Development of awareness of causal relationships in mentally retarded adolescents through the use of science

Robert Wallschlaeger

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THE DEVELOPMENT OF AWARENESS OF CAUSAL
RELATIONSHIPS IN MENTALLY RETARDED ADOLESCENTS
THROUGH THE USE OF SCIENCE

by
Robert Wallschlaeger

A RESEARCH PAPER
SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS IN EDUCATION
(EDUCATION OF MENTALLY HANDICAPPED)
AT THE CARDINAL STRITCH COLLEGE

Milwaukee, Wisconsin
1972
This research paper has been approved for the Graduate Committee of the Cardinal Stritch College by

[Signature]

Date [Date]
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CHAPTER I
THE PROBLEM

Introduction

The investigator believed that science could assist the Educable Mentally Retarded (EMR) child develop an awareness of cause and effect relationships which are related to the cognitive development, or such processes as perception, concept formation, reasoning, and judging. Although the student may be mentally retarded, he must develop awareness of the reality, thinking and language, and social concepts. Through the means of controlled questioning, the investigator will stimulate the realization of these many cause and effect relationships.

Statement of the Problem

This study will attempt to answer the following questions:

1. Does science help the EMR student to develop the ability to perceive cause and effect relationships?

2. Is mental age a critical factor in the development of ability to perceive a cause and effect relationship?
Justification of the Study

All children are interested in the phenomena of nature and the environment in which they live. Since children are interested in nature, the environment or science, is a natural area of study for retarded learners. The cognitive approach therefore fits into this investigation well.

In Piaget's theory, the active participation of the child in his environment and his innate tendency toward adaptation are fundamental in effecting development in understanding and in basic knowledge. 1

Hence, natural motivation exists so that reading is undertaken at times by non-readers and retarded readers to satisfy their curiosity of science regarding this environment.

In some cases retardation may be caused by difficulties in reading. On the other hand, science books have encouraged many poor readers to improve their reading abilities. 2

The retarded child frequently needs more contacts with the phenomena of his environment to develop causal relationships.

Some children require more sensory experiences for building mental pictures and abstraction than others. Many children considered slow learners have built up rich experiences with phenomena. It seems as if they have been having rich experiences with living and nonliving things while others have been making use of abstractions. 3


Since every word in the English language connotes or
denotes different mental images to different people, a great
variety of sensory experiences are necessary for most children
to build or create mental images. Imagery is a tremendous
means of provoking mental pictures. Many terms in the English
language are so vague and abstract that it becomes necessary
to "paint pictures" to explain these terms.

Limitations

The time spent on gathering the data was somewhat
limited; thirty lessons were covered in ten weeks. Each
lesson was approximately thirty minutes in length. During
the early days of the study, a flu epidemic caused the
absence of some pupils for more than one day from the lessons
and the cancellation of classes for two days. However, the
investigator was able to reschedule the suspended classes
at a later date.

The number of subjects involved was very limited. Two
groups of subjects participated in the study; the first group
consisted of eleven individuals and the second group of nine.

All of the subjects were an intact population from a
small residential school.

Another limiting factor was the type of subject; all
EMR students with various learning disabilities.

The lack of an availability of science equipment to
be used for individualized experiments proved to be a
limitation also.

Classification of Terms

E.M.R. - The term educable mentally retarded is used to describe the child whose intelligence tests place him in the 50 to 75 I.Q. range, and whose learning characteristics and social adjustment suggest the need for special services and social adjustments to meet his needs.4

Pre-test - A test given on the material to be covered in the unit, before the unit is taught.

Post-test - The same test given at the conclusion of the unit, identical to the pre-test.

Science - "...Knowledge of the material world in which we live and the laws by which it operates..."5

Types of questions -

Type I - A cause is given, the student responds with the effect of the cause.

Type II - The effect is given, the student responds with the cause for the effect.

Social reinforcement - Verbal rewards, these tend to increase the likelihood that a given behavior will be repeated.

