VOLUME 4 NUMBER 4 SEPTEMBER 1972

FOCUS ON EXCEPTIONAL CHILDREN

SCIENCE EDUCATION FOR THE EXCEPTIONAL CHILD

SCIENCE EDUCATION FOR THE EXCEPTIONAL CHILD

Norma Boekel and Joe M. Steele[1]

In the past, special class teachers faced a common dilemma—a real dearth of materials, equipment, and methodology for the educable mentally handicapped (EMH) population they served. The solution was to develop their own curriculum which they did, with varying degrees of success. Presently, teachers and teacher-trainees face another common problem: a smorgasbord of curricular designs and methodology. They are being deluged with new materials, instructional models, and curriculum designs—all requiring them to make countless decisions and choices. What? How? When? There are almost as many designs for teaching as there are differences among the children they teach.

The fully integrated curriculum for educable handicapped children is still a long way off, but no longer do we need to flounder in a sea of color-coded idea boxes. A serious effort has been launched by the Bureau for the Education of the Handicapped to develop sequential curricular materials in four major content areas: science, mathematics, social learning; and health, physical education, and recreation (see Figure 1). In addition to the development of sequential materials in these four areas, explorations are underway for the development of materials in reading. Some of these materials are available for use now; when they are all available (in the near future), they will provide teachers with a comprehensive curriculum of scope and sequence across developmental levels heretofore unrealized.

Although the subject matter may differ, the projects have certain commonalities: (1) They are breaking away from tradition and beginning anew with an emphasis on relevancy. (2) Goals are being redefined for the educable handicapped population. A common set of objectives seems to underlie all the projects. Representative of the objectives for these curricula are those listed in Figure 2 which were drawn from the BSCS science materials for EMH children. (3) Those who are experienced in designing and

1. Norma Boekel is a demonstration teacher at the University of Northern Colorado, School of Special Education, Greeley, Colorado. Joe M. Steele is evaluation consultant for the Biological Sciences Curriculum Study (BSCS) and on the faculty of the University of Colorado, Boulder, Colorado.

The authors thank Robert Wilson, art director of the BSCS, for assistance in illustrating this article.

producing materials are combining efforts with the consumers (teachers and pupils) to develop appropriate strategies. (4) Research surrounding these projects is intended to provide some real help to classroom teachers and narrow the traditional gap between theory and practice. All these projects seem to be discovering how well the materials work with the handicapped population and also which variations in teaching strategies would enhance the effectiveness of the materials.

Rationale for Teaching Science

Of the four major curriculum development efforts, science is entirely new to the scene of special education. But what has science to offer the handicapped child? Perhaps this question can be answered by describing what science is—and is not.

Science is discovery—learning fascinating things about ordinary, daily situations. It is the solving of problems that occur regardless of where we live. It is the broadening of curiosity and nurturing of interests. It is finding answers to questions that all of us ask: Who am I? How am I changing? What will I be? How do I differ from my neighbor? How will I affect others, and they me?

Science is *not* hit-or-miss lessons about thermometers, salt crystals, or butterflies. It is *not* learning the names of mushrooms or identifying the parts of insects. There is much more to science than substantive knowledge. Human interaction is important. Solving persistent life problems is important. Problem solving is important. In science, it is not the product alone but the process undergone that is important. We need to teach science as a series of *thought processes* and *inquiry skills* in order to develop necessary tools that our students need now and in the future. Science can teach children problem solving skills they will need to cope with the problems of living.

The notion that science education was necessary and desirable for only an elite cadre of pupils has all but disappeared. Most educators agree that it is necessary and desirable for *all* students. Slow-learning children cannot escape being confronted with science concepts and problems. If they are to survive in and contribute to this complex society, they must be provided with the tools to operate within it.

When we contrast our lives today with those of people living a century ago, we see how quickly the impossible becomes reality in man's achievement. "When all men hunted for food, all men were more alike." The key, then and now, is adaptation to the environment, not intimidation

Figure 1

Federally Funded Curriculum Projects for Educable Mentally Handicapped Children

Life Sciences for the Educable Mentally Handicapped

The Biological Sciences Curriculum Study
P. O. Box 930
Boulder, Colorado 80302

Math for the Handicapped

John F. Cawley
Educational Psychology Department
University of Connecticut, U-64
Storrs, Connecticut 06268

Social Learning Curriculum for the Educable Mentally Retarded

Herbert T. Goldstein
Curriculum Research and Development Center in Mental Retardation
Ferkauf Graduate School of Humanities and Social Sciences
Yeshiva University
55 Fifth Avenue
New York, New York 10003

Health, Physical Education, and Recreation

Janet A. Wessel
WIM Building, Room 102
Michigan State University
East Lansing, Michigan 48823

FOCUS ON EXCEPTIONAL CHILDREN is published monthly except June, July, and August as a service to those concerned with mentally retarded and emotionally disturbed children. This journal is abstracted and indexed in *Exceptional Child Education Abstracts.* Subscription rates, $9.50 per year. Printed in the United States of America. Second class postage is paid at Denver, Colorado.

Executive and Editorial Offices
6635 East Villanova Place
Denver, Colorado 80222
Telephone (303) 757-2579

by it. Science can be the vehicle for teaching how to live—for adapting, for coping with change, for solving problems.

Diversity in Special Classes

If we agree that the teaching of science to handicapped children is justifiable, then we should turn to the more difficult task of describing the population with which we are concerned (cf. Kolstoe, 1970).

Although there are some characteristics common to many EMH children, we are quick to recognize that the makeup of most special class settings is filled with inconsistencies. In fact, the hallmark of the special class is its enormous diversity as illustrated by the following examples:

- Some students are successful with some school tasks but are unable to apply them. This "chalkboard syndrome" reveals itself when students demonstrate the ability to compute difficult arithmetic problems, such as the division of large numbers, but at the same time are unable to conceptualize when to divide.
- Another group of students is completely disinterested in or antagonized by school-related tasks, but at the same time are engaged in fairly complex nonschool activities. Usually, they have met with much more experiential success than they can demonstrate academically.
- There are many imbalances in the overt as well as hidden abilities in many of the children. Some have no understanding of the simplest arithmetic operations, yet are proficient in reading.

Success at the school's chalkboard may have little to do with living. The President's Committee on Mental Retardation and the Bureau for Education of the Handicapped co-sponsored a conference that issued a publication entitled *The Six-Hour Retarded Child* (1970). The following sentence extracted from the Preface summarizes the contents:

> We now have what may be called the 6-hour retarded child—retarded from 9 to 3, five days a week, wholly on the basis of an IQ score, without regard to his adaptive behavior, which may be exceptionally adaptive to the situation and community in which he lives.

