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ABSTRACT

This is the second sourcebook that has been produced by members of the Council of Elementary Science International (CESI) in cooperation with the ERIC Clearinghouse for Science, Mathematics, and Environmental Education. This sourcebook is focused on activities designed to enhance children's thinking. Activities emphasizing creativity, inventiveness, visual thinking, and problem solving have been made available to teachers so the activities can be easily incorporated into the teacher's lesson plans. Each activity includes the title, focus (a short description of the concepts and/or skills developed by the activity), challenge or problem posed to students, background information (if needed), a list of materials, suggestions for implementation, further challenges, and references. (Author/PB)

EXPANDING CHILDREN'S THINKING THROUGH SCIENCE

CESI SOURCEBOOK II

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An Occasional Sourcebook of
The Council for Elementary Science, International

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The ERIC Clearinghouse for Science, Mathematics, and Environmental Education is pleased to cooperate with the Council for Elementary Science International in producing this sourcebook. We believe that this publication will be of value to elementary and middle school teachers who wish to enrich their science programs with activities emphasizing creativity, inventiveness, and problem solving.

We invite your comments and suggestions for future publications.

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Preface

The CESI Board of Directors has been able to continue its commitment to science teaching in the elementary and middle school by providing teachers with another Sourcebook of activities to supplement and enrich their science programs.

Our second Sourcebook focuses on activities to enhance children's thinking. This topic was the outgrowth of workshops sponsored by CESI at the annual meetings of NSTA and recommendations from a survey of CESI membership.

Activities emphasizing creativity, inventiveness, visual thinking and problem solving may not be readily available to all teachers. By providing a collection of these activities we hope they will be incorporated into existing programs.

Expanding Children's Thinking Through Science would not have been possible without the dedicated efforts of a number of people. First and foremost are Michael Cohen and Larry Flick the editors, organizers, and authors of several activities. We appreciate their long hours of work on this project.

Our book would not have been possible without manuscripts, artwork and publishers. Special thanks to each of the authors who contributed manuscripts; to Gregg Floyd, Kathy Osting, and Ann Solomon for their artwork; to Stan Helgeson, Bob Howe, and Pat Blosser of ERIC/SMEAC for making the project possible.

We are now thinking about Sourcebook III, we need your ideas. We would welcome your comments on this book, suggestions for themes for future sourcebooks, and offers of authorship.

Betty M. Burchett
President, CESI 1981-82

CESI (The Council for Elementary Science, International) an affiliate of the National Science Teachers Association, is an organization interested in improving the science education of children. It is an organization OF teachers, presenting conventions and publications BY and FOR teachers.

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A Rationale

"Is there a teaching no master (teacher) ever taught before?"

Douglas R. Hofstadter [1]

[1] Hofstadter, Douglas R. Godel, Escher, and Bach: An Eternal Golden Braid. New York: Vintage Books, 1979, p. 248.

A PUZZLE THAT LOOKS LIKE A BOOK

by Michael R. Cohen

It is common to use analogies to help explain new educational ideas. For this Sourcebook the closest analogy is probably that of a jigsaw puzzle. That is, each individual who uses this Sourcebook develops her/his own picture of children's thinking by putting together different pieces from this Sourcebook and his/her own ideas. So each jigsaw puzzle will look different. Each person builds a different picture. It might help to add that each person is building a jigsaw without benefit of knowing beforehand what the final picture will look like. A good analogy, we thought, until you realize that most of us have not had that experience with jigsaw puzzles. We usually have an idea of what the final picture looks like, and even if we do not study it during the building of the puzzle, we might sneak a peek if the going gets tough. The puzzle we are talking about in this Sourcebook is therefore really not like any puzzle we have seen. And therefore the analogy may not fit. So let's try a challenge.

Challenge: Build a jigsaw puzzle in which the pieces can be put together in many different ways to produce many different pictures.

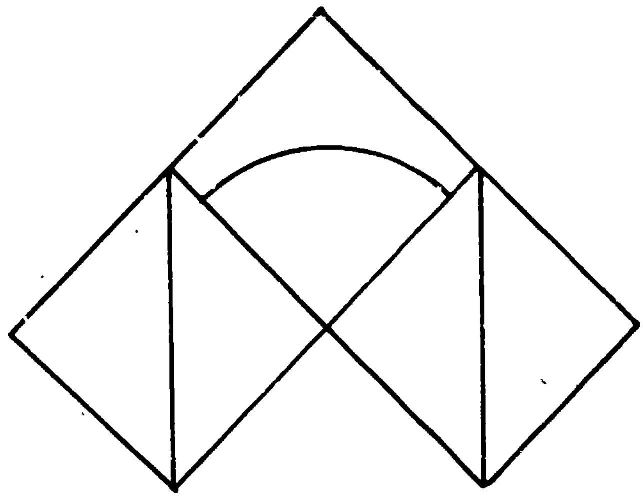
Now you have an idea of the jigsaw analogy for this Sourcebook. Can you design such a jigsaw puzzle? There is a puzzle on the market which has every piece exactly alike. Since the puzzle is only one color, you have only one solution to the challenge. We know at least two different solutions to the challenge. How many can you invent?

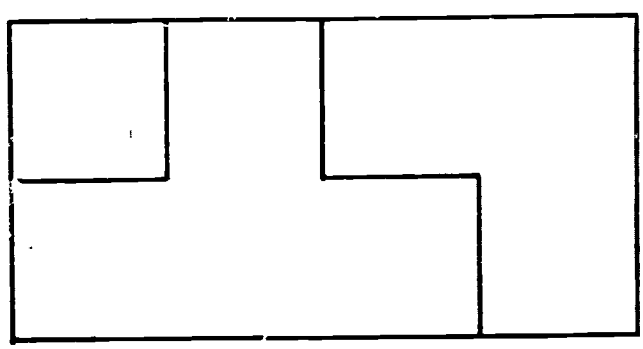
Further Challenges:

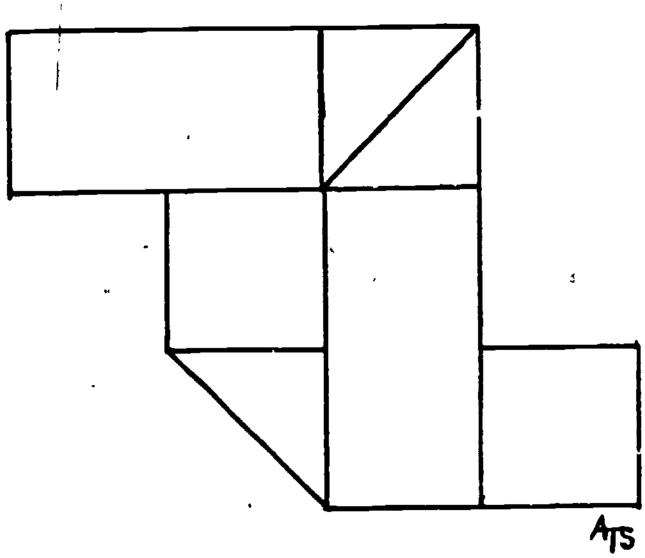
1) Invent a jigsaw puzzle where the picture changes continuously as you add pieces.

2) Copy the following drawing onto a piece of graph paper. Color the squares. How many different jigsaw puzzles can you invent?

3) Send us an example of your favorite new jigsaw puzzle.







A PUZZLE THAT LOOKS LIKE A BOOK

WHAT THIS SOURCEBOOK IS ABOUT

by Michael R. Cohen

The simplest child's riddle may seem impossible to answer until you hear the obvious, funny and often corny response. In this book many of the activities fit that situation. Many teachers try and find new and motivating approaches for the material taught. But until they see a unique approach, the problem of improving instruction may appear impossible.

The activities in this book provide examples of all teachers' potential ability to continually improve instruction. Some activities like Robert Silberman's "A Question of Magic" are elegant in their simplicity. He took a common experience and instead of presenting it in the traditional manner, as a "demonstration," he required the children to figure out the "trick." Simple? Yes. Obvious..., well maybe now, but surely not an approach that would have come easily to mind.

Other activities, like Larry Rother's "Peel A Pattern" are exciting in their ability to simplify a seemingly impossible task. It is common to study standard, symmetrical, three-dimensional objects in mathematics and science. The relationship between the three-dimensional object and its two-dimensional outline is not as common, although some activities and standardized tests consider the problem. "Peel A Pattern" presents an intriguingly simple method for changing between two and three dimensions with non-standard, non-symmetrical forms. And we must not forget that most of our three-dimensional concepts in science are presented as two-dimensional pictures, diagrams or graphs.

We feel the activities in this book are useful in themselves and hope you and your students have as much enjoyment and learn as much as we did during its development. But we [illegible] hope that the activities will serve as examples for your own development [illegible]ivities. Can you approach the problem from a different perspective? Can you explain the idea with a different activity and vocabulary?

Let me provide one example from my own recent experience. During the time I was working on this Sourcebook I had many opportunities to read student papers. While reading a graduate student's paper on the teaching of the circulatory system, the idea of pretending you could ride on a red blood cell came to mind. An then, within a second, I was thinking of opening a travel agency for red blood cells. Which would be the most popular trips? Would there be a special charge for going through the heart and lungs? Which trips would be most exciting? I believe I was able to think of an alternative activity because I had been primed by reading many of the exciting activities within this Sourcebook and my mind felt free to wander.

This Sourcebook is also a dialogue. Some authors ask for your comments. All of us, however, would be interested in your reactions and your additional ideas. Let us hear from you. Join us at regional or national meetings of the National Science Teacher's Association. Join the Council for Elementary Science - International.

THE HISTORY OF THIS SOURCEBOOK

This Sourcebook is the result of a series of workshops sponsored by CESI at the 1979, 1980 and 1981 annual meetings of the National Science Teachers' Association. Originally organized by Michael Cohen, they developed and evolved around ideas supplied and workshops presented by Joe Abruscato, Jack Hassard, Martin Kagan, Alan McCormack, Stan Rachelson and John F. Thompson.

The response of the participants attending the workshops was very positive. At Atlanta, in 1979, CESI presented a series of seven workshops around the title "Activities Fostering Children's Thinking." At least fifty percent of the audience attended more than one session. To our surprise, about thirty percent attended four and ten percent attended all seven workshops. To our further surprise many of the participants from the 1979 workshops attended the 1980 and 1981 workshops.

The continued positive response of the participants to the 1980 series of workshops led Alan McCormack, then chairperson of the CESI Publications Committee, to suggest that the content of the CESI workshops be developed into this CESI Sourcebook. It is interesting that one participant at the original series, Sheila M. Jasalavich, is the author of three activities in this Sourcebook.

THE STRUCTURE OF THIS SOURCEBOOK

The format of this Sourcebook is very closely related to that used by Alan McCormack for the first CESI Sourcebook. When possible, each activity includes the following sections:

Title: We have tried to invent titles that reflect both the fun of the activity and its learning focus. In many instances, our hope is that the title itself will pique a youngster's curiosity.

Focus: This is a short description of the concepts and/or skills developed by the activity. It also provides a quick capsulization of the activity to assist the reader in rapidly understanding what the activity is all about.

Challenge(s): Using a challenge or problem-oriented approach to activities is one good way to stimulate youngsters' interests.

Background: A few activities require specific background information that may not be readily available. In those cases we have provided enough information for you to begin the activity. Of course, further study and the use of references may often be needed.

Materials and Equipment: A list of everything needed is provided with each activity. Fee free to vary the materials. Invent ways to obtain the materials at no cost.

How-To-Do-It: These are suggestions for planning, organizing, and actually implementing the activities with youngsters. They are ways that have worked in the past. But, feel free to invent your own variations.

Further Challenges: Some solved challenge always leads to new challenges (and those, to new learning activities). Here can be found a few ideas for related, but different, learning activities. These challenges are entirely open-ended, and solutions are left to youngsters and their teachers.

References: Articles and books to give both teachers and students useful information related to the activity are identified.

Safety: Children's safety should always be the first of our concerns. And we assume all activities will be used with the children's safety in mind. However, in a few cases specific safety precautions are noted. Please use all activities wisely.

Sensitivity: The success of this Sourcebook's activities depends on the emotional safety and security of the children in your class. In a number of cases the children will have to take risks to state a point or express an idea. Be sensitive to their feelings. This includes a sensitivity to their many cultural, ethnic, gender and religious beliefs.

This idea is mentioned only briefly throughout most of this Sourcebook. But it is a critical point to keep in mind at all times.

THE BEST OF ALL POSSIBLE INCOMPLETE CLASSIFICATIONS

by Michael R. Cohen

The goal of this Sourcebook is to provide a variety of activities that enhance children's thinking. A problem for the editors was to find an acceptable way to classify those activities. A classification that expressed and extended the idea that children's thinking was critical to learning science.

Challenge: What set of categories or theoretical frameworks would you use to classify the activities in this Sourcebook?

One Choice: The most common system of classification might be that originally developed by AAAS for Science - A Process Approach program. The SAPA processes, listed below, are critical to any science education program. However, from our point of view they tend to emphasize hypotheses testing more than hypothesis generation. We will include them here for your information. They have a place in many of the activities. But we will not classify our activities into the SAPA categories. The spirit of this Sourcebook requires us to look for alternative classifications.

S-APA PROCESS SKILLS
(from, Commission on Science Education, 1965, page 2)

THE BASIC SCIENCE PROCESSES	THE INTEGRATED PROCESSES
Observing	Formulating Hypotheses
Classifying	Controlling Variables
Using Space/Time Relations	Interpreting Data
Using Numbers	Defining Operationally
Communicating	Formulating Models
Measuring	Experimenting
Inferring	
Predicting	

Another Choice: A new and interesting classification has been provided by the film series/book, Search for Solutions. The set of categories for the films (from Stensrud, undated, page 3) are:

"Investigation - The basic process of science: observation acted upon by thought. It is what an infant or a detective does when collecting impressions or facts, then mentally organizing them into a meaningful structure.

Evidence - Information that fits into a pattern and helps prove or disprove a theory. It must be recognized, collected, verified, and interpreted. It's tricky. Everything is evidence of something, but it's hard to be sure of what.

Patterns - These underlie the structure of both the world and the mind. Because these patterns are related, we can understand the world and investigate it with confidence that it will somehow make sense. Patterns reduce problems to their essential order. Their symmetry and elegance help us to recognize the basic nature of things.

Adaptation - A refined process that applies empathy to problem solving-it suits the answer to the question. Feedback is a systematic repetition of this process in situations where the problem and the solution are in a continually changing relationship.

Context - As described in the fable of The Ugly Duckling, a thing that means one thing in one setting means something different in another. By imaginatively shifting problems into new settings or combining them with other problems, discoveries can be made.

Trial and Error - The elementary mode of learning: falling down and getting up - pioneering. Error is essential and creative. If a mouse in a maze gets it right the first time, it has not learned.

Modeling - Thinking out loud, a way to find truth without consequences. Models are simplified representations of real objects or situations; with their help it is possible to treat theories or predictions in whole or in part. When a problem contains many variables, modeling is often the only way to deal with it.

Theory - Making up stories to explain things you don't understand, jumping to conclusions and then looking around from where you've landed to see the world from there. Theories have tremendous power to explain and to set in motion the other processes of problem solving, but they are, by nature, temporary. No theory explains anything completely or forever.

Prediction - Seeks to foresee and manipulate consequences, to get a jump on the future of a problem with an eye to controlling what will happen-minimizing undesirable results, maximizing desirable ones. Prediction is especially useful in checking out the implications of theories."

This set places emphasis on the development and testing of hypotheses as well as on various processes of creativity used in science. It is interesting to note that while there was obviously some relationship in the development of both the book and film series, they used different terms to describe the nine categories. The two sets are provided in the next paragraph. Try to match up the chapters.

Categories from Film - Search for Solutions (from Stensrud, undated, page 3)	Categories from Book - Search for Solutions (from Judson, 1980, page VII)
Investigation	Investigation: the rage to know
Evidence	Patterns
Patterns	Change
Adaptation	Chance
Context	Feedback
Trial and Error	Modeling
Modeling	Strong prediction
Theory	Evidence
Prediction	Theory

Yet Another Choice: A third set of categories is provided by Douglas Hofstadter, a computer scientist, in Godel, Escher and Bach: An Eternal Golden Braid. They are some categories Hofstadter used to describe intelligence, or what we would call thinking. (from Hofstadter, 1979, page 26.)

> "...essential abilities for intelligence are certainly:
> to respond to situations very flexibly;
> to take advantage of fortuitous circumstances;
> to make sense out of ambiguous or contradictory messages;
> to recognize the relative importance of different elements of a situation;
> to find similarities between situations despite differences which may separate them;
> to draw distinctions between situations despite similarities which may link them;
> to synthesize new concepts by taking old concepts and putting them together in new ways;
> to come up with ideas which are novel."

Our Organization Of The Sourcebook: The organization of this Sourcebook could have followed at least three different classifications. The one finally selected was based on the experience of CESI at the 1979, 1980 and 1981 annual meetings of the National Science Teachers Association. At those meetings CESI presented a series of workshops on "Activities Fostering Children's Thinking." Each workshop in the series had a specific approach: creativity; problem solving; visual thinking; inventions; self-esteem; values and futures. Since the response to the workshops was very positive, many teachers expressed interest in those particular aspects of fostering thinking through science, we have maintained that classification in this Sourcebook. They are our attempt to justify these categories as legitimate components of a science education program.

Further Challenges:

1) List other classification systems you think are appropriate for this Sourcebook.

2) Try and fit the Sourcebook activities into the other classification systems provided in this introduction.

References:

Commission on Science Education. Science - A Process Approach. Third Experimental Edition, American Association for the Advancement of Science Miscellaneous Publication 05-22, 1965.

Hofstadter, Douglas R. Godel, Escher, Bach: An Eternal Golden Braid. New York: Vintage Books, 1979.

Stensrud, Rockwell (Editor), The Search for Solutions - Teaching Guide, New York: Playback Associates, (undated).

Judson, Horace Freeland. The Search for Solutions. New York: Holt, Rinehart and Winston, 1980.

DO GOOD STUDENTS MAKE GOOD PROBLEM SOLVERS?

by Larry Flick and Michael R. Cohen

Thinking, learning or problem solving - what do our classrooms emphasize? One approach to begin our examination would be:

Challenge: Describe a good student.

Taking a few minutes to actually write down one solution to this challenge will aid you in giving personal meaning to what follows. Here is one description of a "good student": One who listens to (reads) instructions discerningly yet seeks clarification to eliminate apparent ambiguity and/or contradiction, approaches tasks with order and purpose, exhibits enthusiasm in his/her work, and completes assignments by the specified deadlines.

Predictably our definition, and perhaps yours, reads like comments on a report card. With a few additions concerning initiative and citizenship, it is possible to sum up the major goals of schooling. A teacher's perception of a good student affects his/her own mannerisms, responses, and the entire environment of the classroom.

Challenge: Describe a good problem solver.

Here is one description we thought of: One who considers several approaches suggested by the available information, seeks additional information to distinguish ambiguities and/or contradictions from possible errors, and takes the time necessary to imagine additional interpretations of the information.

Does schooling develop both good students and good problem solvers, or is one sacrificed to the other? Our view is that both the student and the problem solver should be encouraged, but that the exigencies of the classroom often sacrifice the problem solver to the student. To continue in this examination consider the following table:

Aspects of	School Performance	Problem Solving
TIME	speed counts	speed kills
MEMORY	may get you through	may block solutions
IMAGINATION	must elaborate on the given rules	may generate new rules
PROBLEMS	to be overcome or avoided	to be savored or simply considered interesting
APPROACHES	determine which are acceptable	look for ones that have the most meaning
ERRORS	to be caught before detected	to be made - measured and evaluated
AMBIGUITY CONTRADICTIONS	seek an explanation	look for new interpretation, refine the old, or live with it
QUESTIONS	begins with Who, What, Where, How, When and Why	begins with I wonder if...or What if...
INFORMATION	knowing where to find it and how much is needed	seeking ways to find what the situation calls for

Are these categories mutually exclusive or inclusive? Complementary? Conflicting? Can you think of a student who fits into both the problem solver and student categories? Which activities in this book would appeal to that student? Which do you disagree with and why?

CHALLENGE ASSUMPTIONS - Challenging assumptions is daring to question what most people take as truth.

SEE IN NEW WAYS - Seeing in new ways is seeing the commonplace with new perception, transforming the familiar to strange, and the strange to the familiar.

MAKE CONNECTIONS - Making connections is bringing together seemingly unrelated ideas, objects, or events in a way that leads to new conceptions.

RECOGNIZE PATTERNS - Recognizing patterns is perceiving significant differences or ideas, events, or physical phenomena.

DO GOOD STUDENTS MAKE GOOD PROBLEM SOLVERS?

DEFINE GINKINTH*

by Michael R. Cohen

It seems logical to begin a book aimed at fostering children's thinking by defining what is meant by thinking. The reader could then try to make sense of the definition and remember it while scanning and studying the activities. But it also seems logical for a book about activities to begin as early as possible with experiences. So, following the format of the activities we challenge the reader.

Challenge: How would you define thinking for a sourcebook that aims at fostering children's thinking?

We would suggest that you take a few minutes to think about (incubate) the challenge. Are you thinking about the challenge? Are you thinking hard? Are you trying to begin to write the definition? Are you trying to define the problem? Are you using any systematic approach? Are you...?

At a CESI workshop at the annual meeting of the National Science Teacher's Association in Anaheim, California in 1980 Joe Abruscato provided one excellent way to answer the challenge. He said, "For the next thirty seconds, STOP THINKING!:

Try it! How did you do? This is an interesting activity to try with children. It is a good warm up for many of the activities described in this Sourcebook.

Further Challenges:

1) What is another creative way to solve the challenge?

2) What activities in this Sourcebook are helpful in solving the challenge?

*Unscramble to find the meaning

USING A SOURCEBOOK APPROPRIATELY

by A. Leon Pines and Lynne Pines

A resource book of activities that have been tried and found successful, perhaps modified many times from experience, can be a wonderful thing to have on hand. Good sourcebooks do, in fact, enable most of us in teaching to pinpoint relevant exercises quickly, to challenge individuals or groups of students more engagingly, and offer us useful primary or supplementary learning experiences. Often they provide relief from the constant drain of inner resources, and at other times, good sourcebooks stir out own creative powers to invent, with a particular idea or child in mind. The worn pages and frayed edges of those few volumes that survive daily shuffling and yearly room changes are testimony to the fitness and thoughtfulness of their content and design.

But there are dangers inherent in the general manner in which activities handbooks may be used --- when ideas, like technologies, run rampant, and improper classroom strategies fail to fulfill the purposes they were planned to serve. It is to this unwise use of sourcebooks that we address ourselves here, wishing to inform you briefly of our perspective on curriculum and instruction and to alert you to certain signals that will ensure what we consider to be appropriate, intelligent, even sophisticated handbook use.

The Magician Perception A market glutted with teacher handbooks, as seen on every publisher's stand at every annual teachers' convention, at administrative conferences, and winking at us in our daily office mail, offers ample opportunity for teachers to become magicians: "I'll pick out an exciting experiment here, a colorful exercise there," "Got to get the kids outdoors this Fall; Let's find some neat things to do on a nature walk," or, "I'd like to do a unit on 'Eyes' this year, ah, here's one!"

The problem that we see with this kind of handbook usage--if it is continuous--is often subtle, but, nonetheless, psychologically very real for the students. For it promotes a kind of teaching that results in meagre long-term learning, engaging students perhaps in interesting personal episodes and activities, but depriving them of a basic, conceptual foundation of knowledge, which is, after all, supposed to be the thrust of schooling.

Challenge: What are your reasons for using the activities in this Sourcebook?

Curricular Content vs. Instrumental Content: Two (Too) Often Confused Ideas
The number of definitions for "curriculum" and "instruction" that abound in any one school system alone may be profuse. That is unfortunate, for these two concepts, when clarified and understood, lend power to pedagogical thinking and, consequently, promote excellence in teaching. We view curricular content as a structured series of intended learning outcomes, what we want the students to come away with after instruction; while we consider instrumental content to be the methods and content used to facilitate teaching and learning (Johnson, 1967, 1977). Curricular content is the content or processes to be learned *per se*; instrumental content is that which is used to exemplify, explain, or achieve the meaningful learning of curricular content--the means to one or several ends.

Whatever is used as instructional content then is merely vehicular to teaching the curriculum. Our use of the qualifier "merely" should not be taken in any pejorative sense, however, for instrumental content can make the difference between successful and unsuccessful teaching. The catch, as you can see, comes when our ideas about just what we are to teach are unclear and become obfuscated by the thrill of an exciting demonstration, a series of interesting experiments, a routine of old, familiar exercises, a year of disjointed, unintegrated activities (no matter how much fun)---or twelve years of conceptually fragmented school experiences.

One extreme, but familiar example should suffice to clarify our point. A primary teacher who wishes to teach the letters of the alphabet (curricular content) uses a tune or melody (instrumental content) to help the children acquire this knowledge in an enjoyable fashion. (This example is extreme precisely because it so clearly distinguishes between the curricular and the instrumental content.) The teacher's ultimate goal is the children's acquisition of the letters of the alphabet; the tune or melody is merely instrumental.

But, in this example, the tune may actually prohibit the learning of the alphabet, for there are many children who learn to sing the 'Alphabet Song' thinking that "LMNO' or "LMNOP' is one letter, not four or five separate ones. Here, the instrumental content, the pleasant reason for the instruction, in fact may create improper and unintended outcomes.

In most cases, the distinction between instrumental and curricular content is not as clear as in the above example. And it is often possible that curricular content can become instrumental content for future learning (Gagne, 1970). These issues may become even more complicated as students progress in age, experience, number of years in school, and gain complex academic and personal knowledge. The important point, however, is that as teachers, we need to be sure of curricular content, so that we can choose appropriate instrumental content from the wide range of resources and activities available. If, for instance, one considers this Sourcebook as a curriculum guide, instead of as a repertoire of activities from which to carefully select instrumental content targeted at communicating key ideas, we would send that teacher a signal marked "unwise handbook use."

Challenge: What are your conceptions of "curricular content" and "instrumental content"? How will *you* use this *Sourcebook*?

The Purposes of Schooling and Science Education: Our Anti-Busywork Stance

Tremendous controversy centers today over the question, "What are schools for?" Government agencies, communities, parents, administrators, teachers, and students are weighing their answers. We are holding firm to our belief, however, amidst the complexities of the issues, that the purpose of schooling is to educate creative problem-solvers who will in turn become a responsible, informed citizenry. In order to accomplish this, students must be supplied with "tools of thought" so that they can make independent decisions which integrate moral, rational, creative, and ever-expanding experiences. Furthermore, school students will need to continue learning in meaningful ways throughout their adult lives; the "learning how to learn" notion.

We view "tools of thought" as concepts and processes which, to be learned meaningfully, must relate to what students already know. Thus teachers must first make decisions about which concepts and processes to teach--and then seek ways for imparting these in some meaningful fashion. Science education provides unique opportunities to educate appropriately; for science, unlike some other subject-matters, in all forms is disciplined knowledge. The major scientific concepts are generally the curricular content and each can be elaborated by relating it to dozens of subordinate concepts. Each concept and conceptual relationship can be exemplified with numerous examples, illustrations, demonstrations, etc., chosen usually after evaluating stude.ts' prior knowledge and geared especially toward that individual or group.

Some outstanding examples and activities can be found in this CESI Sourcebook, Expanding Children's Thinking Through Science. Hopefully, these exercises will neither become magicians' tricks nor be inducted into the ranks of busywork exercises, but will be used appropriately for instrumental content selection and "wise handbook use."

Challenge: What are your key curricular concepts and processes in science education? What do your students already know about these? What instrumental content will you use to teach your science curriculum meaningfully?

Further Challenges:

1) Let the author of the activity know what you learned from the activity.

2) Ask your students to evaluate the activity for curriculum content and instrumental content.

3) Identify curricular content in some of these activities which may later become instrumental content.

References:

Gagne, R. M. The Conditions of Learning (2nd Ed.). New York: Holt, Rinehart, and Winston, 1970.

Johnson, M., Jr. "Definitions and Models in Curriculum Theory." Educational Theory, 1967, 17: 127-140.

Johnson, M., Jr. Intentionality in Education: A Conceptual Model of Curricular and Instructional Planning and Evaluation. Albany, New York: Center for Curriculum Research and Services, 1977.

AN AMBIGUOUS CERTAINTY

by Rochelle F. Cohen

Focus: As sure as you are reading this Sourcebook, I am sure that each of you has a set of beliefs about certain types of children that enables you to group them. These beliefs and groupings affect your expectations about their behavior, motivation, ability and intelligence. This is the certainty in my title. The ambiguity is whether or not the grouping or label, often called stereotypes is whether or not the grouping or label, often called stereotypes, are valid or does some ambiguity exist?

As you read throught the Sourcebook it will become apparent that the authors and editors have spent a great deal of time in creating a book that is non-sexist, non-racist, and that doesn't stereotype. The intent of this effort was to practice what they believe in. The purpose of the Sourcebook is to stimulate cognitive development, enhance opportunities for creative thinking and problem solving.

Challenge: Choose a child from your class who, because of a label, you might select as being unable to successfully complete an activity from the Sourcebook. Work out a way to help that child succeed.

Materials and Equipment:
A visual image of your classroom of children.
Sensitivity and awareness to the effects of labels.
A large sheet of paper folded in fourths.

How-To-Do-It: On the first column, make a list of the different groups of children in your class. Be honest about your feelings, the myths and beliefs you hold about these groups. In the second column list the behaviors you expect from a child in the group identified in column one. In the third column, write down why the activities in the Sourcebook won't work or be useful for that particular group or type of child. In the last column write down how you could make that activity a successful experience for any child regardless of grouping or label.

SELECTED OPPORTUNITIES FOR EXPANDING ON THE IDEAS OF THIS SOURCEBOOK

by Karin Donahue

Challenge: How will you continue to improve your ability to "expand" children's thinking?

Baker, Paul. Integration of Abilities: exercises for creative growth, New Orleans, Anchorage Press, 1977.