Research Paper

The investigator hypothesized that through an exper-


mental approach to the teaching of science to EMR children could more clearly relate to causes and to their effects.

Secondly the investigator has hypothesized that mental age is a factor in the development of causal relationships in mentally retarded children.

Summary

Through an experimental approach to the teaching of science to EMR children could develop the technique whereby a word or group of words could more easily imply a visual reproduction for them of the scene described.

Using the tools of the experimental approach gave the EMR children the opportunity to understand the meaning of many terms which before had been unintelligible to them. Thus they will also be able to see the cause and effect relationships of many situations.
CHAPTER II

REVIEW OF THE LITERATURE

Science as a Necessary Factor of Life

Science as a process is a means of coming to know about natural phenomena, a very significant factor in our life today. Since every child has a natural inclination to investigate, to ask questions, and to seek solutions to problems, science can nurture this tendency by providing many opportunities for the child to investigate.

It has been stated that science is man's attempt to interpret the world, and both children and science are involved in the procedure of interpreting the physical world.

Science should be considered a way of learning about the world, rather than a body of knowledge about the world, and scientists regarded as perpetual learners. Scientific facts should therefore not be acquired as ends in themselves, but rather be acquired in a "search for meaning, perhaps for wisdom, and indeed for growth."6

Science teachers must be interested in teaching the principles of science so that the student can be prepared to operate effectively in his environment.

There has been a renewed interest in the science

programs in schools. "Many citizens recognize that science and the applications of science have a profound relationship to their living."7 This interest was exemplified when the National Association of Secondary School Principals in their ten imperative needs of youth listed as number 6:

All youth need to understand the method of science, the influence of science on human life, and the main scientific facts concerning the nature of the world and of man.8

The importance of teaching science is obvious to all of us.

Unless a person is isolated from the rest of the world he will need some knowledge of science. As James Conant pointed out, "Whether we like it or not, we are all immersed in an age in which the products of scientific inquiries confront us at every turn. We may hate them, shudder at the thought of them, embrace them when they bring relief from pain or snatch from death a person whom we love, but one thing no one can do is banish them. Therefore, every American citizen in the second half of the century would be well advised to try to understand both science and scientist as best he can."

This belief in necessity of science has been repeated by many.

The student must learn to comprehend and deal with his environment. He must understand the methods and attitudes of science so that he may apply them to his current and future problems. And he must recognize the inter-relationship of science with all human experiences.9

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8Ibid., p. 13.
One of the primary responsibilities of the schools is to produce intelligent citizens.

The ability of our citizens to understand national and international problems is dependent in part upon their scientific literacy. The layman is surrounded by scientific developments and is bombarded with a wealth of scientific information ... The literate individual must have some understanding and appreciation of science in order to make valid judgments as a citizen.\(^\text{11}\)

The American industrial society is based upon scientific discoveries. "Science of the future will need to be dynamic and changeable in order to meet the demands of a rapidly accelerating scientific age."\(^\text{12}\) This is a changeable era and the science student, a questioning student, can and must meet this challenge.

Science, economics, politics, and government touch the lives of us all in countless ways. Ignorance of the principles on which these institutions operate may leave us victims of the complexities in our society, while knowledge allows us the privilege of meaningful participation.\(^\text{13}\)

Science instruction is a vital part of the educational system, since science is a vital factor of life. The native desire of man's curiosity must be capitalized upon if our instruction is to succeed and humanity is to prosper.


\(^{12}\)Ibid., p. 61.

THERE WAS A POPULAR DEPARTMENT STORE IN NEW YORK CITY THAT CAME TO MY ATTENTION FOR A SPECIAL REASON. THE STORE WAS KNOWN FOR ITS EXQUISITE DESIGN AND LUXURY ITEMS. ONE OF ITS BEST SELLERS WAS A SET OF SHINY, GOLDEN VASES. THE STORE ALWAYS HAD A LONG LINE OF CUSTOMERS READY TO GRAB THEM. THE MANAGER TOLD ME THAT THEY WERE THE MOST EXPENSIVE VASES IN THE STORE, BUT STILL, THEY SOLD OUT EVERY SUNDAY. THE CUSTOMERS WERE NOT INTERESTED IN THE PRICE; THEY WANTED THE VASES BECAUSE OF THEIR DESIGN AND QUALITY. THIS STORE WAS IN A NICE NEIGHBORHOOD, AND THE PEOPLE WHO SHopped THERE WERE CONNOISSEURS OF DESIGN.