Many EMH students bring to the school setting a history of failure. The school must build a success pattern for them. Conversely, some of the more "protected" students in our special education classes have met with excessive amounts of success, leading to a false estimate of their own abilities. Teachers need to guard against this overestimation as well as underestimation of abilities on the part of students. Settings must be provided wherein the students can get a realistic picture of their own weaknesses and strengths.

Figure 2

Some General Objectives

To help the mentally handicapped child develop interests, skills, positive attitudes, and a sense of identity through active participation and concrete experience.

To provide the mentally handicapped child with challenging intellectual activity at a level commensurate with his ability to respond effectively.

To aid the child in establishing acceptable competence in, and functional modes of living through, heightened observation; a well-developed curiosity; an increased measure of self-confidence; and a sense of responsibility to and for his environment.

To contribute to the child's development of a higher level of social maturity and emotional stability that can lead to increased vocational proficiency, realistic self-concept, creative self-expression, and more effective assimilation into the community.

To develop in the child a knowledge of himself in relation to his environment along with a tendency to apply this knowledge to the tasks of everyday living.

To contribute to increased knowledge about the learning characteristics and limitations of the educable mentally handicapped pupil and about effective strategies for instruction.

Many of the EMH students are highly susceptible to ambiguity. Precision teaching is probably of greatest significance for this group because they are most easily thrown off the track by imprecise teaching. They cannot fill in the gaps or compensate for teaching deficiencies as can those youngsters at the other end of the spectrum, the gifted. The design of the curriculum should take this into account.

Most EMH students are highly motivated by the novel experiences and ideas that science can provide. Instead of engineering extrinsics, we teachers can take advantage of built-in, intrinsic motivators. At the same time, each experience can further the broad objectives we hold for these children.

Figure 3

Basic Assumptions Underlying the Design of the Curriculum Materials

EMH children need and can respond effectively to an activity-centered instructional approach.

To achieve the objectives, materials should, maintain a balance between detail and motivation; that is, the amount of minute and abstract detail that can be learned is probably a function of the interest and motivation that can be established to deal with it.

The classroom environment and the materials should be free from distractors; however, a variety of perceptual modes and instructional media should be used in all efforts at communication (e.g., sight, touch, smell, etc.).

An activity must involve the student in ways of applying the desired behavior; transfer cannot be assumed.

Activities should be developed in small, discrete units that build on or reinforce a concept or skill.

Entry points should be concrete, tangible "things" rather than abstract, intangible ideas or concepts.

Involvement of the student in manipulation and actual contact with materials is mandatory.

Ideas must be developed without the *necessity* for reading on the part of the student.

Vocabulary, where possible, should involve *functional* language rather than technical nomenclature.

Learning for the EMH student requires slower pacing, greater redundancy, and time for participation by each student.

Efforts to describe the "average" EMH child are essentially futile because of variability within the population; therefore, materials and methods should allow for attention to individual differences and needs.

A Basic Construct for Curriculum Development

Activities must be developed that are true to the demands required by the assumptions about handicapped children and that are consistent with the concepts and sequence suggested by scientists and educators (see Figure 3). The materials must then be reviewed from the standpoint of the intellectual and psychological tasks the children are expected to perform, as distinct from the information they are to learn or the skills and activities in which they will be engaged.

In the development of the BSCS Life Science materials for EMH children (with which the writers have been concerned), much thought and study was given to the developmental level of the child in terms of Piaget's theory. Activities that depend on such abilities as serial ordering or conservation of quantity are questionable if the majority of children using the materials have not reached that particular stage of development. To design activities requiring abstract thinking and mental (rather than actual) manipulation of ideas is especially inappropriate in a curriculum for the mentally handicapped.

As a basis for understanding how a child learns, Piaget says that a child must assimilate his environment and accommodate new thought patterns into existing ones. Concepts are not externally imposed on a child; they are attained through experience. Skills too must be gained through experience and practice in using them. Skills cannot be internalized from vicarious experiences. Simply having students observe, hear, or be told something is insufficient for them to be able to ingest the information, plug it into their own conceptual organization, and then do something about it.

It seems more and more apparent that a child's educational progress depends on his level of cognitive development. If this is true, the standard timetable of subjects and skills in the public schools is largely inappropriate. Because we have lacked a theoretical base, curricula have not taken adequately into account the cognitive developmental level. Many are pitched far above the appropriate stage, with too much emphasis on abstract logical thinking. Success can be achieved only when the complexity of the content of skills is synchronized with the learner's cognitive and idiosyncratic level of development.

Science Programs for the Elementary School

Those of us in special education have been quick to discuss diversity among our student population, but often have been slow to develop realistic curriculum designs to take account of this diversity. It is difficult to make the transition from descriptions of students to the educational decisions which must be based upon these descriptions.

Why has the federal government invested so heavily in the development of science curricula for handicapped children? Part of the answer lies in the success of large-scale curriculum studies in various subject areas over the last dozen years. In the sciences especially, a range of curricula have been developed that update and introduce innovations in the instruction and content of science. As Figure 4 illustrates, there are several science programs that have been developed for the average and above average student in the elementary school.

While these programs vary in comprehensiveness, they have a number of good features in common. They focus on process rather than collection of facts. They focus on skills utilized in thinking about and solving problems. They highlight exploration in working with materials and doing things. In contrast to the slick packaging of a scattering of ideas and concepts that represent many "programs" currently on the market, these are well-developed and coordinated curricula. They do develop sequentially a carefully selected set of concepts. Moreover, they all have been tested in the classroom.

Evaluation evidence from these and from science curricula developed for other levels and age groups is positive. Materials such as these do help children learn to think as well as interest and excite them and show that science does not have to remain in the realm of the technician, filled with formulas and detailed explanations.

The four curricula described in Figure 4 contain excellent materials and strategies for normal children. Although they were not designed for special education settings, there are many aspects of these materials that have relevance for handicapped children. Until the new materials developed especially for exceptional children are available at all age levels, efforts to adapt these materials can be rewarding, though time consuming. Excitement and involvement of students can be generated by the presentation of science as a process in which the children are allowed to participate actively.

