Creative Problem Solving: Nine Model Lessons on the Rainforest

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CREATIVE PROBLEM SOLVING:
NINE MODEL LESSONS ON THE RAINFOREST

A Thesis Presented

by

CHRISTINE MORTON

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

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CREATIVE PROBLEM SOLVING:
NINE MODEL LESSONS ON THE RAINFOREST

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ABSTRACT

CREATIVE PROBLEM SOLVING:
NINE MODEL LESSONS ON THE RAINFOREST
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The need for imparting critical and creative thinking skills to students has never been greater. No longer can students be expected to absorb passively each aspect of their education without the means of understanding more fully the nature and content of the learning experience.

The amount of information currently available for teaching purposes alone is truly staggering. Just as the instructor must choose the most appropriate material for a curriculum, so too must the student decide what will be the most useful to study from this endeavor.

Teachers need to become developers of critical and creative thinking skills, and advocates of interdependence, teamwork, and interdisciplinary thinking. They should also see themselves as managers of learning experiences to help students accomplish these goals. Such managing of students' learning should result in the individual student deriving some proficiency at creative problem solving.
The selection of the tropical rainforest as the focus for this critical and creative thinking curriculum offered sixth grade students a timely and relevant topic which they were able to investigate with enthusiasm. With each succeeding lesson, students gained greater confidence in taking responsibility for their own learning. This confidence was reflected in class discussions and group projects.

Fundamental to this curriculum was the use of well established strategies for teaching creative problem solving. These included the use of knowledge webs, visualizations, simulations, guided imagery, role playing, and analogies.

Key to the success of this program was the decision to have students work primarily in groups rather than individually. This strategy promoted greater productivity, bolstered student confidence, and improved class discussions. This unit serves as an example of how critical and creative thinking programs, when offered to young students, can serve as a valuable foundation for their overall academic success.
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INTRODUCTION

The nature and scope of public education has dramatically changed in the past thirty years. Where once memory, rote exercises and inflexible curricula were seemingly the standard, a new set of conditions now exist.

The information age, coupled with greater diversity in the demographics of the student client population, has heralded the need for fresh and more innovative approaches toward teaching. The amount of information to be transmitted to students has become so great in recent years that traditional teaching methods have become increasingly ineffective.

Clearly, a restructuring of the educational apparatus was needed lest the teaching profession become overwhelmed in a sea of endless information to be imparted to students. Thus arose the notion among professional educators that students need to take a more active role in the learning process. Critical and creative thinking has emerged as a discipline wherein students can directly participate in their own education.

Implementation of such a radical approach is not easy. Traditional methods though cumbersome and somewhat flawed hold certain redeeming aspects which can never be totally abandoned. In essence the trial and error approach through empirical experimentation, is the time honored pathway by which new and viable teaching methodologies can emerge.
For students, the educational experience needs to transcend the traditional parameters of four walls, textbooks, and six-hour school days. Somehow, educators need to enable students to recognize the connection between their daily experience and the real world. Otherwise the myriad of academic disciplines to which they are exposed are rendered all but irrelevant in their eyes.

The author, recognizing this dilemma and the problems associated with it, set out to create a curriculum which focused on two goals: to impart critical and creative thinking skills in students, and through the accumulation of information, to assist students in better appreciating the application of facts to their everyday lives.

After considerable thought, the author selected the tropical rainforest as the subject for establishing a curriculum for critical and creative thinking. In recent years, the increasing awareness of the destruction of the tropical rainforest has led the author to believe that it would be an ideal topic as the focus of a thinking curriculum. Not only was this topic timely and relevant, but it also held a certain exotic charm likely to capture the imagination of sixth grade students. This curriculum focused on the Brazilian Rainforest. Please note that any future references pertain to the rainforests of Brazil.
The anatomy of a curriculum requires not only that the sum of its parts fits together, but also that the parts function smoothly to a discernable degree. Each new lesson plan sought to add at least one important new tool or skill toward the students' ability to think in a critical and/or creative fashion. Naturally, not all cognitive skills are acquired with the same ease and celerity. It was anticipated that certain exercises involving the more tedious aspects of problem solving would be particularly difficult to grasp.

The need for students to pursue their assignments as group endeavors seemed essential for a variety of reasons:

1. The less talented students, without the reinforcement and encouragement of their team members, would be at risk of falling behind and "disappearing" from the curriculum.

2. Social skills such as cooperation and group communication would be greatly improved among the participants.

3. Individual barriers to unfamiliar tasks and information would become less formidable.

4. Students would experience cooperative learning before becoming involved in the creative problem solving process.
Perhaps the single most important notion that needed to be conveyed to students was that thinking and not the information per se empowered them to be successful. Ergo, the ability to problem solve, cooperate, and to network their thinking would be the keys to evaluating information, establishing relative value to facts, and drawing conclusions predicated upon these orderly and logical approaches.

In the nine lessons which ensue, the implementation of each exercise is fully described in the section entitled Format. The Commentary section which follows reflects upon the relative merits and flaws contained within the lesson plan and the particular difficulties encountered by the students. The Theoretical Review describes the rationale for the specific approach used in each chapter. Also located within the Theoretical Review are the definitions of the key educational strategies that have been deployed within each lesson plan.

The thesis style of unfolding the Format, Commentary, and Theoretical Review lesson by lesson is intended to bring clarity in describing a "real life" teaching endeavor. Its true value to the author has been the orderly and scholarly study of practical ways of imparting a new approach to education.
CHAPTER I

LESSON 1: INTRODUCTORY SIMULATION AND AN INITIAL KNOWLEDGE WEB

Format

This lesson enabled students to personalize the problem of the deforestation of the tropical rainforest through the use of an analogy and by participation in a group simulation. The teacher began with a short explanation that informed the students that they would be working through a process that would generate possible solutions to this serious world problem. Students were asked to close their eyes and visualize the following:

Imagine that in this year, 1991, brick has become extremely valuable. The entire downtown of our community has been sold off to foreign investors who have paid billions of dollars for the properties. They have dismantled all the buildings and shipped the valuable bricks back to their countries. Our beautiful downtown no longer exists. Let's brainstorm all the ways this will affect our lives.

As students began to brainstorm, they could identify such ramifications as no tourists, no shopping, no entertainment, a housing shortage, no community center, or even no schools. Recognizing the problems associated with destroying what is an integral part of one's environment, they started to appreciate the interdependent, as well as the corollary, aspects of this imaginary event.
After the simulation, the teacher explained to the students that they had in fact compiled a list of the ways their lives would be affected if the downtown were destroyed, and for the next five weeks, they would be examining the destruction of the tropical rainforest. They began by creating an initial knowledge web (see Appendix A). The webbing activity, which was done individually, helped students clarify what they already knew, flush out incorrect information, encourage the sharing of the information with other students, and begin the metacognitive process. (Metacognition is defined in the theoretical review section of Chapter II).

