition of the problem, brainstorming ideas and plans, evaluation of solutions in terms of originality, fit and appropriateness, criteria generated by the teacher as opposed to student generated criteria. The teacher would then be able to determine if the class understands the process of problem solving and make appropriate lessons or problems based upon these observations.
2. Another means of evaluation would involve giving the students an alternate story in which they could identify and solve possible problems as the story unfolds. The students should be able to identify a problem situation before the author states it. In addition to identifying the problems, they may identify possible solutions they would have had in common with the author, note where they would have changed the story, or explain how they would have solved the problem differently for a different audience. Their responses would indicate their understanding of problem solving and the teacher could plan accordingly. This type of evaluation makes the assumption that the teacher is well experienced in or well trained in the area of problem solving and can easily make the assessments necessary in this type activity.

3. Giving the students a real life situation similar to one they have worked on in literature will quickly identify those students who are able to use the problem solving techniques. Assume the students have worked on "Goldilocks and the Three Bears" and were asked to determine if Goldilocks was justified in going into the Bears' house. Having gone through the reasoning process required to solve the imaginary problem, students should have ideas or strategies for solving a similar real life situation: Johnny's neighbor's door is open, but the neighbor does not come to the door when he rings the bell. He knows the neighbor will not mind if he uses the phone to make a call, but he also knows that he should not enter the house without permission. Would it be all right for him to enter the house just long enough to call his mother? In the moments which follow the
students have to make a decision. At the end of the allotted time, the teacher would then lead a discussion around the following questions designed to get the students thinking about their decision in terms of problem solving: Did they brainstorm ideas about the problem and try to decide what the underlying problem was? Did they brainstorm ideas related to the solution? Did they evaluate their solution in light of any criteria given or generated? Did they evaluate their solution in terms of fit and originality? Would a product, design or model have been appropriate for this particular problem? What values in the Goldilocks story were the same or different from Johnny's story? By having the teacher guide them through the analysis of their solution, they should be able to decide if their solution was appropriate.

Although there are several issues involved in the example used above, such as the ethics involved and whether or not students would really be asked to compare a "literary" problem with a simulated one, how the problem is solved and if it is solved in a logical manner, are paramount. Problems in life are not going to appear in neat little bundles; therefore, students need to be ready for a mixture of many types of problems in various places.

4. Reflection is another type of evaluation and probably the one which is going to foster transfer of skills. Looking back on how and why the solutions were derived often gives new insight into what could have been done differently or how the process could be improved upon the next time. Helping the students to determine if, how and when certain principles were used, helps in the process of
transfer as well as in the skills of evaluation and reflection. It may
be necessary to refer to Chapter V for ideas on how to make this
happen in the classroom, for it takes much practice in a variety of
different situations.
Name _______________________ 

Questions to Consider When Reflecting

1. Can you tell where you are in the problem solving process?
   Can you tell another person how you finally got your solution?
   If you got stuck did you work your way back to where you were comfortable and try again?
   Did you use the chart to make sure you used each stage in problem solving?

2. Did you try other methods or techniques when you were stuck at a certain point?
   Did you choose your first answer?
   Did you change it any way?
   Did you elaborate upon it?

3. Can you describe information you would need to make better decisions?
   Do you need more data?
   Do you need more support for an idea?
   Did your final solution satisfy you or did you want to work on it some more?

4. Did you find working in a small group helpful?
   Did the group cooperate and take turns talking?
   Did the solutions come mainly from one person?
   Did you get a chance to voice your solutions?
   Was the teacher available to help?

Figure #12: Worksheet on Questions to Consider When Reflecting
Stage 8  Focus of instruction: Transfer on own to new problem

The ultimate goal for the students in teaching problem solving is to produce students capable of solving future problems on their own. After going through seven stages of the eight stage program, the process should be familiar enough that students can try to solve problems independently. Stage 8 is an ongoing situation where students become better problem solvers through a variety of experiences, practice and reflection. Stage 8 involves problem solving situations that arise in the everyday curriculum. Such examples include:

1) a situation to solve from a story such as Joan Lowery Nixon's, A Family Apart. The students would identify and solve problems the family faced as the story unfolds.

2) a real life situation in which they have to identify the underlying problem in order to determine an appropriate solution. Students may be asked to devise ways in which poor students could improve their grades.

3) a well-defined problem where there are many avenues to a desirable solution. The class wants to go to Disney World, but the superintendent says they have to earn their own way. The process of attaining the goal statements will be varied. Students will be able to determine their success in solving the problem when forced to think about their decision. Did they brainstorm various ideas related to the problem? Did they generate many solutions, then evaluate
them for fit, originality and appropriateness to the situation? Have students refer to the worksheet on reflecting found on page 58.

Whatever the problem is, transfer will not take place easily, but with practice and reflective thought, a chart to guide them through the steps and a resourceful teacher, the students should develop an idea of how to solve the problems in a logical manner.

The lessons which follow, although limited to a rather small population, are suitable as springboards for creating situations appropriate to other grade levels and/or student populations.

Although the reading text book for the class, a few trade books and several well-known stories were mentioned, this program can be used successfully with any good children's literature. The following literary works are just a few of the thousands which will work. Picking out works which will be applicable to your grade level will be rewarding:

- Stuart Little
- Winnie-the-Pooh
- Moby Dick
- Farmer Boy
- Anne of Green Gables
- Charlie and the Chocolate Factory
- The Giving Tree
- The Five Little Peppers
- Ramona Quimby, Age 8
- The Hardy Boys
- James and the Giant Peach
- Little House on the Prairie
- Little Women
- The Ugly Duckling
- Charlotte's Web
- The Call of the Wild
CHAPTER V
Lesson Plans

Two problems are presented at each stage. The first problem is designed around a fourth grade text book and trade books. The second problem uses the familiar story, "Jack and the Beanstalk", as a means of illustrating the nine stages of instruction. If the teacher's goal is to teach problem solving within the bounds of the everyday curriculum, the first lesson reveals how this can be accomplished without adding new material to the content area. Rather, the teacher's approach and skills used within the curriculum are changed. If the goal is to teach problem solving as a unit, then "Jack and the Beanstalk" may be easier to follow since most teachers are familiar with the story and need only to adapt their teaching style to the program.

Although both lessons contain the same focus of instruction at each stage, they are necessarily different. The problem solving model has been designed to enhance important ideas in the stories and books as well as to present important concepts in the problem solving model. The changes between problems #1 and problems #2 reveal how easily the model adapts to various types of literature.

The traditional directed reading approach, where the teacher meets with small groups, may be used with any of the following
plans; however, some of the reading strategies included in the lessons will not only add variety to the program, but should elicit critical and creative thinking.

Lesson Plans

Lesson Plan #1. Focus of Instruction: Understand some problems have multiple solutions

The first selection for problem solving, "The Day After Thanksgiving", is part of the required fourth grade reading program from Scribner's text, Finding Your Way. The emphasis will be on generating ideas in order to solve a problem which could have multiple solutions.

Objective:
1) Students will be able to understand that some problems have more than one correct answer.
2) Students will be able to read the story, review solutions and decide which solutions generated are most appropriate.

Goal:
1. Be able to brainstorm possible questions and answers appropriate to the problem.
2. Be able to brainstorm possible solutions.
3. Develop an awareness that there can be many solutions to a problem.
4. Develop an appreciation for differing opinions.
**Material:**
A copy of the text for each child, Scribner's, *Finding Your Way*, copy of worksheet on multiple solutions found on page 46.

**Procedure:**
1. The teacher will present the problem *before* the story is read: The main character has fallen off her horse and has broken her ankle. How can she get back home? (2 minutes)
2. Students will break into small groups to solve the problem. Students generate questions that may be appropriate for the problem before they solve it. (examples) How far is she from home? Did she go with a friend? Can she remount the horse? After determining what they know or what they need to know in order to make a good decision, they develop solutions. (5 minutes)
3. The group will choose one solution and a spokesperson for the group will share that solution with the class. (5 minutes)
4. The teacher will list each group's solution on the board, then invite the class to draw conclusions from the results. (The class should determine that there were several ways in which the little girl could have returned home since the circumstances around the fall are vague or nonexistent.) (10 minutes)
5. Students will read the story up to the point where the main character falls off her horse and breaks her ankle. This may be done as a whole class or in small groups. (10 minutes)
6. The students will review the questions and solutions they have discussed earlier, then determine which ones, if any, are relevant
now that they have actual facts and pictures from the story. (10 minutes)

**Alternate Lesson:**

1. The following problem is presented to the class: The main character has just traded the family cow for a handful of beans. His mother is angry. What should he do?

2. The students break into small groups to solve the problem. They generate questions and ideas that must be considered before they try to solve the problem. For instance, they may ask if the cow was worth more than Jack received. They may ask if the family truly needs the money from the sale of the cow.

3. Students generate various solutions, then pick the one they like the best to share with the class based upon implied criteria.