During the school year of 1971, some of us in Special Education at the University of Northern Colorado have adapted the *Science Curriculum Improvement Study* materials for use with young retarded children, with varying degrees of success. The success of each lesson was dependent upon such variables as (1) the age of the youngster, (2) the skill of the teacher, (3) the extent to which the lesson was a concrete learning experience. Others, such as Ruth White in the Allegheny County Exceptional Children's Program outside Pittsburgh, have been working on adapting the *Science–A Process Approach* materials for special education. *Elementary Science Study* materials also have potential for young EMH children. However, the problems of adapting, revising, and adjusting these materials to the needs of exceptional children can be a time-consuming and sometimes very difficult process. At the present time, *ME NOW,* the BSCS-EMH science curriculum for the upper elementary level is already available.

A CURRICULUM DEVELOPED FOR THE SPECIAL CHILD

How is a science program designed especially for the handicapped child? Figure 5 gives a brief history of the curriculum which is being developed by the Biological Sciences Curriculum Study (BSCS). This effort is *not* an adaptation of existing materials. Instead, the total curriculum is being developed in consultation with scientists, special educators, teachers, and students.

The BSCS has been in existence for over a dozen years and has produced a number of successful curricula for the high school student. One of these, *Biological Sciences: Patterns and Processes,* was designed specifically for the academically unsuccessful high school student. Concern for that unsuccessful student and the lack of materials in science suitable for him led BSCS to undertake this task. The challenge was especially great since many of these students had been denied access to science as a discipline because it was "too hard" or because acceptable ways to present it to the target population could not be envisioned.

Purposes of Science for the EMH

The objectives of the BSCS-EMH program can be described in many ways: in terms of the ideas and concepts that are being developed; in terms of inquiry skills, problem solving skills, and thought processes that are emphasized throughout the activities; in terms of specific performance objectives related to cognitive, affective, and psychomotor operations that the students will perform during instruction and the things that students will know or be able to do after a sequence has been completed.

Figure 4

Science Programs

	Individualized Science	SCIS	ESS	S-APA
General Description	Individualized Science. Developer: Learning Research and Development Center, University of Pittsburgh, Pittsburgh, Pennsylvania. K through 8. General Science (an individualized, ten-level program). Complete science program.	Science Curriculum Improvement Study. Developer: Elementary Science Project, University of California, Berkeley. 1-6. General Science (two tracks; one physical science, one life science). Complete science program when both tracks are used.	Elementary Science Study. Developer: Educational Development Center, Newton, Massachusetts. K-6. General Science. Complete science program or units may be used as supplementary materials.	Science — A Process Approach. Developer: Commission on Science Education of the American Association of Science, Washington, D.C. K-6. General Science. Complete science program.
Goals	The objectives are directed toward developing student competencies in the areas of Self-Direction, Co-Evaluation, Inquiry, and Scientific Literacy. The program also concerns itself with the development of positive attitudes toward science and scientists (Affective Goal) and with the social aspects of science.	"The program's goal is to provide students with a framework of concepts to which they can relate their science experiences and an understanding of the processes of scientific investigation."	"The developers of ESS believe that elementary science instruction should be based on involving children with reality. They argue that because learning does not come about by a wholly logical route, children should be encouraged to learn by experimenting and trying things on their own and by setting their own goals."	"The goal cf the program is the students' mastery of the specified processes. The developers believe that systematic teaching of the skills that make up a given process will lead to mastery."
Instructional Strategy	Students work with self-instructional materials, progress at their own rates, and utilize whatever learning resources best meet their interests and needs. Some learning resources are designed for individual study and some for the student to work with other students or the teacher in small group settings.	"SCIS specifies a three-part instructional procedure: 1) *exploration* in which students explore materials, 2) *invention* in which the teacher presents a concept scientists have invented to explain what has happened, and 3) *discovery* in which students discover other applications of the concept, that is, generalize. Teaching instructions are explicit, but the presentation of material within a unit may be arranged to suit the teacher's needs."	"Students are free to work with the materials in any way they wish. Suggestions for presentation are given, but not prescribed. The teacher may make use of the materials in any way that meets his requirements."	"Students are directed through activities designed to develop particular skills. The skills are defined in terms of observable student behavior; the developers believe this is the only way to judge intellectual growth. A student completes a lesson when he successfully demonstrates the skill it teaches. Although general teaching methods are suggested, the teacher is free to handle the lessons in any way that will achieve the specified outcome."

Perhaps the intent of the curriculum is best captured by the broad, major aims for the whole curriculum which can be expressed in just a few statements (see Figure 6). First of all, the curriculum includes instruction related to the personal well-being, self-worth, confidence, and successful coping of each student to meet persistent daily life problems. The curriculum is designed for the unsuccessful in school, regardless of cause. One aim, then, is to develop in the student a sense of identity as a person who has some degree of control over and can act on his environment. A second major aim is to develop a success syndrome. The student is provided with a series of successful experiences in school. The curriculum is also intended to be intellectually stimulating, exploratory, and have the student actively involved as an inquirer. As a third major aim, it encourages the following outcome: the development in the student of

Figure 4

Science Programs (Continued)

	Individualized Science	SCIS	ESS	S-APA
Major Subject Emphasis	The subject studied is general science with some emphasis on biology. The organizing themes for content are "Man and His Systems" and "The Biosphere: Ecosystem of the Earth." The major emphasis, however, is placed on science as inquiry, and on the individual's needs for knowledge and understanding of scientific ideas which are relevant to current societal issues and relevant to himself.	"SCIS focuses on two areas, physical science and life science. Both tracks emphasize concepts but also expose students to processes of scientific investigation. The physical science topics covered are material objects, interaction and systems, subsystems and variables, relative position and motion, energy sources, and electric and magnetic interaction. Life science topics are organisms, life cycles, populations, environments, communities, and ecosystems."	"Subjects for study include eggs and tadpoles, lights and shadows, mystery powders, 'small things,' pendulums, bones, batteries and bulbs, mealworms, gases and airs, kitchen physics."	"[S-APA] focuses on scientific processes: observing, classifying, using numbers, measuring, using space/time relationships, communicating, predicting, inferring, defining operationally, formulating hypotheses, interpreting data, controlling variables, experimenting."
Unit Sequencing	A basic core of units (Mainstream) is designed to develop the student's competencies under the Scientific Literacy, Inquiry, and Self-Direction goals. Lessons and investigations within Mainstream units are sequenced, as are Mainstream units within levels. Alternative Pathways units, which are loosely articulated with Mainstream units, are available. The student chooses those Alternative Pathways units and activities he will work in.	"For each grade level there are two units on physical science and two on life science. The units are sequenced in a recommended pattern but can be restructured. Together, they compose a program for grades 1-6."	"ESS consists of 54 units that can be organized as a complete K-6 program or used as supplementary material over several years. Each unit may be used at several grade levels."	"Every exercise is organized around one of these processes (see Major Subject Emphasis) and its related skills. Together the exercises form a sequential K-6 program. Each exercise is designed to follow and build on the preceding one for the same process and should not be used out of sequence."