This book is a series of lectures given Fall 1970 at Trinity University-Texas dealing with finding out where a student is, how to help her/him express himself/herself, how to develop confidence to go beyond the point where she/he is, and ultimately to find his/her creative self. Though Dr. Baker is in the Department of Speech Drama at Trinity, his philosophy of creativity and teaching as expressed in his book has relevance for all disciplines and all ages.

Carkhuff, Robert R. The Art of Problem Solving: a guide for developing problem solving skills for parents, teachers, counselors, and administrators, Amherst, MA: Human Resource Development Press, 1973.

The Art of Problem Solving is a manual for developing decision making skills on a practical level. Included are sections on developing the problem, breaking down the problem, considering and developing courses of action, as well as implementation. There are step-by-step exercises which parents, teachers, and administrators can use in teaching problem solving.

DeMille, Richard. Put Your Mother On the Ceiling: children's imagination games. New York: Penguin Books, 1976.

The author has collected series of games in directed imagery. He bases the need for such activity on the premise that "creative persons are said to need full access to their own private imagery." Imagination games increase the childrens' belief in their own effectiveness. These exercises give the student practice in visualizing and distinguishing fantasy from reality.

King, Nancy. Giving Form to Felling, New York: Drama Book Specialists, 1975. This is an activities book which in a variety of exercises shows the teacher how to express and to be able to deal openly with feelings. It provides both teachers and students with ideas for exploring different forms of emotion. These activities will improve verbal and non-verbal communication which in turn will access the imagination and will give the student the ability to express herself/himself creatively.

Koberg, Don, and Bagnall, Jim. The Universal Traveller: a soft systems guide to creativity, problem solving, and the process of reaching goals. rev. ed. Los Altos, California: W. Kaufmann, 1976.

This guide tells the traveller how to get through the problem solving journey of life. It provides guidebooks, maps, translations, and travel tips. As one reviewer put it "though the style and format are pure(?) California/Monty Python, the message is Polya, Synectics, Parnes, Creativity, Bruner, etc., etc." Highly recommended.

Parnes, Sideny Jay, Noller, R. B., and Biondi, A. M. Guide to Creative Action and Creative Actionbook (workbook) rev. ed. New York: Scribner, 1977, 1976.

The Guide to Creative Action and the accompanying workbook are invaluable for anyone teaching creativity. It is used in the Creative Studies Course pioneered by Parnes at State University College of Buffalo. Included are detailed explanations of the curriculum, guides to practice exercises, significant articles on the development of creative behavior, and an annotated list of films, tests, topics for research, and an extensive bibliography on books on creativity. Reviewers feel that this will be a standard textbook for years to come.

Prince, George M. The Practice of Creativity: a manual for dynamic group problem solving, New York: Harper and Row, 1970.

An excellent book to help overcome the competitive approach used by most groups when solving problems. Prince shows how our present habits of creativity and problem solving limit our abilities in this area. Probably, the greatest contribution, however, is his use of "mental trips" and "excursions" to aid the creative process. His approach, called synectics, has been successful in the business world and has many applications for education.

A Source Book for Creative Thinking, edited by Sidney J. Parnes, Harold F. Harding, New York: Charles Scribner's Sons, 1962.

The editors have selected and arranged the best thinking on creative problem solving that came out of the 1950's. The articles reflect the desire of the editors to make people more productive thinkers and innovators by developing a creative climate internally and externally. The book includes a useful compendium of research on creative imagination and a selected publications list. Though this book has been around a while, it still provides an excellent source of background information.

Transpersonal Education: a curriculum for feeling and being. Edited by Gay Hendricks, and James Fadiman. Englewood Cliffs, N.J.: Prentice Hall, 1976.

Key contributors tell students how to get in touch with themselves and their creative abilities. The teacher will learn how to build such activities as dreamwork, fantasy, and body awareness into an exciting curriculum. Transpersonal Education is based on its application in the field of education. Along with the theoretical aspects, there is a how-to section helpfu' for classroom teachers concerned with the daily management of classroom activities.

In addition to these books we must recommend the film series "Search for Solutions," available from Playback Associates, 708 Third Ave. New York, N.Y. 10017. The series includes nine short films providing vignettes of scientists of work creating, problem solving, excitingly searching for solutions. Playback Associates also publishes a Teaching Guide and Teaching Notes to complement the films and provide many additional activities.

Further Challenge:

1) Find additional books, films, T.V. programs, lecture series, courses and people that will provide the additional resources you need.

CHAPTER II

Creativity

"I use to think of (creativity) as an extraordinary a^t that produced something new and useful to mankind. I now see it as less cosmic and more common, an everyday affair, a mode of thought and action that is intimately associated with learning and changing not only oneself but one's situation."

George Prince

Prince, George M. The Practice of Creativity. New York: Collier Books, 1970 page 8.

NOITATERPRETNI

by Larry Flick

Focus: Just as inferences effect observations, the interpretation of a problem effects the eventual solution. The first step in solving a problem is recognizing that the problem exists. Next the problem must be interpreted. Consider the problem of learning how to fly. This has been a dream of human beings for many centuries. In 1903 the Wright brothers accomplished the first powered flight. Leonardo da Vinci, if he were alive, would contend that humans did not learn to fly until 1977 with the flight of the Gossamer Condor. Da Vinci's interpretation of the problem meant that the power for flying must come from one's self. Differences in interpretation can be obvious or they can be very subtle.

Challenge: How many ways can you interpret something?

Materials and Equipment:

Sheets of paper of the same size

How-To-Do-It: With perhaps no more introduction than stating that solving a problem requires understanding what the problem means, give the following task: Without looking at anyone else and without asking for further instructions, fold a piece of paper eight times.

The results of this exercise may be dramatic including the complaint that it is impossible. If a student tries to fold a sheet of paper in half eight times without unfolding it, he/she is almost certain to fail! Clearly the instructions to fold a piece of paper eight times does not mean to fold in half eight times, or does it? For those students who attempted the folding exercise and failed, how did their misinterpretation of the problem enhance their knowledge? Why is it so easy to misinterpret a problem? Remember the old composition exercise of writing the instructions for making a peanut butter and jelly sandwich.

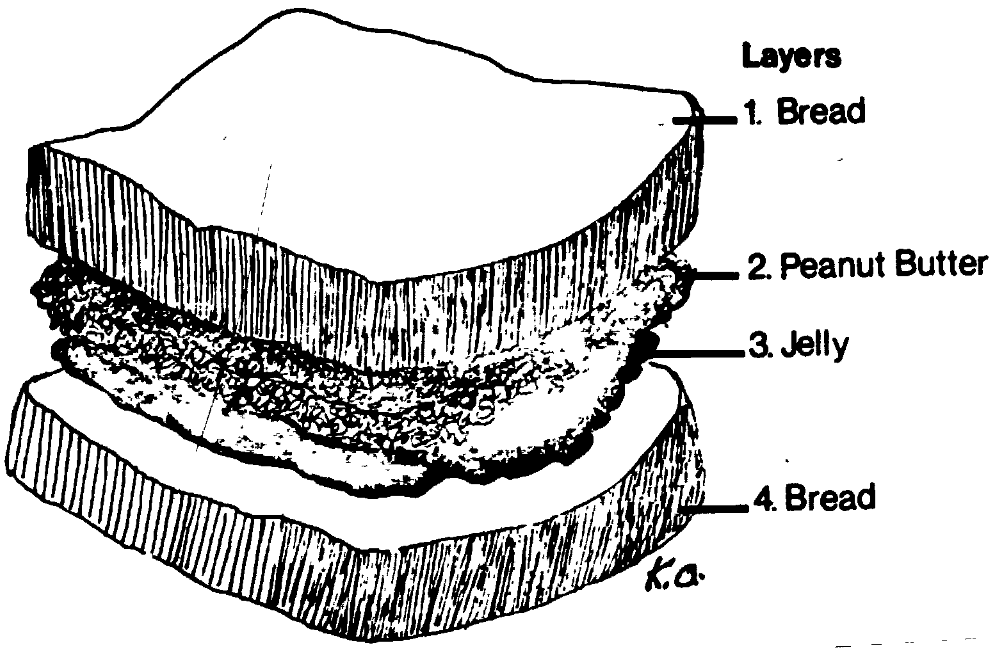
Futher Challenges:

1) Can you state a sentence that won't be misinterpreted?

2) Give different groups of students a description of one of the following devices (along with advertisements if you can find them) and ask them to write down the problem that each was designed to solve.

Weedeater - a high spinning string
Weedpopper - a foot operated weed digger
Herbicide - chemicals that effect the leaves or the roots of the week
Black Plastic - something that blocks sunlight

3) Think of your own weed device



NOITATERPRETNI

4) Write a problem in five different ways each time changing only one word. For example: Design a (waterproof/water-tight/water resistent/leakproof/water repellant) container. Put each problem on a different index card and give it to a small group or an individual to solve. Compare the different solutions. Give two or more groups the same problem statement, word for word. Is there as much difference between groups with the same problem as there is between groups with altered problem statements?

5) Have a contest to see who, or which team, can invent the greatest number of interpretations for a problem. Who can create the most unique interpretation?

6) Try to misinterpret the questions in your science textbook. Besides being fun, can a misinterpretation help you understand a concept?

MAKING SENSE OUT OF NONSENSE

by Larry Flick

Focus: A billiard bouncing off cushions and other billiard balls may look like random motion to the untrained eye. Similarly the burning of wood may appear to be just a cataclysmic event with no order to it. Through careful observation and trying many different interpretations of the events, scientists have managed to show how these apparently chaotic events can conform to some totally logical rules. You might say that the business of science is to reveal the order behind what appears to be chaos.

Challenge: Using your imagination, reveal the order that lies within a table of random numbers.

Materials and Equipment:

Copies of a table of random numbers, pencils, crayons, markers, and raw imagination.

How-To-Do-It: Making sense out of nonsense is a matter of finding an interpretation for nonsense that gives it meaning. For example the table may be thought of as an image. The possible pathways are constructed by connecting contiguous 2-digit numbers going any of the eight possible directions. This, of course, still has no meaning as a maze until you add an interpretative rule. Problem 1: Starting at the upper left-hand corner find a path to the lower right-hand corner connecting only numerals that contain a numeral with an enclosed space, e.g., 9. So 41 is part of the path but not 11. Problem 2: Connect numerals that contain a 6 or are devisable by 3.

By using different colors for each path rule the tables can be used several times. After several journeys through the table there will be a pattern of lines. Do they suggest anything to you? Rivers and creeks? Veins and arteries? Branches or roots? After choosing an interpretation, what might the connecting rule stand for? Perhaps the appearance of a 6 means the presence of a nutrient that allows the root to grow in that direction. This brings up the possibility of a negative rule--places where the root can't grow. Problem 3: Safe paths are those that don't contain a 7 or a multiple of a seven or numerals whose digits don't add or subtract to seven.

Interpretations should abound. Remember that information, unlike energy, flows in an open system.

Further Challenges:

1) Some rules give you access to a lot of numbers. "All even numbers" give you access to half the numbers on the page. Who can invent a rule that gives you access to the fewest numbers but still completes a path?

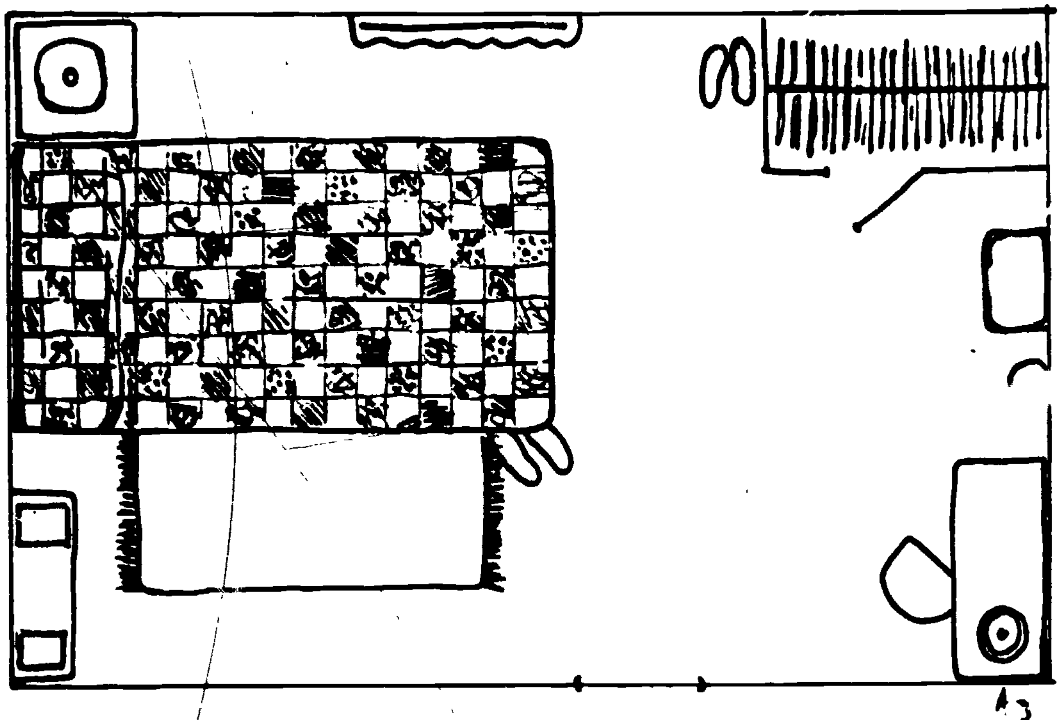
60 36 59 46 53	35 07 53 39 49	42 61 42 92 97	01 91 82 83 16	98 95 37 32 31
83 79 94 24 02	56 62 33 44 42	34 99 44 13 74	70 07 11 47 36	09 95 81 80 65
32 96 00 74 95	36 40 98 32 32	99 38 54 16 00	11 13 30 75 86	15 91 70 62 53
19 32 25 38 45	57 62 05 26 06	66 49 76 86 46	78 13 86 65 59	19 64 09 94 13
11 22 09 47 47	07 39 93 74 08	48 50 92 39 29	27 48 24 54 76	85 24 43 51 59
31 75 15 72 60	68 98 00 53 39	15 47 04 83 55	88 65 12 25 96	03 15 21 91 21
88 49 29 93 82	14 45 40 45 04	20 09 49 89 77	74 84 39 34 13	22 10 97 85 08
30 93 44 77 44	07 48 18 38 28	73 78 80 65 33	28 59 72 04 05	94 20 52 03 80
22 88 84 88 93	27 49 99 87 48	60 53 04 51 28	74 02 28 46 17	82 03 71 02 60
78 21 21 69 93	35 90 29 13 86	44 37 21 54 86	65 74 11 40 14	87 48 13 72 20
41 84 98 45 47	46 85 05 23 26	34 67 75 83 00	74 19 06 43 45	19 32 58 15 49
46 35 23 30 49	69 24 89 34 60	45 30 50 75 21	61 31 83 18 55	14 41 37 09 51
11 08 79 62 94	14 01 33 17 92	59 74 76 72 77	76 50 33 45 13	39 66 37 75 44
52 70 10 83 37	56 30 38 73 15	16 52 06 96 76	11 65 49 98 93	02 18 16 81 61
57 27 53 68 98	81 30 44 85 85	68 65 22 73 76	92 85 25 58 66	88 44 80 35 84
20 85 77 31 56	70 28 42 43 26	79 37 59 52 20	01 15 96 32 67	10 62 24 83 91
15 63 38 49 24	90 41 59 36 14	33 52 12 66 65	55 82 34 76 41	86 22 53 17 04
92 69 44 82 97	39 90 40 21 15	59 58 94 90 67	66 82 14 15 75	49 76 70 40 37
77 61 31 90 19	88 15 20 00 80	20 55 49 14 09	96 27 74 82 57	50 81 69 76 16
38 68 83 24 86	45 13 46 35 45	59 40 47 20 59	43 94 75 16 80	43 85 25 96 93
25 16 30 18 89	70 01 41 50 21	41 29 06 73 12	71 85 71 59 57	68 97 11 14 30
65 35 20 76 29	37 32 93 32 95	05 87 88 11 19	92 78 42 63 40	18 47 76 56 22
36 81 54 36 25	18 63 73 75 09	82 44 49 90 05	04 92 17 37 01	14 70 79 39 97
64 39 71 16 92	05 32 78 21 62	20 24 78 17 59	45 19 72 53 32	83 74 52 25 67
04 51 52 56 24	95 09 66 79 46	48 46 08 55 58	15 19 11 87 82	16 93 93 3[illegible] 61
83 76 16 08 73	43 25 38 41 45	60 83 32 59 83	01 29 14 13 49	20 36 80 71 26
14 38 70 63 45	80 85 40 92 79	43 52 90 63 18	38 38 47 47 61	41 19 63 74 80
51 32 19 22 46	80 08 87 70 74	88 72 25 67 36	66 16 44 94 31	66 91 93 16 78
72 47 20 00 08	80 89 01 80 02	94 81 33 19 00	54 15 58 34 36	35 35 25 41 31
05 46 65 53 06	93 12 81 84 64	74 45 79 05 61	72 84 81 18 34	79 98 26 84 16
39 52 87 24 84	82 47 42 55 93	48 54 53 52 47	18 61 91 36 74	18 61 11 92 41
81 61 61 87 11	53 34 24 42 76	75 12 21 17 24	74 62 77 37 07	58 31 91 59 97
07 58 61 61 20	82 64 12 28 20	92 90 41 31 41	32 39 21 97 63	61 19 96 79 40
90 76 70 42 35	13 57 41 72 00	69 90 26 37 42	78 46 42 25 01	18 62 79 08 72
34 41 48 21 57	86 88 75 50 87	19 15 20 00 23	12 30 28 07 83	32 62 46 86 91
63 43 97 53 63	44 98 91 68 22	36 02 40 08 67	76 37 84 16 05	65 96 17 34 88
67 04 90 90 70	93 39 94 55 47	94 45 87 42 84	05 04 14 98 07	20 28 83 40 60
79 49 59 41 46	52 16 29 02 86	54 15 83 42 43	46 97 83 54 82	59 36 29 59 38
91 70 43 05 52	04 73 72 10 31	75 05 19 30 29	47 66 56 43 82	99 78 29 34 78
09 18 82 00 97	32 82 53 95 27	04 22 08 63 04	83 38 98 73 74	64 27 85 80 44
90 04 58 54 97	51 98 15 06 54	94 93 88 19 97	91 87 07 61 50	68 47 66 46 59
73 18 95 02 -7	47 67 72 62 69	62 29 06 44 64	27 12 46 70 18	41 36 18 27 60
75 76 87 64 90	20 97 18 17 49	90 42 91 22 72	95 37 50 58 71	93 82 34 31 78
54 01 64 40 56	66 28 13 10 03	00 68 22 73 98	20 71 45 32 95	07 70 61 78 13

2) Try interpreting the entire page. For example each single digit is the birth of a baby. Two of the same numbers in succession (55 or 45 or 56) indicates twins, three numbers are triplets, etc. According to the table how many twins are born per 1000 births? What is this statistic for human births? Are the births of twins a random event?

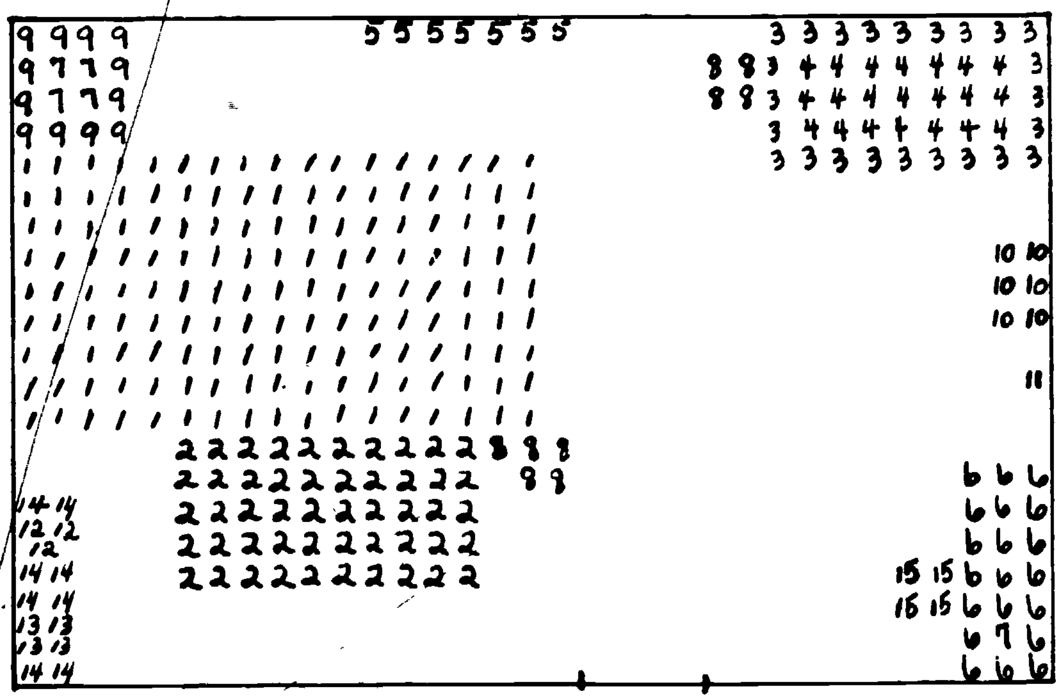
3) Interpret the table in clumps. Take the top ten blocks of numbers as one day's worth of food intake. If each of the numbers 00 through 99 represent an essential nutrient, did the person get all 100 essential nutrients in the day? Which did she/he get the most of? Least? Which ones are missing? How did he/she do in day 2 (the next ten blocks)?

4) Count the number of occurences of a number on the page or in a given area. The interpretation might be that this is the concentration of a chemical. In those areas where the concentration is above a certain level, a new rule (reaction) takes place. Go to those areas and find what that rule might be.

5) Find other examples of apparently chaotic patterns and invent a rule that will provide some order.



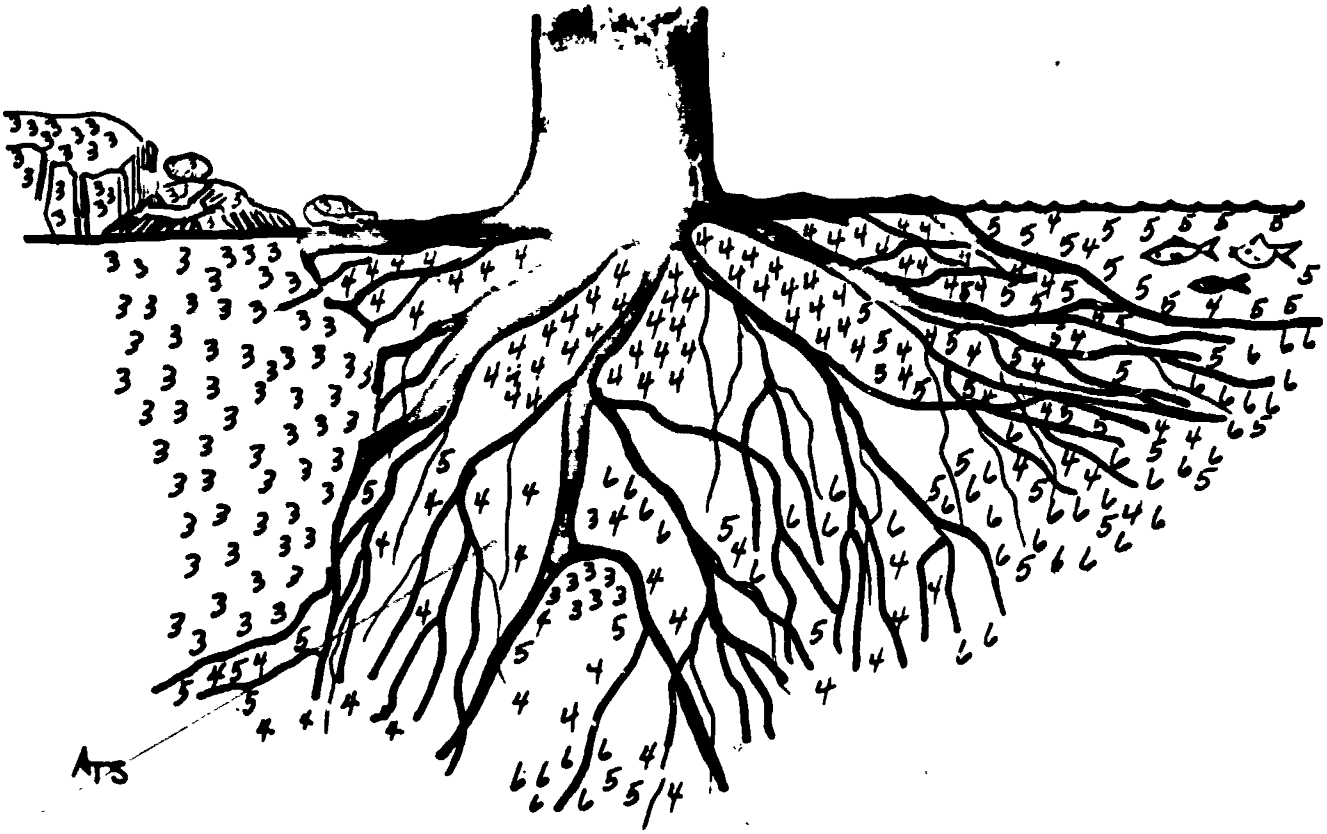
A scientist might make a table to locate objects in the room above. If the numbers are moved, the object was moved.



1 Bed 2 Rug 3 Closet 4 Clothes 5 Drapes 6 Desk 7 Lamp 8 Shoes 9 Table 10 Dog's bed 11 Basketball 12 Game 13 Book 14 Shelf 15 Chair

MAKING SENSE OUT OF NONSENSE

3 = Stone   4 = Nutrients   5 = Water   6 = Sand



A QUESTION OF MAGIC

by Robert Silberman

Focus: This activity is designed to encourage combinatorial reasoning, note taking, and problem solving in chemistry. The trick works if the chemicals are mixed in a particular sequence in about equal amounts. Therefore, keeping track of how solutions are mixed and what combinations have been tried is important to the success of the experiment.

Background: The trick is based on the chemistry of iodine. First iodide ion is oxidized by bleach (NaOCl) to iodine (brownish orange color). The iodine is reacted with starch solution (dark blue color). The iodine starch complex is reduced by sodium thiosulfite (hypo) to iodide (colorless).

Challenge: Can you figure out how a magician was able to make chemical solutions change color?

Materials and Equipment:

8 - 10 test tubes or small flasks per group
5 Dropping bottles (1 for each chemical used) per group
1 Test tube rack per group Chemicals: .5% by weight soluble starch solution
0.1 molar sodium thiosulfite, $Na_2S_2O_35H_2O$ (2.5 gram 100 ml water)
0.1 molar potassium iodide (1.66 gram 100 ml distilled water)
.1 molar hydrochloric acid (1 part conc. HCl to 11 parts distilled H_2O)
Bleach solution scldium hypochlorite, NaOCl, 1 part bleach to 4 parts distilled HCl

General Safety Precautions: It i good safety practice for everyone to wear eye protection (goggles) when performing any experiment using chemicals. Bleach and diluted hydrochloric acid will damage clothing. Adding a large amount of the hydrochloric acid to the bleach solution can liberate small amounts of chlorine. All chemicals can cause eye damage if splashed into the eyes.

How-To-Do-It: One possible way of introducing this activity is as follows: "Recently I attended a magic show. During the show the magician carried out a series of mysterious transformations. He began with a large flask of colorless liquid, he then added other liquids and the liquid in the flask became yellow, then blue black, then colorless again. Naturally, I was intrigued and delighted by the chemical trick. At great expense and from the four corners of the world I collected the solutions used to perform this trick. Unfortunately, I was unable to obatin the instructions."

Demonstrating the magic trick sequence is not necessary but the order is as follows:

1. KI 2. HCl 3. NaOCl 4. Starch 5. $Na_2S_2O_3 \cdot 5H_2O$

Divide the class into groups and give each group a set of chemicals. Write the color sequence on the board to help the students keep the problem in mind. As the students experiment with various combinations of chemicals, emphasize the importance of detailed records. Each group should prepare a set of instructions for the magic trick.

Discuss how students solved problems. Emphasize the importance of the systematic approach by asking how many possible combinations of chemicals there are.

Note: The sequence can be affected by using an excess of some chemical or the reaction may not appear to work if students do not use approximately the same volume of each solution.

Further Challenge:

1) Have students look up the chemistry of iodine. Give them a solution of KI and have them speculate on the possible identity of the other solutions.

HOT STUFF

by Robert Silberman

Focus: What does the temperature of something really indicate? What is meant when the temperature of something increases? How is temperature related to heat? What kind of property is heat? How is heat content related to other properties? This exercise uses simple measurement of hot and cold water, using styrofoam cups, to give background experience necessary for developing answers to these questions. In addition, students can discuss and develop a reasonable experimental procedure for the exercise. The procedures used must minimize heat loss for the results to be accurate.

Background: It is possible to measure the temperature of hot water by mixing it with cold water and measuring the temperature of resulting warm water. To do this one needs to measure the mass of the cold water, the initial temperature of the cold water, the mass of the hot water, and the final temperature which results when hot and cold water are mixed. The following relationship can be used:

$$M_c(T_f - T_c) = M_h(T_h - T_f)$$

Symbol Identification:

Mass in grams	M_h	M_c	$M_h + M_c$
	Hot >40°c	Cold	Hot and Cold <40°c
Temperature °C	T_h	T_c	

The only unknown quantity is the initial temperature of the hot water.

Challenge: Using your 40°C thermometer, determine the temperature of the hot (greater than 40°C) water in the coffee pot.

Materials and Equipment:

Balance
3 or 4 6-oz. styrofoam cups
1 40°C thermometer. This can be prepared by taking a standard thermometer and dipping it upside down in dark latex paint so that all the numbers above 40°C are obscured
25 ml and 100 ml graduated cylinders
25 ml pipet and bulb (if available)
1 large 30 cup coffee pot filled with water at a temperature of about 70°C.