4. The teacher records the solutions on the board for reference during the reflective thinking time.

6. The students read the story of "Jack and the Beanstalk" to the point where Jack returns with the beans.

7. The students will break into small groups and consider which solutions generated in the first part of the lesson are still relevant now that they have some facts from the story.

**Conclusion and/or Reflective Thought:**

The teacher will help the students formulate the idea that some problems have more than one possible solution and that being able to see a problem and guess what will happen before all the information is given involves creative thinking. Creative thinking is needed for creative problem solving. However, once actual facts are
known, critical thinking skills must be used in order to obtain a logical response based upon reason and/or knowledge. This concept will be important as they use divergent and convergent thinking in future lessons. (10 minutes)

Day 2
Objective:
1. Students will be able to read the remainder of the story and answer comprehension questions through cooperative learning or reading teams.

Goals:
1. Be able to generate ideas based upon content.
2. Be able to use interpretation and inference.
3. Be able to propose solutions that are logically related and/or appropriate to the situation.
4. Achieve agreement.

Materials:
A copy of the Scribner text, Finding Your Way, or a copy of the story, "The Day After Thanksgiving", a copy of the worksheet on multiple solutions found on page 46.

Procedure:
1. In paired teams the students will read the story and answer comprehension questions, some of which have multiple answers. (See paired teams, page 40). The partners, or reading teams, may be designated by the teacher or chosen by the students. (30 minutes)
2. After the students have answered the questions, they will switch partners and decide if they agree with the new partner. This
procedure encourages the students to support their ideas with facts from the story. It also helps them to realize that there can be more than one correct answer to a question, but that supporting the answers is essential. (10 minutes)

3. The large group will resume and answers will be discussed. Students who disagree with answers presented will suggest alternative ideas, supporting the idea with evidence from the text. (10 minutes)

Conclusion:
The teacher will elicit from the students that problems can have more than one answer, but that certain circumstances indicate the need for a best answer, so students need to be able to support their answers with evidence. (The strategy of supporting an idea or answer will act as a transition into Lesson #2). (5 minutes)

Lesson Plan #2. Focus of Instruction: Evaluating solutions

The following situation comes from Mr. Popper's Penguins, by Richard and Florence Atwater. The problem has a well-defined initial problem statement, but the goal statement is ill-defined or open to many possibilities that are appropriate for the story: How can Mr. Popper keep his penguins alive and happy?

This particular lesson covers two days and has different goals and objectives for each day. A similar format can be used throughout the remainder of the book. Adapting some of the following strategies in future lesson plans may prove exciting and more beneficial to critical and creative problem solving.
Day #1.

Objective:
1. Students will be able to demonstrate knowledge of vocabulary and show comprehension of story content.

Goals:
1. Students will be able to read material that is part of the required reading program for enjoyment, understanding and as a basis for problem solving in Day 2.

Materials:
A copy of Mr. Popper's Penguins for each child, a copy of the worksheet on evaluating solutions found on page 49.

Procedure:
1. The class will read the first chapter of Mr. Popper's Penguins in order to obtain the flavor of the main character and the manner in which he lives. This may be accomplished during traditional reading groups or in paired reading teams. Teams may be chosen by the teacher or students may choose their own partners. (20-30 minutes each group)
2. After reading the chapter, the class will try to define Mr. Popper's problem. (Students should come up with the fact that penguins cannot live in warm climates. Since they will have had very little, if any, training in problem finding, the teacher may have to guide them. Most students will be able to define at least one of Mr. Popper's problems based upon everyday experience. They will probably have more difficulty defining a single problem or the underlying problem, but this can be pulled out in the discussion.
Students will have more practice in defining a problem in future lessons). (10 minutes)

Alternate Lesson:
1. Students are familiar with the story of "Jack and the Beanstalk" so right on to Day 2.

Conclusion:
The teacher will remind the students that they were reading to obtain a knowledge base for the problem solving lesson on Day 2. They will also be reminded that defining a problem clearly helps in formulating the solution. (5 minutes)

Day #2.
Objective:
Students will be able to brainstorm questions and ideas appropriate to the story to solve Mr. Popper's problem. Ideas, especially creative ones, will be supported with evidence from the text. The solutions will be ranked according to practicality or probability of successful implementation.

Goals:
1. Be able to generate ideas and evaluate for best solution.
2. Be able to transfer concept of brainstorming to new situation.
3. Be able to identify elements in the story which would support an acceptable solution.
4. Begin to realize that some problems require creative solutions, others require critical solutions.
5. Start to develop a proper regard for opinions that differ from their own.
Materials:
A copy of Mr. Popper's Penguins for reference, a copy of evaluating solutions found on page 49.

Procedure:
1. The teacher will present the well-defined problem statement that was generated by the class in the previous lesson: How is Mr. Popper going to keep the penguin cool in his home? The emphasis will be on finding and evaluating ideas that are appropriate to the story. (Use the worksheet on page 49 as a reference tool). (2 minutes)
2. The class will divide into groups to determine the best solution to Mr. Popper's problem. The emphasis will be on evaluating ideas. The group will present its best solution to the class. (10 minutes)
3. The teacher will record the idea offered by each group. The class will evaluate the ideas and rank them in the order of preference or how well they think the solution will solve the problem.
4. After the discussion, the class will read Chapter 2. (20 minutes)

Alternate Lesson:
1. The students use the list of solutions generated from lesson one. They evaluate the solutions, trying to determine which solution would be best. (Use the worksheet on page 49).
2. They select the solution, modify it if necessary, and present it to the class with reasons for their selection.
3. The students decide if the solutions were well supported by evidence from the story. Even creative solutions need support for their selection.
Conclusion and/or Reflective Thought:

The teacher will point out that the students were allowed to generate questions and solutions and to be as creative as they wished in the first lesson. However, when part of the story had been read and they had some significant information, then they had to think about the questions and solutions they had formulated. This may involve changing or modifying the solutions to fit the story.

It would be a good idea to go over some real life situations where they could use this strategy. For instance, the door is locked and they cannot get into the house after school. What should they do? If they know mother will be home within fifteen minutes the solutions will be different than if they had no idea when she would return. Such practice helps reiterate the need to know information before determining a solution.

The students also need to discuss ways in which to avoid premature decision making. In the real life situation they could sit down and think about where mother could be, whether she had left any directions in the morning, look at a watch to tell the time. Students may be encouraged to think about what could be done, then compare it to what actually happened. They could be encouraged to be receptive to new information, rather than locking into one solution based upon one idea or fact. They need to be encouraged to defer decision making just as they have been taught to defer judgment until all the ideas are presented.

It is important at this time to go over the strategies used in evaluating the solutions. Did the students brainstorm ideas; that is,
did they accept everyone's ideas, deferring judgment until they exhausted possibilities? Did they sense that ideas were coming more easily or that there was a fluency of ideas? Did they cooperate in making the judgments for evaluation? Could they support their solutions with evidence from the story? Could they go from a creative situation where all answers were acceptable to a critical thinking situation where the solutions had to be evaluated? (10 minutes)

Lesson Plan #3. Focus of Instruction: Recognize and state the problem or multiple representations of the problem

The following lesson is to be conducted prior to reading Miriam Cohen's, "The Beach", from the Scribner series. The teacher will describe the character's behavior. The emphasis will be on finding and defining the problems which may cause the character to act in a particular manner.

Objective:
The students will be able to identify or define possible problems or reasons for the character's strange behavior in order to find a reasonable solution.

Goals:
1. Be able to find and define the underlying problem in a situation.
2. Be able to brainstorm solutions.
3. Begin to deal with ambiguity. (See Chapter IV).

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4. Begin to withhold judgment, but take a stand when evidence and reason are sufficient to do so. (See Chapter IV).

Materials:
Pencil and paper, chalkboard and chalk, a copy of the worksheet on determining the underlying problem found on page 52.

Procedure:
1. The teacher will present the following situation to the class: The main character seems to have no fun or enjoyment. For instance, the character doesn't want to take her children to the beach on a sunny, hot afternoon. She is always cleaning her little apartment. She doesn't spend any money on treats like ice cream. (Refer to worksheet on page 52). (5 minutes)
2. The students will break into small groups to define possible underlying problems. (15 minutes)
3. They will decide which cause is most probable, based upon their own life experiences, then determine a solution based upon their definition of the problem. (15 minutes)
4. The students will share their definition of the problem and the solution(s) they have determined based upon this definition of the problem. (15 minutes)

Alternative Lesson:
1. The teacher presents the following situation to the class: The main character wants friends, but no one likes him. (Refer to worksheet on page 52).
2. The students break into small groups to discuss possible reasons for the character's problem.
3. The students elicit solutions once they have defined the character's problem.

4. The groups share their definition of the problem and their solution with the class.

5. The teacher presents the following situation to the class: The giant in "Jack and the Beanstalk" wants to have friends.

6. The students break into small groups and try to determine the giant's problem based upon what they know about the giant. They develop a solution based upon the problem they have defined.