I也开始注意到这个部门商店。它的设计和奢华物品都很出名。其中一个最好的卖点是一个闪亮的金色花瓶。商店总是有一条长长的队伍等着购买它们。经理告诉我，这些花瓶是商店中卖得最贵的，但仍然售罄。顾客们对价格不感兴趣；他们想要这些花瓶是因为它们的设计和质量。这家商店位于一个漂亮的社区，购物那里的人都是设计方面的行家。
authorities on this is Jean Piaget. He has four stages in the cognitive development: the sensorimotor stage; the preoperational stage; the stage of concrete operations; and the propositional stage. It is not until the stage of concrete operations that the child even begins to perform logical operations, and formal thinking operations develop in the propositional stage.

According to B. S. Bloom’s Taxonomy, "The cognitive domain is concerned with the recall of knowledge. This includes such behaviors as remembering, problem solving, concept formation, and creative thinking." His divisions of the domain in ascending order of complexity are: knowledge, comprehension, application, analysis, synthesis, and evaluation. Knowledge includes the recall of the specifics, structures, or scientific processes; it emphasizes memory. Comprehension is the translation from one form to another and interpretation. The application division involves the ability to apply abstract ideas to concrete situations; the determining of relationships is involved in analysis. Synthesis would be necessary to develop ways of testing hypotheses or to formulate new hypotheses. Finally evaluation, the highest cognitive level, demands ability to make quantitative and qualitative judgments.

Others have stated that the cognitive tasks may be identified as concept formation, development of generalizations and inferences, and finally the explanation and prediction of new phenomena by applying known principles and facts. "Each individual possesses a unique framework of experience, capacity, and environment." Therefore this must be considered in teaching. "That importance lies in the fact that we learn best in terms of what we already know and/or have experienced." These principles can be applied especially to science teaching.

Each biology student, as well as all students, possesses a unique cognitive structure that is a product of his environment, past experience, and physical and mental capabilities. This structure can be outlined as follows:

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<td>Comprehension</td>
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As the student becomes a seeker of knowledge, a learning being who actively searches his environment for clues and answers he must develop cause and effect relationships and concepts.

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"Perhaps the search for cause-effect relationships is the Holy Grail of science. At any rate, the search is difficult."²¹ Scientists believe that all physical and biological changes can be understood, the causes of change determined and the effects of change predicted. Early in life the student has begun to think in terms of cause and effect interrelationships.

At the same time the child is learning about his newly acquired self, he is also developing concepts of the causation of events especially when viewing himself as a possible motivating force for events: the toy does not squeak until I squeeze it, the tall pile of blocks does not fall unless I push them over, Mother does not pick me up unless I cry. Repeated experiences with these types of activities assist him in becoming more aware that he is capable of producing effects in this world; later on he sees that other forces can also produce effects and that there is a cause and effect for events.²²

Piaget states:

Until age seven or thereabouts the child's notion of cause and effect and of ordering are limited to coincidence, contiguity, and the salient characteristics of those objects he encounters.²³

These relationships can be cultivated through science, for science tends to develop working explanations. Scientists do not believe that changes occur because of some mysterious magic. "Scientists generally believe that for every change or effect there is a cause."²⁴

²¹Thurber, Teaching Science, p. 27.
²⁴Sund, Teaching Science by Inquiry, p. 9.
perhaps first and foremost the theory and practice of
cause-and-effect relationships." 25

By thinking through the possible consequences of
behavior the child is led to understand cause and effect
relationships, for there is a natural sequence of events
encountered in everyday life. "It seems as if one of the
drives of children and of man kind is to get back to the
reason for, and cause of events." 26