The temperature of the water in the coffee pot can be controlled by using a variable transformer in series with the pot, or with a little more difficulty, by turning the pot on and off.

How-To-Do-It: Here is one way to introduce this activity: "As an energy conservation measure you have decided to turn your water heater down so that it only heats water to 55°C. (NOTE: usually a water heater keeps water between 48° and 70°C) Unfortunately, when you decide to measure the temperature of water in your water heater, the only thermometer you have is unmarked above 40°C. In class, we have a simulated water heater (i.e., a large coffee pot with hot water). Using your 40°C thermometer, and any of the materials on the desk, determine the temperature of the hot water in the coffee pot."

Divide the class into groups. Each group gets a set of equipment. Give out the problem and let the grou experiment. It is helpful to explain that styrofoam cups insulate the liquid and do not allow heat to escape. If students are totally baffled, suggest they mix hot and cold water and measure the temperature before and after. After everyone has a method and an approximate temperature, start a class discussion of the results. The results will vary depending on how the experiment was carried out. Discuss various methods tried. After explaining what heat capacity is, you can discuss amount of heat necessary to raise the temperature of the cold water.

(NOTE: The best experiment involves adding the hot water directly to the "Calorimeter" cup that has measured amounts of cold water in it. The amount of hot water added can be determined by weighing the cup before and after water is added. This minimizes heat loss.)

Further Challenge:

1) Measure the heat liberated when 2 chemicals in water solution are mixed. For example, dilute acid and dilute base. Design a hot or cold pack. Ammonium nitrate will lower the temperature when added to water. CaCl will raise the temperature when added to water. Packs that get either hot or cold when struck are available in most large drug stores. They work because a fragile plastic bag containing water breaks when the pack is struck. The water mixes with ammonium nitrate or calcium chloride in the pack.

A SOUND STORY

by Michael R. Cohen*

Focus: Musical instruments are often studies during a unit on sound. In some science programs children even build their own instruments to study sound. Having children create their own sound effects is a variation of the musical instrument theme.

Challenge: Create the sound effects to accompany a story.

Materials and Equipment:

A wide variety of objects collected by the children and/or teacher such as various bottles, rubber, plastic and metal tubes, blocks of wood, boxes, etc. You are limited by your imagination.

How-To-Do-It: Begin with a discussion of sounds and sound effects on radio and in the movies. Ask the children how they would create sounds like thunder, rain, wind and various animals. You could demonstrate thunder with a large cookie sheet or rain by crinkling various types of paper in your hands.

Once the children get the idea of sound effects being created, have the children read a story to the class using their sound effects when appropriate.

Further Challenges:

1) Have the children write their own radio story with sound effects.

2) Have the children use a tape recorder to record their story with sound effects. How does a tape recorder help with the creation of sound effects?

3) Can the children tell a story without words, using only sound effects?

4) How many different sounds can you make with the same materials?

5) Can you make similar sounds using different materials?

*The idea for this activity was suggested by Romie Vrabely and Karen Chatterton, students in my undergraduate science methods class.

ANATOMY NARRATIVES

by Sheila M. Jasalavich

Focus: Children draw from their imaginations to creatively interpret a system of the human body. It is a challenge to write creatively yet maintain a factually accurate tone. Refining and editing one's writing is also a stimulating and at times a frustrating venture.

Challenge: Write a story about your favorite food during its adventures through your digestive system.

Materials and Equipment:

Pencils
Pens
Paper
Coloring materials for writing and illustrating
(For background information and pre-composition activities sources, see references).

How-To-Do-It: Choose a food. Give it a name (Ex. Sally Sausage). Give your story a tentative title. Outline the order of the major organs in the digestive system. Jot down your creative interpretations of what happens to the food in each organ. Draft your story using your outline as an overall guide to the series of events. Trade your story with three others in the class and read their work carefully. Discuss the creative ideas and the factual ideas you found in each. Edit and refine your tale. Make a final copy of your story. Sketch illustrations of your story.

Further Challenges:

1) Compose a song (a ballad) that tells the story you just wrote.

2) Sit in a circle with some friends. Pick a system of the body. Have one person begin the story of how the system works. Go around the circle and have each person add to the unfolding tale. Emphasize creative description based on personal observations of your own body.

3) Pantomime how the heart works with a group of friends.

4) Create a card game to help you learn a system of the body. Write down the instructions of the game utilizing words from the body system, e.g. inhale a card from the file, if a player coughs that means he/she has cards to get rid of.

5) Create a system of the body based on information from television advertisements.

References:

Health Activities Project, University of California, Berkeley, CA, 94720 or Hubbard, P.O. Box 104, Northbrook, IL 60062.

Klein, Aaron E. You and Your Body. Pocket Books, 1230 Avenue of Americas, New York City, NY 10020.

Bellin, Carol and McLaughlin, Doris. The Body Book. Active Learning Systems, 13906 Ventura Blvd., Suite 192, Sherman Oaks, CA 91423.

A LIBRARY DETECTIVE

A LIBRARY DETECTIVE

by Karin Donahue

Focus: There is more to the library than students are aware of. Library research is more than just using the encyclopedias. In the course of searching for information the student will become familiar with the layout of the library and be exposed to many different kinds of resources.

Challenge: How would a detective use the library?

Materials and Equipment:

Handout: page 1, map of the library, page 2, printed scavenger hunt

How-To-Do-It: Page 1: Student takes map of the library and fills in the empty boxes using a numbered list of items at the bottom of the page. Include such items as the card catalog, vertical file, reference section, magazines, newspapers, location of non-fiction and fiction books, records, films, periodical index, etc.

Page 2: Scavenger hunt should correspond to the places mentioned on page 1. Some sample questions are:

Does the library subscribe to ____________________?(name of magazine)
How many books does the library have on ____________(subject)
What are the headlines in this morning's paper? ____________________
Find two articles on Dolphins. (Hint: look in the Reader's Guide to Periodical Literature)
Does the library have ____________________?(title of book)
Where is it shelved? What is the call number?
How many books written by ____________________(name of author, last name first) does the library have?
Find the latest almanac, who won the 1980 World Series? What was the score?
Locate the atlas and name three rivers which are found in the state of New York.

Further Challenges:

1) Have the student choose a topic of interest and find materials on that subject using the card catalog, periodical index, vertical file, specialized encyclopedias, almanacs, audio-visual materials. Have the student share information on the topic with the class as well as discuss how the information was found. How many different sources of information can you find on any one topic?

2) Make up similar exercises but deal with the card catalog only. Include how to read a catalog card, how to use call numbers, how to use the subject heading, how to tell if a book is illustrated, how many pages does it have, date of publication, etc.

3) Make a map of the inside of the library. Compare your school library with the public library.

WHICH COMES FIRST, THE QUESTION OR THE ANSWER?

by Helen Ellis and Michael R. Cohen

Focus: It may be funny to watch a comedian like Johnny Carson try to guess the questions based on the answers. In science education, the consequences of trying to force an answer because we know it is "right" may not be as funny. One way to see the effects of "known" answers on our question asking ability is to have our students take the role of Johnny Carson with respect to scientific or other school answers.

Challenge: Can you guess a question from its answer?

Materials and Equipment:

Brain teasers or other questions written on index cards

How-To-Do-It: For this activity, it is useful to form groups of students. Initially each group is given an index card with a question. They are to try to answer the question. After a reasonable amount of time, the groups are to pass on their answer(s), and only their answer(s) to another group. All groups now have an answer(s), and they are to try to figure out the original question.

It is not necessary for every group to completely answer the question before passing on their results to the second group. They are, however, to try and write as much of an answer as possible.

The process can continue for a number of rounds with groups passing their newly written questions and then their newly written answers. It is interesting to see how the questions and answers change as they progress around the class.

The questions you choose can come from your science textbook, laboratory assignments, brain teasers or riddles. It is probably easier to start with riddles or brain teasers. Once the children have the idea, then try questions from your textbook.

Further Challenges:

1) Make up a test of answers and have the children write the questions.

2) How many different questions can you invent for the same answer?

"A solution may be obvious after it has been found."

Edward DeBono

DeBono, Edward. The Mechanism of Mind. New York: Simon and Schuster, 1969
page 240.

CREAte an acTIVITY

by Michael R. Cohen

Focus: As you go through this Sourcebook, ideas may "pop" into your head. Good, that's the first step in creativity. Now try to turn that idea into an activity.

Challenge: Create an activity

Materials and Equipment:

Depends on what you decide to do.

How-To-Do-It: This activity was orginally to include only a title and challenge. The how-to-do-it was to be left to the reader. But that's not really fair. Many of us feel "we're not creative." So here are a few clues to get you started.

As you read and try the activites in this Sourcebook, various thoughts should come to mind. Write them down. Ask yourself "What if I..." or "What if the students...".

Listen to your students. I know many of my ideas begin with questions or answers my students raise. It's not that they are more creative. It's just that they ask different questions.

Try doing something backwards. Think of an answer, then think of the opposite answer. Think of the obvious solution, then try the least obvious solution.

Write "I am creative" one hundred different ways.

Further Challenges:

1) Invent a new way to become more creative.

2) Send us a creative activity.

3) Find ten examples that support the quote by George Prince on the title page for this creativity chapter.

CHAPTER III

Problem Solving

"If you spend any time spinning hypotheses, checking to see whether they make sense, whether they conform to what else we know, thinking of tests you can pose to substantiate or to deflate your hypotheses, you will find yourself doing science."

Carl Sagan

Sagan, Carl. Broca's Brain. New York: Random House, 1974, page 14.

PLANT GROWTH RACE

by David R. Stronck

Focus: Growing plants from seeds is an activity which can become exciting when each student competes in a contest to grow the tallest plant. The time frame is over several weeks, not a few hours. Students are required to record data and to hypothesize the best conditions for growth.

Background: There are many important variables influencing the growth rate of plants: temperature, amount of light and water, type of soil, parasites, and many others. Younger children may be given a simplified problem by providing only one type of soil and/or relatively uniform light and temperature. Older youngsters may be challenged to consider a wide range of variables, especially soil types and fertilizers.

Challenge: Who can grow the tallest plant from a seed in four weeks?

Materials and Equipment:

Six seeds per students (Bean seeds, even dried beans from the grocery store, are recommended. Pea seeds also work well.)
Cups for measuring water
Rulers
String for supporting tall plants
If done outdoors, stakes to identify plants
If done indoors, lamps with electrical outlets
Flower pots or styrofoam egg cartons
(Egg cartons are prepared by cutting off the top cover and using it inverted as a tray below the section with the egg cups. Use a knife or scissors to punch a small hole in the bottom of each egg cup. Through this hole, push a small strip of cloth to serve as a wick. When the "tray" contains water, the wick allows the soil in the egg cup to remain wet.)

How-To-Do-It: Begin by describing the long race which will not have a winner until several weeks later. (Set a time limit of approximately four weeks). Encourage the students to plan carefully the best strategies for getting their seeds to germinate quickly and to grow rapidly in height. Help them to organize a system for recording their activites.

Many youngsters enjoy working in pairs. Partners tend to discuss and even to argue over the best ways to treat their seeds. By pairing students, the class will require less materials and equipment. If one student of a pair is absent, the other can continue to apply water, measure the growth of the plant, and record the data.

Each pair of students should work with several seeds because some seeds may never germinate, and because some of the plants may die from adverse conditions. One seed in each of the twelve egg cups of an egg carton is a good system for each group of youngsters.

An expected outcome is that only a few plants will be tall and strong at the end of the four-week period. Some students may have no surviving plants at the end of the contest Some of the problems are the development of mold on seeds because of too much watering, and cooking the plant because of too much heat from a lamp. Usually the winning plant is easily identified although its height should be carefully measured with a ruler.

The winners should be required to give the class their successful formula, i.e., procedures for encouraging rapid growth. Some reward, e.g., a florist's plant, may be given to the winners. If the winners have not kept adequate records, the first prize should go to those with the next tallest plant. Older youngsters may be required to graph their plants' growth rates.

Further Challenges:

1) Another variable is to allow the selection of the type of seeds, e.g. beans, peas, corn, tomatoes, etc. Since the major goal is to identify optimum conditions for growth, one species of seed is sufficient. On the other hand, the genetic variable can be very interesting.

2) Various types of soil can be tested with "soil testing kits" for the presence of specific minerals. Hydrion paper allows the measurement of the pH (acidity) of the soil. The soil may also be analyzed for water-holding capacity and for pore space by measuring the amount of water which tends to run through the soil in a specific amount of time and by measuring the amount of water which may be added to the soil in a container. Various fertilizers may be added to the soil.

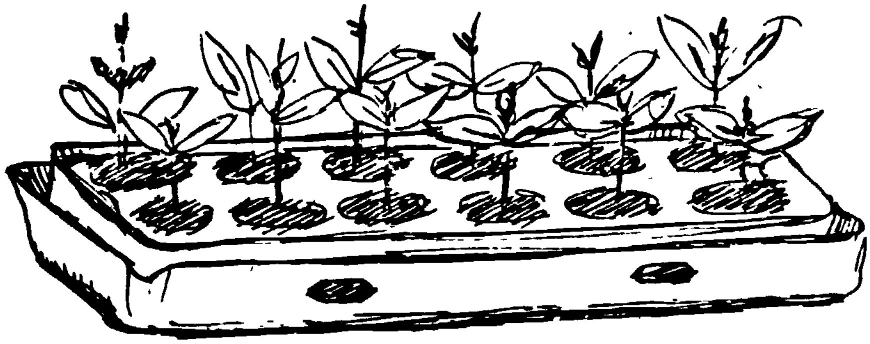
3) If the activity is done outdoors, a light meter may be very helpful in recording various intensities. If a light meter is not available, the students can make general observations, e.g., sunny, cloudy, raining, etc.

4) In the outdoors, the study could become focused upon animals and insects that may destroy or greatly weaken the plants. Caterpillars, snails, slugs, or nematodes may be identified as the problem. After identifying the cause of the problem, the youngsters can seek means to control them and evaluate the effectiveness of each technique.

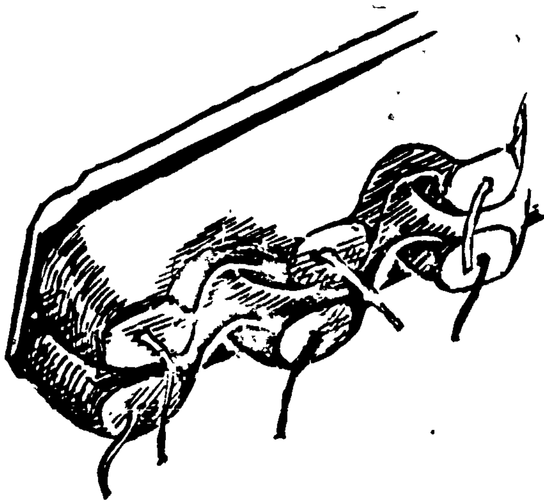
References:

Andrews, W. A., editor. A Guide to the Study of Soil Ecology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1973.

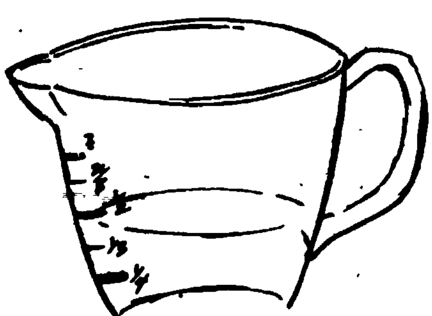
Withington, J. J. "Microecology: A Discovery-Oriented Field Activity." Science and Children 10: 6, 15-17, March 1973.



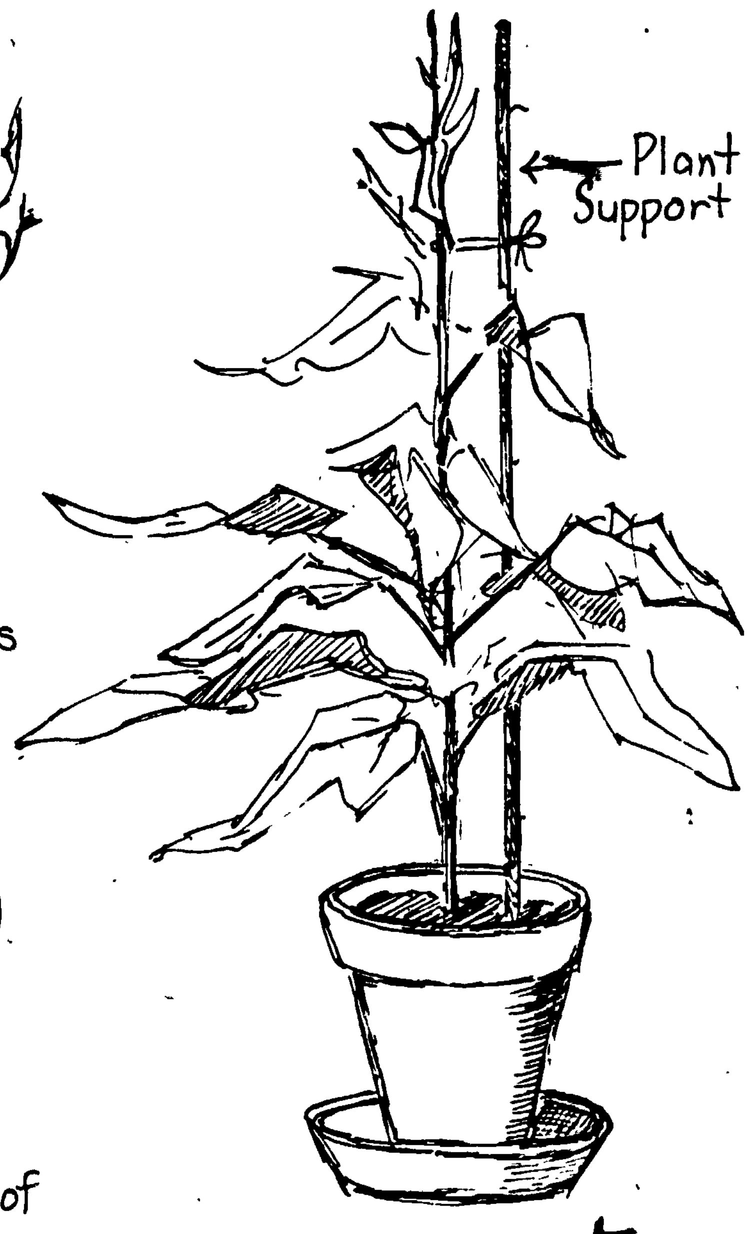
① Egg carton planter



② Bottom of egg carton with wicks through holes



③ Record exact amount of water given to plants



" . . . one does one's thinking before one knows what one is thinking about."

Julian Jaynes

Jaynes, Julian. The Origin of Consciousness in the Breakdown of the Bicameral Mind. Boston: Houghton Mifflin, 1976, page 39.

MNEMONIC PLAGUE

by A. Leon Pines

Focus: As a science, psychology gets little attention in elementary school. Yet some of the knowledge in the field can be both interesting and useful to children. Kids are fascinated by memory and often work at memorizing just for the sake of repeating the memorized material. What they may not realize is that without constant practice this same rotely memorized material is soon forgotten. Many examples of this type of "learning" followed by forgetting can be found in a child's school experience. Demonstrating how our brain finds it easier to remember things that are meaningfully structured should be beneficial to the student's general learning capabilities.

Challenge: Perform an experiment that compares children's abilities to remember items in a random order with their abilities to remember items in a meaningful order.

Materials and Equipment:

A task to be learned or memorized in two formats: organized and random. (See Figures 1 and 2).
Paper and pencils
Graph paper to analyze the results

How-To-Do-It: Using the task provided here or a task that you have invented, carry out the following experiment: Divide the class into two random groups and give one the structured task to learn and the other the list. Take a measure of immediate recall. Retest in two to four weeks.

Make sure that participants do not discuss the experiment until all measures have been taken. Collect all recall pages and for each group calculate the average number of correct responses. Plot the results on the graph paper.

Further Challenges:

1) Try the above experiment with several groups, using different tasks, and send me the results.

2) Make a list of science vocabulary words from your last science unit and put them into a meaningful order.

3) Which of these two numbers would be easier to remember over a period of a month?

134278586 or 13579111315171921

In this example, the short set is random and the longer set has a meaningful structure.

WIND	VIOLIN	MUG
SAW	EATING	STRING
GOBLET	VICE	SCISSORS
FLUTE	TRUMPET	CELLO
CUTTING	PLIERS	SPOON
HORN	FORK	GRIPPING
KNIFE	GUITAR	BOWL
TOOL	UTENSIL	BASS
PLANE	TWEEZERS	WRENCH
PLATE	AXE	GLASS
MUSICAL	DRINKING	INSTRUMENTS
STRAW	CLARINET	SAXAPHONE
HARP	CHISEL	SPANNER
CUP		

Figure 1. Random order of items.

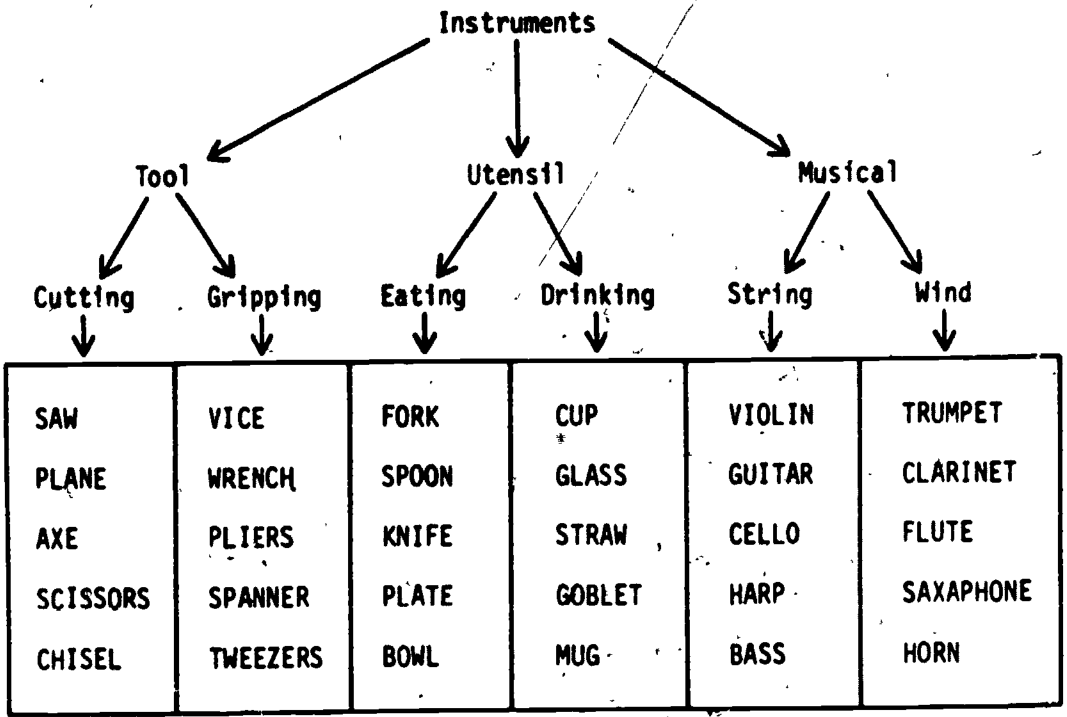


Figure 2. Items in a meaningful order.

COFFEE POT PHYSICS

by George F. Smith

Focus: In these days of high energy costs, we should realize that time of operation of common appliances can be related to money. More specifically, how much does it really cost to heat water for a cup of coffee and what can be done to reduce the cost?

Background: Your local electric utility sells energy at a predetermined rate (.10/kilowatt-hour as an example). By dividing this rate by 1000 and dividing again by 60 the rate can be converted to an equivalent rate in terms of cost/watt-minute. In this form the rate is easy to use in calculating the cost of using electrical appliances. For the .10/kilowatt-hour example, the rate converts to .00000166/watt-minute (.10÷60000).

Challenge: What is the cost of boiling water in an electric coffee pot?

Materials and Equipment:

Electric coffee pot
Water
Clock with second hand
Cup measure
Laboratory type thermometer (capable of measuring 212 F or 100 C) for further challenges.

How-To-Do-It: Safety Precaution: Electrical power and hot water can be dangerous. Make sure that hands are dry before plugging in the appliance. Be careful not to allow hot water to touch skin or clothing.

Put a cup of tap water into an electric coffee pot. Plug in the coffee pot and determine the time in minutes required to bring the water to boil. The cost of boiling the water is calculated by multiplying the power requirements (watts) of the appliance by the number of minutes of usage and then multiplying by the converted cost factor. The power requirements of the coffee pot is 1000 watts, the cost would be 1000 x 4 x .00000166 for the sample rate. In this example the computed cost is .006 dollars or .6¢.

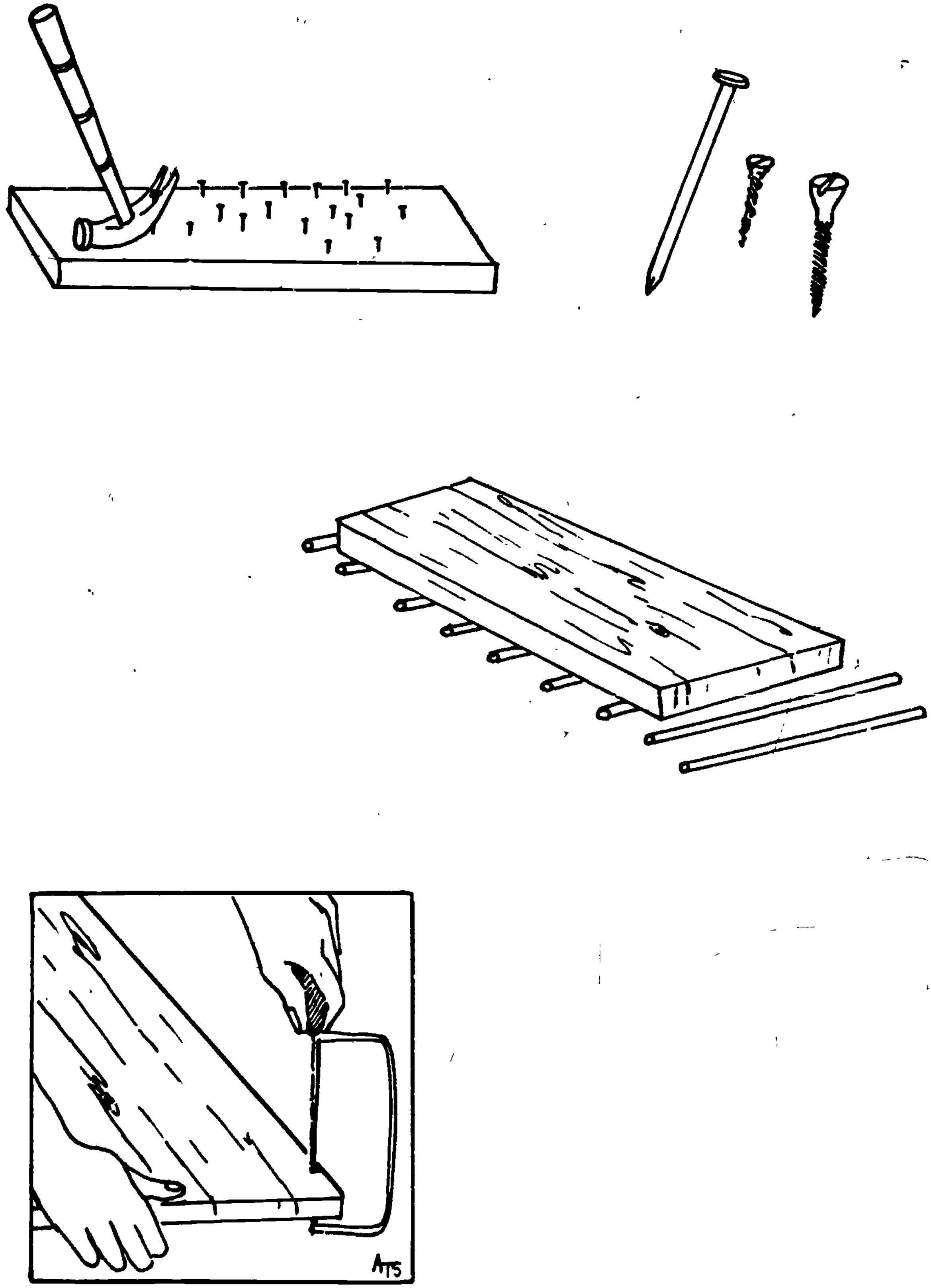
The experiment can be repeated with two, three, and four cups of water. Make sure that the coffee pot has cooled down to room temperature between trials. One student can do each trial of the experiment while the rest of the class does the cost calculations. Experiments can be changed for each trial. Did it cost twice as much to boil two cups of water as it did to boil one cup? What other comparisons can you make? Is is just as expensive to boil five cups as it is to boil four cups?

You can simplify the math in this activity by calling 1 watt-minute of electricity a unit of electricity. Money can be introduced later.

Further Challenges:

1) Have the student experimenters use a laboratory thermometer to record the temperature minute by minute during the heating process on each trial. The data can be used to generate termperature vs. time graphs for each trial.

2) Costs of operating other electrical appliances that boil water can be calculated. Some appliances will boil small amounts of water efficiently while other appliances will boil large amounts efficiently. What causes the difference? Why is size an important factor?



USING SIMPLE TOOLS TO SOLVE PROBLEMS

USING SIMPLE TOOLS TO SOLVE PROBLEMS

by Vincent G. Sindt and C. Kent Allen

Focus: The janitor's tool box, the home work bench, the garage or the shop are the sites of many interesting and intriguing science related experiences for children. Just think of the many times that a person using a tool capitalizes on the mechanical advantages provided by the tool. Imagine for instance how hard it would be to drill a hole into a block of wood if you turned the bit with your fingers. The following activities will encourage youngsters to explore the mechanisms of the daily things that we do with tools. The vast number of science concepts available to the individual who uses tools in a shop is indeed surprising. Encourage your students to explore these exciting principles with you and to find more of their own. Be sure to check with the high school or junior high industrial arts department for help and suggestions.