Conclusion:

The teacher recaps each problem and solution listed on the board, then leads the class into a discussion where the class determines which problems are underlying problems and which are not. They also cite evidence to support whether or not each solution was appropriate based upon the group's particular definition of the problem. They come to realize that a solution is dependent upon how the problem is defined. The more information they know, the better they can define the problem, which leads to a more appropriate solution.

It is important to have students reflect on how they came up with their definition of the problem. Did they brainstorm, allow fluency of ideas, evaluate based upon evidence, cooperate within the group to make a group decision? (10 minutes)

Lesson Plan #4  Focus of instruction:

Establish and/or generate criteria for a problem
The following lesson is relatively short but important in determining the overall situation. It requires that the students determine the type of problem that has been presented and establish criteria before developing solutions. They must decide what type of question the teacher is asking: fact-finding, judgmental or creative (Dillon, 1982) in order to know what type of answer is expected. They must decide if the teacher has given criteria or limitations which must be addressed. If the answer has to be a one word consensus, the approach will be much different than if the answer must be a model, a product or a design. (Refer to worksheet on page 54 as a guide).

Objectives:
1. The students will be able to determine whether a problem is fact-finding, judgmental or creative as explained on page 50.
2. The students will be able to create problems which are fact-finding, judgmental, or creative.
3. The students will become aware that solutions are dependent upon the type and clarity of the problem.

Goals:
1. Be able to generate problems and ideas.
2. Begin to evaluate solutions in terms of given criteria.
3. Begin to determine various kinds of problems.
4. Be able to solve various kinds of problems.
5. Show cooperation in a small group situation.
Materials:
Pen or pencil, paper, copy of the worksheet on determining or generating criteria found on page 54.

Procedure:
1. The students are broken into small groups to solve the problem.
2. The teacher states the problem: Create three situations or problems. One problem must be set up to require a factual answer. One problem must require a judgment or decision based upon evidence. One problem must require a creative solution. (The teacher may have to give a guideline or hint for each type of problem in the beginning, but having students work in a group situation usually eliminates the need).
3. The students create problems, selecting their best one of each kind to present to the class.
4. The class discusses the problems suggested and decides if the problem really meets the teacher's criteria.

Alternate Lesson:
1. The students are broken into small groups to solve the problem.
2. The teacher states the problem: Create three situations or problems about "Jack and the Beanstalk". One problem must be set up to require a factual answer. One problem must require a judgmental solution. One problem must require a creative solution. (The teacher may have to give a guideline or hint for each type of problem, but having students work in a group situation usually eliminates the need).
3. Students create problems, selecting their best one of each kind to present to the class.
4. The class discusses the problems suggested and decides if the problem really meets the teacher's criteria.

**Conclusion and/or Reflective Thought:**

In the discussion of whether the problems met the criteria of the three different types of problems, the teacher must emphasize that this skill is necessary in determining what type of solution is necessary. The teacher should help the students realize that a factual question needs a factual answer: short and sweet, to the point, concise. The teacher should also draw out from the students that judgmental questions and problems may have numerous solutions, for people do not necessarily think alike but have opinions based upon their interpretation of the facts. Moreover, the students should be on the lookout for clues within the problems which may limit solutions: "Who do you think is most likely the thief and why." "What is the best use of the shells found on the beach?" "What is the most reliable source of information regarding the street brawl?"

It should also be brought out that teachers may put other limitations or criteria on the solutions; therefore, it is not only important to know what type of answer to give, but it is also important to know any other criteria. For instance, if the solution has to be a product, a model or a design rather than a one word consensus by the group, the approach would be quite different. Determining the situation and planning ahead for the solution can often save valuable time.
Students should also be reminded that using what is known helps determine or to define the underlying problem in a situation. Defining the problem as clearly as possible helps in formulating a solution.

**Lesson Plan #5** Focus of instruction:

Find and evaluate solution in terms of criteria

The following lesson will be presented before the students read the story entitled, "A Hike in New York City", from the Scribner series where the author turns a routine outing into a special happening. The teacher will establish the criteria for this particular assignment, but in the discussion that follows, it will become apparent that the students must develop their own criteria in addition to the instructor's when problem solving. It is be helpful to present the worksheet on page 56.

**Objectives:**
The students will be able to create a letter that would impress a friend with a description of a hike. (This assignment may have to be tailored depending upon the population in the school and whether they're urban or rurally located).

**Goals:**
1. Be able to generate and elaborate upon novel ideas.
2. Be able to evaluate for originality.
3. Be able to apply writing principles to interest a particular audience.
4. Begin to determine appropriate criteria.
5. Be able to search for alternative ideas and be willing to change.
6. Begin to evaluate solutions against criteria.

Materials:
Pencil or pen, paper, a copy of the worksheet on selecting a solution with regard to criteria given or generated on page 56.

Procedure:
1. The teacher will state the problem: Create a letter that would impress or entertain the person to whom you were assigned with a description of your adventure up a beanstalk to the giant's house. Use details and events that would make it seem more realistic. The teacher will assign each student a different person to whom to write, including different classes of people such as the President, a pilot, a garbage man, a doctor, a best friend, an old aunt, a movie star... This assignment makes the assumption that students have been taught to respond differently to different audiences due to different frames of reference. If they have not been taught such strategies, the possible responses may be discussed at length prior to the assignment or the assignment may be tailored to meet the capabilities of the class. For instance, the teacher could have part of the class write to grandparents, part to friends and part to a camp counselor. They could compare their letters, denoting common features and differences for each audience.
2. Students will work by themselves, creating a letter that is directed to a specific person. (Refer to worksheet on page 56).
3. Students may share the letters with the class.
Alternate Lesson:

See procedure above as the lesson is appropriate for both problems.

Conclusion:

The students read their letters to the class. The class decides how, or if, the teacher's criterion has been met in each letter, that is, that each letter be written with a frame of reference appropriate to the audience intended. Strengths and weaknesses are discussed so the students have a definite feeling for which incidents or descriptions met the criterion and which did not.

It is necessary at this point to make certain students understand that everyone had a slightly different criterion as each person was writing to a different audience. Once again they should reflect on how they made their decisions. Did they brainstorm ideas deferring judgment until they had a pool from which to select? Did they evaluate their ideas and solutions, picking only those that were most appropriate for their particular audience? Did they eliminate ideas which did not meet the teacher's criteria? Did they eliminate ideas which did not meet their own criteria?

Lesson Plan #6. Focus of instruction: Communication and implementation of the solution

The following lesson should be used after the story, "The Best Town in the World" by Byrd Baylor from the Scribner series. The story is written to convince the students that Parmele really is "the best" in the world by using a series of support statements, some fact, some opinion. Just as the goal in the story is to convince the
audience, so too, will be the goal in lesson six. The goal statement will be definite; however, the means by which the goal is achieved will be ill-defined or open to interpretation and creativity. In all cases the solution must be supported when questioned by students and teachers.

Objective:
Students will be able to pick, modify or invent a toy which is appropriate for children between seven and eleven. They must try to convince the class that their particular choice is the best.

Goals:
1. Be able to brainstorm necessary questions.
2. Be able to brainstorm solutions for fit and originality and evaluate against criteria.
3. Be able to develop argument to "sell" the solution to the class.
4. Begin to be able to transfer concepts of withholding judgment, willingness to change, sensitivity to others' feelings to a new situation.

Materials:
Drawing paper, pencil, a copy of the worksheet on communicating and presenting a solution found on page 58.

Procedure:
1. The students will divide into groups to determine what type toy would be best for children between the ages of 5 and 14. They must develop an argument to "sell" or convince their audience that their toy is the best choice. (20 minutes)
2. The group spokespersons will share the choices with the class. (10 minutes)

3. The class determines the criteria, then decides how well each toy meets the criteria. They may also decide which one toy would be most appropriate if only one toy were allowed for everyone. (10 minutes)

Alternative Lesson:

1. The teacher will present the problem: Jack is allowed to take only one object from the giant's castle. Any object may be chosen, but it must be accompanied by an argument which convinces the audience that it is the best choice.

2. The students will divide into groups to decide and develop an object for Jack to take back to his house. They will develop the criteria and the argument for their choice.

3. The argument is presented to the class.

4. The class decides if the object discussed meets the group's criteria. They will decide what elements in the argument were persuasive.

Conclusion:

The class will reflect upon what kind of support or argument was needed to "sell" or convince an audience that something is best or better than an object of comparison. Did they need to use fact or opinion? Did they have to appeal to emotions, cost, reliability, endurance? They need to reflect upon the processes they used to make their decisions. Did they brainstorm, allow for fluency of ideas, evaluate solutions in terms of criteria? How did they decide what
criteria was to be used for the final decision? Were the criteria they chose really appropriate to satisfy the audience? Were they successful in withholding judgment and being sensitive to others' feelings? (15 minutes)

Lesson Plan #7. Focus of Instruction: Evaluate and reflect upon the processes used in problem solving

There are several ways in which to evaluate students' growth in problem solving without testing. Once students have finished the first seven steps in the problem solving process designed above, they should, with help, begin to use these skills in similar problems. With practice in various areas, transfer should begin to occur. Although transfer to other areas is difficult to obtain, the teacher should continue use techniques which would encourage such transfer in many areas.