Working with materials in the classroom and at home
may be used to illustrate over and over again, the
sequences of events and how certain conditions and
certain behaviors produce certain events. 27

The child is concerned with unfolding the idea of
sequence of events or cause and effect relationships and
how to cope with them in life. Closely related to this
relationship is concept formation. "Concepts are indi-
pendable for transmitting man's previous experiences,
interpreting present situations and projecting plans into
the future." 28 Just as the child discovered the possible
consequences of phenomena, he must classify bits of related
information into a recognizable and meaningful idea - a

25 Richard, Science Teaching in Secondary Schools,
p. 125.
26 Gerald S. Craig, Science for the Elementary School
27 Ibid., p. 85.
28 Herbert J. Klaussmeier and William Goodwin, Learning
and Human Abilities: Educational Psychology (New York:
concept. "By discovery learning we mean learning in which the student, without being told by someone else, achieves an answer to a problem, concept, or a principle." 29

We learn all knowledge from our senses, the child is enraptured with the information his senses send to him. Out of these he then passes from perceptual awareness to conceptual understanding. An individual has many perceptions before one abstracts out of these the essential qualities; these mental abstracts formed are called concepts. Klausmeier has a model for aiding concept learning: emphasize the attributes of the concept; provide for proper sequencing of instances; encourage and guide student discovery; provide for application of the concept; and encourage independent evaluation.

Concept learning or "concept generalizing", as some prefer to call it, has the advantage of helping the child relate specific items of information to general categories or classifications of knowledge and to relate new items of information to what has already been learned. 30

The heart of the concept idea lies in understanding. If the concept is really understood the student should be able to apply it to a new situation and retain it for further application. Through science this principle can be achieved in a meaningful manner since the senses can easily be involved.

29 Ibid., pp. 242-43.

30 Kenner, Teaching Science in the Elementary School, p. 69.
The individual has the opportunity to work with concrete objects, acquire facts and mentally manipulate ideas, in a classroom laboratory.

Bruner has called attention to an important principle of concept development in the statement: "What is most important for teaching basic concepts is that the child be helped to pass progressively from concrete thinking to the utilization of more conceptually adequate modes of thought." 31

All psychologists believe that the concept starts with concrete perceptions and spirals to successive levels of broadened conceptual abstractions. "Concepts are learned through meaningful reception learning and purposeful discovery learning." 32

"A person's conceptual view never ceases to grow. It expands with knowledge and experience." 33

Teaching Science to the Normal Student

In more general terms, the aim of teaching science is life enrichment. The objectives are functional understanding of the major generalizations of science and the development of associated scientific attitudes. 34

However this has not always been true.

Teachers have traditionally emphasized the product of science but have failed to give students an un-

31 Ibid., p. 68.
32 Klausmeier, Learning and Human Abilities, p. 250.
33 Sund, Teaching Science by Inquiry, p. 31.
34 Thresher, "Science Education for Mentally Retarded Children," p. THR-1A.
derstanding of the means of solving problems, one of the most valuable educative objectives for science instruction. 35

The need for changes in school science programs became evident midway through the twentieth century. A number of forces brought about conditions which affected the curriculum: the rapid increase in scientific knowledge, the competitive nature of the race for space, technological advancements in teaching tools, and gradual dissatisfaction with the encyclopedic approach to the teaching of science.

Science is inquiry or discovery. "In a formal well-organized science program, children in all grades beginning in kindergarten, explore widely and deeply into all areas of science." 36 When science is taught as inquiry the emphasis is placed upon the student doing the learning. John Dewey stressed learning by doing and becoming actively involved in experiencing. The student is the inquirer, not a passive observer, and confidence is instilled so the student can learn on his own.