Challenges: How many ways do the tools in the shop make jobs easier for people?

Materials and Equipment:

Hammer
Nails, screws
Vise and C clamps
Various pieces of soft and hard wood
Hand drill - gear driven with bits
Plastic straws, dowel rods
Coping saw
Sand paper
Different Weights

How-To-Do-It: Mark the handle of the claw hammer with equally spaced marks about three inches apart. Tell the youngsters to pound in as many identical 10d or 8d nails into a soft board as there are marks. Have the head of the nails stick up from the surface of the board at least one to one and one-half inches but have them all the same distance out. Clamp the board to the table and have the children attempt to pull the nails out first with their fingers and then with their hands positioned at each of the marks. Have them all tell you which of the nails come out easier.

Have the students try to push a small board across a table or on a smooth floor from one place to another. Cut small pieces of the plastic straws or dowel rods and place these under the wood like wheels. Have the students push the boards this time and ask them to describe the differences.

Give the children a piece of wood and have one of them hold on to it while the other pulls it away. Ask the kids to place the wood in the vise and tighten it. Now try to pull the wood away from the vise. Ask, "Why can the vise hold the wood so much more tightly than our hands?"

Have the students lift a weight that is approximately two kilograms. (A small bucket of sand or salt would work well here.) Clamp a hand drill to the table so that the drill can still be easily turned but so that it will stay solidly in position. Put a small eye bolt into the chuck of the drill. Wrap strong string around the bolt and tie it to the weight. Let the children turn the drill to lift the weight. Ask them to describe the differences (Do not use an electric drill).

Further Challenges:

1) When pulling the nails, have the students test how hard it is to pull different nails and screws out of the board.

2) The nail activities can be initiated with different sizes of nails and the students can put the nails to different depths and as they experiment, they can be asked whether those are "fair tests".

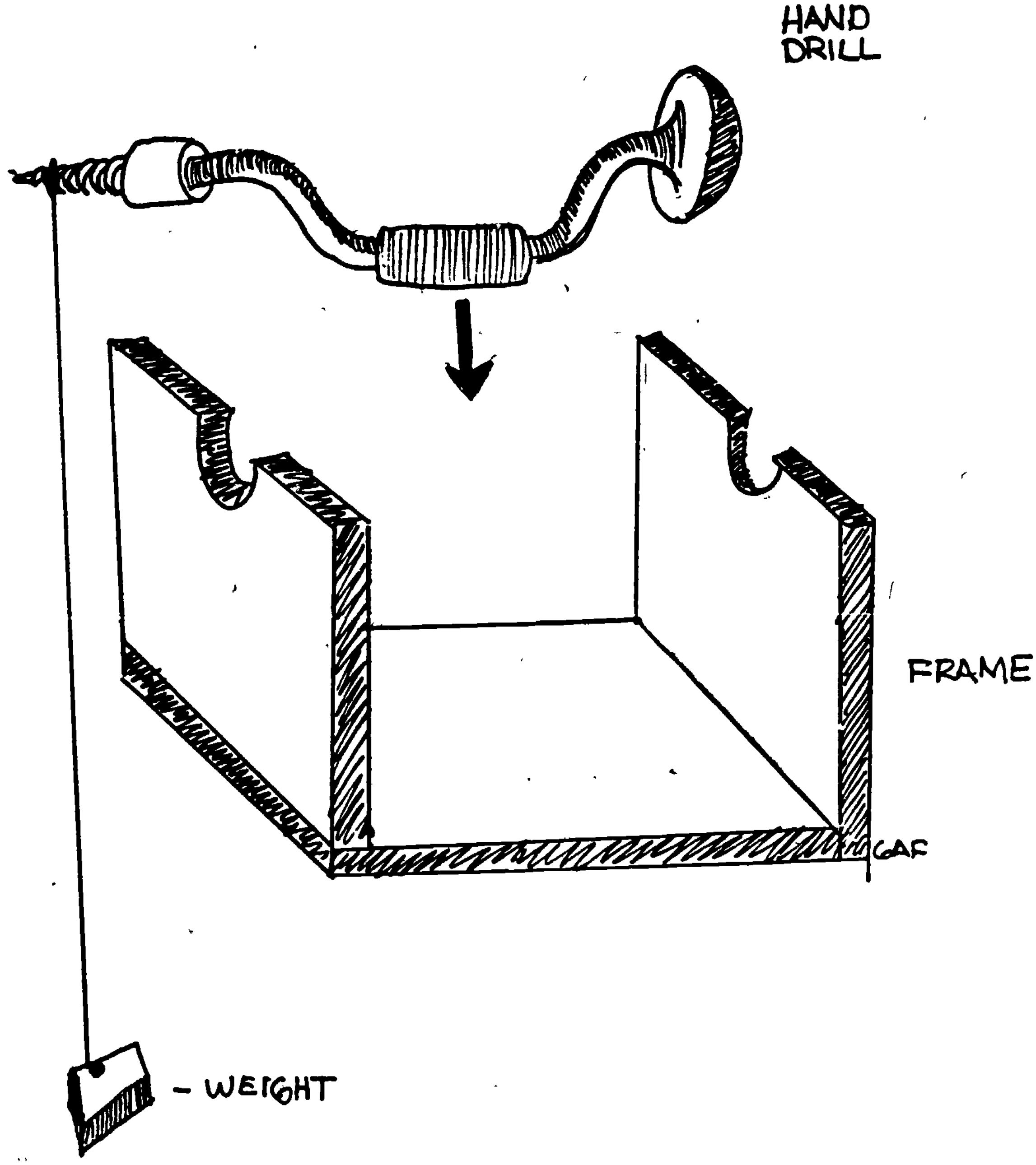
3) Try to saw with a coping saw with the blade turned to different positions and backwards and forwards. Is there a way that does the job easiest?

4) Ask the students to find ways to produce heat with friction in the shop.

5) Try to drill a hole in the wood with a nail in the drill as a bit.

6) Try different types of files on wood and metal. Can you describe what they do and how they are different?

7) Remember the girls can do this as easily as the boys.



USING SIMPLE TOOLS TO SOLVE PROBLEMS

TESTING MATERIALS

by Vincent G. Sindt and C. Kent Allen

Focus: As you have used the common materials around the home workbench or garage, have you ever wondered how it is that people determine the best material to do the job? Questions like "Which glue is strongest?", "Which wood will bend the most without breaking?", "Which polish will make metal surfaces shiniest?" are the basis for some fascinating investigations for youngsters.

As your students explore the following activities, see if you can help them invent the concept of "fair tests." The activities that you will be doing will provide several instances where fair response will require or depend upon the need for students to control some variables. Even if this lofty goal is not achieved, our experiences have been that the children had a good time testing the stuff.

Challenge: Find out which common material around the workbench or shop works the best for different jobs.

Materials and Equipment:

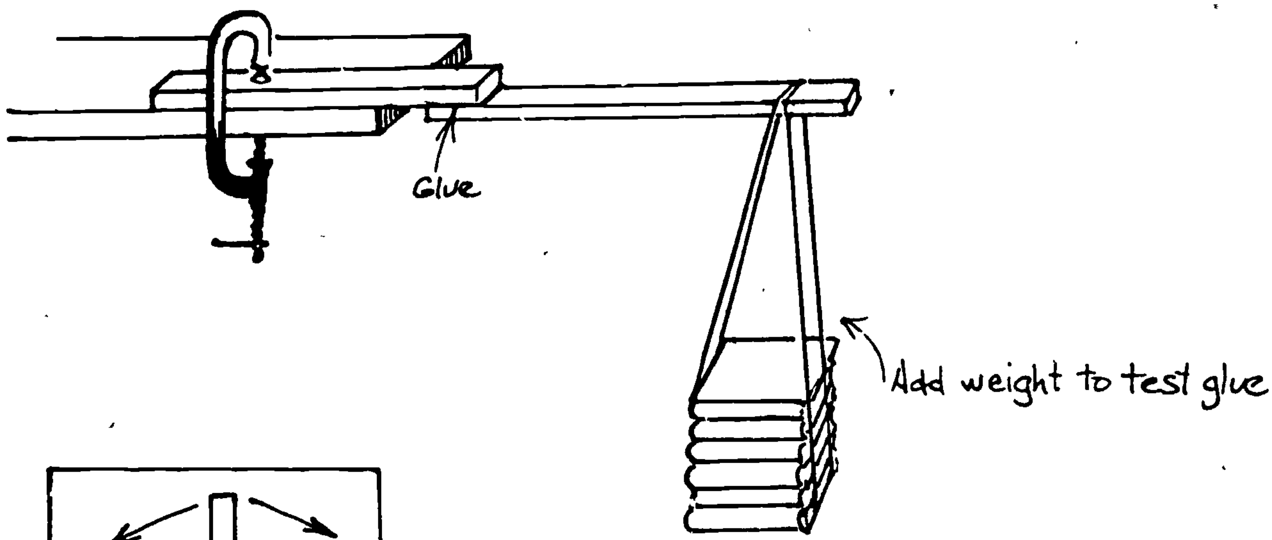
Clamps
Different types of cardboard
Varieties of polishes
Steel wool
Magnifying glasses
Different kinds of glue
Strips and blocks of wood of different types
Pieces of different metals
Safety goggles
Work gloves

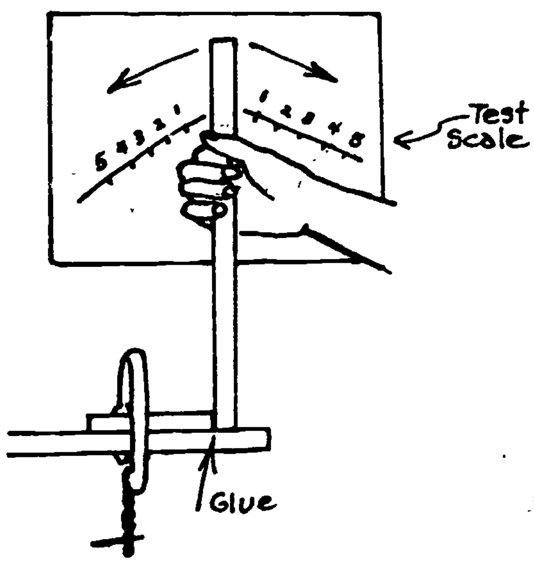
How-To-Do-It: Glue Strength Tests: The students can test the strengths of different types of glue by gluing similar strips of the same kind of wood together. After drying, the young experimenters can try to break the glue joints as shown.

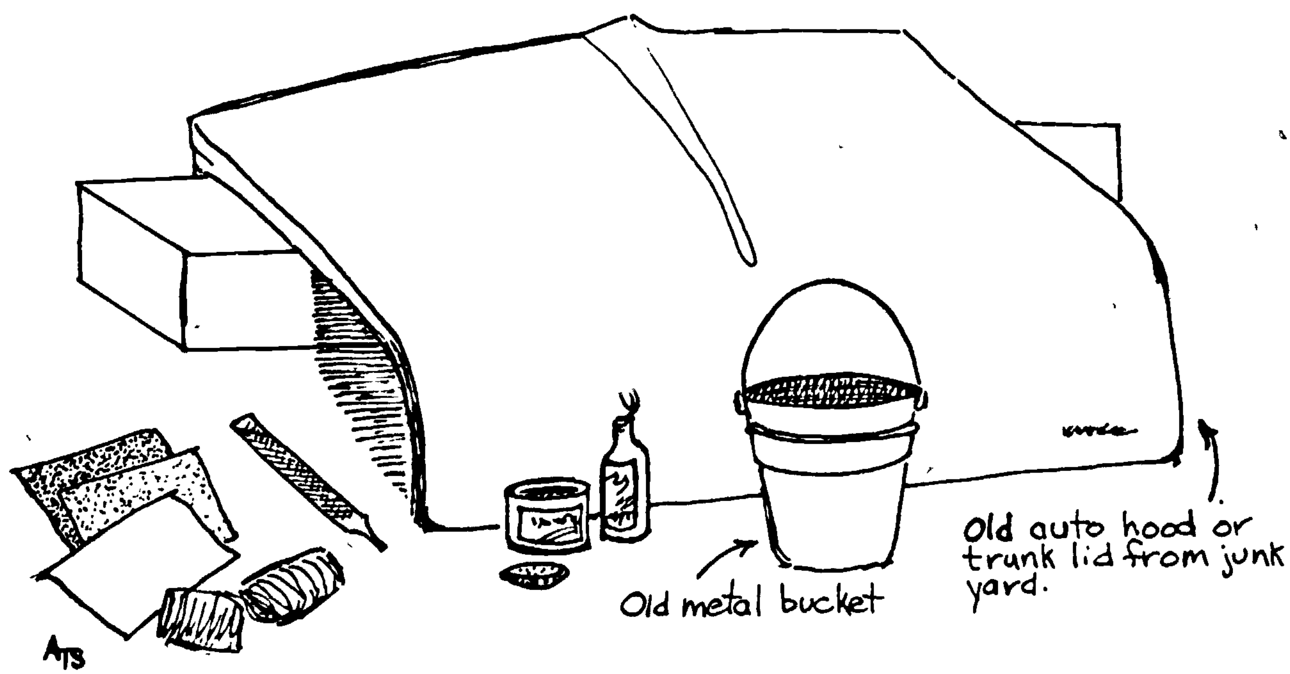
Have the students observe the breaks with a magnifying glass to see which broke: glue or wood. This can lead to trying to use the glues with different kinds of wood to examine how these glue joints break. Ask "What really happens when things stick together?"

What information is provided by the test scale to help the children decide which glue is strongest?

Strength of Structural Shapes: What other ways can you "stick" wood together? How are these other ways better (or worse) than the glue? Using corrugated cardboard, have students construct a variety of structured beams. Other paper products may be used to show and compare the strength of each.


Glue
Add weight to test glue


5 4 3 2 1
1 2 3 4 5
Test Scale
Glue


Old metal bucket
Old auto hood or trunk lid from junk yard.

COULD TWO PLUS TWO EQUAL ANYTHING BUT FOUR?

by Michael R. Cohen

Focus: A major emphasis of this Sourcebook is the continual need of teachers to be skeptical about answers they think they "know." A good example of this is found in that old problem, "How much is two plus two?" You will shortly see many different correct answers. Yet most people, adults as well as children, usually answer with the only response they know: four.

Challenge: Find additional answers to a problem that you know has only one answer.

Materials and Equipment:

Depends on the activity the children select

How-To-Do-It: Place the simple arithmetic problem, 2 + 2 =, on the chalkboard and ask the children to answer the problem. Then place the same problem on the board again and ask the children to answer this different problem. You may repeat the procedure four or five times. The children may at first look for a trick answer like 22. But just keep going. After the children have had a number of tries, have the children tell you their answers. They may at first tell you that "four" is the only correct answer. Challenge them to find other correct answers. There are many: 1 + 1 + 1 + 1, 3 + 1; 5 - 1; 2 x 2; for, fore, etc.

A discussion of the value of knowing the many correct answers should prove interesting. It is also worthwhile to discuss the reason the children initially could not think of any other possible answers. The discussion should lead to the challenge for this activity. It is easiest to have the children try to find additional solutions to riddles and brain teasers. Once the children can pick up on the idea, there are no limits to possible additional solutions.

Further Challenges:

1) Interview an old person and have them tell you how things have changed in their lifetime.

2) Find old family pictures. What changes do you notice?

"Like any form of deviance within a social group, unconventional ideas in science are seldom positively greeted by those benefitting from conformity. But science's basic dependence upon such innovations for its growth should remind us of a special need for tolerance often absent in the rest of society."

Marcello Truzzi

Truzzi, Marcello, "Discussion: On the Reception of Unconventional Scientific Claims," in Mauskopf, Seymour H. (Ed.). The Reception of Unconventional Science. AAAS Selected Symposium. Boulder, CO: Westview Press, 1979 page 131.

CHAPTER IV

Values

"...which of the conventional truths of our own age will be considered unforgivable bigotry to the next."

Carl Sagan

Sagan, Carl. Broca's Brain. New York: Random House, 1974, page 10.

ONE'S TRASH IS ANOTHER'S EDUCATIONAL TREASURE

by Leon Pines

Focus: The natural resources in the world are rapidly becoming depleted while our environment is becoming polluted. This is reason enough to conserve energy and materials and to recycle them. There are, however, educational benefits that accrue from creating and managing a recycling center. This is not a new idea and museums, such as the children's museum in Boston, already use recycling and recycled materials as part of their educational display. The point is that any dedicated group of teachers, students and/or parents can do the same thing.

The ideas suggested in this activity are based on the experiences of recycling resource center at the University of Maine at Farmington. This center was originated by volunteers. It now generates enough revenue to hire a part time supervisor.

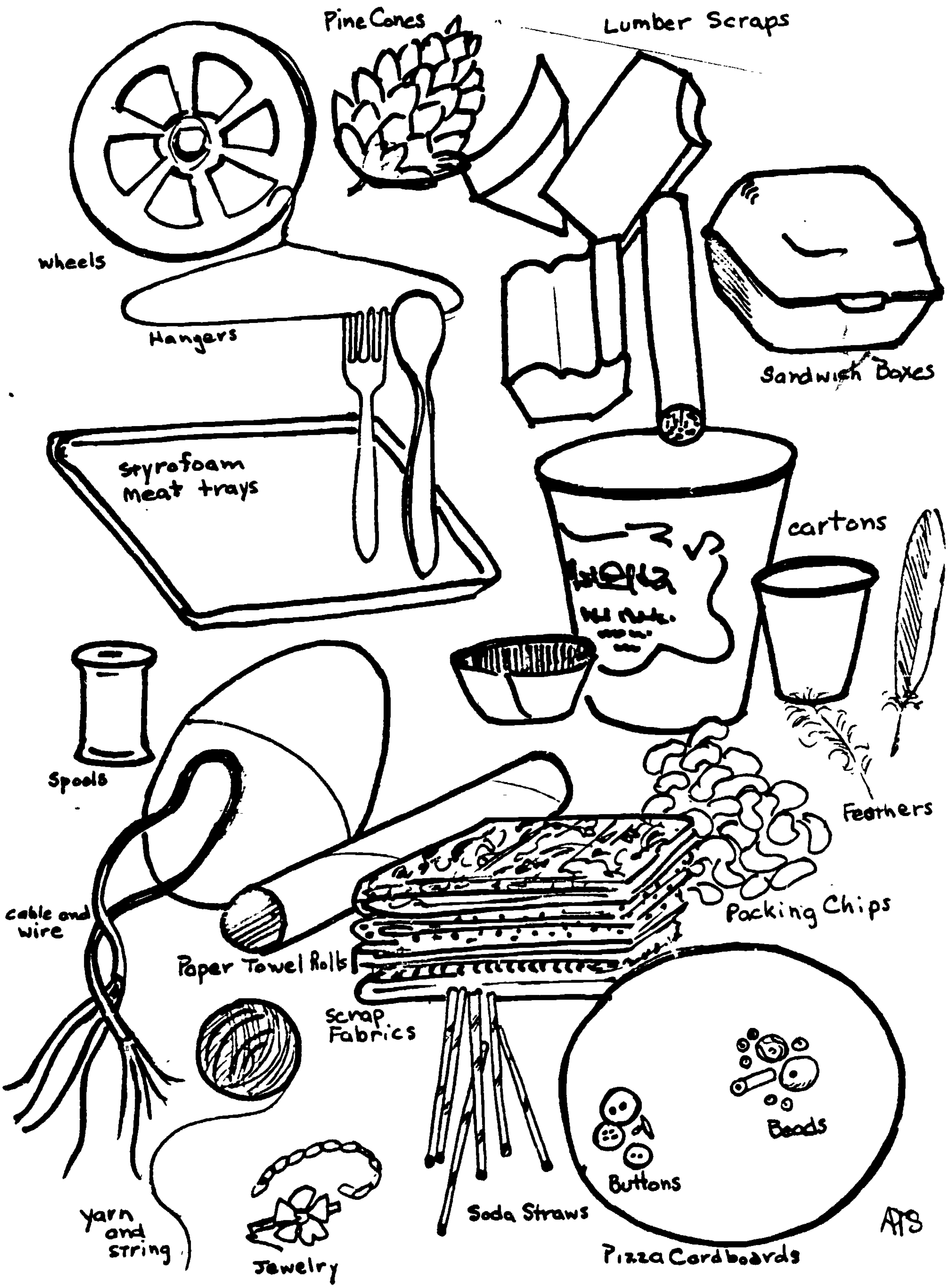
Challenge: Create a recycling center that can be used as an educational resource center.

Materials and Equipment:

A large room, preferably with shelves. The shelves can be built using planks and cinder blocks. Other storage containers such as bins or large wooden boxes are useful. The room must be large enough to accommodate not only materials, but also to provide adequate space for groups of children to comfortably sit, construct and interact.

How-To-Do-It: a. Organize a group of people who are willing to volunteer their time and energy for ecological and educational purposes. This group will be the board or steering committee of the recycling center. They will act as a network to contact industries, small businesses, and families to encourage the recycling of waste materials. Many of the industries and businesses will be happy to donate reusable materials if they are picked up by the center. These are the materials that will be useful in using the center as an "educational game room." Dowels, cardboard, containers, leather, and other industrial wastes can be used by children to construct devices, instruments and games. Families must be educated to sort out their home trash and bring reusable materials into the recycling center. The recycling center must be open during a number of regular hours throughout the week. Volunteers should divide the burden of collecting items from industries and businesses, and looking after the center when it is open.

b. Teachers should be notified of the recycling center and invited to visit. They should be encouraged to bring their classes for visitations as an educational experience in ecology. The items recycled should be sorted in bins and other containers or placed neatly on shelves. Many



ONE'S TRASH IS ANOTHER'S EDUCATIONAL TREASURE items could be priced reasonably. Art teachers, for example, will be able to purchase large quantities of art materials on a small budget. The general public should also be encouraged to visit the recycling center and to bring their children. In order to encourage people to become familiar with the center, activities such as workshops can be offered.

After the center has begun to operate successfully it can be used during certain days and certain hours as a "creative game room." Parents can bring their children or teachers can bring their classes to the center, which will be made available with all of its materials. These visits could be made by appointment and a small charge could be requested.

The revenue generated by the sale of items and the use of the center as an educational and recreational center can be used to help run the center. Certain expenses, such as gas for the vehicles used to pick up items from industry, can be paid. Recycling of items such as bottles or newspapers which will not be sold to the public or the schools can be facilitated. If the center is flourishing with a large turnover, then some of the revenue can be used to hire additional help or even a fulltime supervisor.

Teachers and parents can decide how the children are to be supervised. Either they can be left to produce their own ideas without restraint or they can be given tasks to accomplish.

The activities begun within the resource center can be continued at home or in the classroom. Activites for future visits to the recycling center can also be planned ahead of time at home or in the classroom.

Further Challenges:

The outline for establishing a recycling center as an educational enterprise does not go into detail on how this resource can be used by science teachers. This is indeed a further challenge. In fact, a whole sourcebook could be devoted to suggestions for how the center could be used by science teachers. I pose this as a challenge and will be happy to receive suggestions for activities that you have tried and found useful and successful. Some of the activities outlined in this and other sourcebooks and in teacher journals can be easily implemented with the recycling center.

A SCIENCE SURVEY

by Larry Flick

Focus: Children learn many things from informal contact with other people. Conducting a survey can be a way of bringing some of that information up for rational discussion. Surveys are conducted in order to collect information on some subject. If that subject concerns the understanding of a science concept, a wealth of information can be gathered for later study, discussion, and more surveys.

Challenge: Using a student generated question concerning a science concept, structure a survey that the students can conduct.

Materials and Equipment:

A printed survey form can be used but is not necessary.

How-To-Do-It: Capitalizing on some puzzling question in class, suggest that the class take a survey. Stress that a survey must be kept objective, impartial, and accurate. Discuss the types of information that might be of interest concerning the people surveyed. Avoid the use of names since you want to encourage all possible responses without emphasizing "scientific" correctness. Some possible demographic data might be: grade in school, subject studied or taught, occupation, interest in science, sex, age.

Recording the response to the science question (e.g., What causes the phases of the moon?) accurately and completely is critical. The students should allow the subject to read over their recorded response. These data can then be categorized, tabulated, and analyzed for the variations in meaning. This experience should enrich the students' awareness of possible meanings and not cause them to classify rightness or wrongness. The most important (science) question that you have to ask when considering each interpretation is: What was the evidence that was used to come to this interpretation? If rightness and wrongness was the issue then the students wouldn't have asked the question in the first place. Even if you have a student(s) who seems to be scientifically literate, there is still much to learn about the interpretation of evidence and in particular the wealth of evidence surrounding the concept in question. As much can be learned from inconsistent interpretations as those which the available data render consistent.

Further Challenges:

Your first survey probably took the form of a question from an existing science concept deductive in nature. Try presenting some evidence in survey form and ask for an interpretation. This inductive step should lead to a wider ranging collection of responses.

SCHOOL YARD COMBING

by Lowell J. Bethel

Focus: Most students like to search out and explore new places. Exploring is an important aspect of learning. Making observations and forming inferences on the basis of the observations is natural behavior exhibited by students.

Challenge: What do the things you find in the school yard tell you about the life and geography of the area?

Materials and Equipment:

String
Collecting bag
Twistums or ties
Paper and pencil
Masking tape
Clear plastic bag
Hand lens

How-To-Do-It: Explain to the students that they are scientists who have set out on an expedition to identify plant and animal life in an unknown area. They are to collect any other items which might offer clues concerning the nature of the inhabitants. What they pick up may yield clues as to what the people (animals?) eat, or how they work, or even how they play or do art work.

Discuss ways to collect and record their findings. What would be useful information for later study in the laboratory? Encourage diverse approaches including tracings, rubbings, photographs, drawings, descriptions, labeling, mapping etc.

There should be geographical boundaries set for the children and a time limit on their search for clues and information. The children should work in teams. All should then discuss their finds and infer some things about the people (or animals) that left the clues. Questions such as the following may be asked but discussions are not limited to just these:

> Where was the object found? Where did it come from? Who or what put it there? How long has it been there?

The following questions could guide the observing and inference making on the part of the students:

- Collect an object that does not belong on the school yard.
- Collect an object that feels slippery.
- Collect some different colored rocks.
- Collect some different shaped rocks.
- Collect some paper.
- Collect some metal.
- Collect something made by humans.
- Collect something that is not made by humans.
- Collect an animal.

SCHOOL YARD COMBING

Collect an animal that has eyes.
Collect an animal's home.
Collect a feather.
Collect an animal that flies.
Collect an animal that crawls.
Colle . an animal that walks.
Collect a producer (plant).
Find evidence of erosion.
Find an animal that lives under something.
Find a bright colored animal.

Further Challenges:

1) This same activity could be adapted as an environmental science activity for the school area, a greenbelt area or some woods. It could also be adapted for a pollution or date-letter study around the school and the clues adapted to the activity.

2) The children can collect various items (non-living) and, after discussing their finds, make a collage of the items found.

3) Give the children cards with descriptive words on them such as "smooth", "rough", "soft", slippery", etc. This can be done using a variety of descriptors.

4) Have students gather and write observations about four different objects or items in a given area and then make some inferences as to its origin, use(s), cost, and whether they are made by humans or are naturally occuring.

WHY EAT JUNK?

by David R. Stronck

Focus: Youngster's selection of foods is often influenced by advertising and by a taste for sugar, salt, or various artificial flavorings. Surveys demonstrate that youngsters rarely consider the nutritional value of foods when they are making selections. This activity is designed to raise the awareness of the youngsters toward a possible contradiction between their habitual food selections and the optimum selections for good health. Hopefully this new awareness will lead to a conscious change in selecting foods, especially by avoiding junk foods, e.g., candy bars and popcorn. Research demonstrates that children who tend to select junk foods will continue to make poor selections when they have a free choice of many other foods. But education can be effective in changing such habits.

Challenge: Can you classify various foods on a scale ranging from highly nutritious to junk?

Materials and Equipment:

- If a trip is made to a local grocery store, the students need only paper and pencils to record information.
- In the classroom, the activity may be done by using a wide variety of food wrappers and containers
- Labels from cans and jars (Containers and labels represent the foods with which they were associated.)

How-To-Do-It: Ask the youngsters to define both "junk foods" and "foods of excellent nutritional quality." Without much effort, the youngsters will probably be able to organize a scale of criteria similar to the following. You may wish to have more or less categories than this example:

A = very nutritious fresh food with high concentrations of protein, vitamins and minerals, e.g., fresh eggs, fresh shrimp, etc.
B = nutritious fresh food but low in protein or some vitamins and minerals, e.g., lettuce, tomatoes, etc.
C = minimally processed food and/or a possible cause of food allergies, e.g., frozen unsweetened apple juice, homogenized cow's milk, etc.
D = highly processed food with food additives and some deficiencies, e.g., canned chili beans, white bread, etc.
E = junk food consisting mostly of highly refined fat or carbohydrates (i.e., sugars or starches) with artificial flavorings and preservatives, e.g., potato chips, soda pop, etc.

Students should work in pairs. One student may read from a label while the other records the information. Explain to the youngsters that the first item listed under "ingredients" is the most abundant in the food.

For example, if sugar (or dextrose or sucrose or honey or other names for sugar) is listed first, the food is probably a junk food. Some presweetened breakfast cereals are mostly sugar but disguise this fact by including the sugar content under "carbohydrates." Among the common carbohydrates are both sugars and starches. Although the interpreting of all ingredients may be difficult, the goal of the activity is simply to classify the foods according to the few categories of a nutrition scale.

After the foods have been classified by nutritional quality, have the same foods reclassified by a selection ranking scale, for example:

1. a favorite food
2. a liked food
3. an acceptable food
4. a disliked food
5. a rejected food

Now the youngsters can compare the two classifications. Probably many of the least nutritious foods will be favorites while some of the most nutritious may be rejected. This comparison encourages a discussion of value clarifications. An expected outcome is some change in the selection habits of the students.