All statements concerning the S-APA, ESS and SCIS programs have been obtained from an impartial source, "A Review," a booklet in the *Elementary Science Information Unit* (copyright 1969 by the Far West Laboratory for Educational Research and Development, Berkeley, California).

an interest that could become a hobby or avocation over a lifetime through an array of experiences in science.

What are the science concepts that serve as the vehicle for achieving the aims and skills listed above? At the 11- to 13-year-old level, the curriculum is organized around the human body and its structure and function. During this period, the child is growing and changing rapidly; he is interested in himself and how his body works. Through experiments and activities, the child learns about digestion and circulation, respiration and body wastes, movement, support, and sensory perception, his own growth and development from birth, as well as about conception and the birth process itself. This is fitted into the context of growing up, family life, and the different roles that a person plays throughout his lifetime, including consideration of old age and death. It develops the dynamic idea that "I" am ever changing, growing, developing, and am now somewhere on life's continuum from birth to death.

For the 13- to 15-year old child, the curriculum is organized around a number of ecological themes. The content

Figure 5

The EMH Science Project in Brief

The BSCS project for the Educable Mentally Handicapped (EMH), funded in 1969 by the Bureau of the Handicapped, United States Office of Education, has the specific goal of developing and producing an effective set of relevant instructional materials in the life sciences for the eleven- to nineteen-year-old population of educable mentally handicapped pupils. The initial set of multi-media materials developed, *ME NOW*, was directed toward the intermediate, eleven- to thirteen-year-old age group. It is now in commercial production and is being distributed by Hubbard Scientific Company of Northbrook, Illinois. Last year a three-year continuation grant was awarded to the BSCS, enabling it to proceed in the development of life science materials for the thirteen- to fifteen-year-old EMH population. The second set of multi-media materials, which is now being tested in an experimental edition, is entitled *ME AND MY ENVIRONMENT*. Both *ME NOW* and *ME AND MY ENVIRONMENT* are student-centered activity programs that consist of very little written material for the students. Both programs rely on a Teacher's Instructional Manual to direct inquiry strategies.

The content areas around which the EMH program has been developed are as follows:

ME NOW

Digestion and Circulation
Respiration and Body Wastes
Movement, Support, and Sensory Perception
Growth and Development

ME AND MY ENVIRONMENT

Exploring Our Environment
Energy Interrelationships
Pollution and the Quality of Life
Populations and Societies
Recycling Finite Resources
Living Space and Technology

Figure 6

Aims for *ME AND MY ENVIRONMENT*

Development of a sense of identity as a person who has some degree of control over and can act on his environment. This will lead to a degree of self-determination based on a rational coping with situations rather than passive compliance or impulsive response to problems.

Development of a success syndrome. More than anything else, each activity is intended to be a success experience for each child. It is the teacher's responsibility—almost his sacred obligation—to see that each child succeeds at a level that is challenging to his abilities and that preserves his self-respect. It is a further responsibility of the teacher to point out his achievement. The students as a group should feel a sense of worth and growth. The teacher should help them fit what they have done into a pattern of accomplishment.

Development (through an exposure to an array of experiences in science) of an interest that could become a hobby or avocation over a lifetime. It is hoped that many would find some area—perhaps growing plants, caring for animals, identifying flowers, collecting things, or simply enjoying outings into the country—that they feel strongly about and can develop some competence or knowledge in. This would provide a means of self-expression and (perhaps) allow some degree of sharing or involvement with others.

Development of a sense of relationship and empathy with other living things that will lead to a positive regard and caring about what affects them because what affects them affects the community of man.

Development of an understanding of environmental conditions which will lead to a sense of responsibility for the environment and actions that protect or improve it.

is aimed toward the development of a sense of relationship and empathy with other living things that will lead to a positive regard and caring about what affects the students, because what affects them affects the community of man. The content is also aimed at the development of an understanding of environmental conditions which will lead to a sense of responsibility for the environment and actions that protect or improve it. Eventually the BSCS will produce materials for 15- to 19-year-old handicapped youngsters. These materials will use science as a vehicle for coping more successfully with job situations, family planning, and a variety of other concerns that have a direct application to the adult world.

Plans are also being made to extend the science curriculum below age 11. At present, however, schools that begin teaching the available materials, *ME NOW*, at the 11-year-old, upper elementary level will be able to continue a sequential integrated science curriculum for a five-year period. By the time the two-year *ME NOW* sequence is completed, the *ME AND MY ENVIRONMENT* sequence for 13- to 15-year-olds will be available. Each of the hundreds of activities will have been tested, revised, tested again, and then revised for general release.

SOME SCIENCE ACTIVITIES

Several activities have been selected from the BSCS science materials to suggest what teachers and students do. It is difficult to illustrate a sequenced curriculum with a few lessons pulled out of context. However, these activities have been chosen because they can stand alone and require no special materials.

The first activity (see Figure 7) is taken from the *Teacher's Instructional Guide* for *ME NOW, Unit I, Digestion and Circulation.* This selection represents only one of the nearly one-hundred activities in the two-year instructional block that is the *ME NOW Life Science Program.*

The next activity (see Figure8) is from *ME NOW, Unit IV, Growth and Development.* This time the page format is not reproduced.

The third example (see Figure 9) is an activity from *ME AND MY ENVIRONMENT, Unit I, Observing Habitats.* This unit ranges from macro to micro habitats and heavily emphasizes inquiry skills.

THE RÔLE OF THE TEACHER

Any curriculum, no matter how well conceived and developed, becomes a curriculum only in the hands of the teacher who interprets it, responds to the students, and draws on her experiences to broaden and breathe life into the materials that are worked with. Curiosity cannot be aroused by a teacher who is not curious. Human interaction cannot be taught by a teacher who scoffs at humanity. Problem solving cannot be taught by a teacher who does not recognize a problem. What is taught most effectively by the teacher is what is practiced by the teacher.

The teacher may be overjoyed at the quantity and quality of materials being made available in the area of science. However, the responsibility of the teacher is to decide whether or not this material is useful for the children enrolled in her classroom. This cannot be relegated to any curriculum committee. The teacher's insight and understanding of every child she is teaching will prompt her to provide stimulation in terms of the needs of John, who has had an ideal experiential background, or Fred, who has been emotionally and socially impoverished. She will provide the *environment* and the *opportunities* to help each of these children and give them *time* to attain the maximum amount from each science concept.