Day #1.

Objective:
Students will be able to use the problem solving chart for reference and create a story which illustrates critical and creative problem solving techniques. The story will define a problem, reveal possible solutions and develop a final solution that can be supported.

Goals:
1. Begin an awareness of transferring strategies learned in previous lessons to new situations.
2. Develop decision making skills.
3. Develop problem solving skills.
4. Demonstrate a beginning ability for literary cohesiveness.

**Materials:**

Paper, pencils or pens, dictionary, a copy of the questions to think about when reflecting found on page 63.

**Procedure:**

1. The teacher will present the following problem: Create a story in which a problem exists and solve the problem. Be as creative as you wish with the problem and the solution, but remember that the problem and solution have to fit logically within the story. (5 minutes)

2. Students will use the problem solving chart as guide.

3. Students will break into small groups to generate ideas for the story. Notes may be taken. (10-15 minutes)

4. Students will create the stories, individual stories or one story per group, depending on teacher objectives and student capabilities. (30 minutes)

**Alternative Lesson:**

1. See the lesson above as the procedure is most appropriate for problem solving at this stage whether the students have been working with a particular reading series or whether they have been working with "Jack and the Beanstalk".

**Conclusion:**

The teacher will remind the students that they should be thinking about what, how and why they are making decisions. These observations will serve as the basis for the discussion about the
creation of their story. Problems, concerns, inspirations and strategies should be noted.

**Day #2.**

**Objective:**
Students will be ready and willing to share their stories and reflect upon the thinking involved in deciding what to write.

**Goals:**
1. Begin synthesis of decision making and problem solving.
2. Develop realization for necessity of reflective thinking.
3. Develop realization that problem solving transfer to new situations is a goal.

**Materials:**
Pencils or pens, paper, dictionary, a copy of questions to consider when reflecting found on page 63.

**Procedure:**
1. Students will share the stories with the class. (30 minutes)
2. Students will reflect on their thinking and the processes used to develop the stories. (30 minutes)

**Alternative Lesson:**
1. Students will have above.

**Conclusion:**
The groups will be asked to try to explain what thinking went on as they decided what to put into their stories. The actual thinking and the delivery of that thinking will be different for each group. However, if transfer has occurred, a pattern should start to emerge that looks somewhat like the stages of problem solving.
This is only the beginning of reflective thought, or thinking about thinking. They will not be experts, but they will be aware that thinking about their thinking process is helpful in recalling what has actually happened. They will gain insight into their thinking and, hopefully, into how they have solved a problem. With practice, they should be able to see where their thinking was appropriate or where it went awry so that the same errors will not be repeated the next time a similar problem occurs.

**Lesson Plan #8** Focus of instruction:

Transfer on own to new problem

By the time the students have gone through the previous eight lessons including the time for reflective thought, they should be ready to tackle problems that are closely related to the ones that have been accomplished in literature. As practice with various problems continues, they should find transfer becoming easier. The chart has been included on the next page for use in the classroom as a reminder of what strategies should be used in attempting to solve problems and the techniques needed to make these strategies easy to implement.

Students should always be required to take time to reflect on what, how and why they have made their decisions. Each time they think about the principles involved in a particular strategy and see its application, the strategy should become easier and more versatile. Reflecting on what has transpired will take practice, but it will lead to problem solving in an orderly manner with strategies and
techniques that they understand. Problem solving at the elementary level will become an intriguing part of the curriculum.
Problem Solving

Stage 1 Understand some problems have multiple solutions
Brainstorm ideas related to the problem
Brainstorm solutions

Stage 2 Evaluate solutions
Allow for fluency of ideas (brainstorm)
Choose best solution
Be able to support choice

Stage 3 Recognize and state the problem
Brainstorm ideas related to problem
Determine the underlying problem in the situation

Stage 4 Establish or generate criteria for the solution
Understand the problem
Decide what type of question is involved
(fact-finding, judgmental, creative, combination)
Determine or generate criteria

Stage 5 Find and evaluate solution in terms of criteria
Determine underlying problem
Brainstorm possibilities and solve problem
Solution must meet criteria

Stage 6 Communicate and/or implement the solution
Determine underlying problem
Select solution in terms of criteria
Present solution

Stage 7 Evaluate and reflect
Review stages 1-6
Reflect, think and discuss process

Stage 8 Enjoy the challenge of problem solving in all areas

Figure #13: Problem Solving Stages
CHAPTER VI
Workshop and Helpful Hints

Chapter VI will describe a two day workshop which should be made available to go with the problem solving program. The first day is an introduction to the terms, strategies and format of the program. The second day involves teachers teaching teachers in a hands on situation. By working together, teachers will build confidence and feel comfortable using the program, thus continue with problem solving even after the introductory lessons are finished. While it is not feasible to specify in full detail precisely how each part of the workshop would be conducted, an outline of the major content is provided, plus lesson plans with a typical schedule.

Day #1

The first day will be divided into sections covering four major areas: environment, teacher modeling, strategies and designing problems, plus an introduction to stimulate thinking and a what can go wrong session at the end of each section. Topics covered in the section on environment will include the physical environment and the mental environment in such areas as dealing with risks and ambiguity, developing a fluency of ideas and accepting multiple answers. Teacher modeling will include subtle methods to use which will help elicit desired behaviors. Strategies will include a sampling
of techniques felt helpful to good thinking and therefore to good problem solving. Lastly, designing problems will involve practice with questioning techniques and developing and defining problems so that teachers feel comfortable when delving into this critical area.

The techniques to be used in the workshop have been discussed in the thesis, but the workshop will provide a situation where the techniques can be used and applied. It also provides time to reflect on their application and value as well as time to share ideas and concerns.

**Introduction:**

In order to have teachers receptive and responsive to the techniques that will be presented, they would benefit from an introduction which challenges their present thinking patterns and generates excitement for creative ways of thinking. By presenting problems which lend themselves to perceptual, cultural and emotional blocks and by making the teachers aware of the pitfalls into which they can easily fall, hopefully, they will have a more receptive attitude and a more creative striving in their solutions and development of problems. By providing problems where answers can be creative, teachers will see the fun and excitement which motivate students to continue thinking, as well as the diversity of solutions possible before making a final evaluation and judgment.

In order to accomplish this awareness, the teachers will be divided into two (or more) alternating groups so that both the "student" and "teacher" role may be practiced throughout the workshop. Working through the problems as "students" seeking
solutions, and as "teachers" developing the problems, will provide far more insight into the problem solving situation than could be accomplished from lecturing about the techniques.

Adams suggests conceptual blocks which may hamper teachers as well as students in problem solving: perceptual blocks, cultural biases and emotional blocks.

Several perceptual blocks to problem solving which will be discussed in the workshop include: inability to isolate the problem, putting self-imposed limitations on a problem, being unable to see a problem from another's viewpoint, stereotyping and inability to use all possible senses (Adams, 1976). Although time will not permit teachers to experiment with all areas, examples of each will be presented. Leaders of the workshop may then select those most appropriate for the group.

People often fail to see multiple or appropriate solutions because they fixate on one way of viewing the situation, only considering their first solution; satisficing or accepting the first solution; or by adding constraints which are not really part of the problem.

Presenting Duncker's (Duncker, 1945) candle problem, may help overcome some of this rigidity. The "students" must figure out how to mount a candle vertically to a plywood wall so that it will act as a lamp using only the materials given: a candle, a book of matches and a box of thumbtacks. If an appropriate solution can not be figured out, then the problem may be presented again, but this time the thumbtacks are dumped out of the box. The problem solvers
should realize that the box is no longer only a container for the thumbtacks, but the stand for the candle.

A not so easy, but enjoyable problem which helps one step out of the usual mental confines, is to present a nine dot matrix, the objective of which, is to connect all nine dots with four straight lines. See Figure #11. In order to reach the goal, the lines must be extended beyond the matrix. Many "students" will automatically assume that the lines must be limited to the space within the dots. Suggestions as to line length may be necessary for the problem solvers to break the mental confines they impose upon the problem (Hayes, 1981). Although two solutions have been presented, there are many other possibilities.

![Nine Dot Matrix](image)

Figure #14: Nine Dot Matrix

Inability to see a problem from another's view can also stifle solutions. To help students and teachers overcome this, have them pick a problem they have or one which the school has. Write a
statement of the problem as seen by each party involved. (In the regular classroom you may have the students write a problem statement for each party involved with changing recess from 11:00 to 11:15). Once they can view the problem from someone else’s perspective, they will be able to suggest more and, quite often, more appropriate solutions.

Stereotyping is a common perceptual block. Common stereotypes involve, long hair on males, boys with earrings, single parent families, race, sex, age, occupation and the nouveau riche. To help students become aware of possible stereotypes, have the "students" write down their reactions when a teacher enters the classroom dressed in a tennis outfit. Adults will probably think the person is there for pleasure rather than work. The students will probably take it as an invitation for frolicking, rather than serious work.