The initial knowledge web was started in class, but then was completed at home with the help of family and friends. This began the individual’s search for knowledge and built excitement about the topic. After completing the web, students were asked to develop five questions that remained unanswered (see Appendix B). This helped to place the responsibility for learning on the student.
Commentary

This first lesson attempted to immediately engage students both cognitively and emotionally. The acquisition of knowledge occurs more successfully after interest has been piqued. As one student said, "When I pictured this happening all around me, it was much easier to imagine what is going on in the tropical rainforest."

The author, recognizing the limited experience and exposure of twelve year olds, selected an environment that the average student would be most familiar with and able to appreciate. Though their own hometown and the tropical rainforest have precious little in common, they nonetheless both represent integrated living systems with innumerable subcomponents. Thus, the students could readily appreciate the problems which could befall a system when an easily identified and integral component was eliminated.

The ensuing class discussion provided the first opportunity for an exercise in webbing. Building upon a series of analogies, the students created their own webbed descriptions of what the outcome would have been if the downtown were destroyed (See Appendix A). One student cogently noted that, "If this were happening downtown, how long would it be before it came to my house?" This and
other observations demonstrated a growing appreciation for
the phenomena of cause and effect.

Individually, the students' initial knowledge webs helped to identify where gaps existed in their knowledge about the rainforest. As another student said, "It was interesting to see how my feelings had changed by the end. When I looked back at the first web, I realized how little I knew about the rainforest." Through this exercise, the author gained a greater appreciation for the need to expose the students to more facts about the problems associated with deforestation. Their overall lack of information about this topic needed to be addressed before problem solving could occur.

Fostering creative thinking through the use of analogy and visualization was an important goal of this lesson. A fundamental purpose for the use of analogy and visualization is to produce a new perspective.

One helpful suggestion for the future use of this lesson would be to create different categories of questions for further assisting the students in focusing upon the most important elements to be pursued in the forthcoming lessons. Examples of different types of questions might include any of the following: a number question, a history and science question, and a "What If" question.
Such questions might include the following:

1. How many acres are destroyed daily in the rainforest?

2. When did the public first become aware of the problem of deforestation?

3. What do scientists believe will be the most damaging effect resulting from the destruction of the tropical rainforest?

4. What if a specific type of plant needed for a medical cure became extinct?

Theoretical Review

The use of guided imagery helps students become more adroit at deploying the visualization process.

Certainly the ability to visualize objects, concepts, systems, organizations, processes - the earth, the universe - is essential to successful creative work in writing, musical composition, creative dance, mechanical invention, football and other sports, scientific discovery, and many areas of creative achievement. It is important that the images visualized be varied, strong, vivid, lively, and intense. I have called this - "richness of imagery." It is also important that these images be colorful, exciting, unusual, and appealing to the various sense modalities. I have called this - "colorfulness of imagery." (Torrance 1979, 126)
Simulations are defined as representations of a condition or process in a different medium. Additionally, they also serve as powerful strategies for enhancing understanding of complex issues. They help bring information to a level where one can get an overview of the entire problem.

The ability to visualize alternative techniques for arriving at solutions is paramount to solving problems. Visual thinking skills need to be isolated and taught in a systematic way so that students do not remain visually illiterate.

Extremely supportive of the methodology of using guided imagery to enhance visualization of a problem is Edward T. Clark. In his article, "Environmental Education as an Integrative Study" he states the following:

Thus the tendency in environmental education - as elsewhere in the curriculum - is to provide students with lots of facts about various environmental issues and assume that this will lead to better understanding and eventually to a change in behavior. I suggest we have the cart before the horse. The first step is to provide students with the conceptual framework as a context for understanding the facts. To paraphrase the well-known Chinese proverb: A concept is worth a thousand facts. The facts have their place, but they are not at the starting point of learning. (Clark 1991, 51)
Webbing, which is a graphic structure used to represent different types of information, works best for representing a major theme, idea, or concept. The central concept is the main node, and details may be added by using words on lines jutting out like spokes. A curriculum web is a cognitive organizer that allows one to evaluate prior knowledge, identify gaps, and develop a structure for further inquiry. Marzano et al. (1988) in Dimensions of Thinking classify this form of representation as an analyzing skill because it goes beyond ordering and classifying and often elicits the analysis of patterns and relationships.

That is, to represent information, the learner identifies the parts and conceptualizes them into a new form, usually for a particular purpose, and is often led to new understandings and capabilities as a consequence of this reformation. (Marzano et al. 1988, 86)

Although the use of analogies is an integral part of this lesson, treatment and discussion of their use and value will be discussed in the theoretical review of Chapter IV.
CHAPTER II

LESSON 2: THE GATHERING OF FACTS AND THE ACQUISITION OF KNOWLEDGE

Format

Four class periods were devoted to this lesson to insure successful completion of this portion of the curriculum. The ensuing exercises on the gathering of information were important building blocks in the process of creative problem solving. The intent was to engender a strong sense of understanding for the need, accuracy, and skill required in the gathering of facts and the acquisition of knowledge.

Lesson Plan 2a.

During the first class, students shared facts from their webs, avoiding the repetition of information, while encouraging the development of questions. Following the sharing of information, students were given a list of organizations to write to for pamphlets on the tropical rainforest. A business letter format helped to facilitate the process. A rough draft was done in class, edited by a classmate, and completed at home. As the students began to
receive the requested materials, a bulletin board was created to allow students to review the collective information.

Lesson Plan 2b.

As with most topics, there is a specialized vocabulary pertaining to the deforestation of the rainforest. Through the use of visual symbols, students not only learned new vocabulary, but also a strategy for remembering. To learn the strategy, students were asked to draw symbols for concrete nouns (canopy, tropics, etc.). Children were instructed to develop a symbolic representation, rather than realistic drawings. They were then asked to create symbols for abstract nouns (extinct, transpiration, etc.). Students drew their symbols on the board and guessed the meaning of each others' symbols. Students were next presented with a workbook containing fifteen words that needed definitions and pictorial clues (see Appendix C). This assignment was completed at home.

Lesson Plan 2c.

A sound filmstrip, The Vanishing Forest: The Crisis of Tropical Deforestation, provided by Knowledge Unlimited was shown to the students. This filmstrip presented uses of the
rainforest, the differences between tropical and temperate forests, reasons for deforestation, and future implications for the environment when unplanned or wanton destruction of the rainforest continues unabated.

Students were instructed to take careful notes while viewing the filmstrip. Upon completion of the filmstrip, they were asked to draw four detailed pictures that recalled facts which had been presented in the filmstrip. Making a chart of four general classifications on large poster paper, students placed their pictures under the appropriate category. The classifications were: uses of the tropical rainforest, reasons for destruction, differences between rainforests and temperate forests, and future implications. Although the goal of this lesson was the acquisition of knowledge, the classification of the pictures brought the thinking to the analysis level.

Lesson Plan 2d.