An appropriate wrap-up activity is to record all the foods eaten during the day. In order to meet better nutritional standards, most youngsters will attempt an exemplary diet during the day of recording the selections. By repeating this activity, the youngsters may begin to maintain an improved diet.

Further Challenges:

1) Pick a food label and learn the meaning of all the words on it.

2) Stand at the trash cans in the lunch room and record the types and quantities of food wasted.

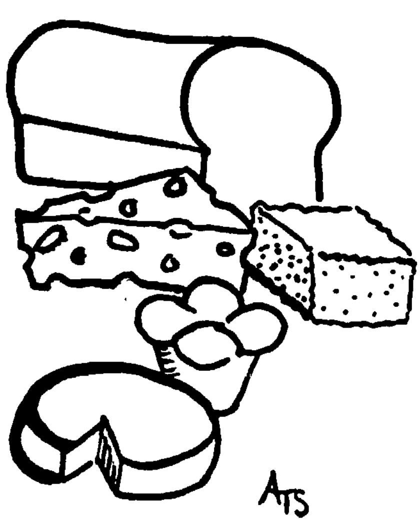
3) Survey your family's diet.

4) If people make it, people buy it and people eat it, how could foods be junk?

Reference:

Goodwin, M. T. and Pollen, G. Creative Food Experiences for Children. Washington, D.C.: Center for Science in the Public Interest, 1974.

Awareness Note: Be sensitive to cultural, ethnic, and religious perferences and economic restrictions such as school lunch programs.



FOOD FOR THOUGHT

FOOD FOR THOUGHT

by Marilyn Flick

Focus: The simplified nutritional categories of the four food groups are often stressed when talking about a balanced diet. While the importance of a balanced diet is an important aspect of the four food groups, the process of grouping foods in this way is not easy to understand. This activity demonstrates that food groups are determined for specific purposes. Dietitians, doctors, cooks, grocers, restaurant owners, and families must determine groupings of foods to suit particular needs.

Challenge: Using samples of real food create ways to group them and state a purpose for that grouping.

Materials and Equipment:

Have each student bring in a sample of their favorite food and a sample of any other food they choose.

How-To-Do-It: On the day before the activity discuss the tremendous variety of foods available in this country. Besides being rich in farm land, discuss how technology has created fast food chains, restaurants of most any description, and modern super markets with their various ways of packaging and preserving foods. Certainly the modern kitchen with its microwave ovens and food processors add to the variety of foods we eat.

After the foods have been brought in, you can start by asking for comparisons between them. Each student should consider likenesses and differences. For instance how are a banana and cereal alike? As a start two categories can be determined, e.g. external protection (banana peel) and internal protection (BHA in cereal). Students can then place their food samples on the appropriate table identified with each category. Are there foods which are hard to classify? This is certainly true for nutritional categories. Some other categories might be:

- Appearance - size, shape, color,...
- Texture - crunchy, soft, chewy,...
- Cooking requirements - necessary, neither, either,...
- Grocery - canned, frozen, fresh, ...
- Go-togethers - ham and eggs, peanut butter and jelly,...
- Special diets - no salt, no additives, high fiber,...

As each set of categories are established and the foods are arranged, determine a purpose that these food categories might serve. A restaurant owner would be interested in foods with an enticing appearance. For whom would this set of categories be important? Who could ignore the categories? How do food categories for good health change with age? With sex? With size? With health? With geographic location?

Further Challenges:

Identify a table as "Junk Food". Can any food be labeled as junk? If lack of nutrients means junk, what's water? Are calories junk?

SCIENCE IN THE COURTROOM

by Sheila M. Jasalavich

Focus: Children role-play the people in the community. Children engage in a decision-making process. They learn to weigh both sides of an issue and work through the judicial process. During their involvement, students are exposed to current civic and environmental issues and become aware of a variety of careers in law, government, environment, and dramatic arts fields.

Challenge: After hearing all the evidence, make recommendations that will be legally binding concerning strip mining in the area.

Materials and Equipment:

Props for the hearing/trial
Judge: gavel, robe
Lawyers and experts: formal clothing, briefcases, charts, maps, etc.
Miners: hats, picks, bandages, slings, casts, charcoal to smudge faces
Courtroom clerk: Bible
Courtroom: chairs and tables

How-To-Do-It: The Digger Mining Company has been granted permission to strip mine an area of rich coal deposits found to the west of Boomtown. Citizens United to Preserve the Beauty of Boomtown have been actively protesting strip mining of the land. They are now considering legal action to stop the Digger Mining Company.

As the judge appointed to the case, schedule a hearing to assess the necessity for strip mining. Review the need for more coal. Examine the past records of the Digger Mining Company on mine safety and concern for the environment. Listen to the reasons behind the citizens group's opposition to strip mining.

Research the judicial process, coal production, strip mining, mine safety, and environmental protection laws.

Form a committee of writers to draft your script. Scenes in which lawyers state the cases for the mining company and the citizens group can include: documented maps, projected needs charts, mine safety trends, environmental rehabilitation projects, etc. Witnesses can serve to validate the various points made by the lawyers representing the two sides.

Secure people to play the roles of: judge presiding over the hearing, lawyers, witnesses, experts, mining company representative, citizens, group representative, and any additional role.

Form committees to obtain props, costumes, sets, etc.

Rehearse. Polish the script, interpretation of the characters, and the issues at hand.

Schedule the hearing and invite people in your school and community to observe the proceedings.

If the outcome of the hearing warrants further legal action, adapt steps above as guidelines to prepare for the trial.

Further Challenges:

1) What other sources of information on strip mining can you find?

2) The mayor of Mothtown has just announced that spraying to curtail the activites of gypsy moth catepillars will take place within the next two weeks. Schedule a hearing to review the pro's and con's of the insecticide they plan to use. Make recommendations to the mayor's environmental concerns committee.

3) A community of aliens has been discovered in a remote area not far from where you live. The president has requested that a panel of scientists, military personnel, and town officials explore ways to peacefully communicate with them. If the aliens prove hostile or if you cannot establish communication with them, generate additional alternatives to deal with the situation in a peaceful way.

References: Background information on coal can be obtained from:

National Coal Association, Coal Building, 1130 Seventeenth St., N.W. Washington, D.C. 20036.

EEE: Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy for: U.S. Dept. of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

Background information on law and the judicial process can be obtained from: American Bar Association, Special Committee on Youth Education for Citizenship, 1155 E. 60th Street, Chicago, IL 60637.

WHICH KIND OF COW GIVES CHOCOLATE MILK?

by Elvin E. East

Focus: It is truly unfortunate that in today's high technology life style children do not have a realistic grasp of how they get the chocolate milk they drink or French cut string beans they eat. Since very few families produce their own foodstuffs or even part of their own foodstuffs, children do not have the opportunity to observe first hand the processes that use to be common occurances.

Challenge: Trace the paths taken and the people involved in producing a glass of chocolate milk from raw materials.

Materials and Equipment:

None

How-To-Do-It: A schematic on the wall with a picture of a glass of chocolate milk at the top is a good start. As each step is identified further pictures can be added below the milk. Small group or class discussions may give some answers or identify some misconceptions but they should point out some methods and resources available to use to discover the information. Extremely imaginative students may find that they cannot truly identify an original source for the milk but can create an increasingly intricate network of interdependencies.

Follow-up discussions about producers, consumers, middlemen, mark up, profits, economics, etc. should be easy to start.

Further Challenges:

1) Other final products can be used as a beginning, such as a ball point pen or a popular TV show.

2) Conservation of raw materials or elimination of chemicals from diets can be best achieved through what methods? (This is a follow-up challenge not an alternative).

3) In today's belt tighting times, what changes would you make in the schematic to save money? Is there a limit to changes that can be made and still have money?

"As children we learn certain patterns of behavior... If our early childhood training has been too rigid we cannot go beyond the old patterns, and we become increasingly unable to handle our own experiences."

Linda Phelps

Phelps, Linda, "Female Sexual Alienation", in Freeman, Jo (Ed.). Women: A Feminist Perspective Palo Alto: Mayfield Publishing, 1979, page 19.

BREAKTHROUGH

by Larry Flick and Mildred Moseman

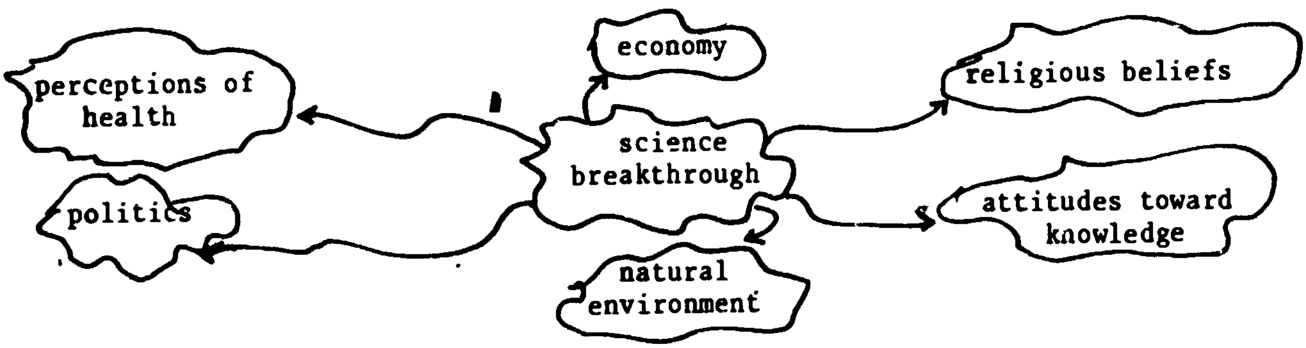
Focus: We fear a breakthrough when walking on ice but look forward to it when building a tunnel. We try to keep it from happening when stuffing garbage into a bag but applaud when it happens to our seed sprouts in the garden. Literally all these meanings can apply to a single breakthrough! Just ask a number of people what they feel about the scientific breakthrough that brought atomic energy. Our students will witness many breakthroughs over the next 50 years. They will need all the wisdom and preparation they can accumulate to live with these mixed blessings.

Challenge: Imagine a scientific breakthrough. Examine the consequences of the effects and side effects on the future.

Materials and Equipment:

Have students bring in news clippings or reports from TV news programs related to science issues. Get as diverse a group of sources as possible.

How-To-Do-It: Use the following diagram to help the children develop a sense of how science affects many aspects of life:



Considering these many ramifications, identify how a scientific breakthrough might affect the problem. A breakthrough can be considered the solution to a problem in science that has been a barrier to progress.

Expand the diagram to include future effects of the breakthrough (See Figure 1).

Further Challenges:

1) Work in small groups on a new science issue and compare the imagined breakthroughs.

2) Compare imagined futures working from the same breakthrough.

3) Code the diagram showing the effects of the breakthrough. Choose symbols for harmful, beneficial, and benign effects.

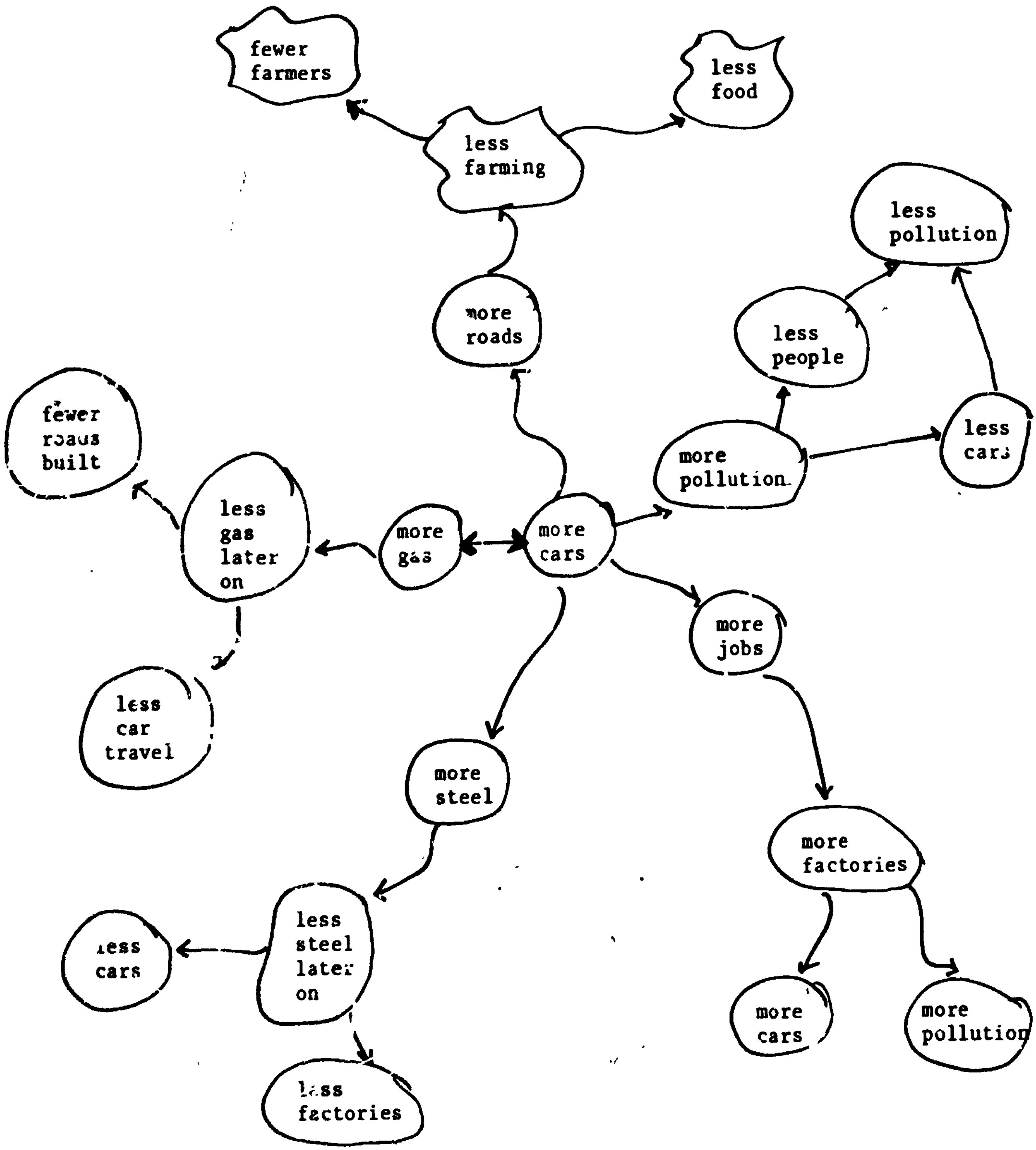


Figure 1. Example of future effects of a breakthrough.

CHAPTER V

Self-Esteem

"When the great innovation appears, it will almost certainly be in a muddled, incomplete and confusing form. To the discoverer himself it will be only half understood: to everybody else it will be a mystery. For any speculation which does not at first glance look crazy, there is no hope."

Freeman Dyson

"We are all agreed that your theory is crazy. The question that divides us is whether it is crazy enough to have a chance of being correct. My own feeling is that it is not crazy enough."

Neils Bohr

(Both Dyson and Bohr are quoted in) Brower, Kenneth. The Starship and the Canoe. New York: Bantam Books, 1979, page 150.

WHO WEAVES THE FABRIC OF SCIENCE?

by A. Leon Pines

Focus: Science is a human creation. This is not often understood and students memorize by rote large quantities of scientific "facts". These facts are poorly remembered because they do not become meaningful to the child. In order to make science a meaningful endeavor students need to see how scientific concepts are produced.

Challenge: Illustrate the relationships among several scientific concepts. Analyze scientific concepts to see how they were produced.

Materials and Equipment: The class textbook or an encyclopedia can be used as a source for materials to be analyzed. An overhead projector and transparencies may be useful in explaining the procedure and displaying the student's work.

How-To-Do-It: Take a portion of the course content from the textbook. List the concepts and draw a map which displays these concepts and their relationships (see Figure 1). Explain this process to the students and let them practice this process on other content.

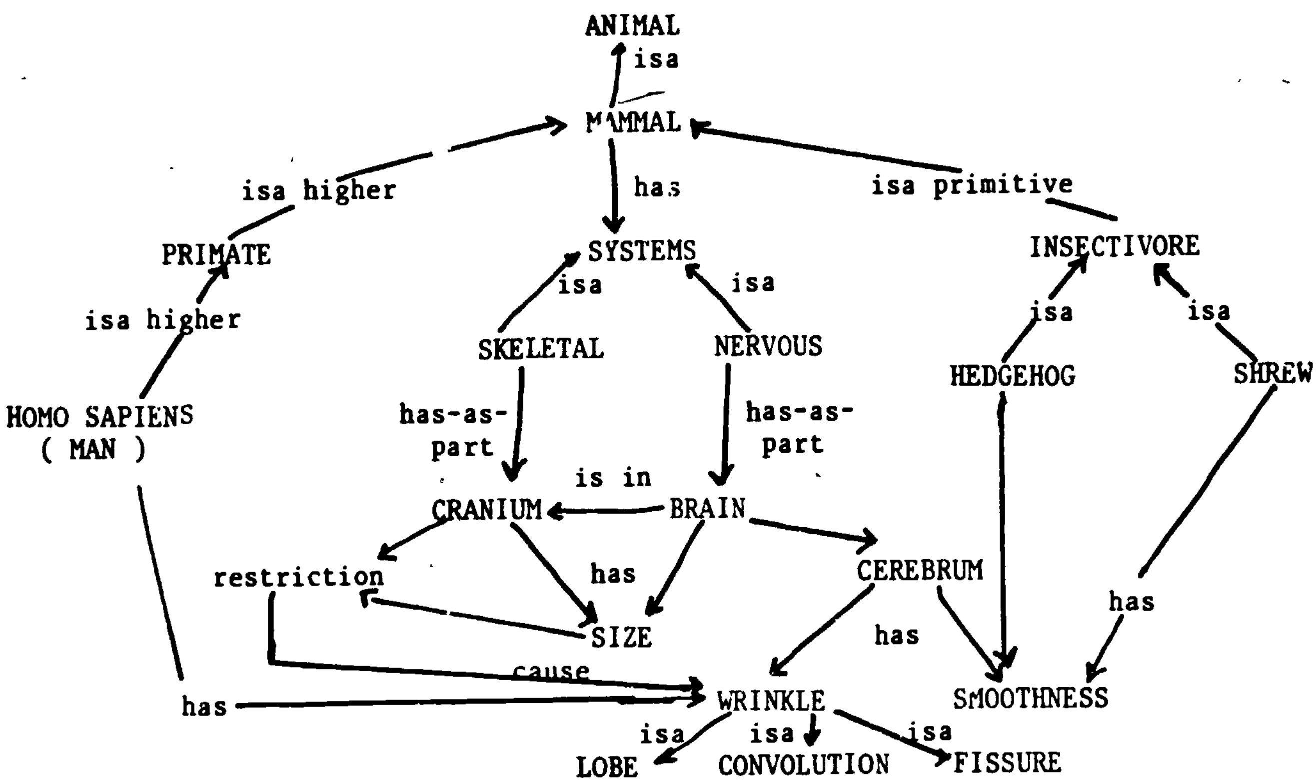
Pick out one concept and go back to the primary source which shows how this concept was established. Jot down how the measurements were made and how the conclusions were drawn. Explain this process to the students and have them try to figure out, from their text, how other concepts were made. As such, they will begin to appreciate science as a human endeavor and not as a mystical enterprise of *a priori* knowledge.

Further Challenges:

The activity outlined here gets to the core of science and extends over the total domain of science teaching and learning. The challenge is to analyze all scientific information and not accept anything as a dogmatic rhetoric of conclusions. Find other activities in this *Sourcebook* that help students understand this idea.

Can you map a set of concepts in more than one way? Compare the concept maps of students who used the same text materials. Do the two maps together represent the concepts better than either by themselves?

"The extensive wrinkling of the cerbral cortex in higher primates seems to be almost entirely due to the physical strains and stresses of its growth in the confined space of the cranium." (The Brain: Toward an Understanding. C.U.M. Smith. New York: G.P. Putman's Sons, 1970, p. 254).



TRACING YOUR BODY

by Stan Rachelson

Focus: The physical body with all its uniqueness is an important factor in the way students see themselves. This activity is designed to allow the students to metaphorically attach meaning to various parts of their bodies through the use of pictures.

Challenge: Trace your body and then fill in the design with pictures from magazines.

Materials and Equipment:

Sheets of butcher paper cut in 1-2 meter lengths
Crayons or markers
Assorted magazines that can be cut up
Scissors
Glue or paste

How-To-Do-It: Ask the students to form pairs. Have each student lie down on a piece of butcher paper while the partner traces the outline of his/her body. After this has been accomplished pass out the magazines and scissors and ask the students to cut out pictures they like (or thing represents something unique about them), and then paste them on their outline.

Next allow the students to display their body tracing around the room and have a class discussion about this activity. Some questions for sharing this experience might be: How did it feel for you to have your body traced? Did you have any problems in picking out pictures and placing them on the body tracing? What did you find out about yourself?

Further Challenges:

1) Allow time for students to write about their experiences in a journal.

2) Ask the student to trace where they think their various internal organs are located. (You may have to show a picture/chart of the human body to help get them started.)

3) Ask the students where in their tracing do their emotions reside. Their social self. Their intellectual self.

Awareness Note: Be sensitive to the selection of magazines made available for this activity. Illustrations should be representative of the variety of individuals in the community.

Reference:

Greer, M., and B. Rubinstein Will the Real Teacher Please Stand Up (2nd Ed.). Santa Monica, CA: Goodyear Publishing Co., 1978.

HOW DO YOUR HEROES SOLVE PROBLEMS?

by Michael R. Cohen

Focus: We may not be aware that most of our behaviors are based upon the actions of others. For many of our children, these models are provided by characters on TV. In this activity the children will list their TV heroes and critically review their choices.

Challenge: How do you select your heroes?

Materials and Equipment:

Class developed list of TV heroes
Questionnaire, following format below, developed from the class list

How-To-Do-It: Begin with a discussion of the TV programs the children regularly watch. Have the children provide a list of the names of the characters who appear on the programs. You should easily obtain a list of 20 characters. Try and lead the discussion so that the list eventually includes women, minorities and various occupations. The activity works best when the children have a variety of models to study.

Once the list is complete, the children are to indicate which characters they would like to act like--always, sometimes or never. This selection should not be done in an open vote. The children might feel pressured to follow their peers. Prepare a written ballot with the names and three spaces for the children's choices. An alternative would be to have the children number a piece of paper with each character and indicate, "A," "S," or "N," next to each number.

The results of the vote should be tabulated by the children and discussed with the entire class. The idea is to find out why each character did or did not end up as a model. Ask questions as to how each character solves problems, is creative, is helpful, protects the environment and others. As an example, in past discussions Gomer Pyle would not be selected as a hero. Upon discussion, however, the children would talk about the fact that Gomer was good at lots of things. His voice and manner were funny so they did not see him as a hero. Prejudices effect our selection of heroes.

Further Challenges:

1) Discuss models provided by people in stories read in class. Find examples of science related news reports and discuss the kind of skills needed by the people who created the news. What skills would help the students in their science classes?

2) Repeat the activity after a short time, using the same list and see if the children have changed their hero selection. Or, have children develop a new list and see if the characters selected change. How do the children explain any changes in their heroes?

Heros Would you like to act like this person:

	always	sometimes	never

KO.

HOW DO YOUR HEROES SOLVE PROBLEMS?

I MADE SOMEONE HAPPY!

by Lorraine B. Ide

Focus: The science processes used in researching a problem can be applied to study behavior and increase an awareness of the characteristics and actions which contribute to happiness.

Challenge: Do something that would make you deserving of the "I Made Someone Happy!" award.

Materials and Equipment:

Paper
Pencil

How-To-Do-It: Through discussion and questioning children can gain an understanding of what feelings, thoughtfulness, and kindness arouse. Try to avoid criticism and negative judgements from others by having the children determine for themselves whether they have earned the award. Accept their decisions. Practice will bring about an increased awareness of thoughful behavior.

Ask the children to think about some of the nice things you do for other people that make them happy. Then ask them to think about nice things other people do that make you happy. What is "something nice?" Can it be the things you say as well as what you do?

How many times should you do something nice to deserve the award? Should you get the award if sometimes you do something that makes people unhappy? Why?

Can a person be expected to always be nice? Why?

How can you tell when someone is happy?

How do you feel when you make someone happy?

On a special paper or in a notebook, keep a record of the nice things you do in one day. The following chart could be used:

DATE	TIME	WHAT I DID	WHO WAS HAPPY?	HOW I KNOW THEY WERE HAPPY

At the end of the day, study your chart. Did you earn an award? Are there others in your class that you think really deserve the award too? What did they do? Would you make them happy if you told them so?

Further Challenges:

1) Make a list of the kinds of things that make particular people happy. What makes a baby happy? What makes a police officer happy? What makes a bus driver happy? What makes a teacher happy?

2) How could you check to see that you really made someone happy?

A SYMBIOTIC WALK

by Stan Rachelson

Focus: A critical dimension for enhancing self-esteem in the science classroom is the level of trust between students and between students and teachers. This activity is directed toward the development of trust in a paired situation. It is best done after the students know each other fairly well.

Challenge: Take your blind-folded partner for a walk around the school.

Materials and Equipment:

Blindfolds (equal to ½ the number of students in the class)

How-To-Do-It: You might begin this activity with a discussion of the concept of "trust." Ask the students to share situations in which they trusted another person, including what about this person invited trust. You might talk about how the scientific enterprise is based on trust. The idea of a symbiotic relationship in nature is critical to extending the idea of trust and should also be discussed.

Next have the students form pairs and then tell them they will be going on a walk around the school in which one person will be blindfolded and the other will be the guide. Allow them to decide who is going first and then tell them the ground rules and boundaries for the walk. Explain that it is the guide's responsibility to make sure her/his partner is safe at all times - i.e. doesn't fall or bump into anything. Tell guides they can take their partner for an interesting walk and can give their partners a variety of sensory experiences by placing their blindfolded partner's hands on objects with different textures (i.e., rough concrete, a water fountain, etc.) For safety keep all pairs within view of the teacher.

Next, allow the guide to blindfold the partner and tell them you will have them switch roles in 10 minutes. Also, explain that the entire exercise is to be done without talking and that they should try very hard to keep from speaking to each other.

After each has had a chance to be blindfolded and to be a guide, bring them back to class to share their experiences. Some possible facilitators for discussion include: Was it easier to be blindfolded or to be the guide? How did objects you touched feel when you were blindfolded? What if your guide was someone you didn't know - how would it have been different?

Further Challenges:

1) Try another walk in a different location. This time ask the students to pair up with a classmate they don't know very well.

2) Try a walk and focus attention on sounds and smells in the environment.

3) Interview a blind person about his/her view of trust.

4) List symbiotic relationships in nature.

5) List symbiotic relationships between people.

Reference:

Abruscato, J. and J. Hassard. Loving and Beyond: Science Teaching for the Humanistic Classroom. Pacific Palisades, CA: Goodyear Publishing, 1976.

A PERSONAL GROWTH JOURNAL

by Stan Rachelson

Focus: One of the most useful tools for long term self-development is the systematic use of an on-going journal. Such a journal can provide a structure to assist us in paying closer attention to our lives and in developing our understanding of ourselves and others. In addition to written material, drawings and other visual materials can be an important aspect to the journal.

Journals are also critical in science. No self-respecting scientists would be caught without a good record of their ideas, experiments, blind alleys tried, failures and successes.

Challenge: Keep a daily journal about yourself and your science ideas.

Materials and Equipment:

Notebook suitable for journal keeping

How-To-Do-It: Begin this activity with a discussion of what a journal is. Ask the students to think about how a journal should look, what should be kept in it, etc. You might want to read excerpts from the journal/diary of a famous person. Tell the students that you will allow them some time each week to record in their journal. To help them get started the following are some suggested entries the students could write about:

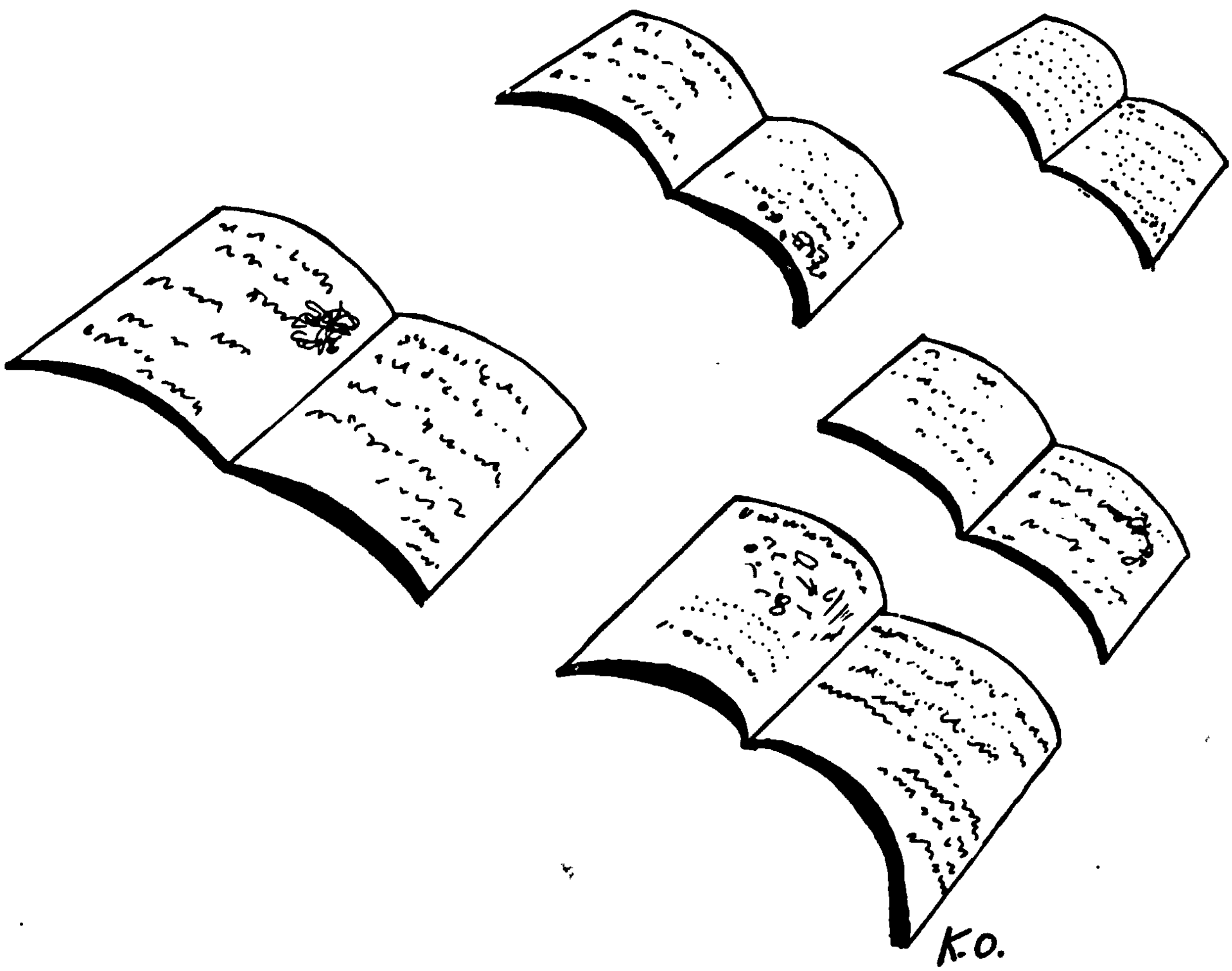
a. Acceptance - The most accepting person I know is...
b. Needs - One thing I really need, but don't get very often is...
c. Self-concept - Something I like about myself is...
d. Risk-taking - I have never told anyone about...
e. Change - Something about me I'm glad is changing is...
f. Anger - When I feel mad, I...
g. Wonder - I often wonder...
h. Think - I think it is true that...
i. Science Ideas - The science book says..., but I think...
j. Creativity - I am creative when...