If science is to be used to develop rational powers of children a method must be found which fosters investigation and inquiry; pupils must be placed in situations which allow them to discover principles and concepts for themselves, rather than being required merely to recite those that have been discovered by others. 37

35Sund, Teaching Science by Inquiry, p. 2.
36Thresher, "Science Education for Mentally Retarded Children," p. THR-4A.
37Kenner, Teaching Science in the Elementary School, p. 57.
The objectives of science are to develop in the learner the ability to think and inquire and to familiarize the child with all phases of his environment.

At the elementary level the trends tend to place less emphasis on subject matter per se, laboratory experiences receive major emphasis, pupils perform the experiments, and draw the conclusions, and the material is written for the average students.

By actively manipulating science equipment and by performing simple experiments, young children are able to understand some basic scientific concepts and generalizations essential to the interpretation and appreciation of the natural phenomena which commonly challenge them.38

Teachers of elementary science should help children:

1. Understand that change, a cause-and-effect relationship, has been, is, and will continue to be a fundamental phenomenon in the universe in which they live.
2. To attain their maximum potential for effective thinking and action.
3. To increase understandings of themselves and of their relationships to their universe.
4. To retain their enthusiasm for seeking more and more knowledge.
5. To accept the challenge that society needs their best talents and wisdom.39

The seventh-, eighth-, and ninth grade student can be described in one word - exuberant. The world around him is his oyster. He is quite uninhibited, but he is serious and reflective on occasion. He is trying to fit himself for the future - whatever

it may be. He finds models and patterns himself after
them. In some cases, his science teacher may be his
model.40

Once more the science program must stress discovery and
inquiry, and de-emphasize facts per se. Since great bursts
of energy can be expected from junior high students, there
must be active involvement, opportunities requiring thinking
and creativeness.

Secondary science courses have been relatively stable
over the years. New courses entered the curriculum from
time to time but only recently have there been numerous
innovations in secondary science.

Science teaching has neglected to present to the pupils
an understanding of the methods used by scientists
to obtain information ... The new approaches emphasize
the process and structure of science and de-emphasize
the use of facts for the sake of facts.41

Scientists have methods for reporting scientific
information and these methods have been incorporated into
secondary school science teaching. The major mental process-
ses which every practicing scientist uses during an investi-
gation are: statement of problem, formulation of hypotheses,
experiment, observation, collection of data, and drawing
conclusions. However, it is not enough to simply memorize
these steps in an effort to be scientific.

Simple memorization of the steps is of little help
in understanding the processes of science. The only
way to learn football is to play it, and so it is

40Gund, Teaching Science by Inquiry, p. 245.

41Thurber, Teaching Science, p. 50.
The only way a student learns to be scientific is to be placed in situations where he is actively involved in using scientific methods.42

When the high school student questions, explores, experiments, he demonstrates the inquiring nature of science. High school science curriculum is designed on the following basis: there is a recognised need for general scientific literacy, our nation is dependent upon scientists and engineers, value is placed on critical thinking, interplay is necessary for individual and group welfare, and the individual's personality must be developed to the optimum. Discussion, experiments, excursions, reading and study of authentic information serve to implement the curriculum. "Experimentation is so much a part of science that it is difficult to conceive of a science program without this type of activity."43

The science program should develop open mindedness, avoid gullibility, distinguish between fact and fiction, and develop responsibility and resourcefulness.

Learning Characteristics of the Educable Mentally Retarded Student

These boys and girls are not mentally incompetent. Comparing their minds to an engine we would say that they have a slower dynamo than the average child, but it is a good dynamo. They do, however, need special- ised methods and techniques and a program suited to

42 Ibid., p. 50.
43 Ibid., p. 160
their needs. This program should be a realistic meaningful presentation of the academic work which will equip them to handle their daily task.\textsuperscript{44}

It is evident that the EMR student can learn and in many instances is not unlike a normal child. "The intellectual and learning characteristics of educable retardates basically follow the developmental sequences found in their normal peers."\textsuperscript{45}

Educable mentally retarded children are able to learn, they are capable of learning, retaining, and transferring even the most complex of verbal and motor skills.\textsuperscript{46}

Special classes for the EMR students have been provided in public schools since the latter part of the nineteenth century. With this in mind one would assume that much has been learned and and presently known about the learning processes of EMR students. Many investigations have been conducted, but it is misleading to say that our present level of knowledge is either adequate or acceptable. "A watered down curriculum for the mentally retarded was obviously the


result of negative attitudes.  