The fourth and final part of lesson two featured a basic comprehension quiz. The quiz was intended to assess the information presented in the filmstrip. The class was provided with a checklist of all the ways they had learned about the rainforest and they were asked to rank them in order of most to least effective. A class discussion
followed to review the questions and to strengthen further each student’s knowledge base through accumulating the collective responses elicited through the quiz.

Commentary

The principal focus of lesson two was to develop an interactive model through which students could further enhance their knowledge of the rainforest. Unlike a traditional, passive learning setting where information is simply placed before them, the students were instead required to seek out information and share it.

This particular exercise served to place the responsibility upon each student to actually collect information which would be for the benefit of the entire class. Students also took greater pride in exhibiting responsibility toward the development of our informational bulletin board on the tropical rainforest, as it visually reflected their collective efforts.

The students found the use of visual symbols to be an extremely powerful tool in their development of a working vocabulary. Time and again, the pupils indicated that the pictorial clues came to mind first when they were tested on the vocabulary. Overall, the response to this activity was quite rewarding.
The sound filmstrip provided by Knowledge Unlimited demonstrated the profound importance and significance of quality resource materials. The impact of this audio-visual aid greatly enhanced the concentration and interest on the part of the students. Accurate and expert information is critical for successful problem solving.

The fourth and final section in the second lesson proved to be the most problematic for a variety of reasons. The use of a quiz to ascertain understanding of the material proved to be the least popular exercise. This was not entirely unexpected as any form of quizzing or testing is all too reflective of the more traditional forms of mainstream education.

More constructive in nature and scope were the discussions which ensued following the quiz. The students were quite excited about sharing their answers and responses to the questions. Once this portion of the metacognitive process was completed, the students struggled with that portion of the exercise which required them to rank from most valuable to least valuable the various methods employed to learn about the tropical rainforest. It appears that this particular skill of assigning relative value to an exercise or a methodology was simply beyond their grasp. This may have been due to the fact that the students were just beginning their study of this topic.
The evaluation skills of the average twelve year old are at best rudimentary. However, they could quite readily identify those tasks that were the most enjoyable. The author believes that teachers need to model for students how to evaluate a learning activity (see discussion of metacognition in the theoretical review in lesson 2.)

**Theoretical Review**

The principal thrust of lesson plan 2a was to immediately immerse the students in the knowledge acquisition process.

Although students and teachers use knowledge-acquisition processes to build a foundation for learning any content area, the knowledge is useful only to the degree that students can apply the knowledge or produce new knowledge. Therefore, as we write each unit of curriculum, we need to design opportunities for students to use their knowledge to compose, to solve problems, to make decisions, or conduct research for discovering new knowledge. Each unit in the curriculum should provide structural opportunities to use at least one of these processes, and in planning the overall curriculum we should provide a balanced menu of opportunities to apply the various knowledge-production or knowledge-application processes. (Marzano et al., 1988, 64, 65)

The use of visual symbols proved to be an invaluable adjunct to augmenting the knowledge-acquisition process. In lesson plan 2b, visual symbols were essential in helping students gain a more profound understanding of abstract
concepts. Through the use of pictorial clues, the instructor was able to gauge how successful the students had been at understanding the definitions and translating them into a means that held the meaning for them.

When complex materials are used, very often the need exists to break down the subject matter into smaller, more digestible components. This task is readily achieved through transmitting information by means of different forms of media. For example, the different senses (e.g. sight, sound, touch, taste, smell) provide the pathways for the accruing of information. In particular, sight can capitalize upon a variety of message forms including pictures, written words, and film. In lesson plan 2c, the use of a filmstrip offered an outstanding source for communicating information in a way that was superior to other less visual forms of communication.

It is the author's belief that visual symbols provide dual benefit in not only conveying information, but also in assisting the student to retain that information. Thus, it is incumbent upon the instructor to deploy any and all tools and strategies available to enhance students' learning.

This notion is particularly championed by Hopkins (1990) when he quotes from Bruce Joyce and Marsha Weil (1986) in Models of Teaching.
The premise is that student achievement is enhanced through the teacher’s use of appropriate and specific models of teaching. Since no single strategy can accomplish every purpose, the wise teacher will master a sufficient repertoire of strategies to deal with the specific kinds of teaching problems he or she faces. (Hopkins 1990, 44)

It is desirable for students to be conscious of their own thinking, to reflect on their own style of learning and to evaluate the methods used. This process is often called metacognition. "Metacognition refers to awareness and control of one’s thinking, including commitment, attitudes, and attention" (Marzano et al. 1988, 146). Self-monitoring can be fostered in students through the use of certain teacher behaviors.

Teachers need to model the process of planning, monitoring, evaluating, and revising and then gradually give students responsibility for these tasks. In fact students should recognize that experts (e.g. teachers) devote substantial energy to planning, monitoring, evaluating, and revising; that experts often have problems carrying out a plan or revision; and that they sometimes fail, but that they learn from their failures. (Marzano et al. 1988, 15)

When asking students to rank the lessons according to what was the most productive for them, students began to become aware of the different techniques teachers use to impart knowledge. The process of inviting students to share
what goes on in their minds and in turn talk about what could be done differently demonstrates methods of how to reflect upon a given task and make modifications.

Without the presence of a demonstrated knowledge base it becomes very difficult to evaluate thinking skills. There must be in place some type of mechanism to indicate the amount of information that is possessed by the student. Consequently, testing has been the chief means for fulfilling this condition.

The result of this way of thinking has been an attempt to reduce all learning to that which can be measured. To accomplish this, we have created an elaborate system of testing based almost entirely on those learnings that can be demonstrated and quantified. (Clark 1991, 21)

This approach has not been without cost to the learning process.

In doing so, we have reduced concepts like understand, know, appreciate, enjoy, and believe into measurable behaviors like write, recite, identify, list, compare, and contrast. Since the only learning that can be accurately measured without ambiguity is recall, we have, implicitly if not explicitly, reached the conclusion that the measure of recall is a measure of learning. As a consequence, virtually the entire teaching/learning process is centered around the presentation, memorization, and recall of facts. (Clark 1991, 22)
CHAPTER III

LESSON 3: THE GATHERING OF FACTS AND THE ACQUISITION OF KNOWLEDGE THROUGH COOPERATIVE LEARNING EXERCISES

Format

The author developed the curriculum in 1989 and later changed the format to include this lesson after discovering a Zephyr Press curriculum entitled, *The Future of Our Tropical Rainforests*. This lesson included two cooperative learning activities. The students were given five class periods to complete each activity. The fact that these were group endeavors necessitated the use of classroom time.

Lesson Plan 3a.

The first activity involved learning information about the rainforest that was presented on fact cards. For example, pupils worked in groups of four with each group pursuing a separate category. The students learned the facts, taught them to their group members, selected eight to fourteen facts to teach the rest of the class, and then developed a presentation for doing this. It was suggested that they teach in a way that enabled others to learn the information, not just listen and forget.
It appeared that the students did learn their own facts quite well, and for the most part, were creative in their presentations which were portrayed as news broadcasts, talk shows, telethons, and video tapes.