Further Challenges:

1) Allow time for students in pairs to share anything they want to about their journal. Its important to keep these sessions confidential.

2) Allow time for a whole class discussion to talk about the positive and negative aspects of keeping a journal.

3) Use the journal to lead to discussion about the needs of scientists to keep journals. This discussion can often be started by having children read journal entries from previous months and mention those they forgot about. The journal helps us remember.



Reference:

Canfield, J. and H. C. Wells 100 Ways to Enhance Self-Concept in the Classroom. Englewood Cliffs, N.J.: Prentice-Hall, 1976.

"We shape our programs, and then afterwards our programs shape us and our children!"

Rene Dubos

Dubos, Rene. So Human An Animal. New York: Charles Scribner's Sons, 1968, page 191.

STRENGTH SHARING

by Stan Rachelson

Focus: An important aspect of a student's self-esteem are those things she/he does well. These strengths are often implicit and are not always communicated openly. This activity gives the students an opportunity to share their personal strengths with others in the class.

Challenge: Share with others what some of your strengths are.

Materials and Equipment:

A watch or clock with a second hand to measure seconds

How-To-Do-It: Have the students break into groups of five or six. Explain to the groups that this activity is designed to allow you to share with each other your personal strengths - things you do well. You might give a few examples of your own strengths to give the class a flavor of this activity. The only ground rules are that each person has one minute to share and that no negative statements or weaknesses can be brought out. Also, the others in the group must remain silent while they listen to each person. A time keeper in each group can be appointed, or you can let each group know when one minute is up so that another person can share. Explain that a minute is a long time and that if a person runs out of strengths to share before the minute is over, they can tell the group he/she is finished and the next person can begin.

After each group has finished allow the students to talk for a few minutes within their group about their reactions to this activity. Then bring everyone together as a whole class and allow time for a class discussion. Some questions to facilitate the sharing might be: How did it feel to share your weaknesses? Did you find that you had some strengths that were unique to the group - or alike others?

Further Challenges:

1) Repeat this exercise with a different small group composition and add a period of time so that group members can tell each person the strengths they think she/he has. This is called strength bombardment.

2) Try a similar exercise where small groups share successes and/or accomplishments instead of strengths.

3) "Survival of the fittest" is based on specific strengths. What do each of your strengths make you "fit" to do?

Reference:

Awareness: Exploring, Experimenting, Experiencing. New York: Bantam Books, 1976.

A CLASSROOM COLLAGE

by Stan Rachelson

Focus: Objects in the world can be used to help the student gain a clearer perspective of self-concept. In this activity the students select one natural object they identify with and then put it into a classroom collage.

Challenge: Select an object from the environment which tells something about you.

Materials and Equipment:

A large sheet of butcher paper

How-To-Do-It: Ask the student to think about how an object in our world can represent or symbolize ourselves. You might give a few examples like: A person is as stubborn as a rock, or as soft as a flower.

Next tell the students to go outside and select just one natural object which represents or symbolizes themselves. They need to be able to bring the object back into the classroom in order to put it into a class collage.

After the students return have them gather around the butcher paper and ask them to place the object on it in a place that fits with the other objects. Invite the students to experiment by placing the objects in several places on the paper.

Next begin a class discussion by having the students talk about the object using the "present tense" rule. For example: "I am a red flower and am soft and smell sweet. I am on the very edge of the collage so I won't get hurt by the rocks and sticks."

Further Challenges:

1) Allow time for the students to write in their journal about their experiences.

2) Try a similar activity using objects found in the classroom instead of objects found outside.

Reference:

Castillo, G. A. Left-Handed Teaching: Lessons in Affective Education. New York: Holt, Rinehart and Winston, 1978.

CHAPTER VI

Visual Thinking

"Images are not pictures in the head, but plans for obtaining information from potential environments."

Ulric Neisser

Neisser, Ulric. Cognition and Reality. New York: W.H. Freeman, 1976, page 150.

WHAT DO YOU STAND FOR?

by Larry Flick

Focus: The computer is perhaps the single most powerful tool, in terms of potential uses, we have invented. Its ability to mimic other machines is nearly limitless. It is probably as important to know something of how the computer operates as to actually learn how to operate one. By following the simple instruction of either "stand up" or "sit down", students can physically perform computer functions as they are accomplished in the machine.

Challenge: Make a human counting machine that counts without numbers.

How-To-Do-It: As the teacher you must understand how this activity works, literally backwards and forwards before you try it on an entire class. The students on the other hand, need only be aware that this activity will demonstrate something of how a computer works. The following may be useful to you but need not be discussed with the children.

1) There are only three things that a computer does inside its circuitry:
   a. Adds 1 to a stored number
   b. Subtracts 1 from a stored number
   c. Compares two numbers (The computer does not recognize a number as a quantity of something, only its code relative to some other number.)

2) The computer stores a number in memory location (sometimes called a register) in the form of a (binary) code by setting elements similar to switches either on or off. Here is the binary code for the numbers 0 through 15:

0	000	4	0100	8	1000	12	1100
1	0001	5	0101	9	1001	13	1101
2	0010	6	0110	10	1010	14	1110
3	0011	7	0111	11	1011	15	1111

You are now ready to construct a memory location or a register with four student. Each student must follow one instruction flawlessly so practice is necessary. The ADD 1 rule is (write on board): When the person on your left sits down, you change your position (if standing, then sit; if sitting, then stand).

Begin the activity with the four students seated, facing the class. This will present the number in its normal left to right form. The input to this register is accomplished by tapping the right most student on the shoulder. One tap and the student stands, resulting in (left to right) three students seated and one standing. In other words seated-seated-seated-standing or 0001. Another tap on the shoulder causes the first student to change positions. Since he/she must sit down, this triggers the next student to stand. If you do not see how this happened read the ADD 1 rule again. We have now tapped the right most student twice and we have: seated-seated-standing-seated or 0010. Check the code to see that this stands for 2.

After the students have had enough time to become familiar with their moves and the coded numbers, ask individual students in the register what number causes them to stand up first. A student in the first position stands for 1, in the second position 2, in the third 4, and the fourth 8. This gives a new and completely concrete meaning the the familiar phrase "stands for."

To cause a register to subtract one from each, the standing and sitting rule must be reversed. The SUBTRACT 1 rule is as follows: When the person on your left stands, you change your position (if standing, then sit; if sitting, then stand). It might be a good idea to have 3 x 5 cards made up with these rules printed on them. Put the ADD 1 rule on one side and the SUBTRACT 1 rule on the other.

Further Challenges:

1) Using the three functions 1a, 1b, and 1c perform the addition problem 7 + 6. Remember if your process is not absolutely mechanical the computer can't do it.

2) If you think adding and subtracting problems are repetitively mechanical, try performing multiplication or division. There is an additional problem to solve when performing division.

3) Video games operate in exactly this fashion. Do you believe that any "thinking" goes on in the computer when playing these games? There is room for plenty of responsible debate as to what constitutes thinking. Not too long ago many thinkers would have been astonished at a machine that could do arithmetic.

References

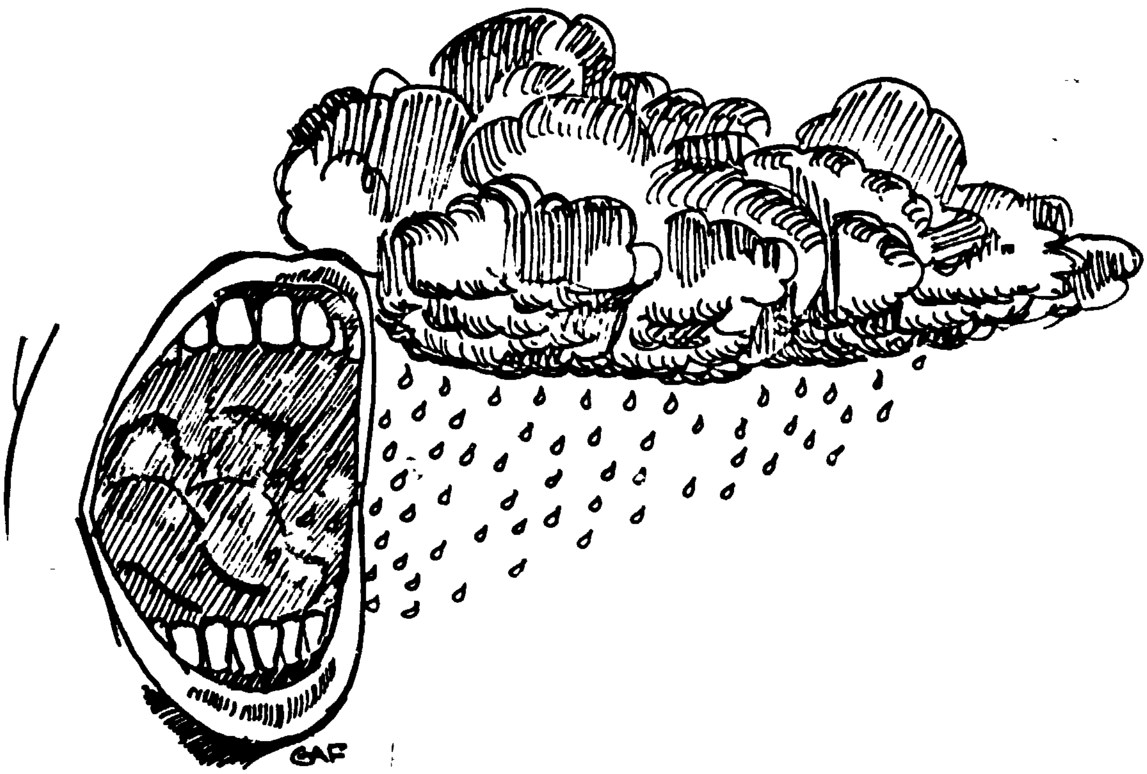
Hofsteader, D. R. Godel, Escher, Bach: An Eternal Golden Braid. New York: Basic Books, 1979.

Ellis, A. B. The Use and Misuse of Computers in Education. New York, NY: McGraw Hill, 1974.

"There isn't such a thing as a hard fact when you're trying to discover something. It's only afterwards that the facts become hard."

Francis Crick

In Judson, Horace Freeland. The Search for Solutions. New York: Holt, Rinehart and Winston, 1980, page 169.



WHEN IS A CYCLE LIKE A MAZE ?

WHEN IS A CYCLE LIKE A MAZE?

by Elvin E. East

Focus: You are thirsty so you get a drink of water. This appears to be a straight path from one location to the other. However, if you consider all of the potential paths that a single rain drop might travel to reach your throat, it becomes an intricate maze with alternate routes, recycling loops, and dead end deposits.

Challenge: Create a schematic drawing showing the paths that a rain drop could take to reach your throat.

Materials and Equipment:

A pencil and lots of paper

How-To-Do-It: Before attempting to put a complete diagram together, it would probably be helpful to write out linear word diagrams of separate paths. Creativity is encouraged in producing these alternative paths. An example might be rain drop-animal trough-animal waste-barnyard runoff-stream-water treatment plant-water tank-your house-your throat. When a complete list of paths is ready, make your schematic on a single (probably large) piece of paper. Simple diagrams or magazine cut-outs may be used in place of words e.g., a cloud, a water tank, a toilet.

Further Challenges:

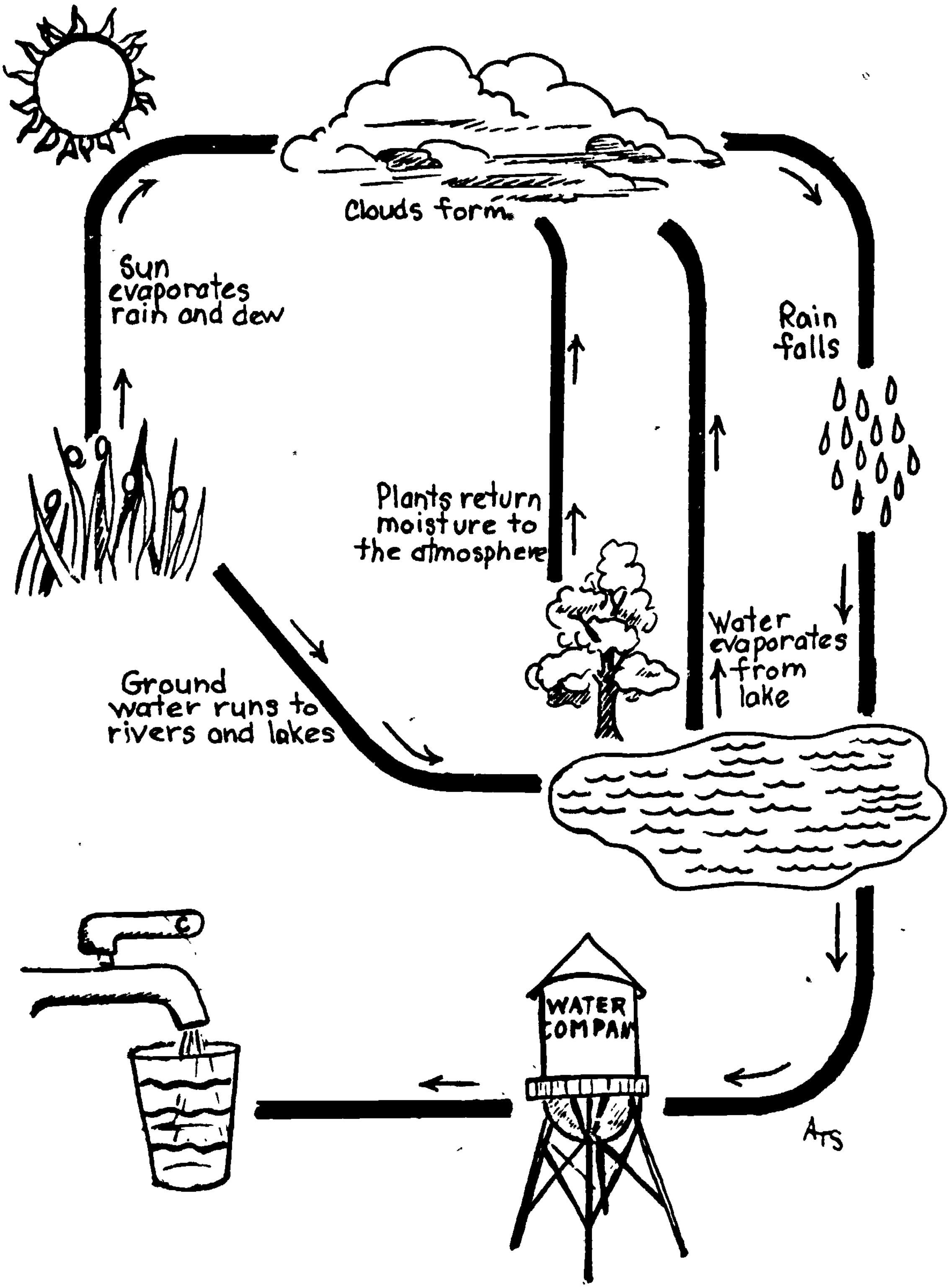
1) The schematic and be made into a maze for use in a newspaper or workbook on water conservation and usage.

2) Other starting [illegible] and finishing points may be used, such as a sun ray and heat for your home or an essential mineral in the soil and a finished product in your home.

3) When students look at each other's schematics, they may notice some very frivolous and/or wasteful alternatives that prevent the rain drop from reaching the students' throats or that add greatly to the cost of getting to their throats. Discussions can develop about why these alternatives exist and what steps can or should be taken to eliminate them.

4) Using their imaginations and their historical knowledge, the student can make a schematic as it would have looked ten or twenty years ago. Value statements can be made about the differences that exist between today and the past. Allow time for discussion to develop from these statements.

5) Invent a board game (like Monop ..,) using the travels and travails of a drop of water.



WHEN IS A CYCLE LIKE A MAZE?

SUN TRACKS

by David R. Stronck

Focus: Students will record changes in the sun's position relative to the earth and try to explain how it happened from the evidence. A sun dial tracks the sun's change in relative position but the process is often too slow to maintain interest. The change in position seems relatively rapid and even dramatic when a small spot of light is observed and timed.

Challenge: What can you learn about the earth and sun by tracking the sun?

Materials and Equipment:

1 large cardboard box, (about 45 cm on an edge) per group
Four large nails
Knife or other pointed object for making 5 mm hole in the cardboard box
Pen or pencil
White sheets of paper, preferably ruled or with graph lines

Optional: Compass
Protractor
Rules or tape measures

How-To-Do-It: On a sunny day, begin by giving each group of students a large cardboard box. Have the youngsters set the boxes outdoors on a level area with the open end away from the direction of the sun. Place the white sheet of paper against the side of the box closest to the ground---the bottom side in this position. Secure the sheet of paper to the bottom side and the box to the ground by driving four large nails through the corners of the sheet, the bottom of the cardboard box, and the ground.

Using the sharp instrument, punch a small hole (about 5 mm) through the top side of the box. Important: If the sun is near the horizon, the hole may need to be punched near the top of the side facing the sun. Have the youngsters use a pen or pencil to draw around the spot of sunlight shining on the paper on the ground. Using a watch time how long it takes for the sunlight's spot to move completely out of the drawn circle. Have the youngsters draw a second circle to make the new position. Again, record the amount of time it takes the sun to move away from the original circle.

Challenge the students to use this evidence of time and motion to demonstrate or diagram how the earth and the sun move. Additional evidence can be obtained by taking one of the recorded patterns, putting it back in its box, and causing the sun to retrace its pattern by moving the box. Note the motion made by moving the box. As models or diagrams are developed, have the students attempt to generate the original sun tracks from their ideas.

Further Challenges:

1) Make a device that can record the motions necessary to keep the sun shining on the same spot. Can you make a device which actually makes the necessary motions? This is a critical problem for solar energy collectors.

2) If we can time the sun's changes easily, could the same changes be used to tell us the time? Make a device that does this.

3) The length of the shadows cast by sunlight differ greatly from one season to another. Have the youngsters measure the lengths of shadows at a specific time, e.g., noon, for several months. A flag pole or lamp post in the school's yard can provide a very long shadow for a dramatic demonstration. A fence post may be sufficient to demonstrate the same changes. Why does noon, 12:00, not coincide exactly with the shadow pointing due north?

4) What happens when you make the hole in the box smaller?

"Problems that have been worked and reworked require fresh approaches: otherwise people keep seeing the problem in much the same way and get caught in the same restrictions."

George Prince

Prince, George M. The Practice of Creativity, New York: Collier Books, 1970, page 75.

PEEL A PATTERN

by Larry Rother

Focus: Interesting surprise patterns can be found by unfolding the surface of a geometric object. You start with a complex three-dimensional object. You then cut out each face (side, surface,) so that you can lay them together as a two-dimensional design. Then you try to fold the old-dimensional d-sign back into the three-dimensional object.

Challenge: Create your own surprise pattern by unfolding a geometric object of your own design.

Materials and Equipment:

Several 9" x 12" sheets and one 20" x 30" sheet of construction paper
Pen
Pencil
Ruler
Scissors
Scotch tape
Elmer's glue

How-To-Do-It: Make three to six paper blocks of various heights, width and depths. Use tape to join the edges. (It may be easier to use small food boxes.) Temporarily glue the blocks together, forming a single geometric object of your own design (fig. 3). Make sure that some portion of each side of each block remains visible otherwise the object may not be unfoldable without overlapping. As an experiment you may want to see what happens when one side is completely covered. Mark the lines at which one block crosses another.

Give a different number to each edge of the object (fig. 1). Record the number on both sides of each edge. Where more than one shape meets an edge, the edge must be divided and separate edge numbers assigned to each portion. (see edge 4-3-5 in fig. 1)

Disassemble the object. Cut out all of the shapes that make up the surface of the object. On a table top, assemble the disassembled surface of the object by taping each shape to the edge of another shape having a matching edge number (fig. 2). If the shapes begin to overlap each other, remove the overlapping shapes and reconnect them to other matching edges. Trace the assembled pattern onto another piece of paper (fig. 4) and cut it out.

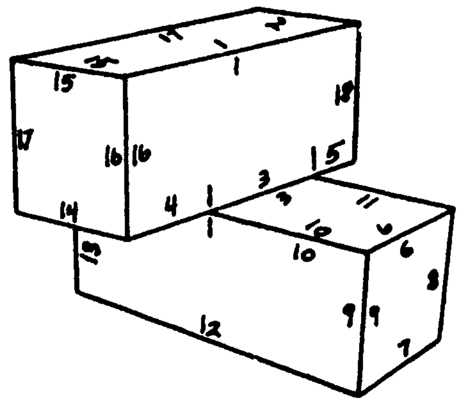


FIG. 1

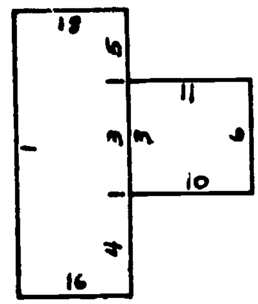


FIG. 2

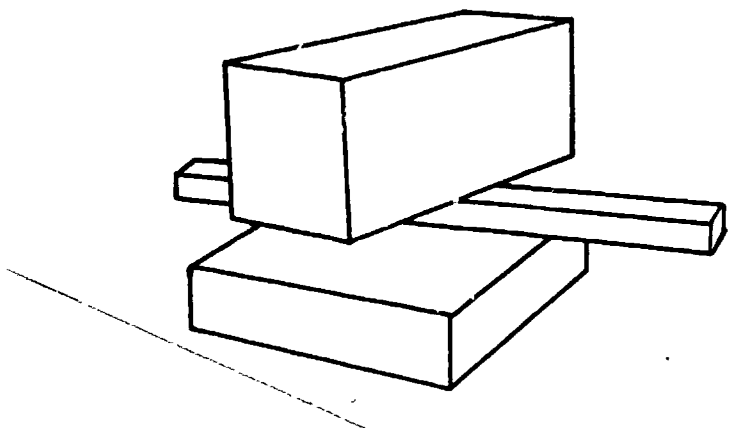


FIG. 3 3-BLOCK OBJECT

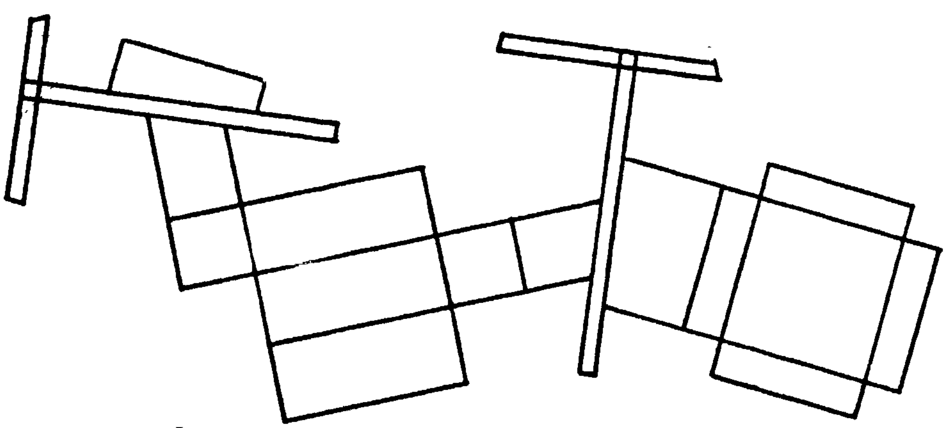


FIG. 4 3-BLOCK OBJECT UNFOLDED

Return the pattern to the form of the object by folding and taping at the appropriate locations. Can you do this without looking at the original pieces? Does the unfolded pattern look orderly, as though it had been deliberately designed? Can you find where parts of the object correspond to parts of the unfolded pattern? How might the pattern change if the blocks in the objects were turned or otherwise repositioned or changed in size? If several groups of students have made unfolded patterns, can you guess which geometric object corresponds to each pattern?

Further Challenges:

1) Make other objects and unfold them. Try using more blocks or using different sizes, positions or arrangements of blocks.

2) Try writing the instructions for "Peel A Pattern." Give them to someone else. Can they peel a pattern by following your instructions?

3) This activity should help you understand the two-dimensional representation of three-dimensional ideas. Find a two-dimensional diagram or picture in your textbook. Can you improve its ability to represent the three-dimensional idea?

AN AMAZING JOURNEY

by Stan Rachelson

Focus: A student's total self-concept consists of physical, social, intellectual, spiritual, and emotional selves. It is necessary for the student to become aware of these different aspects of self and how they create a wholistic picture of self-concept.

Challenge: Take an imaginary tour through your body.

Materials and Equipment:

None

How-To-Do-It: Put the words: Feeling, thinking, body, wishes, and friendship on the board. Ask the class what are some similiarities and differences among these words. Invite discussion about what part of the person controls or directs these qualities.

Next, tell the class that they are going on an amazing journey to discover more about the similarities and differences in these words. This journey will be done with eyes closed and in order to get ready, it's best to get comfortable in your seat.

Read the following slowly, pausing after each sentence: "Close your eyes and keep them closed until I tell you to open them again. Try to become more relaxed. I want you to imagine the words on the board: Feeling, thinking, body, wishes, and friendship. Try to decide what part of you controls these words. Where are your feelings located? Where does your thinking come from? Where is your body? Where do your wishes come from? What part of you makes friends? Now each of these words can also be put together into a whole . . whole person. For example can you think and feel at the same time? Do you use your body when you wish or make friends? Can you see how each is different, but also connected? When you see all these parts as making up who you are, how do you see yourself as a person? What areas are a little stronger than the others? What areas could be improved upon with an effort?

Now become more aware of your place in this room. When you are ready, open your eyes."

Give the students a few minutes to share their imagery journey with a partner. Then entertain discussion as a whole class.

Further Challenges:

1) Allow students to draw a picture about their imagery journey.

2) Allow students to write about their experiences in their journal.

__Reference__:

Harrison, A. __Other Ways, Other Means__. Santa Monica, CA: Goodyear Publishing Co., 1978.

THE BALANCING ACT

by Lorraine B. Ide

Focus: Balancing is a high interest activity for children which offers extensive application to other areas of the curriculum. The initial challenges lead to the formation of a rule for balancing. Further challenges give opportunities to apply this rule and modify or extend it if necessary. Through independent investigations and questioning, teachers can extend the development of the habit of inquiry.

Challenges: Balancing the evenly shaped object. How many different ways can you balance a ruler on your finger? Balancing the unevenly shaped object. How many ways can you balance a twig or a banana on your finger?

How-To-Do-It: These initial balance challenges require only readily accessible materials. Through questioning, the concept of balance can be developed. The balance point of an object is called its "center of mass." As long as the center of mass rests over the balance point, the object is in balance.