A sixteen-year old EMH student who is participating in the first field test of *ME AND MY ENVIRONMENT* expresses what is needed in this way:

> **I just feel that if we want these kids to improve, and that's the whole idea of it, you have to bring these kids a certain amount of happiness. You have got to make them feel that they are really wanted. If they are wanted, they will try a little harder. That sounds kind of childish, I suppose, but it works. . . . Another thing. . . always inspire: "Come on, put your best foot down–try it again." You know, things like that. I mean, to me, just the tone of voice makes a difference to me about going out or staying in this class. I just feel like they don't want me–and they don't (when their tone says) "Oh, Eddie! Why did he have to come to school today?"**

The heart of the BSCS science curricula is the active involvement of the student, a carefully developed sequence of skills and concepts, and the implementation of these by a perceptive teacher. It is discovery oriented. The major teaching strategy is questioning. Effective teachers keep inquiry open by asking questions that require more than superficial answers. They follow up a student's response with probes to draw out further comments. They also redirect their questions to other students.

The following are general guidelines for asking questions. Judge your performance in teaching against these criteria:

1. Allow students ample time to think over the question.
2. Ask clear questions one at a time. Rephrasing should be unnecessary.
3. Obtain answers from many students before going on to another question.
4. Ask "Why?" frequently to obtain elaboration and justification of ideas.
5. Distribute questions among the students so that all are encouraged to speak.
6. Balance the kinds of questions asked:
   - ask factual, descriptive, clarifying, and probing questions.
   - ask questions which elicit inquiry behaviors; higher thought processes; divergent responses.
7. Encourage lengthy responses.
8. Encourage student-to-student exchanges.
9. Ask questions that cannot be answered merely with a "yes" or "no."

It is the wise and understanding teacher who will. . .

Allow the child to think about and test his ideas in ordinary daily situations. The child who spends most of his time living vicariously in the colored television world can be a deprived youngster. The child stacking blocks or playing

Figure 7

Unit 1 Digestion and Circulation

Terminal Objective 103 Students will relate structure with function of mouth parts.

Subordinate Objective 1 Students will associate the teeth with chewing, and the tongue with chewing and tasting.

Activity 1-11

Materials

Activity 1-11.

Film (*Passage of Food Through the Digestive Tract*)

*Super 8mm motion picture cartridge projector

Poster 7

Teaching Strategies

Activity 1-11. Functions of the Tongue

The tongue and its functions, especially in chewing and tasting, are now focused upon.

Now tell the class:

> LET'S STUDY ANOTHER PART OF YOUR MOUTH, THE TONGUE. CAN YOU TELL ME WHAT YOUR TONGUE IS FOR?

List their ideas on the chalkboard. Then display the cartoon posters and ask:

> DO THE PICTURES GIVE YOU OTHER IDEAS?

Help students arrive at a list similar to the one at right. If no ideas are forthcoming, ask leading questions based on the statements at the right.

Continue by asking:

> HOW CAN WE TELL IF THESE IDEAS ARE RIGHT? LET'S START WITH TALKING. HOW CAN WE FIND OUT IF THE TONGUE ACTUALLY HELPS US TALK?

Give students a chance to suggest the "experiment." You might also tell them that this really *is* an "experiment," because they are trying out something to see if it will work.

If the students cannot suggest an experiment, then suggest:

> TRY HOLDING YOUR TONGUE WITH YOUR FINGERS WHEN YOU SAY YOUR NAME.
>
> NOW TRY KEEPING THE TONGUE PRESSED AGAINST THE BOTTOM TEETH WHILE YOU SAY YOUR NAME.

Then ask:

> WHAT DID WE LEARN FROM THE EXPERIMENT?

Continue by projecting the next portion of the film, *Passage of Food Through the Digestive Tract*, which shows the movement of the tongue in pushing food around in the mouth and as an aid in swallowing. For further information in using this film refer to the *Instructional Guide* which accompanies it. Stop the film at the question, "What is the tongue doing?"

Anticipated Student Behavior

At the end of this activity, each student should:

--suggest functions of the tongue from his past experiences and from a study of Poster 7
--verify or extend his suggestions as a result of personal experimentation
--complete the sentence, "A tongue is for..." for each of the cartoons depicted on the worksheet for Poster 7

During this activity, students should:

--express orally their conceptions of what the tongue does.

--extend their discussion of functions of the tongue:
"I use it to lick."
"I use it to talk."
"I use it to taste."
"It moves the food around in my mouth."
"I use it to feel things in my mouth."
"It helps me to eat."

--suggest ways to keep the tongue still while trying to talk.

--fail in attempts to talk clearly while holding the tongue still.

--respond that the tongue is needed for talking.

--indicate that the tongue pushed food around while it was being chewed, and that it pushed food to the back of the mouth so that the food could be swallowed.

Figure 7 (Continued)

Activity 1-11

Terminal Objective 103 — Students will relate structure with function of mouth parts.

Subordinate Objective 1 — Students will associate the teeth with chewing, and the tongue with chewing and tasting.

Materials	Teaching Strategies	Anticipated Student Behavior
		Students should:
	After the film, ask: HOW CAN WE FIND OUT IF THE TONGUE HELPS US WHEN WE EAT?	--suggest keeping the tongue still while eating.
*Samples of food, such as crackers, fruit, milk (or water)	Let each student try eating while holding the tongue against the bottom teeth; ask several students to explain how it feels to try to eat without the tongue.	--discover that they must move the tongue to chew or swallow food. --describe to the class how it feels to try chewing or swallowing without moving the tongue.
	Now ask students to explain what the tongue is used for.	--explain that the tongue is used for talking, eating, and for swallowing.
	Suggest that students try another experiment.	
	Ask: WHAT ELSE CAN THE TONGUE DO?	Students should: --suggest things the tongue can do, such as: "Lick ice cream cones." "Remove food particles from between the teeth." "Taste things."
	A tasting experiment will be more difficult for students to devise, but give them a chance to try. Ask them to recall what they learned about eating and swallowing. Then go on to suggest a way to test for tasting.	
*Food samples with definite recognizable taste, such as peanut butter. *Plastic spoon	First, let each student taste a sample of the food.	
	Then ask: WHAT DID YOU TASTE? EXACTLY WHERE IN THE MOUTH DID YOU TASTE IT?	--have difficulty saying exactly where the taste appears because they will involve all of their mouth in the tasting process.
*Sugar solution or clear syrup *Q-tips Worksheet 3 (cartoons)	Now suggest a different procedure. Have students work in pairs, using a Q-tip to place sugar solution on different parts of the mouth while the mouth is held open.	Students should:
	Have them try the teeth, inner jaw, lips, and tongue.	
	Then ask: DID THIS HELP TO SHOW YOU JUST EXACTLY WHERE YOU TASTE FOOD?	--identify the tongue as the place where they taste food.
	As a review of this activity, display the cartoon posters dealing with the tongue again. Give each student the individual sheets for sentence completion, then ask them to fill in the words that describe what the tongue does.	--fill in the blanks on the worksheet.
	WRITE NEEDED WORDS ON CHALKBOARD	
*Film strip projector, 35mm	<u>INSTRUCTIONAL ASSESSMENT QUESTIONS</u> (related to subordinate objective 103-1) IA-24 and IB-17	
*Not furnished in materials kit.		