Lesson Plan 3b.

The second cooperative learning exercise involved the creation of a group product rather than a group presentation. The groups could choose from the following options that were offered by the text *The Future of Our Tropical Rainforests* (MacRae-Campbell, McKisson 1987).

1. Create a graph showing the amount of timber being removed.
2. Draw a time line showing a regrowth of a tropical rainforest.
3. Make a collage showing the significance of the tropical rainforest products.
4. Write a poem that tells the consequences of the deforestation.
5. Assemble a chart that lists major causes of deforestation.
6. Develop an alphabet book that tells about the tropical rainforest.
7. Invent your own product that depicts factual information about deforestation.
The groups decided which product they wished to pursue and spent the next five class periods completing it. At the end, they were asked to evaluate their experience according to information obtained, contradictory information discovered, strategies used to complete the assignment, difficulties encountered by the group, and suggested changes for future classes.

**Commentary**

Both of these activities directly involved students in the task of creative problem solving (see theoretical review for further discussion concerning creative problem solving). The total time involved was ten class periods. The development of the necessary skills for group decision making far outweighed the actual acquisition of knowledge. The author felt that most students had derived a sound understanding of the issue. Several students verbalized their confidence on the topic with the following comments.

Creating a product and doing the presentation has helped me learn the truth about what is happening. I didn’t know all the facts. It was fun working with friends while learning.
I used something I enjoy, rap music, to teach other kids about the rainforest. I guess you'd call me a rainforest rapper! Seriously, my group had times when we didn't get along and I wished I was working by myself, but when it was finished, I had a lot of new friends and cooperation skills. Let's not forget I now have a lot of knowledge about the rainforest too.

The author felt that each group's presentation of the facts failed to facilitate a collective acquisition of knowledge of the other groups' presentations. It seemed that the cleverness of the presentations overshadowed the actual learning of the material being presented to the audience. There was no discernable motivation for actually learning the information. The focus was on each group's performance, and the "pressure" was off when its turn was over. The compilation of facts and information by all the student groups as a total learning exercise was not totally successful.

To limit the value of this endeavor to a quantitative outcome would be detrimental to the whole experience. A creative and critical thinking curriculum should be viewed as a training endeavor which imbues students with skills rather than an educative process which simply bestows facts.

However, an examination of the growth of the individuals contained within each functioning group showed discernable progress. At the beginning, the students in each group appeared disorganized, uncertain, and unthrifty in their
management of time. With successive class periods, a distinct trend emerged. The students became more productive, more cooperative, and more confident with the material. In particular, the final two class periods were hallmarked by student groups which were focused, directed, and highly productive.

It was important that the students themselves, within a peer setting, identify the facts they believed were most germane to their presentation. As the class periods progressed, the author received fewer and fewer questions concerning the nature of their selected facts. This autonomous group decision making process was in fact the key reason for sustaining a cooperative learning experience. By this very endeavor of a collective exercise, the students strengthened their individual thinking skills.

Theoretical Review

Why group work? Surely the controversy continues to rage on about the pros and cons toward such an approach. Several parameters for discerning the meaning and purpose for this form of intellectual endeavor can be established.

Groupwork is an effective technique for achieving certain kinds of intellectual and social learning goals. It is a superior technique for conceptual learning, for creative problem solving, and for increasing oral language proficiency. Socially,
It will improve intergroup relations by increasing trust and friendliness. It will teach students skills for working in groups that can be transferred to many student and adult work situations. Groupwork also is a strategy for solving two common classroom problems: keeping students involved with their work, and managing students with a wide range of academic skills. (Cohen 1986, 6)

Under the best of conditions, groupwork offers many positive elements to the learning experience.

In group investigation, students take an active part in planning what they will study and how. They form cooperative groups according to common interest in topics. All group members plan how to research their topic. Then they divide the work among themselves, and each group member carries out his or her part of the investigation. Finally, the group synthesizes and summarizes its work and presents these findings to the class. (Sharan and Sharan 1989, 17)

However, there are certain inherent flaws in this approach which have left educators less than unanimous in their agreement regarding the validity of this approach, especially if it breeds competition between the groups. In particular Alfie Kohn (1986) in his text, No Contest, examines the grim side of competition when he lucidly states:
Competitive individuals might... focus so heavily on outshining others and putting themselves forward that they lose track of the scientific issues and produce research that is more superficial and less sustained in direction. And more succinctly: They become so preoccupied with winning...that they become distracted from the task at hand. (John 1986, 56)

Though he has described an individual as the focus of the competitive arena, the same dynamics apply to groups and their efforts of endeavor when competing against one another. If the goal had been in this lesson to imbue the greatest amount of factual knowledge possible in each student, then "Competition between groups can be of value in motivating students" (Cohen 1986, 70). In this instance, the issue of motivation was not a problem. The real difficulty, as described in the section entitled Commentary, identified students wishing to perfect their group presentations rather than acquiring knowledge from the other groups.

Compelling evidence from this lesson gives cause to ponder how some vehicle could have been introduced to insure that the students would have been more attentive to group presentations other than their own. Simply stated, some form of testing as a measure of accountability might have
provided the impetus for the students to be more attentive to the work of the other groups. Likewise, groups could have been rewarded for successfully teaching their facts to the other members of the class.

Despite the strengths and flaws which have been discussed and are inherent in this educative approach, it must not be minimized or forgotten that the core concept remains that:

Although students and teachers use knowledge-acquisition processes to build a foundation for learning any content area, the knowledge is useful only to the degree that students can apply the knowledge or produce new knowledge... (Curriculum... should provide a balanced menu of opportunities to apply the various knowledge-production or knowledge-application processes. (Marzano et al. 1988, 64,65)

Creative problem solving draws upon numerous skills that must be acquired, refined and repeatedly used before genuine ability is demonstrated. The need for problem solving skills impacts upon virtually every function and activity an individual will undertake in today's society. "The skills of creative thinking must be recognized as mankind's most important adaptability skills. Such skills must become basic to the curriculum of schools, homes, business, and other agencies" (Torrance 1979, 9).
In order to inspire students to think symbolically about the complex issue of the rainforest, the author used three synectics exercises (see theoretical review for a definition). In one, students were asked to make a personal analogy, "In what ways are you like a rainforest?" In a second exercise an attempt was made to force fit a set of carefully chosen words. The students were asked what comes to mind when you think of the rainforest being "carefully destroyed," "consumed by wet fire," or being a "divorced dependency." They were to pick one phrase to think about, close their eyes and visualize it, and then take a few moments to sketch it. The sketches were displayed for viewing by the class. The purpose of this exercise was to spark students' analogical thinking in an attempt to inspire the creation of their visual product. The third synectics exercise involved having students complete the following statement. "The destruction of the tropical rainforest is like_________ because__________________" (see Appendix D).
Working individually at home, each student was to create a visual product that did one of the following:

1. Depicted the value of the tropical rainforest;

2. Predicted what might happen if deforestation continued;

3. Presented a solution to the problem of deforestation.

The product could be either two or three dimensional and had to reflect careful planning and construction. Each product had to be accompanied with a museum card that stated the title of the product, and a description (see Appendix E). Students were asked to list the three possible assignments, a list of different possible visual products, and all the materials that could be used. This format was intended to generate possibilities for ideas.