Questioning to lead to an understanding of "center of mass":

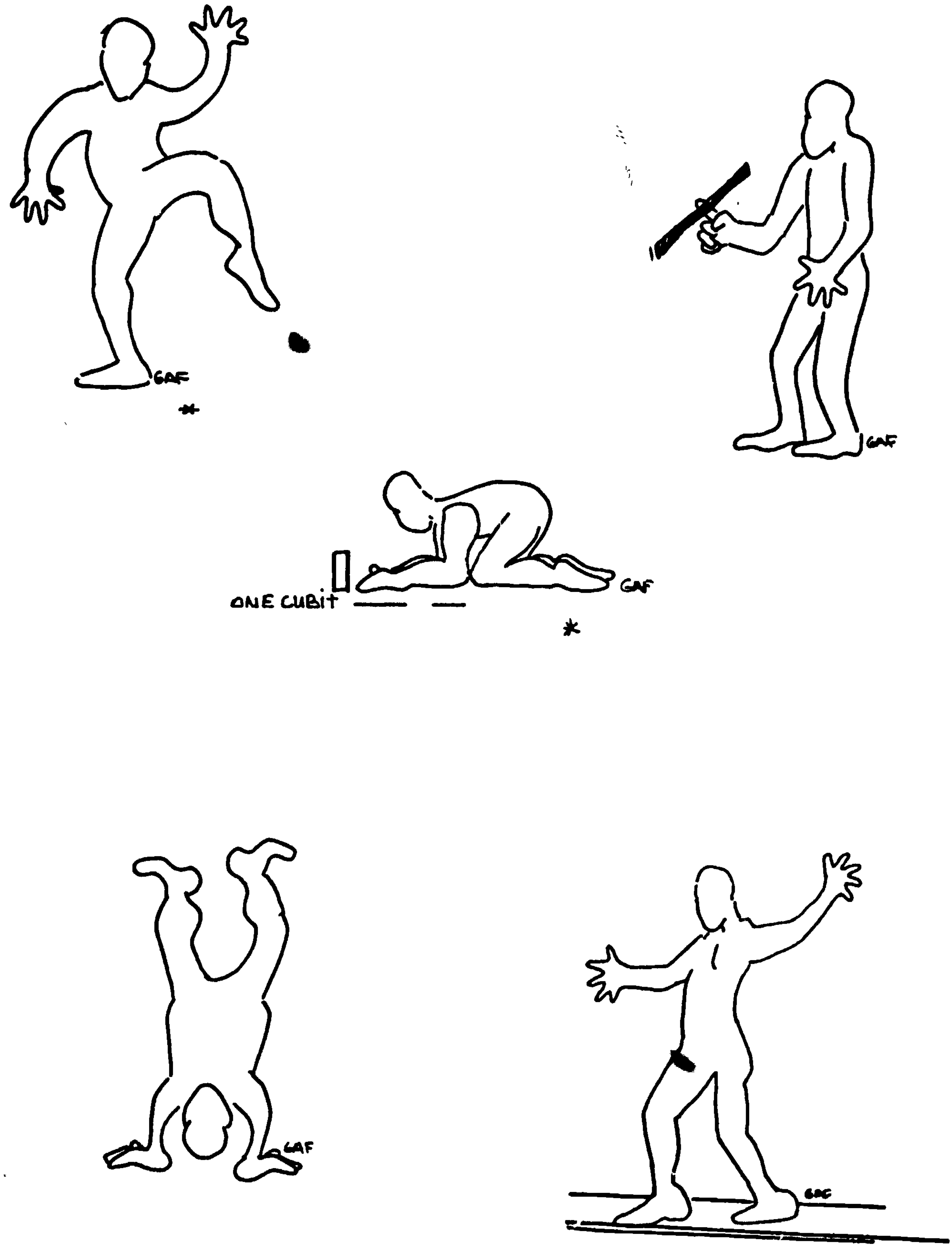
Where was your finger on the ruler when it was in balance?
Was you finger at a number at any balance time?
Where was the balance point?
Why is it harder to find the balance point of an uneven shaped object?

Make up a rule about the balance point of an object.

Further Challenges:

1) The balance point of people.
Where is your balance point?
Is it in a different place when you sit? stand? stoop? lie down?
Where is your center of mass when you are standing? (over your feet, - exact point varies with individual) Now bend forward so that your center of mass is no longer over your feet. What happens? (feet move automatically to retain balance)

2) A standing fall.
Place an object on the floor just in front of your toes.
Stand straight against a wall with your heels back and head touching.
Pick up the object without moving your feet or bending your knees.
What happens? Where does the center of mass move?



THE BALANCING ACT

3) Kneely impossible.

Kneel on the floor and measure one cubit straight out from your knees (a cubit is the distance from your elbow ot the tip of your middle finger, Old Egyptian measure). Stand a chalkboard eraser one cubit from your knee. Hold your hands behind your back. Slowly bend forward and try to knock over the eraser with your nose. Can your rule help you explain what happens? Can you explain what happens? (as you tip forward, your center of mass also moves forward and you lose balance. If it doesn't move forward enough, you succeed in knocking over the eraser).

4) Get teams of children to try the challenge. Keep records of the number of successes of each team. Study the results. Can you draw any conclusions from these records? Now check your conclusions by trying this with adults--your parents, teachers, friends. Do your conclusions stay the same?

WRITING WITHOUT WORDS

by Michael R. Cohen

Focus: The understanding of concepts within a book are often dependent upon the relationship of the book's text to its graphics. Some concepts can only be explained with the aid of graphics. Others need graphics to present examples. Children often rely more on graphics than on text. Observe children putting together plastic models or toys. Very often they look at the pictures rather than reading the instructions word by word.

The editors of this Sourcebook were pleased and excited by the creativity demonstrated by the art-design work of Gregg Floyd, Kathy Ostling, and Ann Solomon. We felt they took interesting ideas, such as "Wind Inventions Works Wonders," and provided expanded and broader possible solutions. This caused us to wonder what could be gained solely from the graphics and led to this activity.

Challenge: What can you understand about an activity from its pictures?

Materials and Equipment:

This Sourcebook or copies of an activity and graphics from this Sourcebook.

How-To-Do-It: You can begin with a discussion of how children follow plans when building models, putting together toys, learning to play games or following instruction about cooking or building at home. How much of the time do they watch and observe? How much of the time do they discuss and talk over the instructions?

Then present only the graphics from an activity in this Sourcebook. Have the children invent the activity. How close did the children come to the actual activity? What were some differences the children developed? How did the different interpretations help, hinder or expand the activity?

Further Challenges:

1) Try the activity with pictures from a science textbook, a reading book, a comic book.

2) Have children watch TV without any sound. Can they tell what's going on? How is a radio story different from a TV story?

3) Have children create a story using only pictures. Compare your story with the sound only story suggested in the activity "A Sound Story."

WRITING WITHOUT WORDS

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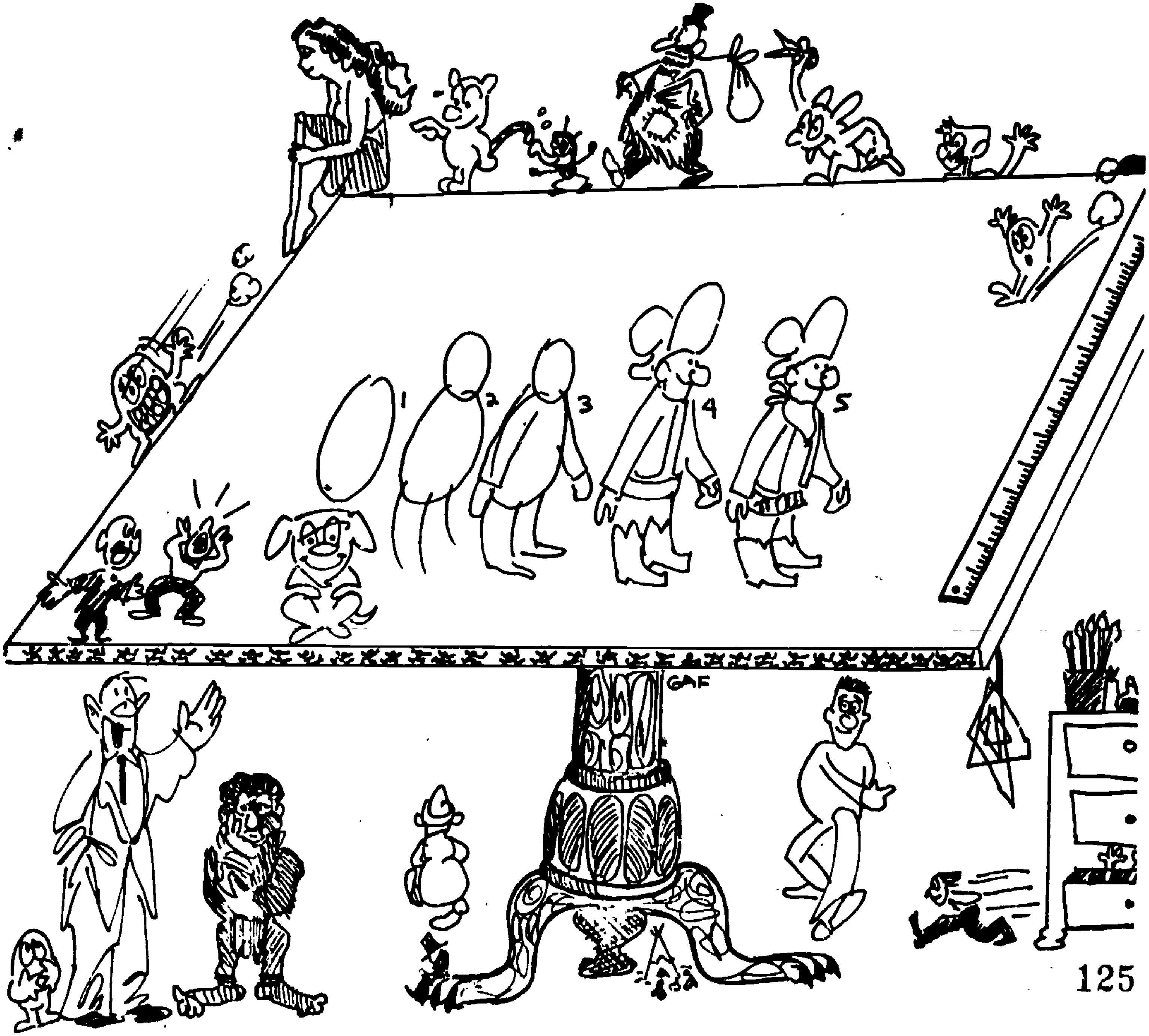


CHAPTER VII

Inventions

"We often forget that different valid models can be developed for the same set of real events."

C. West Churchman

Churchman, C. West, "The Client and the Model". In Stogdill, Ralph M. (Ed.). The Process of Model Building in the Behavioral Sciences. New York: W.W. Norton and Co., 1970, page 29.

MAKING TEMPERATURE METERS

by David R. Stronck

Focus: Invent a system for measuring changes in temperature. Use a thermometer to calibrate the system. (The system will consist of inexpensive materials, e.g., soda straw, bottle, etc.)

Background: Glass thermometers are commonly available in the schools. Unfortunately, youngsters often break these glass thermometers and rarely are able to explain the principle by which they operate, i.e., the mercury or alcohol (usually colored with a red dye) expands or contracts in the glass tube according to the temperature changes. A broken thermometer may be used to show the tiny hole which contained the liquid, i.e., the mercury or alcohol.

The thermometers which are commonly used to operate heating systems in homes consist essentially of a bimetallic strip. This strip has two plates of different metals with different thermal expansion rates. The two plates are fused together forming a strip which bends at different angles according to the temperature.

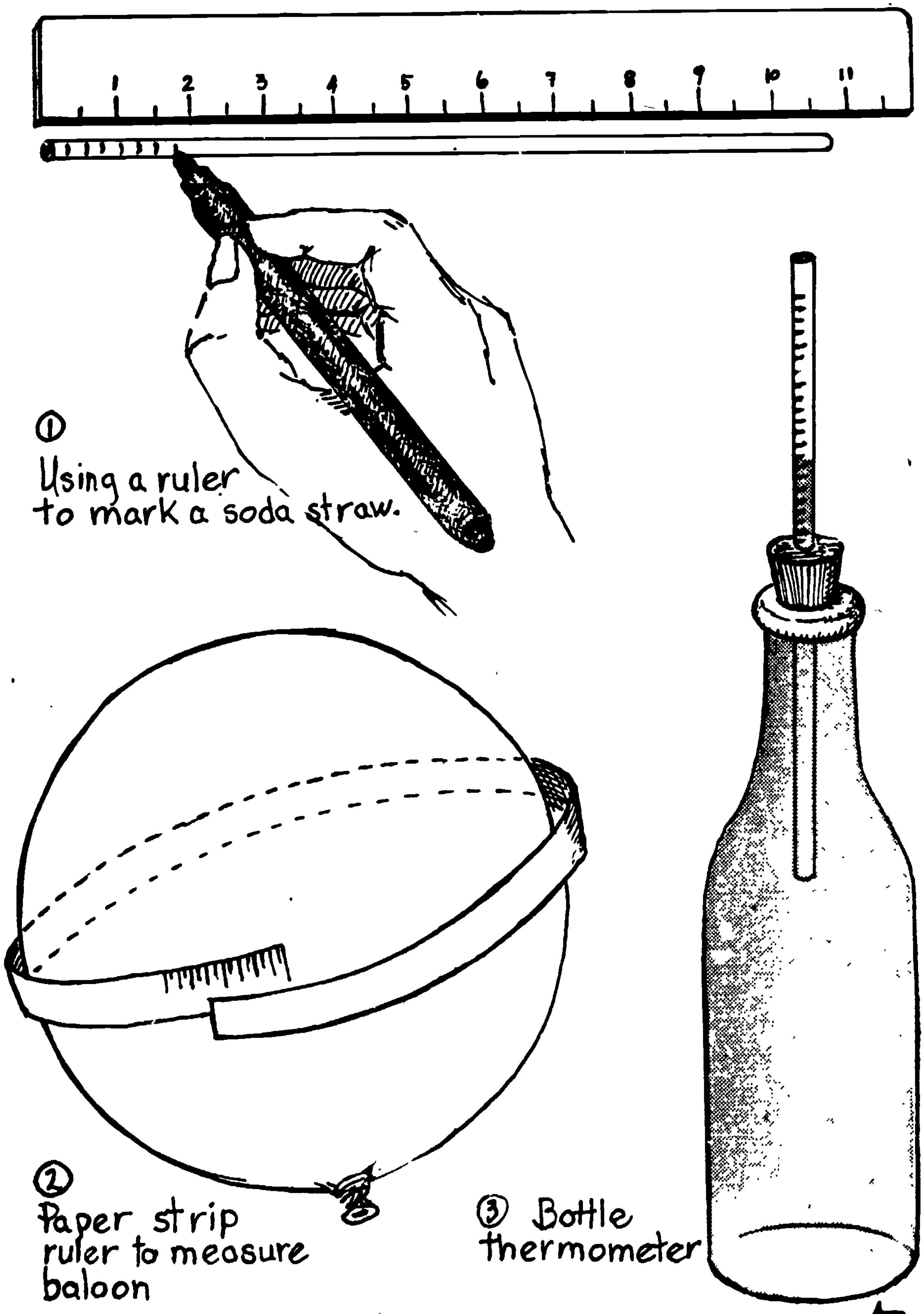
Challenge: Make your own thermometer from common objects which change in length with temperature changes.

Materials and Equipment:

- Balloons of uniform size
- Heat source, e.g., electric burner plate
- Ice cubes
- Pans
- Water
- Small bimetallic strip(s) (which may be obtained from a laboratory supply company or made from two strips of metals riveted together. Use various common metals, e.g., copper, aluminum, iron, etc.)
- Rulers
- Food coloring
- Clear plastic straw with different diameters if possible
- Soft-drink bottle
- Thermometers
- One-hole rubber stopper to fit soda straw and soft-drink bottle

How-To-Do-It: Begin by discussing the expansion and contraction of balloons. Demonstrate to the youngsters the changes in three balloons which were originally inflated to identical diameters. Place one balloon in or near a pan of boiling water; another in a pan containing ice water; the third balloon at room temperature. Use a ruler to measure changes in the diameters of the balloons. Compare these diameters with the recorded temperatures to observe the expansion from cold to hot situations.

Then encourage the youngsters to build a better system for measuring changes in temperature. With little difficulty they can put together a soda-straw thermometer. Changes in the water level within the straw may be measured by using a ruler. Add food coloring to the water for ease of reading.



MAKING TEMPERATURE METERS

The youngsters may use thermometers to record the temperatures at various water levels. The variations in water levels may then be calibrated against these temperatures. The youngsters will discover the distances on the rulers which represent each degree of change. Dramatic differences can be made in the water levels by placing the bottle thermometers in a pan of boiling water and in a pan of ice water. Be careful to handle objects near or in boiling water with appropriate gloves or other protective devices. Allow the bottle to come to room temperature before changing from ice to boiling water.

If bimetallic strips are available, students may similarly calibrate temperature changes by noting the relative curvatures of the strip. The strip must be located at a fixed place to note the changes in these angles.

The youngsters should be expected to understand the following concept: the usual pattern in nature is that gases, liquids and solids expand when they are heated. Some youngsters will be able to suggest ways to measure such changes and to build unusual measuring devices. The "wrap up" activity is to encourage them to invent a temperature-measuring device without directions from the teacher. This activity will normally require the collecting of items at home.

Further Challenges:

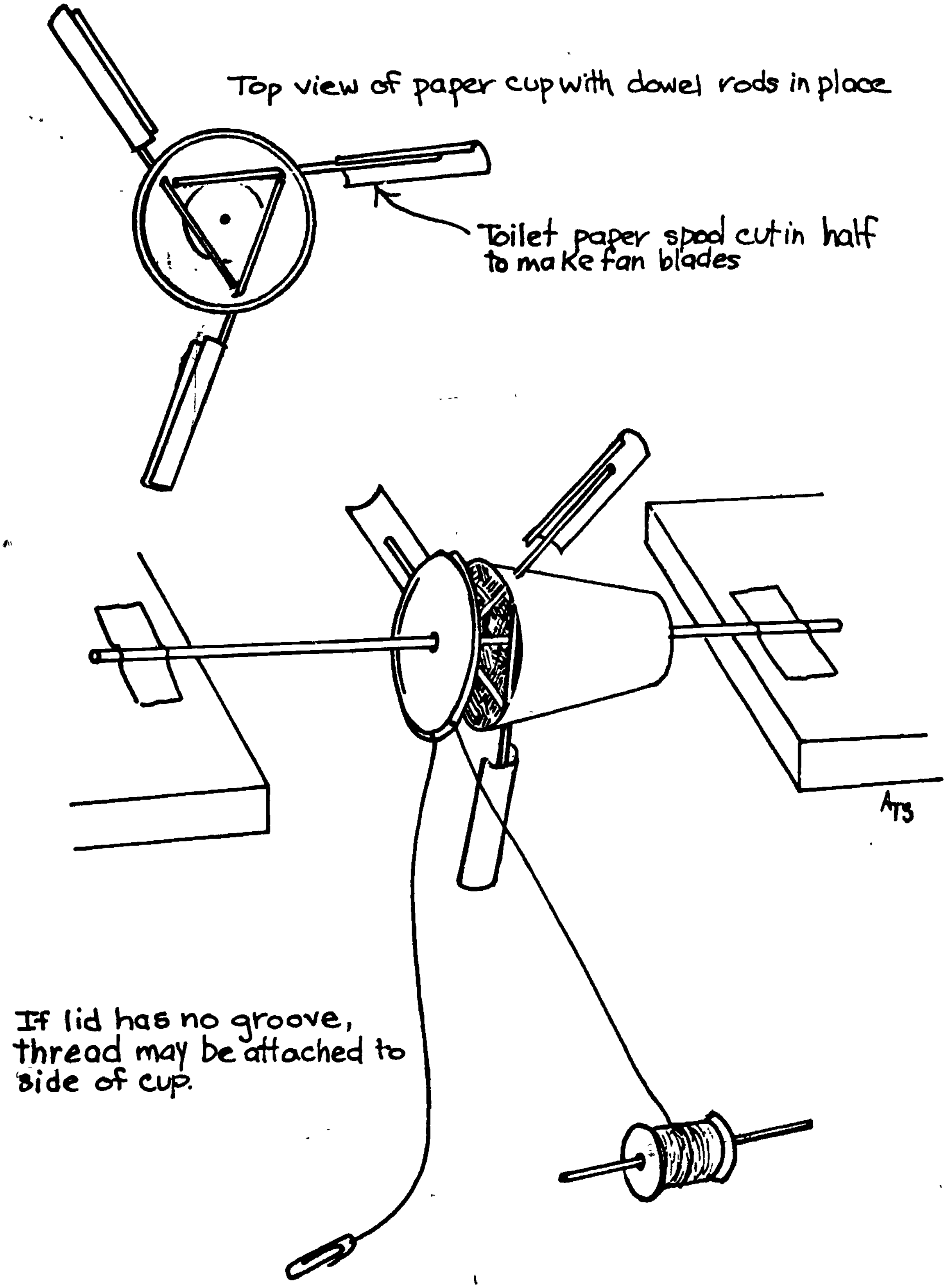
1) Some students may observe that their bottle thermometers have variations in water levels on different days, i.e., variations which are not based simply on changes in temperature. Their first attempt to explain such variations may be that the evaporation of water may be the cause. The youngsters may try mineral oil in place of the water. But probably the variations are from changes in the barometric pressure. The water thermometer is simultaneously showing changes in both temperature and the atmospheric pressure. A discussion of barometers may encourage some to build a barometer.

2) Some students have built a water barometer which must be at least 34 feet in length. A long tube with a transparent section at the top end may be hung at some school building. A pan of water at the bottom of the tube is the only other essential part. The atmospheric pressure will support a column of water in the tube to a height of almost 34 feet.

References:

Sund, R. B., B. W. Tillery, and L. W. Trowbridge Elementary Science Discovery Lessons -- The Earth Sciences. Boston: Allyn and Bacon, 1970.

Unified Science and Mathematics for Elementary Schools. Weather Predictions. Newton, Massachusetts: Education Development Center, 1973.


Top view of paper cup with dowel rods in place
Toilet paper spool cut in half to make fan blades
If lid has no groove, thread may be attached to side of cup.
ATS

WIND INVENTIONS WORK WONDERS

by Vincent G. Sindt

Focus: People have felt the wind for centuries. They have also wondered about, invented and tested a countless number of machines to use this impressive energy source for useful purposes. As your students explore the various areas of science, you should provide them with the opportunity to experience some of the creative experiences that other persons have enjoyed as they invented machines to use the wind. Capturing the wind turns out to be one of the easiest and most interesting activities that children can explore. Think for a minute about the number of jobs that people do and have done with wind. They have transported themselves from place to place, dried their clothes, pumped their water, and generated their electricity with the wind. Moving beyond to studies of moving air, the concepts of propellers, air foils, and streamlining become areas where people still search for better ways to do their work.

Challenge: Invent devices that will lift weights using only the power of the wind, a hair dryer or fan.

Materials and Equipment:

Paper clips
Fans or hair dryers
Metal Strips
Strong thread
Plywood pieces
Dowel Rod
Materials for the wind catching devices: tagboard, toilet paper spools, paper cups, tape, glue, scissors, razor blades, sheets of thin plastic.

How-To-Do-It: Gather a supply of the materials for the students and discuss the idea of using wind to do useful jobs. You can turn the fan or hair dryer on and let the wind blow a piece of tissue paper, a feather or other light object to stimulate discussion.

You should then issue a set of rules for the wind devices. These are normally formulated before the testing, but if you want to work with the concept of "fair tests," you could let the students develop the rules as the testing is proceeding. Some possible rules are:

1. You may not use a commercial product.

2. The tests must be performed with the same wind source.

3. The most successful wind device will be determined by the number of weights lifted.

After the most successful wind device is identified, the students should discuss questions like: What things made this device lift more weights? What effects would stronger wind have? What would a larger model of this device do? Could we use this device outside to do real jobs like pumping water or generating electricity?

Further Challenges:

1) Find out the effects of stronger winds on your devices.

2) Generate electricity with a wind device that you have invented.

3) Invent ways to use the wind to move objects from one place to another.

4) Devise methods to measure the speed of the wind.

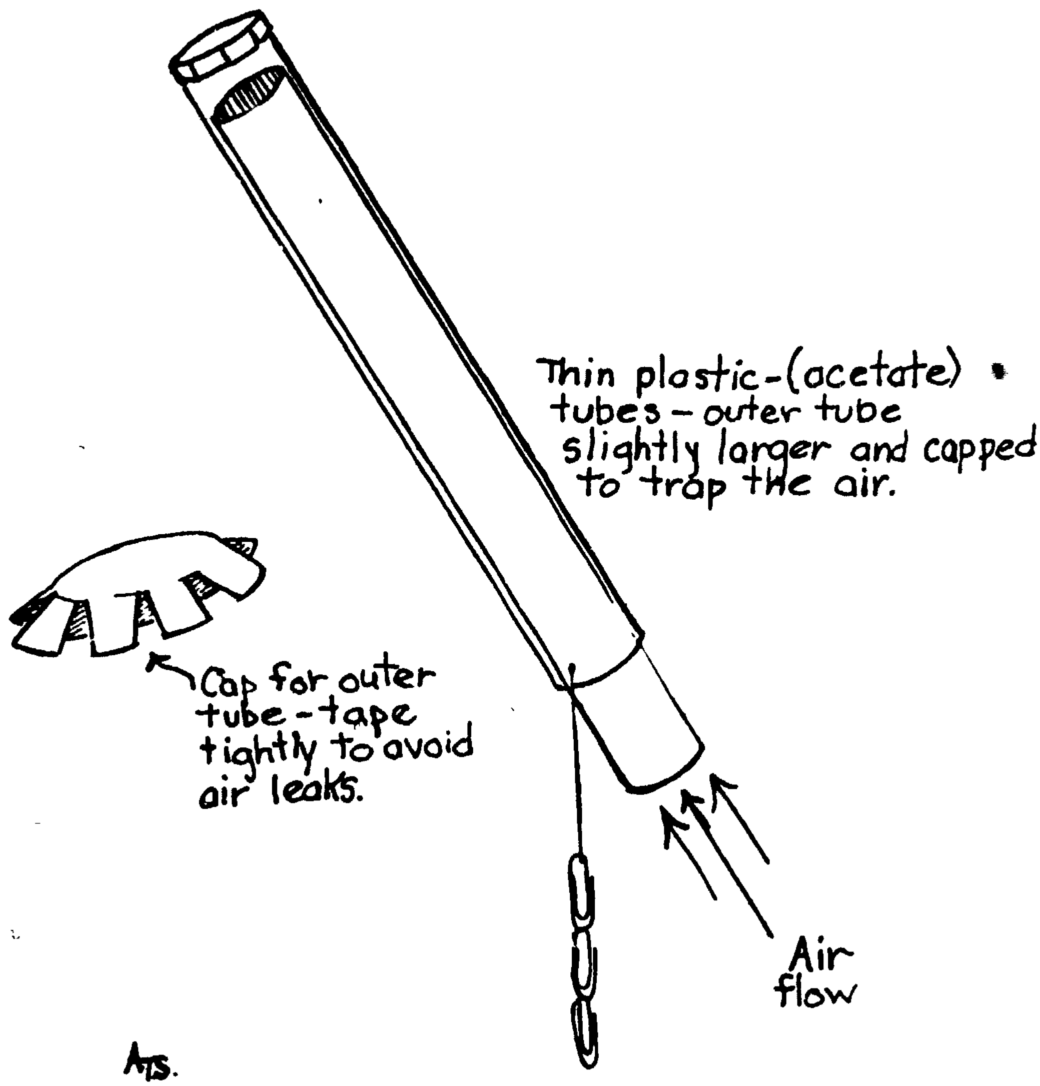
5) What other ways can you use the wind?

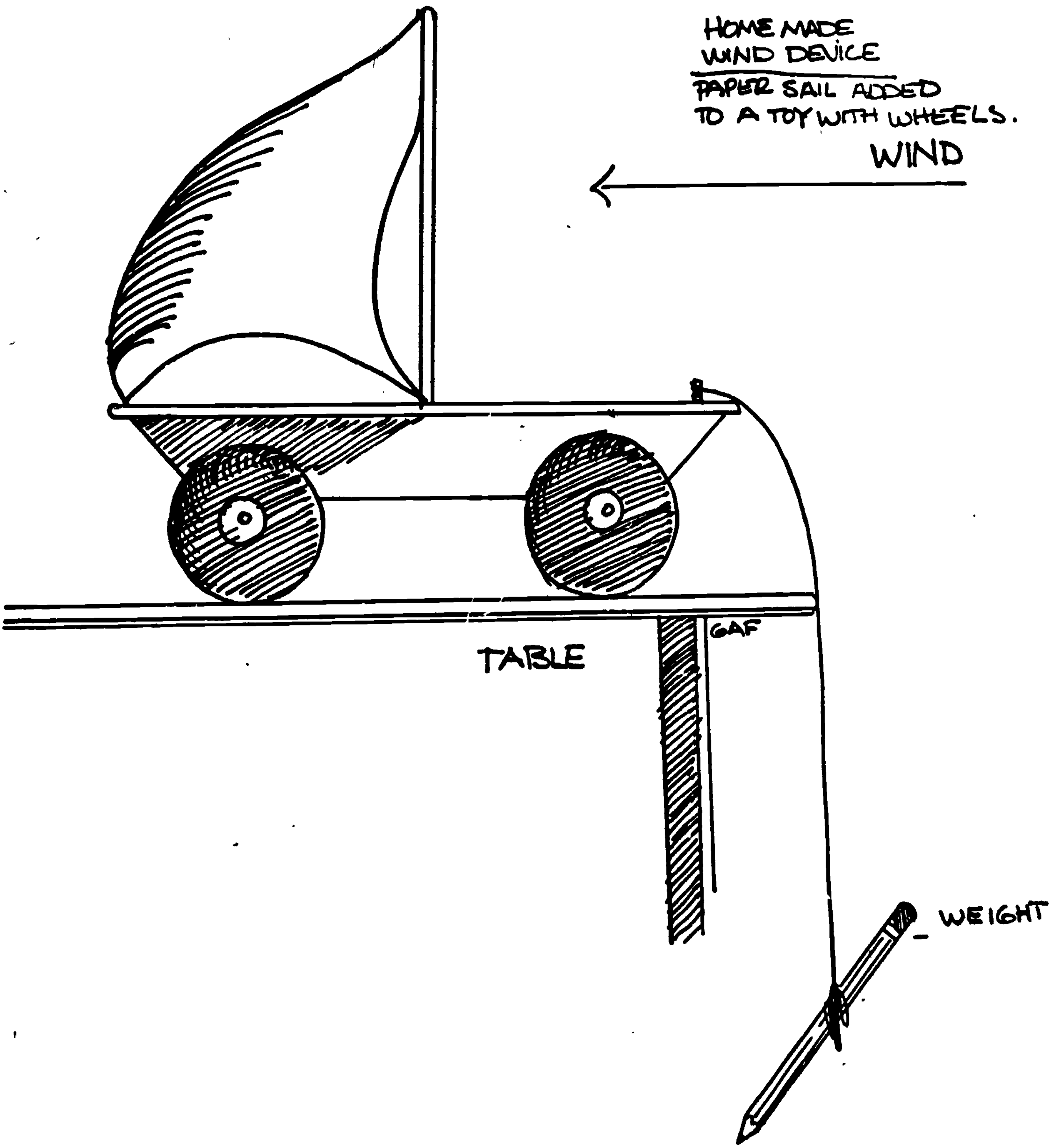
6) Invent a way to store the wind.