Saturation is a block which involves seeing everyday objects in such a way that the sensory input is not available for simple recall. For instance, in our society we use one dollar bills daily, but how many people can recall what is on the back? Adams suggests that we ask people to draw a telephone dial, complete with numbers and letters. Most people can not, for even though we use the device daily, the information is not stored in a manner in which it can be retrieved easily. The objective is merely to get people to realize there are many stimuli or sensory inputs that are unconsciously neglected.
Stereotyping and saturation, although a negative force in problem solving because they shut off possibilities, can also be a positive force in our daily lives. Certain expected responses and expectations are necessary in everyday living, even vital, if there is to be time to attend to all that needs to be done in our hectic lives. It is only when the unexpected input is shut out entirely, that it becomes a problem.

Lastly, many problems could be solved more easily if we use all our senses or a combination of senses. Quite often we forget this and become absorbed in one area, using one sense to the extent that we miss the fact that the problem could be solved by using another one of our senses or a combination of senses.

Another area of conceptual blockage is cultural bias. Cultural bias usually tends to be subtle, but has a definite bearing on problem solving. For instance, a person coming from a home where children have been taught to be "seen, but not heard", will probably have a much different approach to group interaction from that of a child who has been raised to question facts, information and authority. The quiet person may have as much to offer, but may be hesitant to interact.

Several cultural biases that James L. Adams has found to make a difference in problem solving are: playfulness is for children only; problem solving is serious business and humor is out of place; reason logic, numbers, utility, and practicality are good but feeling, intuition, qualitative judgments and pleasure are bad. Therefore, in order to help teachers overcome such biases, it may be prudent to suggest a
problem so far out that humor, feelings and intuition can play a part easily. For instance, Doctor Delores Gallo, professor at Harvard University and The University of Massachusetts, had a class assume that future population growth will depend upon men being the child bearing hosts rather than women. As far fetched as the idea may seem at first, there are numerous solutions which are fun filled, yet plausible and help the person to breakdown cultural biases.

Emotional blocks may be harder to diminish, but not impossible. Common emotional blocks encountered by adults as well as children are: fear of taking a risk, fear of chaos, judging rather than generating ideas, lack of challenge and lack of imagination. Adams suggests that one stand on a corner and make animal noises as the traffic and people go by in order to empathize with those feelings people have when they are put in an embarrassing situation or a situation where they could be wrong or humiliated. Everyone has probably felt that foolish at some time during his/her life, yet the experiment should be conducted in order that the feeling be brought to the surface so that people will be able to identify with the feeling that is trying to be overcome in the program. It is all right to be wrong, all right to change an answer, all right to try for a better answer, to take a risk. Adams suggests that making a list of "catastrophic expectations" helps the person switch from fear to analytical awareness. "What can go wrong" will be sufficient for situations in elementary problem solving. Once the students and teachers have learned to take a risk, even a small risk, the choices will become easier to make.
What can go wrong?

* Conscientious students, even very young ones, may balk at having to do the above mentioned activities, but if they are conducted in a playful atmosphere where the students are not threatened, they will develop a positive response and learn to enjoy the challenges as well as the fun. By using small groups, it is less threatening and gives practice in cooperative learning.

* Some students may come up with answers that are different and challenging. There are many different ways in which to handle the responses. Accept those that you know are correct. Incorrect answers can be accepted with "modifications". Students can look up those answers about which you are not positive. This could even be made into a game to make it more fun--who can prove the answer first, which team can find support for the answer, which team can find the most answers of those suggested. Awards can be given to answers that are plausible, creative, thought provoking or for which the students can give support. An "expert" can be contacted to decide upon the best answer out of several good ones, or the best answers out of many good ones.

* While some students are making responses that are unique, creative and fun, other students may have a puzzled look, but be afraid to ask. Trying to involve the student by asking him/her if there was any evidence for a solution may be putting on too much pressure, but the student may respond to a question which lends itself to a one word answer or an opinion: With whom do you agree the most? Who seems to have the most facts to back his/her
answer? Where else could you go for more information? Are you happy with the answer? Why or why not? Keep encouraging the student with various questions in different circumstances, until he feels comfortable contributing more information.

Environment:

Environment starts with a room that is physically ready to receive active learning students. The desks should be arranged in groups of 4-6 so that small group interaction may take place easily. The students also need to be nearby in order to ask for help. The teacher will be a facilitator rather than a traditional teacher for parts of each day; therefore, freedom to move, but nearness for help, is always a part of the program.

The other part of environment that will be covered involves more elusive needs: the feeling that it is all right to experiment, that it is all right to be different, to be wrong, that multiple answers are all right, that a person's first idea is not necessarily his/her best idea. The activities used in the introduction will help the teachers to see why these attitudes are important. They will see the value of introducing problem solving to the students in a similar manner. One way in which these environmental needs can be met is to start with teachers who provide opportunities for risktaking to occur. The introduction should have teachers aware of this need.

Once a receptive environment has been established, students will be free to experiment with skills such as brainstorming, fluency, deferred judgment, openness to change, perseverance and tolerance of ambiguity. These terms will be discussed in more detail during
the workshop, but they can not occur unless the main ingredient, environment, is conducive to their growth.

**What can go wrong?**

* If it is not feasible to arrange desks in small groups, then areas where small groups can meet within the room are necessary. Students need to be readily available to reassemble into large group activities and need accessibility to the teacher.

* If cooperative learning has not been a part of the teaching situation, these skills may need to be introduced and/or practiced. It is always a good idea to remind students to use their quiet voices so that other groups will not hear and use their ideas. Even in cooperative learning, students will tend to rely on particular students if given the opportunity. By keeping voices low, this problem is diminished and it helps the class to keep in control.

This is not to say that the ideas are never shared. The point of cooperative learning is to have one problem which is not solved until all groups have made their contributions.

* Having one person report on the group’s decision helps eliminate a multitude of voices during the discussion. One person reports the conclusion, then during the discussion everyone is free to interject comments.

**Teacher modeling**

Teacher modeling is another area around which problem solving success ensues. Teachers should model the desired behaviors. For instance, responding to students’ questions with questions, rather than an affirmative, may get them to think more
about the subject. Acknowledging that the student answered with a nod of the head or a simple, "Aha, I see", but not giving an immediate affirmative response may leave the question open for other students to answer. Giving the students longer time to think, a longer "wait" time, both before the student answers and after the student has answered before asking another question, often produces a higher level of thought and response as well as giving the slower thinker a chance to respond. By changing the response rhythm to the fourth or fifth student whose hand is up, the teacher encourages students to think before raising a hand.

Changing such behaviors is hard to do at best. One way to make the transition somewhat easier is to start by observing others who have had practice, or by observing each other during the role playing sessions. Using the chart from figure #12 may help zero in on specific skills. Having a peer come into the classroom may be threatening for some people, but this could be done after having practiced the behaviors.

What can go wrong?

* Finishing the curriculum is deemed a necessity in some systems; therefore, this program has been developed in such a manner that using existing material is stressed rather than the adding of a problem solving unit. Teaching the students appropriate problem solving skills will take time, but they can be taught and reviewed within existing material.

* The problem solving stages may be taught at any time as long as they are taught sequentially. Therefore, if the teacher feels
the class is getting behind in curriculum or is having difficulty with a particular stage, it is all right to stop at that stage and wait until the teacher as well as the class are more comfortable. If some students have a puzzled look, it may be worth giving a concrete example of what you are teaching. For instance, if Johnny gives a correct answer and you say, "Aha, I see", then go on to ask Mary her answer, Johnny may be confused. He may think that his answer was not correct, not sufficient. It would be appropriate at that point to tell the class you are trying to elicit more answers by using a different response.
<table>
<thead>
<tr>
<th>Type of response responses</th>
<th>Number of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer with a question rather than an affirmative</td>
<td></td>
</tr>
<tr>
<td>&quot;Aha, I see...&quot;</td>
<td></td>
</tr>
<tr>
<td>Wait time--before selecting student</td>
<td></td>
</tr>
<tr>
<td>Wait time after student answers, before asking another question</td>
<td></td>
</tr>
<tr>
<td>Changing response rhythm</td>
<td></td>
</tr>
</tbody>
</table>

Figure #15: Teacher Response Sheet
Strategies:

Strategies involved in problem solving can be easily adapted to other areas or subjects; moreover, they can be taught in other subject areas then used in problem solving. It is my contention that transfer will be aided if students see strategies taught in one area, then used appropriately in another. These strategies can be identified and put on a large chart in the classroom and thus be kept visible. It is not easy to apply one strategy in science, then social studies, then literature, so it may be necessary to build a repertoire over time. Sharing ideas with other teachers working at the same grade level or subjects may help.