All children are entitled to equal opportunities for self-development to the fullest extent of their individual physical, mental, and emotional capacities. Because children with mental handicaps do not have the same ability to adjust and to learn effectively in the usual classroom as do so-called normal children, they should be provided with instructional programs specifically designed for their needs and abilities.

In order that successful learning may be experienced there must be positive changes in the student's attitudes to learning and in society's attitude toward the child.

During the last ten years, special educators have seen many innovative changes in educational programs for the mentally handicapped child. Not only have they seen changes in programs, but also in the expectations and attitudes that society has toward the child.

The specific learning characteristics of the EMR student can be stated in terms of problems related to retention, transfer, learning set, auditory and visual discrimination, reaction time, creativity, and incidental learning. Retentive ability is a principal weakness; he has difficulty in attending to a task and resisting the influence of irrelevant stimuli. Transfer is the ability

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of an individual to use previously learned material in another problem experience that may or may not have similar components; the EMR student is in a dilemma in this area, he transfers negative learning rather than positive learning, his skill can be enhanced by the use of concrete instructional presentation.

The cognitive processes of the educable mentally handicapped are also different from those of the average learner. Where the average learner can think abstractly, the mentally handicapped learner tends to think only in concrete terms. That is, he is thing-, ear-, and eye-minded. Transfer can never be assumed, the activity must involve the student in ways of applying the desired behavior.

Closely allied to the skill of transfer is the ability to acquire a learning set and the EMR student can do this if he is guided sequentially from the simple to the more complex. Retarded children learn what they repeat often. This child can learn only when he is ready to learn and learning can be strengthened by success. "For the mentally retarded, successful accomplishment is the dynamo that will generate most of the desire for, and interest in, learning." Ability to discriminate between auditory or visual stimuli is important in the learning process, especially

in learning to read. Each retarded child has a potential deficiency in discriminatory processes. Reading is not the sole means to the end, it should be placed in perspective as an aid to discovering fundamental information. The EMR student can respond effectively to an activity centered instructional approach; ideas must be developed without the necessity of reading.

His deficiency is most marked in activities requiring reading and listening comprehension, following complex directions, gaining insight into problem situations, generalizing from rules and principles encountered in his schoolwork.\(^{52}\)

Reaction time is the time lapse between presentation of stimulus and reaction of the individual to it. The slowness to perceive and to react diminishes the amount and quality of learning that will take place. This can be augmented through practice and/or by increasing the intensity of the stimulus. The EMR student needs time to adjust to a new situation. EMR students are less creative and produce less spontaneous productive-thinking than normal students. "The EMR child appears to be less able to acquire the bonus learnings that normal children usually pick up from the periphery of the teaching-learning situation."\(^{53}\) The teacher must be the catalyst in generating pupil response in the learning situation; he can take nothing for granted.

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... presented, success achieved, recognized, and proudest of it...
G. Orville Johnson reports that studies undertaken indicate that the retarded child learns in much the same way, following the same laws of learning as the normal child.

Teaching Science to the Educable Mentally Retarded Student

Science education has been grossly omitted from the curriculum for the mentally retarded.

The teaching of science to special classes of the educable mentally retarded is largely neglected in our schools today. At best, the teaching of science is incidental to the teaching of other subject matter in the special education curriculum.

However, judging from the literature, formal science instruction has been generally overlooked in the field of special education. Most educators, in planning a curriculum for educable retarded children, whether in a special class in a public school or in an institutional setting, emphasise the three R's followed by some sort of vocational training if the children are able to profit from it. Except for considerable emphasis on health and safety and an occasional vague reference to "nature study", science in special education is a subject conspicuous by its absence from the literature.