References:

The Search for Solutions, Teaching Notes 1, 1980. 708 Third Avenue, New York 10164.

Models: Electric and Magnetic Interactions, Science Curriculum Improvement Study, Rand McNally & Co., 1971.


Thin plastic-(acetate) tubes - outer tube slightly larger and capped to trap the air.
Cap for outer tube - tape tightly to avoid air leaks.
Air flow
AJS.



WIND INVENTIONS WORK WONDERS

LITTLE BIG TINY ENORMOUS CHANGES

by Michael R. Cohen

Focus: Science and technology are interwinded through inventions that effect our lives. Many inventions represent real breakthroughs and are hailed as innovations. Other inventions take years to develop and seem so natural that we rarely think of additional improvements. Even though we live in a world that is continually changing, it is difficult to accept the fact that changes can continue with even the best of inventions.

It is not difficult to find examples of changes in inventions that have effected our lives and those of the children we teach. Recently the picture indicating poison has changed from the "pirate" skull and crossbones to "Mr. Yuk." Many of us would never have considered such a change since growing up with a "traditional" warning picture made sense to us.

A continually changing area for inventions is the soft drink industry. Cans were at first seen as an improvement, but you needed an opener. So the "improvement" was the pull top. A great invention until you had to pick up the dangerous pieces of sharp metal. The latest pull tops now stay on the cans. What will be the next improvement?

Challenge: Improve a commonly used item.

Materials and Equipment:

The materials you need depend on the activity you select.

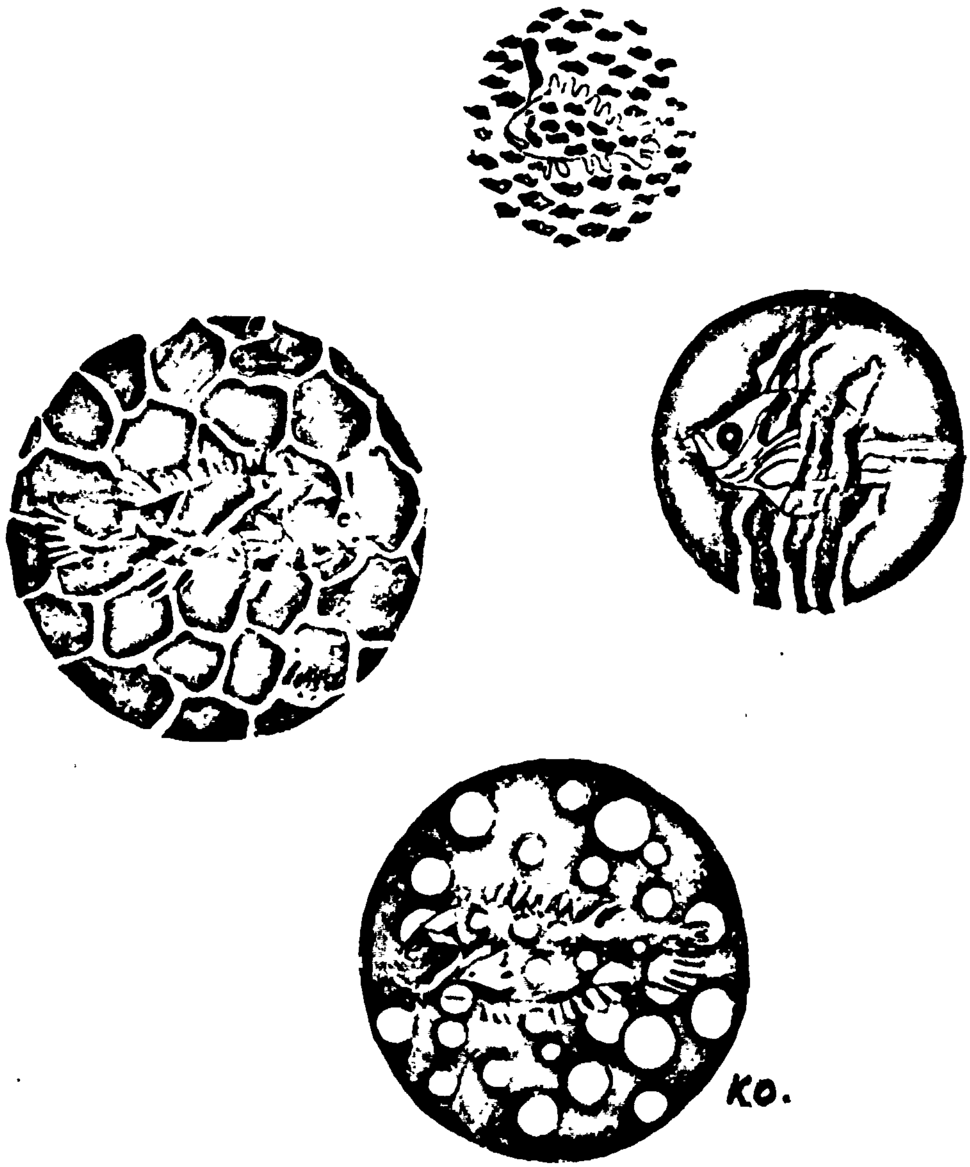
How-To-Do-It: It is often quite enjoyable to listen to six and seven year olds sounding like old wise people as they talk about the times when they were young. But they were serious about their feelings of "growing up." You can take advantage of this by asking them to describe things that have changed since they were young. Have them try to give examples of the changed properties. Then challenge them to improve an item that is commonly used and/or seems perfect. This activity works well in conjunction with the activity, "Could Two Plus Two Equal Anything But Four?"

Further Challenges:

1) Have children predict changes that will occur in the future in schooling, travel, food, entertainment etc.

2) Have the children try to make a list of items that will not change at all.

3) Invent a way to stop change from happening.



DESIGN AND BUILD A FISH

DESIGN AND BUILD A FISH

by Lowell J. Bethel

Focus: All marine fish live in an environment that is challenging. If they are not adapted to their marine environment they cannot survive. The adjustments that organisms make to their environment are called adaptations. Adaptations increase an organism's chances of survival in many different ways. Fish with protective coloration that camouflages them and allow them to blend in with their surroundings protect them from predators. Another adaptation is shape. An example of this adaptation are spadefish and butterfly fish which are flattened laterally so that they can swim fast and squeeze into narrow space for food and protection. Skates and rays have flattened bodies dorsally for living on the bottom of the ocean. Adaptations such as these insure an organism's survival.

Challenge: Given various materials, design a fish with an adaptation required for survival.

Materials and Equipment:

Clay	Scissors	Masking tape
Toothpicks	Magic markers	Twistums or ties
Pipe cleaners	Construction paper	String
Water paints	Stapler	Crayons
Paper clips	Tape	Glue
Paint brushes	Balloons	Buttons
Small sticks	Cotton	Plastic pieces

How-To-Do-It: Before starting this exercise conduct a discussion on fish and their adaptations necessary for survival. The teacher may want to show some pictures or illustrations of fish and their adaptations for survival in a marine environment. After the discussion, picture books of fish may be made available or students may be escorted to the library to research fish adaptations.

After the students have been introduced to adaptations and marine fish, challenge them to design and build a fish. Tell the students that they may use any of the materials provided to design and build their fish. In order to aid students who may have difficulty in creating this fish, conduct a brainstorming session on the many possibilities that the form (an adaptation) might take. Here are some ideas that can be printed on 3 x 5 cards and given to the students.

build a fish that flies
build a fish that walks
build a fish that crawls
build a fish that is transparent
build a fish that has many colors
build a fish that swims in deep, deep water
build a fish that fishes for other fish
build a fish that would scare "Jaws"
build a fish that puffs up when scared

build a fish that does not look like a fish
build a fish that looks like a dog
build a fish that swims fast
build a fish that swims slow
build a fish that eats big things
build a fish that eats crabs

Further Challenges:

1) After students have finished designing and building their fish, display, as if they were in a museum, have the class view and decide how the adaptations aid in each fish's survival.

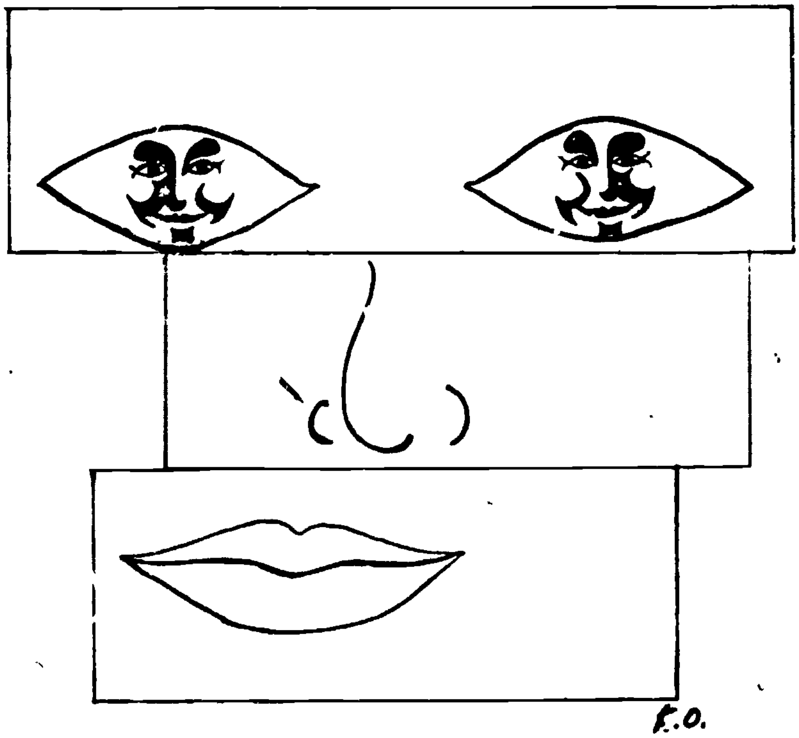
2) Take children out into the school yard and divide the class into two groups. Then tell the children to move to separate areas in the school yard (as far apart as possible). Now, have each group design and build a fish that can hide in the school yard and hide it in the school yard. Gather the groups together and give each group about five minutes to find the other group's fishes. The group that finds the most fish wins the search.

3) Have students design animals other than fish with adaptations necessary for survival in a marine environment. Books and pictures from the library may be available for help in designing and building a marine animal.

". . . a rich background of knowledge in a problem area actually tends to inhibit speculation."

George Prince

Prince, George. The Practice of Creativity. New York: Collier Books, 1970 page 78.



FACE VALUE

FACE VALUE

by Larry Flick

Focus: Children are perhaps more atuned to psychological nuances than adults. When asked to comment on a teacher or another student, they are apt to make a value judgement on some aspect of their appearance or behavior. "Mr. Brake is always giving speeches." "She like to wear dresses." "Miss Arnold has a fun smile." Ironically, this acute attention to spurious details is often hard to develop in other areas such as the way words are spelled or variations in the movement of a pendulum. This natural interest in other people's appearance could be used not only to develop analytic skills but to enhance children's awareness of their own feelings and reactions to other people.

Challenge: Invent a new happy face.

Materials and Equipment:

Comic strips
Political cartoons
Photographs of faces with most of them smiling

How-To-Do-It: Have the students bring in magazine and newspaper pictures and drawings showing a wide variety of smiles. If the school has a yearbook or class pictures these could also be used for study. In case of candid photographs students could brainstorm concerning the cause of the smiles. Not all interpretations of smiles should be expected to be positive. Encourage exploration of the feelings generated by the smiles by accepting all responses and perhaps by probing for deeper feelings.

The question "What causes people to smile?" cannot be fully answered by assuming good feelings and happiness. A thorough discussion of the above question should lead to an interesting discussion of "What smile(s) do you like best?" At this point students should be made aware of how difficult it is to determine the reason for a smile just by looking at the facial features. Many other factors must be considered. The fact that we seldom know many of these other factors behind a smile means that we usually react to a smile on face value only. That is we respond based on our own feelings and attitudes at the moment.

From the students' examination of their feelings concerning smiles, you could suggest a one week study of real smiles with the goal of inventing a new happy face that represents their favorite smile. Using the pictures and cartoons, make a list of facial features involved in smiles e.g., mouth, shape, teeth, eyes, wrinkles, dimples, hair, even sounds could be considered. Using simple line drawings the students should record as many "happy faces" as they can showing the important characteristics of the smiles. Point out that exact duplication of the face is not important. Like a cartoon, special aspects of the face can be simplified and even enhanced.

FACE VALUE

At the end of the week each student should make a composite happy face representing the most pleasing aspects of their data.

Further Challenges:

1) Are there common components in the students' happy faces? Can they be categorized such as according to the shape of the eyes, placement of wrinkles, or the shape of the mouth?

2) By changing just one aspect of a face e.g., the position of the eyelids, what changes are made in the interpretation of the expression? Carry this change through several variations e.g., to what are the respective changes in feelings toward the face? Which feature of a face causes the greatest change in feelings?

CAN I COUNT ON YOU?

by Larry Flick

Focus: Simple mathematical problems such as counting are often thought to be either right or wrong. Closer examination, however, can always lead to divergent interpretations. If you were given the problem to build a device that counts cars, you must decide whether the device will count the wheels that rolled over it or the shadows that passed by it. Will it count only the wheels carrying a certain weight? Will it measure the length of each thing that passed by? In other words what is a "car" and what does it mean to "count"?

Challenge: Invent a counting machine and build a working model out of available materials.

Materials and Equipment:

- String
- Glue
- Paper
- Toothpicks
- Springs
- Marbles
- Rubber bands
- Washers
- Buttons
- Coat hangers
- Clay
- Paper or Styrofoam cups
- Cardboard

How-To-Do-It: With as wide a variety of materials as possible, give the students a significant chunk of time, all at once, to build their machine (30-60 minutes). It is certainly possible that a student's solution to the problem would require a piece of equipment, e.g. camera, light, chemicals, that is not available. As long as the needed item is passive, i.e., not the counting mechanism itself, then the student may assume it is available. This assignment could be given as homework but the divergent, inventive spirit may be lost in adult interpretations.

The interpretation of the problem is based on three words: "build", "counting", and "machine." To some the word "build" may connote something solid, perhaps made from wood and glue. Others may use a "softer" meaning where the structure is less important than the function. This would allow for beads on a string.

"Counting" could be thought of as hash marks, the way a bell on a door gives audible sounds every time someone goes through. Conscious counting requires human intention each time an item is to be recorded. This may lead to allowing counting elements to represent more than one thing. The device may therefore be capable of changing bases as elements are allowed to represent different numbers of things.

The word "machine" may represent a powered device for some, yet others may think in terms as simple and elegant as a die manually turned to represent appropriate numbers of dots.

The culmination of this activity should be sharing of how each "machine" works. Have a counting machine sales convention, a number fair (see The Phantom Toll Booth by Norton Juster), or simply a show and tell session. Then pose a real problem, e.g. counting parts on an assembly line. Ask which device(s) could be used. By posing several other counting problems, difference in the interpretation of "Build a counting machine" can be highlighted. Other discussion questions might be: What more do you need to know before you build a counting machine? Even if you know what is to be counted, do you always have enough information? Whose machine counts the largest number of things?

Further Challenges:

1) Build a machine that counts selectively.

2) Build a machine that takes an average without doing any arithmetic. This is easier than you think. Worn steps show the average location of people's feet as they walked on the steps.

NUMERICAL ORDERS - GIVE ME YOURS

by A. Leon Pines

Focus: The concept of number and the ability to count seem so easy and obvious to us. We often fail to empathize with the problems children have in trying to learn their first number system and the meaning it has to their world. Recall your experience with other number systems such as binary (base 2) or octal (base 8). Students may one day need to work with such systems in the science of information storage, processing, and retrieval.

Inventing a new number system, different from the decimal system (base 10), will highlight a few of the problems that children face. Counting and doing simple addition and subtraction in this new system may point out the need for the notion of "place value." Mastering the new system will enable students to work effectively in other systems and understand the arbitrariness of the decimal system.

Challenge: Invent your own number system that can be used to count to infinity.

Materials and Equipment:

Initially the only materials and equipment necessary are pencils and paper. Later different handouts with exercises can be prepared. Also, wooden blocks of different sizes to symbolize different quantities can be used for counting and for practicing the concept of "place value."

How-To-Do-It: Prepare a number system or use the following system to start with. There are only two basic words (symbols) used in this system; AB and IM.

AB	= 1
IM	= 2
ABS	= 3
ABS-AB	= 4
ABS-IM	= 5
IMS	= 6

More of the system is presented in Table 1. See if you understand the system before looking at Table 1.

Group students into pairs. Display the basic elements of the system. Ask them to practice counting. Use blocks to show the concept of place value. Progress to elementary addition and subtraction exercises, then to fractions, and so on. This can be carried out over several sessions.

Students should have grasped the basics of the number system taught and experienced the difficulty in using this new system. Have students share their feeling about this experience. See if the concept of "place value" is now clear. Provide exercises in simple arithmetic for homework. After several sessions, have students invent their own number system and develop exercises. These can be shared among participants.

Further Challenges:

1) The number of number systems that you can construct is, of course, limitless. All arithmetical exercises that are usually carried out within the decimal system can be carried cut within the systems you invent. Try to invent a few and then use them. Send me copies of the systems that you have invented.

2) How is this system like Roman numerals? Do Roman numerals use place value?

3) Try counting in a foreign language. Can you tell by the words that you are counting in base 10?

Roman Numbering System	Decimal Name	Dot Diagram	New System Name
1	ONE	·	AB
2	TWO	:	IM
3	THREE	⋮	ABS
4	FOUR	::	ABS-AB
5	FIVE	⁙	ABS-IM
6	SIX	∶∶∶	IMS
7	SEVEN	⁙ :	IMS-AB
8	EIGHT	:: ::	IMS-IM
9	NINE	⁙ ::	ABSY
10	TEN	⁙ ⁙	ABSY-AB
11	ELEVEN	⁙ ∶∶∶	ABSY-IM
12	TWELVE	∶∶∶ ∶∶∶	ABSY-ABS
13	THIRTEEN	⁙ ⁙ ⋮	ABSY-ABS-AB
14	FOURTEEN	⁙ ⁙ ::	ABSY-ABS-IM
15	FIFTEEN	⁙ ⁙ ⁙	ABSY-IMS
16	SIXTEEN	⁙ ⁙ ∶∶∶	ABSY-IMS-AB
17	SEVENTEEN	⁙ ⁙ ⁙ :	ABSY-IMS-IM
18	EIGHTEEN	∶∶∶ ∶∶∶ ∶∶∶	ABSYS

Table 1. A number system.

INVENT A CIVILIZATION

by Elvin E. East

Focus: A biochemist might say "You are what you eat", but an anthropologist would probably say "You are what you leave behind." Every civilization has characteristics that identify it as a separate entity. These characteristics can be found in the garbage or junk that is left behind by a civilization. The skills of inference and hypothesis are certainly challenged when archeologist digs up a pil of garbage and tries to describe the civilization that left it behind.

Challenge: Describe your own civilization from your own garbage.

Materials and Equipment:

A fresh bag of garbage

How-To-Do-It: To prevent a sanitation problem the garbage should be quickly sorted and each individual piece identified and described in detail. Perishable things should be discarded and other things washed if possible (do not wash paper).

Nouns should be avoided and adjectives encouraged. A beer bottle is not a beer bottle but it is a container made of brown transparent, rigid materials. It is narrow at the open end and flat on the closed end. It has paper adhering to it on one side, with writing on the paper. The inside of the container smells yeasty.

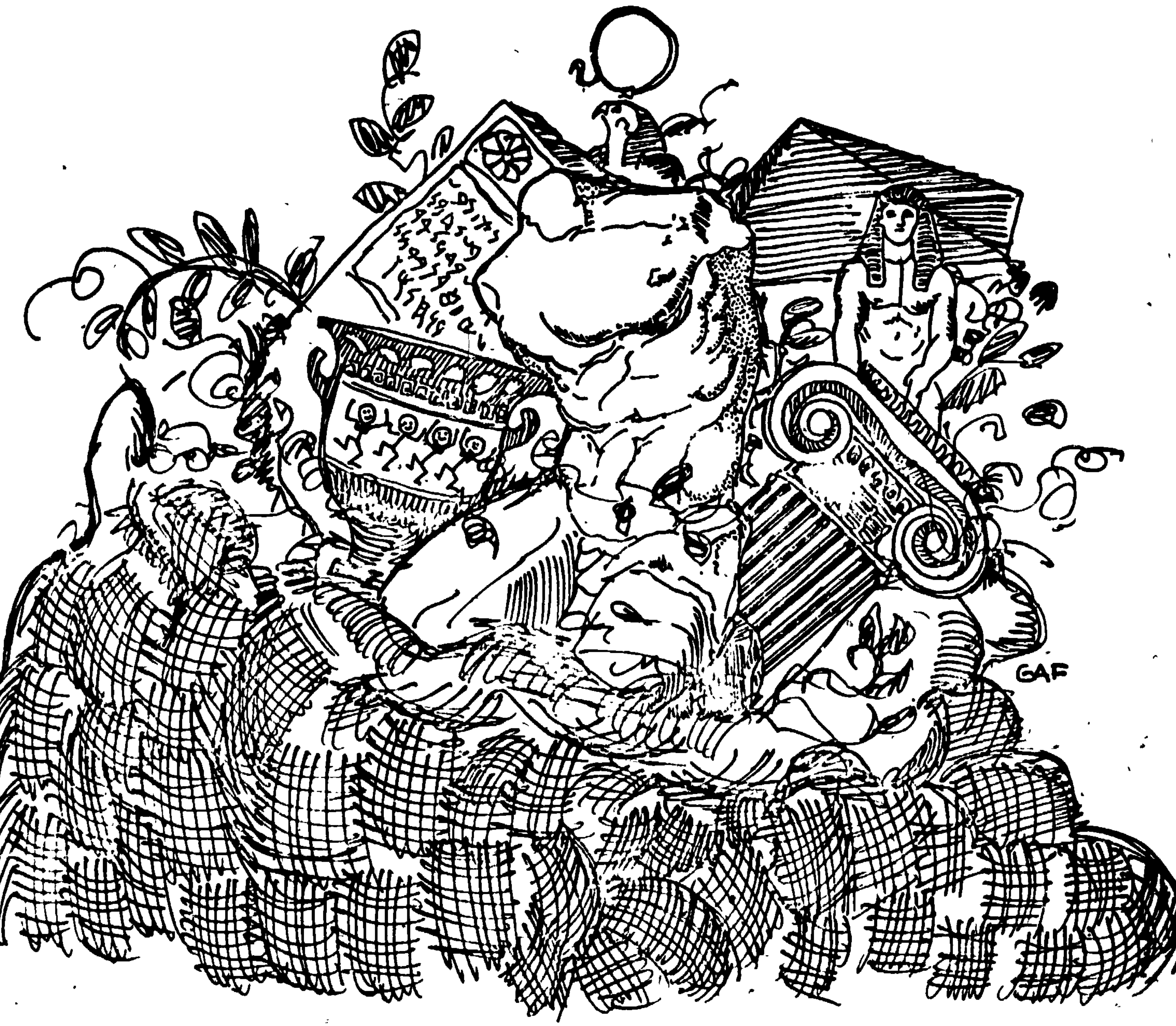
Objects that are in pieces or are broken should be reconstructed. A group of soft irregular objects, orange on the convex side and white on the concave side, should produce an orange colored sphere about three inches in diameter.

After each object is fully described and reconstructions completed, the students should try to make as many inferences as possible about each object or reconstructed group of objects. Simple and elaborate inferences should be made, but not antecedent knowledge.

When the inferences are completed, comparisons of inferences from different objects will enable the students to make hypotheses, e.g., two objects with similar writing would indicate a civilization with a written form of communication. These hypotheses should lead toward a composite description of the civilization.

Further Challenges:

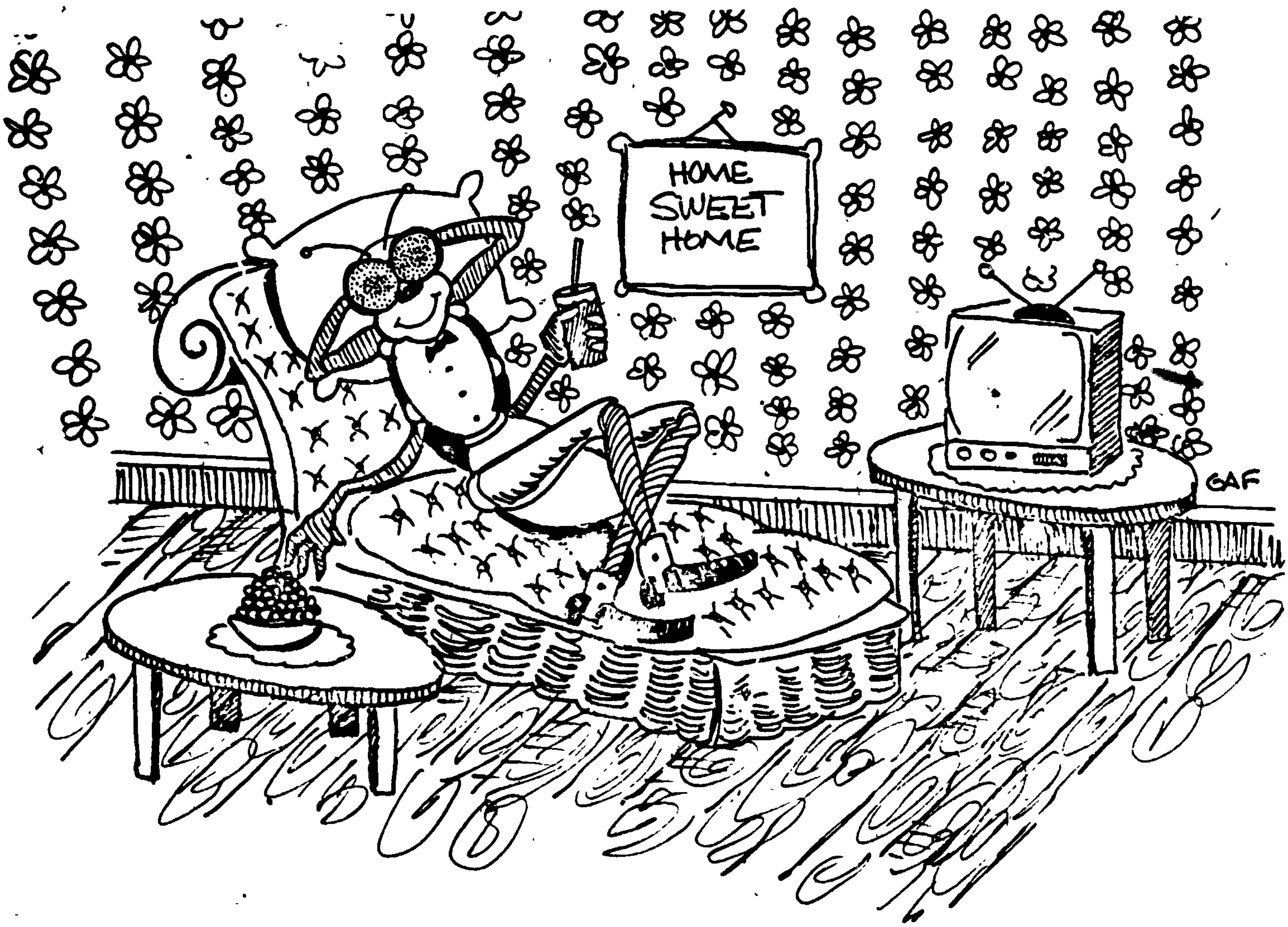
1) Try to produce a bag of garbage that would have existed in 1900. What difficulties would you have in reproducing such a thing?


GAF

2) Try to produce a bag of garbage that would exist in 2000. What difficulties would you have in producing such a thing? For this challenge, assume that life continues along lines similar to or extensions of life today.

3) Assume that next year major conservation laws are passed in all aspects of life. What effects would these laws have on the bag of garbage that you created (imaginatively) for 2000?

4) While reading a novel, jot down a list of things that the main character would be putting in her/his own garbage. Almost any novel would do, but an historical or futuristic one would be more of a challenge.



CATCH A CRITTER

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CATCH A CRITTER

by Elvin E. East

Focus: Thank goodness the days of mass butterfly collecting, chloroforming, and pinning are past. However, the benefits to be gained from close-up observation of insects are still of value. Today, scientists capture their subjects, study them closely, and release them to return to their natural habitat, without harming the insects.

Challenge: Construct an insect trap that will capture a particular insect but will not harm it.

Materials and Equipment:

Household articles
Resource books on common insects.

How-To-Do-It: Select an insect that is readily and seasonably available for you to trap. A knowledge of this insect's habits, diet, and habitat may prove very helpful in designing your trap. Read the resource books to find out all about your insect. Mentally design your trap. Draw and explain your trap on paper. Conduct any tests necessary, i.e. are flies attracted to vinegar? Build your trap and try it out. The survival of your insect will be a true evaluation of your trap.

A wide variety of insects may give birth to a wide variety of traps, but so might the challenge of everyone capturing the same type of insect.

Further Challenges:

1) Now that you have captured your insect, how can you continue to keep it without harming it? Is your trap only temporary and must you construct a holding pen?

2) The purpose of capturing your insect was for close-up observing. Using a hand lens and any other household materials, construct a "safe" close-up observation container. Do not forget that your insect must live through the ordeal.

3) Scientists study animals of all types and sizes. Design a trap that could be used to trap a larger animal without harming it, e.g., a tiger, an elk, a walrus, a bass, an eagle, a kangaroo, a procupine, a flying squirrel.