Once a student selected an idea, he/she was asked to generate a plan for it. The plan included what was being made, materials needed, necessary steps, and possible problems that could arise.

David Perkins' (1986) model was introduced to enhance students' organization and ability to critically think about the proposed product. This model proposes four questions.
The questions are:
1. "What is the purpose?"
2. "What is the structure?"
3. "What is the model?"
4. "What are the arguments, pro and con?" (Perkins 1986, 5)

Using these four questions helped students to analyze and critique their product ideas. It fostered analysis and evaluation. This particular organizational tool was employed at different intervals in the product-making process. The first three steps were turned in as part of the product plan, before the students began construction. The final question was used at the end of the evaluation process.

The final products that were created by the students were subsequently placed on display for other students to view.

Commentary

The students' responses to the personal analogy: "In what ways are you like a rainforest?" were quite varied. Some students were unable to answer the question while others responded, "There are many systems in my body, just like there are many ecosystems in the rainforest," and "I am dependent on others for my survival, just as the rainforest is dependent on all its parts to exist."
An example of a student’s response to the third synectic exercise was, "The destruction of the tropical rainforest is like a nuclear melt down because the devastation spreads, it’s permanent, and it’s global."

When asked to sketch their visualizations of a rainforest being "carefully destroyed," "consumed by wet fire" or being a "divorced dependency," students initially asked for examples. The author suggested that the students close their eyes and imagine fire as a lifesaving destroyer. A class discussion ensued with students reporting such images as people stranded on an iceberg where fires burned to keep them warm, and a nuclear plant exploding, after providing energy for decades.

It appeared that this exercise helped students make an analogy between the conflicting forces present in the problems associated with the destruction of the tropical rainforest. Their drawings reflected a variety of perspectives from a boardroom filled with "greedy" people who were carefully marking out the areas they wanted to strip for their financial benefit, to animated plants and animals singing a chorus of "I need each and every one of you to survive."

In an effort to familiarize students with David Perkins' model, an ordinary thumb tack was introduced. Students were asked to describe its purpose. They said it held things together and allowed for the display of
materials. When describing its structure, the students most commonly identified two major components, a sharp piece and a round flat part. When asking students to present a model, the most frequent response was to draw a two dimensional representation of a thumb tack. With the fourth and final question, the students were asked the following, "What are the advantages and disadvantages of using thumb tacks to fasten materials to a surface?" Advantages of using a thumb tack included: "It made a small hole," "It was easy to use". Disadvantages included: "It couldn't hold much weight," "You need a lot of them for a big surface," and "You can poke yourself with one."

The final products, which included posters, maps, graphs, mobiles, and collages, focused upon a variety of problems and solutions concerning the tropical rainforest. Though there was some overlap among the different products in terms of subject matter, each gave a unique perspective on the overall topic.

**Theoretical Review**

The term "synectics," which labels one of the leading creative thinking models, is derived from the Greek word which means joining together apparently unlike elements. Its procedure or operations seek to maximize the chances that syntheses and combinations of the "aha" variety will occur... Synectics problem-solving groups
bring together people from different disciplines, different ways of thinking, different experiences, and the like. (Torrance 1979, 116)

The three operational mechanisms of synectics chosen for this lesson fall into the categories of evocative questioning and force fitted analogies. They are simply procedures for getting an unusual perspective.

An essential element in all disciplined processes for creative problem solving is a set of deliberate procedures for aiding the problem solver to get an unusual perspective of the problem. This is necessary because we tend to assume that our own practiced way of looking at things is the only way. (Torrance 1979, 117)

Reframing has proven to be a vital tool in assisting students who have had difficulty visualizing or drawing conclusions. This creative approach involves "... the ability to go beyond the schema normally used to approach a problem - to 'go beyond the lines' - and reframe the problem so it might appear in another light. ...Reframing often involves the use of models, metaphors, or analogies" (Marzano, et al. 1988, 26).
The importance of analogies can be seen throughout the entire set of nine lessons. In particular analogies provide an educational cornerstone to lesson plans one and four.

Synectics places a great deal of emphasis on ‘making the strange familiar and making the familiar strange.’ Through the techniques associated with this concept, the creative thinker is warmed up to the strange by associating it with something familiar and to the familiar by associating it with something strange. The use of analogies is one of the primary mechanisms for doing this. To further enhance warm-up, a model is sometimes constructed of the analogy and this suggests even further alternatives. In using the personal analogy, a person may imagine himself as the object and engage in the movements, sounds, and the like of the object. (Torrance 1979, 34)
CHAPTER V

LESSON 5: TEAM FORMATION AND CLASS ANALYSIS OF THE FUZZY SITUATION

Format

The fuzzy situation presented by the author was the 1989-1990 Future Problem Solving Practice Problem (see Appendix F). The fuzzy situation was read out loud to the class and students were then asked to complete a comprehension sheet (see Appendix G). Students were assigned to groups of four in which they remained throughout the creative problem solving process. The groups had been set up to contain heterogeneity of ability and had combinations of students who had worked together in the previous cooperative learning exercises.

Once students comprehended the fuzzy situation, a helpful strategy was used in the formulation of problem statements. The class prepared a forecasting chart that consisted of two columns listing cause and effect (see Appendix H). Once the chart was completed, students used the information to develop categories to be considered for possible problem areas (see Appendix I).
Using the 1989-1990 Massachusetts Future Problem Solving format, each team received a booklet and were told to give themselves an advanced degree in a specialized field that related to the problem.

**Commentary**

Forecasting or prediction is considered to be one of the higher level thinking skills. The author discovered this was an absolutely necessary step in creative problem solving. Once students had the cause and effect chart, they were able to transpose those ideas into problem statements. For example, "shrinking tropical rainforests may cause flooding and the effect may be the loss of coastal cities." "Shrinking tropical rainforests may cause the loss of plant life and the effect may be the loss of food, medicines, and potential medical cures." "Shrinking tropical rainforests may cause global warming and the effect may be the change in world wide climatic conditions." This cause and effect brainstorming sheet represented a group method for generating ideas in a climate of acceptance without a specific right or wrong answer being expected.
Having the students give themselves an advanced degree in a specialized field that related to the problem was a great motivational tool. Students chose to be doctors in entomology, forestry, or veterinary medicine. Students had completed the research and this form of role playing gave them confidence in their knowledge.

Theoretical Review

There are several excellent examples from the literature which address the need for the use of such vehicles as forecasting, predicting, brainstorming, and role playing. The cause and effect model is an excellent format by which students can use the information accrued through the lessons. In this lesson plan multiple strategies came together to bring the students closer to the goal of learning creative problem solving.