"Paramount in this dearth of curricular definition will be science, which most often is lacking or given only perfunctory treatment."59


Why is science missing from the EMR curriculum?
Science has been considered too difficult for the retarded; it has been felt that it requires skills and abilities beyond the range of the EMR student. Teacher preparation has also been inadequate in the science area, and teachers have shunned this field. Teaching materials have not been specifically constructed for the EMR student. Tradition has kept science from the program, there is not a budget to support it, and much work is needed to incorporate it into an EMR curriculum.

"Science teaching must be concerned with helping the child understand, relate himself to, and become better adjusted to his environment."60 The slow learning child cannot escape being confronted with science concepts and principles any more than a normal child. A knowledge of elementary science is necessary for successful community adjustment, satisfactory vocational performance, in establishing desirable work habits, planning to make careful observations, and solving problems.

Somehow, the mentally retarded must also learn to live in our modern scientifically oriented, complex and changing world. Thus, no curricular offering should be omitted, introduced spasmodically, or treated in a perfunctory manner, if this goal is to become a reality for the mentally retarded.61

60 Ibid., p. 157.
61 Ibid., p. 155.
Since mentally retarded children have needs similar to those of children with normal intelligence, they are also challenged by natural phenomena in our environment.

The primary purpose of science for these boys and girls is to help them understand the "how and why" of daily living (environmental science). The balanced program contains the incidental learnings of expressed interests, ideas, and questions within a continuous science sequence planned systematically for living now and in the future.62

Can we justify the inclusion of science as a part of the curriculum for the educable retarded? Seldom does any leading authority in the area of retardation make mention of science as an integral part of the total learning experience of this group of children. Many science educators, however, feel that science as a process approach offers a vast resource to the special education curriculum.63

The goals of science education and special education are highly compatible, so it is logical to include formal science instruction.

A science curriculum involves experiences in the child's immediate environment no matter how limited may be his scope. Science offers many opportunities for easy motivation of the child's desire to learn and also readily appeals to his interest. The world of science is at the child's doorstep and is an avenue leading him to exciting new adventure.64

Since normal children are in science classes, the self concept of the EMR student is strengthened when he is in a science class, doing things other children do. The science

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63 Anderson, Developing Children's Thinking Through Science, p. 245.
64 Surkin, Teaching Techniques, p. 122.
class can also assist the ENR student to observe, explore, and be creative. Interesting science activities stimulate the child's desire to communicate with others and grow in language skills. The ENR student can feel more secure and adequate through his ability to contribute to group activities. In general, a science program has much to offer the ENR student.

The aims or objectives of science teaching involving the mentally handicapped are:

1. To stimulate the child to an appreciation of the wisdom, power and beauty of God the Creator through study of his creation.
2. To present those concepts which will lead to a knowledge of the material universe and of the laws by which it operates.
3. To promote qualities of good citizenship through study of man's role as leader and conservator of natural resources.
4. To prepare the child for a safe and healthy adult life.
5. To enrich the child's experiential and informational backgrounds as well as his vocabulary.
6. To encourage scientific attitudes and habits of careful investigation.
7. To safeguard mental health through elimination of fears and superstitions regarding natural phenomena.
8. To reinforce and integrate skills presented in the tool subjects and content areas.
9. To develop alertness and awareness regarding the child's immediate environment.\(^65\)

These objectives closely pattern the ones stated by the Biological Sciences Curriculum Study in the field of special education.

education, although they are stated differently.

1. To help the mentally handicapped child develop interests, skills, and positive attitudes through experiences with science.

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

3. To aid the child in establishing acceptable and functional modes of living through heightened powers of observation, a well developed curiosity, a good measure of self confidence and a sense of responsibility to and for his environment.

4. To contribute to the development in the child of a high 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.

5. To develop in the child a knowledge of himself in relation to his environment, as well as a tendency to apply this knowledge to the tasks of everyday living.\textsuperscript{66}

All researchers state that science for the mentally handicapped must be meaningful in order to be worthwhile. The course must be concept oriented rather than content oriented. The material must be presented logically and sequentially, the terms and concepts understood operationally and there must be active participation by the child.