It has already been said that the classroom should be set up to allow for small group discussion or peer interaction. Related to this strategy of small group interaction, is McTighe and Lyman's, "Listen/Think/Pair/Share". Students hear the question or problem, think about it alone, share their answers with another student, then switch and share their answer with a different student. This allows the students to change an answer to a more suitable response or it gives them a chance to add onto an acceptable answer. The interaction is also conducive to creativity and helps every student to become an active participant. (See page 40 for details).

Teaching students to think about their thinking is not easily done, but is mandatory if transfer is to take place; moreover, it is effective in evaluating responses. Teachers must plan time into
every lesson to talk about decisions that have been made or problems that have been solved; therefore, the first step is the teacher's: time. The second step is to convince the students of the value of reflective thought so they will eventually do it on their own. The teacher may start with a simple, "Let's look at the answer and see if it makes sense." By constantly using the same pattern, the students will come to realize the teacher values discussing what thinking has occurred after every problem solving session. The pattern will be established, then, hopefully, the students will eventually use it on their own. As the teacher becomes more comfortable with reflective thought, it can be used in other areas such as reading, science, social studies and math. The desired end product is to have students who, independently, look at an answer and say, "Does this make sense? Does it answer the question? Is there a better way?"

One way in which transfer will become easier is to experience it during the workshop. It has been built into every section of the day so that teachers will become comfortable with discussing what has just transpired. Hopefully, by the end of the workshop, the teachers will not only see the value in thinking about their thinking, but will be familiar with the questions used to generate the ideas contributed by the group.

Art Costa has a list of questions that are ideal for teachers to use when introducing reflective thought. Such questions are similar to these: Can you tell where you are in the problem solving process? Can you trace the path you took to get to the dead-end if you are
stuck? Do you remember any techniques which may prove effective in finding an alternative answer? Can you describe the information you need to make a better decision? What data are you lacking? Can you decide how you are going to obtain the data you need? Did you choose your first answer or did you elaborate, discuss it with a friend, change it in any manner? Does your final solution satisfy you or would you like to work on it some more? How did you get that answer? These are only a few of the numerous ways in which students can be coached into describing the thinking that went into their responses, but they do provide a starting point. As students become comfortable in using this strategy, they will start to ask each other questions that will generate thinking in a multitude of ways. A worksheet using many of these questions to stimulate thinking about thinking has been included on page 63 for the teacher's convenience.

Visualization, elaboration, forced relationships, metaphors, and attribute listing are terms introduced during the strategies part of the workshop rather than in the environment section because they require a different emphasis. Whereas the terms introduced in the section on environment are aimed at relaxing, generating and waiting for ideas to flow naturally, students must learn to cope when this is not sufficient. Students need to realize that stumbling blocks can be overcome, maybe not immediately, but with some planned thought. By providing strategies for such thought to emerge, hopefully, students will begin to check for alternative ideas and answers, to see if a more appropriate solution is possible.
Forced relationships can be enjoyable as well as informative. The student picks two unrelated objects and tries to find as many similarities as possible. For instance, a door and a frog could be compared. They both move, have a different outer color than inward color, move, make sounds like "creak" and "croak", are scary at night are found in deserted houses. By learning how to find a new relationship with an object, the problem solver starts to look at an object or an idea involved in the problem for various alternatives.

In attribute listing, the problem solver states as many qualities of an object involved as possible; thereby, stimulating new ideas. For instance, in listing the qualities of a beanstalk, they may come up with: grows quickly; is strong, flexible and long; grows vertically; has leaves; is green. One of these attributes might inspire a new solution.

Most teachers will know what metaphors are, but the students will not, so a quick way to introduce metaphors might be to ask the problem solvers to describe an object in terms of another thing. What is God like? God is a table. How? He can hold you up. Ask them to find an object to describe a typewriter. A typewriter is a friend. How? It lets you express your thoughts and feelings. A typewriter is a maze. It provides many keys with many options, but there is only one correct combination for each word. By going over some examples and adding the strategy to a chart for future reference, students will have a reminder for future reference.

What can go wrong?

* It is difficult to teach the concepts and skills necessary for good problem solving, moreover, requesting that the students
remember them when needed. Having a large chart in the class is almost a necessity to help students recall the options until they become automatic.

* Checking for alternatives or multiple answers may prove difficult at first, but praising students for the number of responses they made before selecting a solution will help.

* If students appear to eliminate solutions haphazardly, it may be necessary to remind them to eliminate their ideas in an orderly fashion using previously established criteria. For instance, if the group has fifteen possible answers, have the students check off the five best answers (using their criteria as a guide), then eliminate until they have the one they feel is the best.

* Cooperative learning may need to be practiced if they students are not familiar with this type learning. If some students are dominating the small group discussion, it may be necessary to stipulate that everyone in the group must present an answer before a group decision is made.

Designing problems and questions:

Designing problems and questions will be the last section of the first day workshop because teachers should be aware of the previous three sections—environment, modeling and possible strategies—before defining problems and developing questions and techniques. Designing problems and questions will be divided into three parts: determining and designing problems, determining the criteria and communicating and/or implementing the solution.
1. **Designing problems and questions:** After the teachers have tried the introductory problems and have been exposed to the discussion and activities involved in environment, teacher modeling and strategies, they should be ready to start designing problems.

They will be divided into two groups: "teachers" and "students". They will all be "teachers" and try to design problems to solve, then they will be "students" and try to solve the problems designed by the other groups. "Teachers" should decide upon a concept that is felt to be necessary for that grade level. "Teachers" should choose a problem which "students" can view from many angles and one which allows them to use whatever process with which they feel comfortable in trying to obtain a solution. It will become evident as they discuss the appropriateness of problems that the process used in solving the problem will be as important, if not more so, than the solution, for it generates creativity and opens avenues for divergent thinking. This is especially true since some problems will not have a solution. Both process and solution will be discussed during the reflective thought period after each lesson.

Torrance suggests a list of ten ideas for generating problem-finding which may prove helpful:

1. Confront students with ambiguities and uncertainties.
2. Call for a student to look at a problem from different psychological, sociological, physical, or emotional points of view.
3. Establish a set of techniques for examining information in new ways.
4. Structure the problem only enough to give cues and direction.
5. Reveal gaps in information; unsolved problems.
6. Create, or reveal, mysteries.
7. Call for going beyond what is known about something.
8. Involve paradoxes.
9. Pose conceptual conflicts; juxtapose opposites.

Ill-defined problems present a somewhat unusual situation for teachers as well as students, for the students may have to try gap-filling where they have to make assumptions about what is happening or they may have to try jumping right into the problem before they can truly understand the underlying problem (Hayes, 1985). Therefore, the teacher must take pains to encourage a variety of perspectives and allow time for incubation of insight into the problem. If the students were asked whose fault it was that Jack stole the giant's hen that laid golden eggs, there would be many immediate responses. After giving the students time to think, someone may give the answer that it was the hen's fault because she was purposely tempting Jack by laying golden eggs in front of him.

Asking more productive questions is also a strategy which helps students think more clearly, focusing on the reason for the information rather than the answer itself. By asking who is the main character in *Stuart Little*, the teacher is inviting a one word answer. By asking why Stuart is the main character in *Stuart Little*, the
student is required to think about why this particular character is
the center of the story. In math it is easy to ask what eight time
seven equals, but a student who has to explain why eight times
seven equals fifty-six must understand and be able to explain the
concept of multiplication. Super Think by Hilarie Davis has many
ideas on how this type of questioning can be used. She even includes
a hands on section where you can try to make your own questions
based upon her examples (Davis, 1982). Hilary Hopkins, educational
consultant, has expanded upon this idea and has made questions for
many curriculum areas. As she notes, it takes practice to ask
productive questions, but it is an essential strategy for designing
good problems and questions.

In cases where the students have obviously picked an incorrect
solution, the teachers will be taught to help the students accept their
mistakes by retracing the thinking processes used to obtain the
answer and to help point out the flaw in thinking that led to the
incorrect answer. By helping the students start at the beginning of
their thinking and discover the flaw that led to an incorrect answer,
rather than by giving them the "correct" answer, the students will be
more apt to catch a similar flaw in the future.

Designing questions aimed at problem solving should follow the
same format as in the program. Questions which have more than one
possible answer are easy to teach and fun for the students. They
encourage the students to deal with multiple answers, to defer
judgment and to develop confidence in problem solving. Once they
can solve well defined problems requiring more than one answer
such as "Why is a ruler useful?" or "Why did the Indians move?", then they can start evaluating their solutions and go on to more complex problems.

Students have to be able to determine the type of question being asked: fact-finding, judgmental or creative. Likewise, teachers must also be aware of the type question they are asking. Whether it is in problem solving or another area of study, the type of question dictates the solution. This can be taught in another area and applied to problem solving, but it should be taught as soon as feasible, since it helps in the next step: determining the criteria. If students are having difficulty in this area, give students a list of statements that they can classify into fact-finding, judgmental and creative. As they gain skill and confidence, they can make statements to challenge each other. At first students may be able to only distinguish between fact-finding and creative, or fact-finding and judgmental, but eventually they will be able to distinguish between all three.