If used in the broad sense we advocate, making predictions can be effective in many learning situations. Teachers may need to ensure, through questioning and other activities, that students actually make predictions and then take time during the learning activity to check those predictions. It is important to note that students can change their predictions as they obtain more information about an experiment, story, or topic. Equally important, students should be informed that some predictions turn out to be incorrect but that such an outcome does not mean the student has failed. (Marzano et al. 1988, 101)
The innate complexity of developing problem statements warranted the use of a combination of techniques to aid students in the creative problem solving process.

The premise is that student achievement is enhanced through the teacher's use of appropriate and specific models of teaching. Since no single teaching strategy can accomplish every purpose, the wise teacher will master a sufficient repertoire of strategies to deal with the specific kinds of teaching problems he or she faces. (Hopkins 1990, 44)

Two such strategies include role playing and brainstorming.

Torrance believes that playing a role permits a person to go beyond himself and shed some of the inhibition that stifle the production of alternative solutions. Playing a role gives a person a kind of license to think, say, and do things he would not otherwise do. Because of its imaginative nature, sociodrama has been used to solve future as well as present-day problems and conflicts. (Dacey 1989, 128)
Again, Torrance provides a vital explanation and insight for the importance of brainstorming. He cogently states that:

Brainstorming training can be conducted with reference to specific subject matter content, within the context of the problems of a business or other organization, or without any immediate goals except training and practice. ... the skills of brainstorming can be developed when practiced in connection with subject matter content or the problems of a group as well as when the practice is solely for the development of skills and problem-solving expertise. (Torrance 1979, 26)
CHAPTER VI

LESSON 6: DEVELOPING PROBLEM STATEMENTS

Format

In lesson six, the students were required to work in groups to develop their own problem statements. The directions were based on the format used in the Massachusetts Future Problem Solving Competitions. The problems were to be written in a statement form. The statements needed to be written in terms of possibility, using verbs such as 'may', 'might', or 'could'. The students worked for the entire class period developing and recording statements in their booklets.

Commentary

Students were expected to generate fifteen to twenty problems in the exercise. Most groups found this task very difficult. Firstly, this was an unfamiliar endeavor; and secondly, they were being asked to work at a higher level of thinking than previously experienced. The students, having had only limited experience in cooperative learning
settings, demonstrated unfamiliarity with this method of generating many ideas. Encouraging students to refer to the category list and the group cause and effect sheet were helpful reference points for teams that were experiencing brain drain.

Students at this age do not appear to possess well developed, pre-existing criteria for applying a wide range of problem statements. In this instance, the author found that direct teaching was required in order that the students could participate in this exercise. This is an example of a situation wherein the youth and inexperience of the students limited the overall outcome for success. The author recommends that in the future a simpler model, such as an everyday event be employed to teach problem statement skills. In this instance, it is of secondary importance as to whether this exercise be viewed as either cooperative or group work; but instead the principal focus should be placed upon instilling problem statement skills into the students.
The students' responses were evaluated according to their fluency, flexibility, and the quality of the statements. Fluency is the divergent ability to generate ideas in quantity, a measurable factor of creative ability, and one of the attributes of creativeness. Students were engaged in expressional fluency which is generating, organizing, and placing words into sentences. Flexibility is the divergent ability to generate ideas from varying perspectives, viewpoints, and categories of thought on a particular subject or problem.

There has been considerable demonstration that the more alternatives a person or group produces and considers, not only the more viable those solutions are likely to be, but also there is greater likelihood of success in solving problems (Torrance 1979, 24).

The cause and effect list and the category sheet developed in the previous lesson (see Appendices H-I) were helpful tools in creating varied problem statements. While the quality of the sentence structure for the individual problem statements was important, clarity of thought was the principal objective.
CHAPTER VII

LESSON 7: WRITING THE UNDERLYING PROBLEM

Format

In this exercise students were again asked to develop a problem statement. Continuing with the Massachusetts Future Problem Solving format, students were instructed to write their statements in the following structure.

1. How might we or in what ways might we...?

2. Use one key verb in a phrase that mandates what must be done to solve the problem.

3. State the purpose which describes the goal toward which you will carry out the mandate of the key verb phrase.

4. Place the underlying problem within the parameters of the fuzzy situation.

Toward the end of the class period, each group was asked to write their problem statements on the blackboard. The entire class discussed, compared, and then selected the best problem statement. The selected statement would then serve as the standardized problem for solution finding.
Commentary

Although each group developed a problem statement, to facilitate the process, the author decided to have each class vote on one problem statement to be used in solution finding. Managing forty groups' individual problem statements would have been overwhelming. The students placed their problem statements on the board and then decided which statement was the best. Perhaps in the future this part of the process would work more efficiently if it was a class rather than a group activity.

After the class decided on a problem statement, they could return to their assigned groups to complete the final steps in creative problem solving. These steps included brainstorming solutions to the chosen problem statement, evaluating the solutions, choosing the best solution, and designing a plan for implementing the chosen solution.

One technique employed by the teacher to help facilitate the writing of problem statements was to create charts on the blackboard. The charts corresponded with the questions that appeared in the format section in lesson 7. Chart number 1 simply contained the stem of the statement. Chart number 2 was a brainstormed list of possible verbs that mandate an action. Chart number 3 was the list of categories used in Lesson 5. The final chart contained the parameters such as time (2010), and place (Brazil).
Examples of problem statements are:

1. In what ways might Brazil restructure its economic system so that by the year 2010 the economy no longer depends upon the destruction of the tropical rainforest?

2. In what ways might the American Medical Association work with worldwide medical teams to create a protected environmental laboratory in the rainforest of Brazil by the year 2010?

3. In what ways might the United Nations work with educators to construct a massive worldwide education plan that would insure the protection of the Brazilian rainforest by the year 2010?

Theoretical Review

Alfie Kohn in his classic text, No Contest states that "... people working cooperatively succeed because a group is greater than the sum of its parts." (Kohn 1986, 61) This synergism is fully detailed in the preceding commentary as well as in the theoretical review in Lesson 3. By generating a pool of choices, the students were ultimately able to identify the best problem statement, which permitted the entire class to complete the creative problem solving exercise.
As described earlier in the commentary for this lesson, the use of subgroups proved to be somewhat redundant in this particular exercise. Instead, the entire class would have been more effective in assembling their various statements.

By enlarging the number of participants in a working group, the desired goal is to establish greater efficiency toward generating solutions. Working with small sub-groups placed an additional burden upon the individuals in these units. When considering the skill level of a twelve year old, the difficulties of problem solving are only magnified.