Figure 8

TERMINAL OBJECTIVE 402 Students will infer social roles related to sex
SUBORDINATE OBJECTIVE 2 Students will infer their potential roles as parents.

Unit IV GROWTH AND DEVELOPMENT Activity 9. Parental Roles

The story used in this activity is designed to bring out social roles associated with adulthood. Care should be exercised in adapting discussion questions to the *group of students you have.* Have the students listen carefully as you read the story.

Pablo and Maria met on the beach in Mexico. They were both young, but they looked as adult as any of the others on the beach that day.

It was love at first sight. Never before had Pablo seen such a gorgeous female. She was graceful in the water and beautiful on the beach. Maria noticed him watching her. She thought he was handsome too.

The vacation was nearly over when Maria and Pablo decided to be married. They did not get to choose where they would spend their honeymoon. Both Maria's and Pablo's families had decided to fly to Canada together for the honeymoon.

When they arrived in Canada, Maria and Pablo got some time to be by themselves at last. After much talking, they decided to build their home near a beautiful lake. They worked hard building the house. When it was almost finished, a big storm came across the lake. The wind blew down trees everywhere. It rained so hard that their entire house was washed away. The day after the storm, they had to start building all over again.

Over the years, Maria and Pablo had a whole flock of children. Their house became a happy home. They took good care of their young ones. For example, one day, Pablo came home just in time to see a huge wolf sneaking in from the woods to grab one of the youngsters. Pablo really flew into that wolf and saved the young one.

The years went by. The family worked together in Canada and vacationed together in Mexico.

One winter, Maria got very sick. The whole family seemed to know that she would not make it. In the spring, she died. Pablo missed his beautiful Maria. He still had his family, but he never found another mate. His youngsters grew up and made homes of their own, but Pablo remained single the rest of his life.

Possible questions for discussion:

USE QUESTIONS APPROPRIATE FOR YOUR STUDENTS

1. Where did Pablo and Maria meet?
2. How old do you think they were?
3. What is an adult?
4. What is love at first sight?

SELECT OR EXTEND ANY OF THESE QUESTIONS

5. What is a honeymoon?
6. What does it take to build a house?
7. What does it take to make a home?
8. What is a mate?
9. What does it mean to be single?
10. Do all families have problems? (storms)
11. What are some problems that families have?
12. How old do people need to be to have children?

RELATE QUESTIONS TO STORY AND TO STUDENTS' OWN LIVES

13. What does "take good care of children" mean?
14. What happens when there is illness in a family?
15. How does death affect a family?
16. What does it mean to remarry?

Continue the discussion, accepting all answers. *Aim toward relevancy and application in the students' lives.* Questions that were related to the story can be used to relate directly to the student, such as:

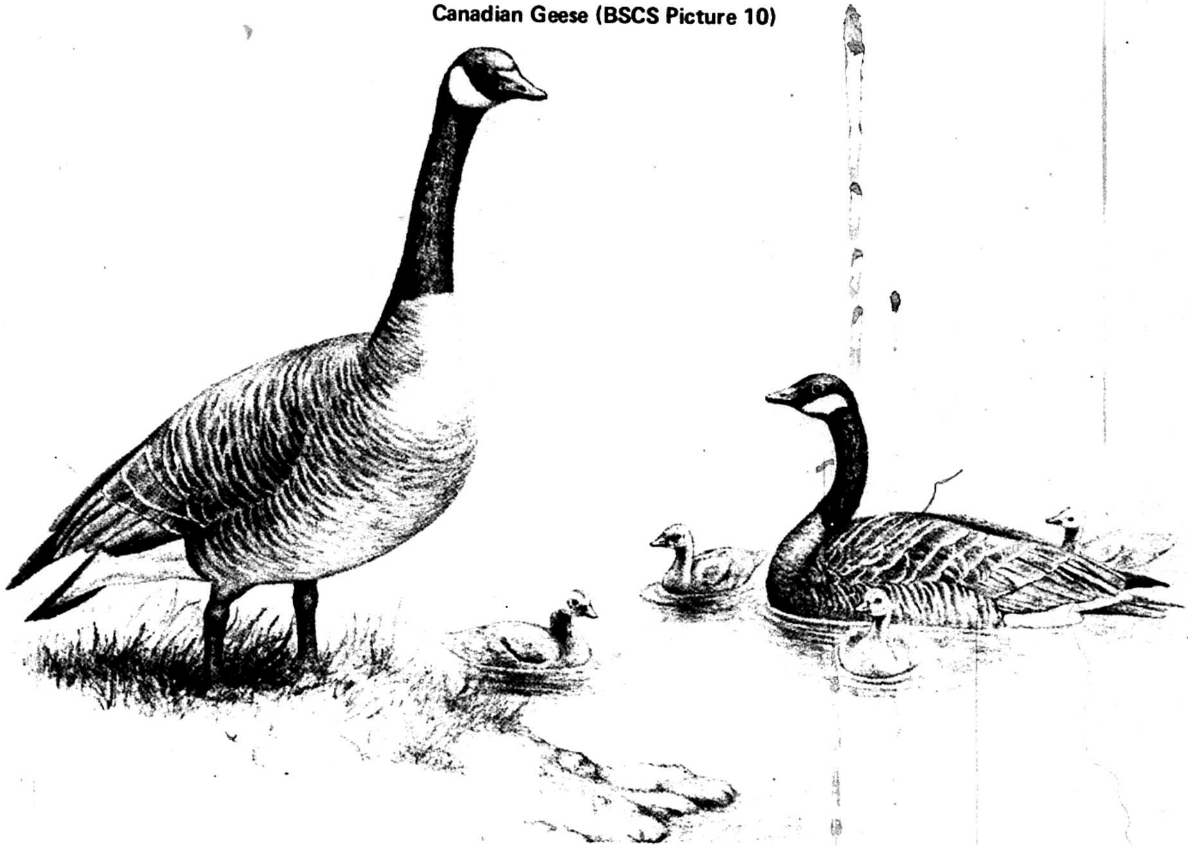
What do you think an adult is? How would you care for your children? What do you think a home is?