When students classify student made statements, the class may not classify the question as the student wished, but having the class ask the person questions will help them decide on the appropriate answer: Did you want a "correct" answer from the text? Did you want more than one answer? Did you want the person to use what he had read to make a decision? Could the person have used previous knowledge to get the answer?

What can go wrong?

* If students have trouble brainstorming, the strategy should be practiced in other areas as well as in literature. The goal is
fluency of ideas to prevent closure so that the best solution may be selected. Brainstorming practice will also help students become aware of questions which lend themselves to a fluency of ideas. It may be necessary to start with a situation where the students feel truly comfortable such as television programs, movies or popular music groups. If they are comfortable with the knowledge base, the skills may be easier to apply.

2. Determining the criteria sounds hard, but the students seem to catch on easily. They tend to be better at setting up their own criteria, be it valid or invalid; however, they readily adapt to seeking out teacher criteria. Teachers must be aware of criteria involved in what they are asking before asking students to determine the criteria. The hardest part in determining criteria for students seems to be in relating the solution to the problem itself. For example, if the problem involves finding the most talented rock group, students would probably use as their criteria whether or not they liked the group. Upon realizing that not everyone in the group felt the same, they may then try to find another criteria such as vocal talent; musical ability; tone, pitch, loudness of instruments; meaningful lyrics. Once they get used to determining criteria, they can start to put the criteria in some meaningful order.

What can go wrong?

* If students seem to be having a problem in this area, it is helpful to remind them to ask themselves some questions: Does the solution really answer the question? If so, is there any reason this solution will not work? Does the solution meet the instructors
criteria? How or how not? (See page 56 for worksheet in this area). Students need to be reminded to ask themselves these questions before presenting their solution. Stressing reflective thought at this point should also encourage such thinking, but it will take time.

**Communicating and implementing the solution**

Communication and implementing the solution will also be a part of the workshop. As in prior activities, it is important that everyone has a chance to be a "teacher" as well as a "student". They need a chance to present the solution to a problem in order to experience a feeling for the strategies, types of support needed, typical responses and pitfalls involved in communicating and implementing a solution. Each group will role play, either solving a problem or being the "teachers" who note what transpires. After the presentation everyone will join in the discussion about what happened, why, what type thinking occurred and possible flaws in thinking. This time for reflection should prove most valuable, for it enables people to question what went on and to clarify any points that may be unclear. After the problem has been solved and reflected upon, the groups will reverse roles and solve the next problem.

**What can go wrong?**

* Communicating and implementing a solution can easily lead to chaos if skits and demonstrations are permitted. Careful consideration should be made ahead of time as to whether the problem really requires implementing such a solution. Questions to ask yourself ahead of time may be: Do you want to take the time for
everyone to present a solution to the class? Are the parents willing to help with the supplies needed for such an adventure? Would the time be better spent in the process of solving problems, rather than in presenting an elaborate solution? It would be better for the students to spend time learning to support their solutions, especially when they will be subjected to questions and comments from their classmates.

* A time limit should be set ahead of time to help keep students on task and in control.

* Timing. Presentations always seem to take longer than anticipated, especially when students really become intrigued by their task. Always set a time limit for presentations, with points being deducted if the presentation goes over the allotted time. This may seem counterproductive, since creativity and fluency are expected; however, it adds the elements of evaluation and critical or convergent thinking. Students are forced to select the best solutions or the best aspects of that solution, solidify and practice their ideas before presenting them to the class.

General Summary for Day #1

The ideas to incorporate for environment, teacher modeling, strategies and hints for success is endless, but the best way to learn, is to approach problem solving with a positive frame of mind and start simply. Always start with examples that start with the concrete, then go to the abstract. Design problems which require divergent thinking, then convergent thinking. Develop fluency before evaluation. Stress the idea of being able to support a solution
when communicating and/or implementing a solution. Lastly, be open to new ideas. With 25-30 minds working on a problem, odds are that someone will think of a solution you have not pondered. Help them to make it work: elaborate, visualize, collaborate, evaluate and enjoy!

Day #2:
The second day of the workshop will provide hands on experience with the actual program. Depending upon the number of teachers involved, groups of two or three should be formed. Each group decides upon a problem related to a particular area of concern for his/her literary curriculum. (The coordinator of the workshop should have ideas in mind if a group can not seem to develop a problem, but it is of primary importance that they learn to develop their own problems). A solution is determined by the other group, using the format presented in the program. By having two or three members in a group, the problem can be tested or discussed before actually presenting the lesson to the larger group. It can decide 1) if the problem is really appropriate for that particular level, 2) if there are possible pitfalls in presenting such a problem and 3) how many stages of the program would actually be needed if the problem were suggested for a classroom. Likewise, when finding a solution, the brainstorming, criteria generating and selection of solution are all determined before presenting the solution to the other group.

The number in the small groups will be determined by the number of participants. For instance, if six people are involved in
the training, it would seem most beneficial to divide into two groups of three. Each group presents a problem. After the group presents its problem, the other group tries to solve the problem. If there are enough people, there could be a third group merely observing the entire process. Although the problem design is a focus of interest, the interaction and reactions by the group solving the problem are equally important. How the group solves the problem will be determined, in large part, by the excitement generated by the problem, teacher assistance and interaction, strategies chosen to obtain the solution and a general adherence to the outline of steps. The observers note when, and if, these particulars are being observed so that any difficulties may be resolved before the teachers in the workshop actually present a lesson to a real class.

Depending upon time and lessons, each group may go through one to seven stages. It will be far more beneficial if everyone has a chance to help both in the process of selecting a solution and in the presentation, rather than having one person do an entire seven stage presentation while others merely watch. Active participation of all "students" is the goal.

Immediately after each group presents, the large group reflects on what has transpired in terms of:

1. what the "teachers" did to make the environment more conducive to problem solving
2. what teacher modeling took place
3. whether the problem was defined in such a way that the problem solvers felt they had a chance to make a difference in the solution
4. what strategies were used to obtain the solution
5. whether or not the "students" or the "teacher" determined the criteria for solving the problem
6. whether or not the problem was relevant to the particular curriculum involved

What can go wrong?
* Teachers and students may balk at having a "reflective" period because of the tight scheduling, but by having them reflect after each presentation, they are actually forced into using a strategy that is vitally important if transfer is going to occur. Once they have experienced using reflective thought or thinking about their thinking, they will be more apt to use it when working alone.
* The problem solving program in this thesis is designed to be used in its entirety at least once. This does not mean the students will have mastered the techniques or skills involved, nor does it mean that the teachers will have become master teachers of problem solving. Thereafter, teachers will have to use discretion as to how far and how fast students will be able to use the various stages. As the students become more familiar with the strategies involved and the process itself, they will use the program quickly and efficiently. There will be times when the teacher wants to solve a problem in small groups, but there will also be times when a problem can be solved independently. Hopefully, the students will be able to avoid
premature closure by brainstorming ideas, determining the criteria, evaluating the solutions and being able to support the solutions that make a thoughtful, insightful answer.

* For some classes and some teachers, stage one will be a new experience and it will be necessary to dwell at that level for several weeks or even months. Teachers need to be comfortable in order for the class to be receptive and enthusiastic. Teachers need time to feel comfortable. Problem solving, at whatever level, should be a positive experience and a positive force within the curriculum. This program has been designed to help meet this goal.
Problem Solving Workshop Day #1

Plans/Schedule

8:45-9:00  Coffee, donuts, name tags
9:00-9:15  Introductions, presentation of agenda, what to expect
9:15-9:30  Brief overview of program  Objectives: to help teachers become aware of 1) reasons for inception, 2) goals for teachers  3) goals for students
9:30-9:45  Introduction to cooperative learning, small groups learning  Objective: to help teachers become familiar with blocks to problem solving  Objectives: to help teachers become aware of various blocks to receptivity, to breakdown such blocks to learning Isolating problem, self-imposed limitations on problems, inability to see problem from another's viewpoint, stereotyping, saturation (activity) Duncker's Candle Problem p. 95 and the Nine Dot Matrix p. 96
10:00-10:05 Reflection on conceptual blocks to problem solving  Objective: to stress the importance of reflective thought after each activity
10:05-10:20 Cultural Biases  Objective: to develop an awareness of biases which hinder problem solving  Playfulness is for children, problem solving is serious business, humor is out of place, practicality is good, pleasure
are bad, long hair/earrings on boys, single parent homes, sex, age, race, religion (activity) You have only Cheerios with which to work, how many uses can you think of for a Cheerio? Objective: to develop an awareness that problem solving can be fun

10:20-10:25 Reflection of cultural biases Objective: to use reflective thought to stress importance for transfer of concepts

10:25-10:40 Emotional blocks to problem solving Objective: to develop an awareness of biases which may hinder problem solving fear of taking a risk, fear of chaos, judging rather than generating ideas, lack of challenge, imagination (activity) What could go wrong in an elevator? What could you do about it? "catastrophic expectations"

10:40-10:45 Reflection on emotional blocks Objective: to demonstrate how reflective thought is used throughout the program

10:45-11:00 Break

11:00-11:15 Physical environment of classroom Objective: to provide an environment conducive to thinking Small groups, teacher proximity, "facilitator" versus "teacher" (activity) How could you arrange your room to be more conducive to thinking? Reflection
on physical environment Objective: to stress the importance of reflective thought in all areas

11:20-11:35 Mental environment Objective: to help teachers become aware that mental environment is as important as physical environment. It is all right to experiment, all right to be wrong, all right to be different, multiple answers are all right, generate multiple ideas before deciding (activity). How could you arrange your curriculum to be emotionally more inviting to problem solving?