Additional skills are required for defining problems for creative attack. When confronted with a perplexing or conflict situation, a person should be able to recognize the "real" problem—the essence of the difficulty—which may underlie the stated question. The creative problem solver should be able to broaden the problem, open it up, or redefine it. He should be able to identify several subproblems which are more manageable or can be solved. The goal is to find the statement which, if solved, will clear up the "mess" or alleviate the problem situation. (Torrance 1979, 13)

Thus, it is understandable that young students with limited skills and exposure to the problem solving process would benefit most from this exercise being conducted as a whole class endeavor, rather than attempting such complex problem statements individually or in small groups.
CHAPTER VIII

LESSON 8: BRAINSTORMING SOLUTIONS TO THE PROBLEM

Format

In their groups, students brainstormed solutions to the underlying problem question. The author presented a model for the writing of solutions. Each solution had to answer:

1. Who will do the action?

2. What will be done?

3. How will the solution be accomplished?

4. Why will it solve the problem?

Each group was encouraged to generate many solutions to the underlying problem.

In order to facilitate the generation of many solutions a strategy called SCAMPER was introduced (see commentary for definition and explanation). Students were asked to apply SCAMPER to existing solutions in order to generate more ideas.
SCAMPER, a checklist strategy, is an idea simulation device that contains possibilities for extending this process. Idea checklists stimulate new and additional ideas from the words or phrases they contain. The first letters in the word SCAMPER stand for substitute, combine, adapt, modify, mini, add, put to other uses, eliminate and reverse, rearrange.

In order to teach this strategy to students, a practice exercise was introduced. A telephone was displayed in the front of the classroom and students were asked to work through the SCAMPER checklist and generate ideas to change and improve a telephone. Some ideas that resulted from the exercise were:

1. "Put lights on the phone so deaf people would know it's ringing."

2. "Create an intercom phone system."

3. "Produce watch phones that everyone wears."

4. "Create phones for the elderly that immediately take their blood pressure and heart rate."
Although students found the strategy difficult, they were able to modify solutions, as well as create new ones. Once again, the students were pushed to generate at least twenty solutions.

Theoretical Review

The SCAMPER model is extremely complex as well as detailed in its effort to further elaborate upon solutions. "Developed by Bob Eberle (1971), its built-in mnemonic device helps in its mastery and in its application in practical situations" (Torrance 1979, 28).

With the assistance of such devices, a formal platform is provided to assist the creative thinking process. Each individual possesses both consciously and unconsciously an organized method for problem solving.

Creativity involves the ability to go beyond the schema normally used to approach a problem - to "go beyond the lines" - and reframe the problem so it might appear in a different light. Characteristically, the creative person has the ability to look at a problem from one frame of reference or schema and then consciously shift to another frame of reference, giving a completely new perspective. This process continues until the person has viewed the problem from many different perspectives. (Marzano et al. 1988, 26)
CHAPTER IX

LESSON 9: EVALUATION AND PRESENTATION OF SOLUTIONS

Format

After recording the twenty solutions, each group picked the five best ones to be judged. As a group the students composed five questions which incorporated the words least or most. The students listed the five best solutions and judged them according to their criteria questions. The final step involved a group presentation of the chosen solution.

Commentary

The concept of criteria development was introduced and resulted in the students looking at cost, acceptability, resources, and time. As a group, the students interacted well while composing the five questions, making sure they incorporated the words least or most in each question. Individually, the students had difficulty forming criteria questions and were beginning to lose interest. Creative problem solving is a tedious process and when you add the introduction of strategies, it can become an overwhelming exercise. Taking this into account, the author decided to
present students with sample criteria questions from which they could choose the most appropriate for their evaluation. Sample criteria questions included:

1. Which solution will cost the least?

2. Which solution will prevent the most destruction?

3. Which solution will be the quickest?

4. Which solution will need the fewest people?

The students listed the five best solutions and judged them according to their criteria questions. For example, if one of their questions was, "Which solution will cost the least?", they would give a score of five to the least expensive and a score of one to the most costly solution. The other solutions would fall somewhere between one and five. After ranking their five solutions, the one with the highest numerical score was considered the best choice.

Each member of the group was responsible for a portion of the presentation. Before the presentation, the group developed a written plan of action. One person described the specific problem the group had tried to solve and another told the best solution.
Two other students listed the steps the group would take to carry out the solution, beginning with what would be done first, second, third, and so on. Other areas covered by students in the presentation included a timeline and a description of the anticipated end result.

Students dressed up as their assumed characters, and made their formal presentations to the audience. The groups were encouraged to involve any community members or groups that they thought could give support. When listening to each group's plan, class members were asked to write what they could do to help carry out the various solutions.

Most students felt a sense of excitement and nervousness when presenting. As one student said, "I felt important sharing my ideas. I felt like my solutions could very well work. For the first time, I was working on a real problem that is happening now." One particularly effective presentation focused upon the creation of a boycott of Brazilian products until the rainforest issue showed promise of being resolved.

The team approach to this process helped students who lacked organizational skills to experience success in a project from start to finish. As one student commented, "I couldn't have done this alone. We needed each other for ideas and I would have hated doing the presentation by myself."
This final step, the presentation of solutions, provided a sense of closure to the sometimes exhausting process of creative problem solving. At the end of the presentations, the students completed a course evaluation (see Appendix J).

**Theoretical Review**

"From a philosophical perspective, establishing criteria refers to setting standards for judging the value or logic of ideas. These criteria are rational principles derived from culture, experience and instruction" (Marzano et al. 1988, 109). In this final lesson plan, the students were empowered to select the relative value of their solutions, deploying an organized method and approach.

This search is for the solution which will take into consideration the largest number of difficulties or conflicts...It is done when a well-planned set of criteria are used to evaluate alternative solutions. (Torrance, 1979, 58)

The students’ responses in the above commentary support Elizabeth Cohen’s (1986) thoughts on creative group problem solving.
Students have much to gain from participating in creative group problem solving. They learn from each other; they are stimulated to carry out higher order thinking; and they experience an authentic intellectual pride of craft when the product is more than what any single member could create (Cohen 1986, 19).

Intellectual hurdles can seem less foreboding when inexperienced students are able to communicate their strengths, weaknesses, insight, and confusion to each other. To feel lost and alone in any problem solving exercise can be an alienating experience. Thus, the goal of teaching problem solving skills is preserved through team work and cooperation.
SUMMARY AND CONCLUSIONS

The notion that developing critical and creative thinking through a single or isolated curriculum unit is indeed most unfortunate. Rather it should be a legitimate cornerstone in the educational process upon which students' ultimate academic success will come largely to rest.

The author has come to believe that thinking skills should not remain a hidden or mysterious discipline which hopefully students might acquire as a secondary benefit through their education. Instead a spotlight should be directly focused upon the mechanics of problem solving. Students should be helped to appreciate more readily that such tools of learning are every bit as important as a computer, textbook, or ballpoint pen.

The selection of the tropical rainforest as a topic proved to have more advantages than drawbacks. Students quickly realized and appreciated the current nature of this topic and were better able to understand its importance. At the same time using creative problem solving, a process that was unknown to them, demanded that they embrace various means to grasp more readily the issue and its subject matter.
The three principal drawbacks encountered by the author were the youth of the students (age twelve), the inherent difficulty associated with creative problem solving, and the complex scientific phenomena associated with the issue.