Next, ask the students if they would like to see a picture of Pablo and Maria. Display and pass out a copy of picture 10 of the Canadian geese to each student.

WHAT CLUES WERE IN THE STORY THAT HINTED THAT THIS WAS A STORY ABOUT GEESE?

Now reread the story in parts. Have the students make comparisons between the family life of geese and of people.

Figure 8 (Continued)
Canadian Geese (BSCS Picture 10)



in a sink full of water has the distinct advantage of learning by experience, not the experience of others.

Allow the child time–time to experiment for himself, time to dream, time to make errors, time to explore an idea. As one of the authors remembers:

> When I was a child, my mother was an incurable nap-taker. She maintained a daily ritual of hard work (mornings) and relaxation (afternoons) and forced all those around her to do the same. I seldom slept! Instead, I spent many afternoons quietly exploring the contents of junk boxes. Other days, I sprawled on my bed and examined the design in the bedspread, tracing and retracing it with my fingers. After I learned to count, I practiced counting squares in the ceiling (there were seventy-two). And *long* after I memorized my multiplication tables, like the good little rote-learner I was, I realized that the dimensions of the ceiling were nine squares by eight squares. What a revelation! This was a move toward understanding why it was useful to know that 8 x 9 = 72. . . . I remember watching the falling snow as it hit against my bedroom window and wondering why the white disappeared when it melted into rivulets of water (I still don't know). . . . And I remember sneaking into my room with a little bucket of water to swing over my head. I really couldn't explain centrifugal force, but I had a good time "discovering" about it. . . . Now, I too have a mania for short naps. Although I cannot recommend that teachers sleep at school, I must advocate the creation of home and school environments in which children have time to think, experiment, and learn!

Allow the child to participate in living wherever he is. Opportunities are found everywhere that students are. Science is on their farms and in their cities. Science is in the park and in the streets, in the doorbell and sand castle. Most importantly, the learner must observe, taste, feel, and so on in first person. *I* must collect, describe, question–not you, or he, or she, or they. The success of any science activity is directly related to individual participation by each member of the class. Learning is by doing, not by watching teachers and parents doing!

I hear. . .and I forget.

I see. . .and I remember.

I do. . .and I understand.

Ancient Chinese Proverb

Figure 9

Me and my Environment UNIT I

TERMINAL OBJECTIVE 101 The student will infer that there is a relationship between himself and his environment.

SUBORDINATE OBJECTIVE 101.1 The student will locate and describe his position in space.

BSCS

MATERIALS	TEACHING STRATEGIES	ANTICIPATED STUDENT BEHAVIORS
		Students:
*Styrofoam coffee cups (Recycled! Collect in advance from your teacher lounge, local restaurant, home, or any other place you can find them.) *Cellophane tape *Scissors *Globe NOTE: Magazines rich in pictures of American society are needed in Activity 3. You may want to initiate plans for collecting these at this time.	Activity 1. <u>A Recycled Spaceship</u> *This activity is designed to focus students' attention on the usefulness of models. Models are often valuable because of our inability to: 1) bring some things indoors, 2) see a large structure all at once, 3) look inside of some things, and 4) understand things that are complex.* *The sequence of activities related to models begins with the construction by each student of a spaceship model using recycled materials. This will ultimately lead into an understanding that the globe is a model of the earth. The culminating activity in the unit will be to construct a model of the city where the students live.* LET'S STEP BACK A PACE OR TWO TO GET A BIRD'S EYE VIEW OF EARTH. IN ORDER TO DO THAT WE NEED A SPACESHIP TO GET US THERE. Begin this activity by distributing the materials (five styrofoam cups, cellophane tape, and scissors) needed for building a spaceship. Then say: USE THESE MATERIALS IN ANY WAY YOU WANT IN ORDER TO MAKE A SPACE SHIP. SEE IF YOU CAN MAKE ONE DIFFERENT FROM ANY OTHER IN CLASS. To insure creative student models, you should not give any further directions. Encourage the students to work individually. If any student's model is "really wild," encourage him to continue; quickly point out that spaceships of the future could take on many different forms. Do not criticize or suggest changes in any model.	*At the end of this activity, <u>each student</u> should:* *--have constructed a model* *--have identified several objects, including a globe, as models* *--have located a place on the globe.*
*Teacher-furnished materials		--construct a model.

		<u>MUCH WORK TIME</u>
	When the spaceship models are completed, ask:	
	WHAT ARE THE DIFFERENCES BETWEEN YOUR SPACESHIP AND A REAL ONE?	--respond, "smaller," "doesn't fly," "different material," "looks different," etc.
	Ask:	
	WHAT COULD A REAL SPACESHIP DO THAT YOURS CANNOT DO?	--respond, "fly," "go to the moon."
	WHAT CAN YOU DO WITH YOUR SPACESHIP THAT YOU COULD NOT DO WITH A REAL ONE?	--respond, "lift it," "play with it," etc.
	DO SPACESHIP BUILDERS EVER BUILD SMALL SPACESHIPS BEFORE THEY BUILD REAL ONES?	--predict that they probably do.
	WHY WOULD THEY BUILD SMALL ONES FIRST?	--respond, "to see if it works," "to save money," "to see what it will look like," etc.
	WHAT DO WE CALL SMALL THINGS THAT LOOK JUST LIKE REAL ONES?	--respond, "models."
*Model car	If students do not say model, display a model car and ask:	
*A model which will illustrate a complex object or phenomena. Suggestions include torso from <u>ME NOW</u>, visible engine, visible man, etc.	WHAT IS THIS?	--respond, "model car," "toy car."
	Relate the model car to the model the students constructed.	
*Teacher-furnished materials		

	Now display complex model and ask:	
	WHAT CAN YOU LEARN FROM THIS MODEL THAT YOU WOULD HAVE A HARD TIME LEARNING FROM THE REAL THING?	--infer that they can more easily see what's inside and understand how it works.
	WHY IS IT EASIER USING THE MODEL?	--respond, "can see in it without cutting it open," "easier to see," "can touch the parts," "can take it apart."
	Continue by asking:	
	HOW MANY MORE MODELS CAN WE THINK OF?	--suggest many familiar models.
	Entertain all the models suggested. (Be sure the globe is in plain sight.)	
	Now point to the globe and ask:	
	IS THIS A MODEL?	--respond, "yes."
	WHAT IS IT A MODEL OF?	--respond, "earth," "world."
	WHAT CAN WE DO WITH A GLOBE THAT WE CANNOT DO WITH THE WHOLE WORLD?	--respond, "bring it into class," "look at far away places," "see it all at once," etc.
	WHAT ARE SOME THINGS WE WOULD FIND IN THE WORLD THAT ARE NOT ON THIS MODEL?	--respond, "people," "animals," "grass," "clouds," etc.
	Have students position themselves so that all can see and participate. Then ask:	

Figure 9 (Continued)

Me and my Environment

UNIT I

TERMINAL OBJECTIVE 101 The student will infer that there is a relationship between himself and his environment.