11:35-11:40 Reflection of mental environment Objective: to stress the importance of reflective thought to the program.

11:40-11:55 Teacher modeling Objective: to show that modeling a behavior can be an effective way to teach that behavior. Answer questions with questions instead of affirmatives "Aha, I see" type responses, wait time before and after questions, changing response rhythm (activity). Give chart found on page 105.

11:55-12:00 Reflection of teacher modeling Objective: to stress the importance of reflective thought in all areas.

12:00-12:30 Lunch

12:30-12:45 Introduction to designing problems Objective: to help teachers become better at defining problems, develop confidence in developing such problems. Definition of problem, well-defined, ill-defined.
Overview of designing a problem/question relating to program

Objectives: to help teachers value creative as well as critical problem solving within the realm of their curriculum

1. Designing problems or questions
   a. Torrance's suggestions for generating problem-finding
   b. Determining types of questions: fact-finding, judgmental, creative

2. Determining criteria
   a. Teacher generated
   b. Student generated

3. Communicating and implementing solution
   a. Type of solution presentation
   b. Developing support of ideas
   c. Audience

4. Relate problem development to program
   (8 stages)

Reflection

Objective: to stress the importance of reflective thought for transfer of concepts

Designing well-defined problems/question

Objectives: be able to determine appropriateness of problem, to develop an awareness that process is more important than solution (activity). Pick an area in literature that is necessary for your grade.
level. Design a well-defined problem for students to develop.

1:45-1:50 Discussion of question from groups. Objective: to help teachers realize the skills needed and the pitfalls which may ensue.

1:50-2:15 Reflection about thinking that went into questions. Objective: to develop questions which stimulate thinking about thinking (activity). Use the following questions to stimulate discussion of thinking: Did you have a problem determining a question? Did you change the wording from how you presented the information or question in previous years? Why is the problem chosen appropriate? Did you have a "correct" answer in mind when you made the question? Are multiple answers appropriate?

2:15-2:30 Designing a more complex question or problem. Objective: to encourage teachers to be receptive to creative and critical problem solving instruction (activity). Group #1 designs problem for Group #2 to solve. Group #2 designs problem for Group #1 to solve.

2:30-2:35 Discussion of problems/questions. Objective: to develop an awareness of skills necessary and pitfalls which thinkers may incur.

2:35-2:50 Reflection on thinking that went into design of problem. Objective: to develop an awareness of
possible questions which will stimulate thinking about thinking  Questions similar to questions for well-defined problem

Wrap-up and brief outline of Day #2  Objectives: to surface any majors concerns or fears, to provide motivation
# Problem Solving Workshop-Day #2

## Plans/Schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>8:45-9:00</td>
<td>Coffee, donuts</td>
</tr>
<tr>
<td>9:00-9:15</td>
<td>Discussion of agenda (use chart), what to expect</td>
</tr>
<tr>
<td>9:15-9:30</td>
<td>Divide group into &quot;students&quot; and &quot;teachers&quot; to solve each others' problems Objective: to have teachers experience problem finding, problem solving and typical pitfalls in both</td>
</tr>
<tr>
<td>9:30-10:30</td>
<td>Hints for better solutions Objective: to help teachers feel more comfortable with the program</td>
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<td></td>
<td>Relate worksheets to each stage of the program Objective: to improve problem solving skills with a visual reminder for each stage</td>
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<tr>
<td></td>
<td>Determine strategies for each stage Objective: to help teachers become aware of the skills students need to become good problem solvers</td>
</tr>
<tr>
<td>10:30-10:45</td>
<td>Break</td>
</tr>
<tr>
<td>10:45-11:15</td>
<td>Groups decide on problems to present Objective: to become better problem finders</td>
</tr>
<tr>
<td>11:15-11:30</td>
<td>Group present problems to be solved Objective: to become aware of strategies needed and possible pitfalls to problem solving</td>
</tr>
<tr>
<td>11:30-12:00</td>
<td>Groups work on solutions for problems Objective: to become better problem solvers using suggested skills</td>
</tr>
<tr>
<td>12:00-12:30</td>
<td>Lunch</td>
</tr>
</tbody>
</table>
12:30-12:45  Group #1 presents solution  Objective: to develop strategies needed for good problem solving and presentation

12:45-1:00  Reflection upon thinking  Objective: to continue use of reflective thought in order to stress its importance in transfer

1:00-1:15  Group #2 presents solution  Objective: to develop strategies

1:15-1:30  Reflection upon thinking  Objective: to stress importance of reflective thought for transfer

1:30-1:45  Group #3 presents solution  Objective: to stress importance of reflective thought for transfer

1:45-2:00  Reflection upon thinking  Objective: to continue stressing use of reflective thought

2:00-2:30  Discussion of "What went wrong", "What went right"  Objective: to provide alternatives when something does not go as planned  What went wrong, right, techniques/modeling that need practice, where to start in the program, what parts of the program to use first, value of using entire program as introduced to problem solving

2:30-2:45  Use of charts, worksheets to keep ideas visible in classroom (charts, worksheets included in workshop packet)  Objective: to help teachers and students become better problem solvers by adding
reminders and organizational strategies within the classroom

2:45-3:00 Reassurance of future help/ideas/support
Chapter seven concludes the discussion of and planning for problem solving through literature, but it also reveals a need for further work in this area. Several implications for further study have arisen. For instance, many students are presently scoring low in problem solving on the Massachusetts assessment tests. If implementation of the plan presented in this thesis does not bring up the test scores, other areas of concern will need to be considered evaluated. Evaluative techniques, themselves, may need to be studied and improved in order to obtain reliable test results, for a reliable means of measuring growth is a necessity. Transfer of problem solving from one subject area to another must occur. If problem solving strategies are not being transferred to other areas, then more research needs to be done ensure this actually takes place.

There is a major problem in the fact that present tests are not aimed at divergent thinking, but rather convergent thinking. We contend that students should become good at divergent thinking before they are asked to make convergent decisions. Learning to think about possible alternatives, then being able to support a decision based upon these ideas helps the person to become good at critical as well as creative thinking; therefore, good at problem
solving. If some emphasis, even just a few questions, require successful divergent thinking in the testing situation, teachers would feel more willing, if not obligated, to spend time instructing in this area. This should not only boost the divergent thinking scores, it should act as the groundwork for improving problem solving scores.

The program described in this thesis is much more elaborate than anything which would be required in the testing situation, but it would enable students to define and solve problems in many given areas more easily. As the program is used in classrooms, it may be found that changes are necessary in the program itself. Some steps may need to be altered or eliminated. It may be found that some students will require more concrete instruction at a specific level. Some modifications in teacher workshops or more support and follow-up with teachers may be needed. The instructor, the class population and its background in thinking skills may dictate changes needed for specific schools, even for particular classes. People using the program must, therefore, be willing to specify changes that are necessary to make it effective for their particular population. Chapter VI mentions many of the problems that may arise and how they may be solved. It also suggests helpfuls hints to answer questions which may arise.

The most important element for the program is receptivity. It must be presented to teachers as an alternate instructional method of teaching creative problem solving which may be more comfortable for them and/or more appropriate for their students' learning styles.
Once the program has been accepted as an instructional method, then changes can be made to fit the particular audience.

Although there are presently few tests to measure the accuracy of creative thinking and/or reasoning related to problem solving, there are observations that can be made to determine if students are getting better. Arthur Costa has enumerated some of these, (Costa, 1986).

1. Can students list the steps and tell where they are in a sequence of a problem solving strategy?
2. Can they trace the pathways and dead-ends they took on the road to solving the problem.
3. Can they describe what data they are lacking?
4. Can they describe what they are going to do to produce enough data to solve the problem?
5. Are students more persevering, self-correcting, taking more pride in their solutions and products?

Instructors should be able to observe improvements in problem solving from the onset of instruction. Skills will evolve in: brainstorming, evaluating, defining a problem, establishing criteria for such solutions and for communicating and implementing a solution. Moreover, students should, with practice and teacher, be able to transfer these skills to other areas in order to solve problems effectively and creatively. Several lesson plans and ideas have been presented at chapter five for such transfer. Most importantly, the instructor should find students defining and solving problems
creatively and enthusiastically as they reflect an instructor who believes in and teaches for critical and creative problem solving.
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