The intent of this endeavor was to present a model for changing curriculum development and selected teaching strategies to enhance certain aspects of the critical and creative thinking of students. Role playing, group endeavors, webbing, visualizations, and analogies are just a few examples of strategies that can augment the teaching of creative problem solving.

The author gained a legitimate sense of confidence in teaching students critical and creative thinking skills. Beginning with a familiar model, such as the students' hometown, it is quite possible to direct students toward thinking about situations that are unknown to them. For example, it could be perceived that critical thinking allowed the students to apply their understanding of problems associated with their own hometown with those of the tropical rainforest. It is this comparative approach which allowed the students to move from the known to the unknown.
The author further believes that it is possible to draw from a vast array of topics upon which meaningful thinking curriculums can be developed. Well structured parameters, combined with the availability of quality resource materials will facilitate achieving the end goal of teaching critical and creative thinking skills to students.

For the students, this curriculum afforded them the opportunity to question and challenge the data and information in front of them. There emerged with time the ability to attack the various issues associated with the deforestation of the tropical rainforest with an increasing degree of sophistication. Where once, students blithely accepted the opinions and facts put before them, they ultimately came to disagree, challenge, and interpret from their own individual perspectives.

Additionally, this curriculum was designed to serve as an educational unit that reflects the needs of a global information society. Students should be informed of how the diverse ecosystems have become increasingly dependent on each other.

So successful was the outcome of this curriculum, that it came to be adopted by the school system in which it was originally presented. Since 1989, when this curriculum unit was first developed, world concern for the tropical rainforest has dramatically increased. Currently, the increased awareness of this issue has been reflected in a
variety of ways including Public Broadcasting documentaries, museum exhibits, and even at the local flower show. It is hoped that the students will come to apply the thinking skills and scientific knowledge acquired by this curriculum to their own local environment. If so, then the author has succeeded.
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Massachusetts Future Problem Solving Program, 613 West Street, Wrentham, MA, 02093, 1989-90.


APPENDIX A

THE VANISHING FOREST

Complete an initial knowledge web on the topic.

RAIN FOREST
APPENDIX B

QUESTION SHEET

USE YOUR WEB TO DEVELOP 5 QUESTIONS THAT YOU WOULD LIKE TO KNOW ABOUT THE TROPICAL RAIN FOREST.

1. How many acres are destroyed each day?
2. What effect does deforestation have on global warming?
3. What animals and plants have already been destroyed?
4. How long has this problem existed?
5. How has the United States tried to stop this problem?
DIRECTIONS: Complete the vocabulary booklet on the tropical rainforest. Each word must have a picture clue and a written definition.

NAME:
**VOCABULARY**

EXTINCT

CANOPY

EROSION

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APPENDIX D

ANALOGY SHEET

THE DESTRUCTION OF THE RAIN FOREST IS LIKE A___________.

BECAUSE___________________________________________.

THE DESTRUCTION OF THE RAIN FOREST IS LIKE A "nuclear melt
down" BECAUSE "the devastation spreads, it's permanent, and
its global."
APPENDIX E

MUSEUM CARD

TITLE OF PRODUCT:

DESCRIPTION:

Name:

Individual Assignment on the Tropical Rainforest

Each student is to create a visual product that:

1. Depicts the value of the tropical rainforest;

2. Predicts what might happen if deforestation continues;

or

3. Presents a solution to the problem of deforestation.

Rules:

a. Products must be two or three dimensional.

b. Products must be well constructed.

c. Products should be attractive.

d. Each product must have the museum card.
The world is facing a crisis that today, in 1999, will impact the future of the entire planet. Never before in the history of the earth has there been such large scale and purposeful destruction of plants and animals. Even the events that led to the extinction of the dinosaurs (and many other species) 65 million years ago did not result in the damage that is occurring today. Each year about 18 million acres of tropical rain forests are being destroyed.

As a result of this destruction, many of the animals that live in the forests are dying along with the plants. Valuable resources are being lost before they can be be discovered, recorded, and put to use. For example, a plant was discovered, tested, and found to cure AIDS. Unfortunately, by the time the curing qualities had been discovered, that area of rain forest (in which the plant was found) was destroyed, and the plant has yet to be found again.

The Amazon River Basin is one area in which such destruction is taking place. Located mainly in northwestern Brazil, this area was once covered with tropical rain forests. Huge trees formed a canopy over several layers of smaller trees and plants. Rainfall was measured in feet, rather than inches. The daily rain and the high temperatures (the equator runs right through this area) combined to create a very hot and humid climate. Not only plants, but also animals (especially insects) flourished in the climate.

But this has changed drastically in the past thirty years. In the 1970s Brazil, like many of the tropical nations, found itself with a huge foreign debt amounting to billions of dollars. It also had a rapidly growing population. Most of the people were extremely poor and lived in slum areas of the large cities. To make matters worse, in the early 1970s Brazil suffered from drought and freezing temperatures that destroyed the coffee crop, one of the country's major sources of income.

To try to solve the problems facing their nation, the leaders of Brazil followed an example set by the United States a century earlier: they opened up Brazil's northwestern frontiers to those who would settle there. Free land was made available to peasants who would clear the forests and develop farms. Cattlemen were given tax breaks if they would turn the forests into ranches. Roads were built to allow timber companies to get into the forests to harvest the valuable trees. Mining companies were encouraged to extract the minerals (mainly tin and gold).

Though the plan seemed reasonable at the time, the officials failed to consider many of the terrible side-effects the destruction of the rain forests would have - not only on Brazil, but on the entire world. From your reading and research, you are probably aware of the many problems related to the destruction of the tropical forests.

Now in 1999 something must be done before this situation becomes still worse. Many feel that the future of the entire world is at stake. You and your team are invited to examine the situation and use your problem solving skills to develop a set of solutions.

Taken from the Massachusetts Future Problem Solving Program (uncopyrighted material 1989-1990)
APPENDIX G

UNDERSTANDING THE FUZZY SITUATION

1. In what year does this take place?

2. How many acres are being destroyed each year?

3. The nations that have tropical rainforests are located close to the....

4. Why are scientists concerned about the rainforests?

5. Why did Brazil's leaders offer free land in the rainforest to their poor?

6. Who else was encouraged to use the rainforest?
APPENDIX H

FORECASTING CHART

TOPIC: THE SHRINKING OF THE TROPICAL RAINFOREST MAY CAUSE...

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>deforestation</td>
<td>global warming</td>
</tr>
<tr>
<td>extinction of animals</td>
<td>disturbance of food chain</td>
</tr>
<tr>
<td>loss of trees</td>
<td>loss of oxygen</td>
</tr>
<tr>
<td>investors buying land</td>
<td>homeless natives</td>
</tr>
<tr>
<td>erosion</td>
<td>flooding</td>
</tr>
<tr>
<td>loss of plant life</td>
<td>loss of possible medicines</td>
</tr>
</tbody>
</table>