SUBORDINATE OBJECTIVE 101.1 The student will locate and describe his position in space.

BSCS

MATERIALS	TEACHING STRATEGIES	ANTICIPATED STUDENT BEHAVIORS
		Students:
	WHO CAN POINT TO THE COUNTRY ON THE GLOBE WHERE WE ARE RIGHT NOW?	--volunteer to point to the U.S.A.
	Make this a game. Revolve the globe, then ask another student to point to the U.S.A. Repeat several times.	
	WHO CAN POINT TO THE STATE WHERE WE ARE RIGHT NOW?	--volunteer to point to their state.
	Repeat with several students.	
	WHO CAN POINT TO OUR CITY?	--volunteer to find the approximate location of their city.
*State map if the name of your city is not on the globe.	If necessary to locate city, display state map. Discuss reason city is not on globe but is on state map. Once city has been located on state map, have students point to its approximate location on globe.	
	If student interest warrants further discussion, you may wish to identify other countries, states, cities, bodies of water, or locations where friends and relatives live. Students may want to locate Cape Kennedy where rockets are launched.	
	The next question will set the stage for Activity 2. Ask:	
	SUPPOSE YOU FIRED UP YOUR MODEL SPACE SHIP AND FLEW TO OUTER SPACE, WHAT DO YOU THINK THE EARTH WOULD LOOK LIKE?	--speculate on earth's appearance from a spaceship.
*Teacher-furnished materials	ACCEPT ALL RESPONSES	

	Save the student models from this activity to be used: 1) as a class or school display, 2) for recycling of materials used on the city model later in Unit I, or 3) for decomposition experiment in the microorganism section of Unit II.	

REFERENCES

Biological Sciences Curriculum Study, *ME NOW, Life Sciences: A Special Education Program,* Boulder, Colorado 80302; published by Hubbard Scientific Company, Northbrook, Illinois 60062.

Biological Sciences Curriculum Study, *ME AND MY ENVIRONMENT, Life Sciences: A Special Education Program,* Experimental Edition 1971-72, Boulder, Colorado 80302.

BSCS Newsletter 46, Evaluation Issue, February 1972. Biological Sciences Curriculum Study, P.O. Box 930, Boulder, Colorado 80302.

Elkind, David. *Children and Adolescents: Interpretative Essays on Jean Piaget.* New York: Oxford University Press, 1970.

Kolstoe, Oliver P. *Teaching Educable Mentally Retarded Children.* New York: Holt, Rinehart and Winston, Inc., 1970.

President's Committee on Mental Retardation, *The Six-Hour Retarded Child.* Washington, D.C.: U. S. Government Printing Office, 1970 (0-381-543).

CLASSROOM FORUM

Edited by Austin J. Connolly, University of Missouri

PROBLEM 19
As a teacher of an intermediate EMR class, I find the area of science instruction quite confusing. While it seems to be of interest to them, I don't know what they should be taught. Can you help?

Science can be one of the most dynamic and interesting parts of the curriculum for the mentally retarded child. Unfortunately, special education programs, curriculum guides, and teacher training programs have long neglected its potential. Because of this general apathy toward science, the response submitted by Ms. Pamela Harrington of Gainsville, Florida, was particularly refreshing. Her comments aptly illustrate how science can and should become an integrated part of the total curriculum.

> Science instruction must be approached globally in the EMR curriculum. When it is "pigeonholed" as a distinct curriculum area, only too often the emphasis is placed on learning which will have little use to the mentally handicapped youngster in his adult life.
>
> A category pertaining to environmental awareness and interaction would encompass the area of general earth science. Study of weather might lead to lessons on appropriate clothing for various weather or adjustment of behavior to different environmental requirements. Also stressed would be general characteristics of the earth, natural resources, and conservation of these resources. Environmental awareness would also include awareness of pollution, differences between useful and harmful plants and animals, and, at the junior and senior high levels, the relationship of earth science to various agriculturally-related jobs which might be available in the community. Senior high students should also be developing an understanding of the importance of a balance in nature and their responsibility in helping maintain this balance.
>
> Another broad category for science instruction would be body awareness and maintenance. This area would relate nicely to social skills development activities concerning personal health and hygiene. By the end of the intermediate level the student should have learned major body parts and their functions. He could also be aware of the effects of drugs, alcohol and tobacco to his body. Detection of major body ailments would be appropriate for study. These areas could easily be expanded at the junior and senior high levels to make the student more responsible for caring for himself and others as a family member now and a potential head of household in later life. Good nutrition study would work in quite effectively with lessons on food and their preparation. Of course, study of the body relates to the physical skills area of curriculum. Along with the study of body parts would come an awareness of how those parts should function together to create balance, strength, coordination and all of the skills necessary for good body control.
>
> Science is an integral part of any EMR curriculum. The skilled teacher will relate all science instruction to the pertinent concerns of his students so that valuable learning can take place.

The response of Ms. Harrington indicates that science can provide the teacher and students with relevant, timely and interesting topics for study. These topics are not only of high interest but also are ideally suited to a wide variety of instructional activities, such as interest centers, small group projects, collections, television programing, book collections, etc. The creative teacher will use the content and instructional activities to promote language development, self-exploration, reasoning, esthetic appreciation, leisure time activities, etc.

Make an effort to work with science this year; you'll find it can put *life* in your curriculum.

PROBLEM 21
Should special education teachers be concerned about fostering creative thinking in their pupils? If so, how can it be done effectively?

All readers are invited to send their solutions to Problem 21. The November 1972 issue will summarize contributions by readers. Complimentary subscriptions will be awarded each month for the best solutions. Send your response to the Editorial Offices, FOCUS ON EXCEPTIONAL CHILDREN, 6635 East Villanova Place, Denver, Colorado 80222.