In a science program for mentally retarded it is especially important that concepts be understood and terms defined operationally through active participation by the children.\textsuperscript{67}

Summary

In the present chapter the related literature was

\textsuperscript{66}Cleaver, "Science Curriculum Materials," p. 2.

\textsuperscript{67}Thrasher, "Science Education for Mentally Retarded Children," p. THR-6A.
surveyed under the following topics: science as a necessary factor of life; development of cause and effect relationships and concept formation; teaching science to the normal student; learning characteristics of the EMR student; and teaching science to the EMR student.

The literature reveals a new interest and honest concern in regard to science instruction for the mentally handicapped. The EMR student has a curiosity to know about the world in which he lives, he loves to see and learn about new things. In some ways he is much like his counterpart the normal student. He can learn and material must be presented to him in a meaningful and interesting way. He must be provided with the opportunity for practical experimentation using concrete materials.
CHAPTER III

PROCEDURE

Purpose

For EMR students, as for others, the excitement of discovery, the use of manipulative skill opportunities, and the questioning of our environment adds meaning to learning. These students must develop an awareness of reality, basic language skills, visual motor coordination, interpersonal relationships, and problem solving. Science activities, that have been wisely selected and carefully planned, can serve the previously stated goals and enrich the lives of EMR youth.

The investigator will use science, more specifically the techniques of experiments and controlled questioning, to stimulate the realization of cause and effect relationships, so important in life for all, including EMR individuals.

Population of the Study

The young people involved as subjects were students at St. Coletta School, Jefferson, Wisconsin. This private school is mainly a residential center for mentally retarded youth.
The group consisted of twenty students, six boys and fourteen girls in the Secondary Level I of the school. Sex was not considered a relevant variable in this investigation. The pupils were considered to be free from undue emotional stress and perceptual problems other than those associated with mental retardation.

Their chronological ages ranged from 14.75 to 17.25 years with a mean chronological age of 16.0 and a standard deviation of .69. The mental ages were from 6.75 years to 15.33 years, mean mental age of 10.4 years, and standard deviation of 2.0. The mean of the I.Q.s was 69.5, standard deviation 11.7, and range from 51 to 101. The I.Q.s were determined according to the Stanford Binet Test.

### TABLE I
Comparison of Mental Age of Groups I and II

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>S.D.</th>
<th>SEM</th>
<th>Difference</th>
<th>S.D.</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11.7</td>
<td>1.56</td>
<td>.46</td>
<td>3.0</td>
<td>.52</td>
<td>5.75</td>
<td>.001</td>
</tr>
<tr>
<td>II</td>
<td>8.7</td>
<td>.94</td>
<td>.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The students were divided into two groups according to mental age. (Table I) Group I consisted of eleven students, three boys and eight girls, whose mental ages ranged from 10.1 years to 15.3 years; the mean mental age was calculated to be 11.7 years. The individuals in this group
were from 15.2 years to 17.3 years in chronological age, mean 15.8 years. The second group, Group II, included three boys and six girls with mental ages ranging from 6.8 years to 9.8 years with a mean mental age of 8.7 years. These pupils ranged in chronological age from 14.8 years to 17.1 years with a mean of 15.2 years. The groups were divided so that Group I contained students with a mental age above 10 years and Group II below 10 years, because the second question of the study was "Is mental age a critical factor in the development of ability to perceive a cause and effect relationship?"

Teacher

The investigator served as the teacher for both groups. Every effort was made to insure that the same techniques and approach were used for each section, initially avoiding the bias that could develop because of experimenter expectancy. Additional factors, such as identical verbal instructions, identical experiments, same questions, equal simple scientific equipment, and limited class time, aided in minimizing this bias.

The investigator, a candidate for a Masters Degree in Special Education, had prior experience in teaching science at the junior high level; however, the investigator's experience involved students considered normal by educational standards. While a teacher, the investigator had numerous
The effects of yeast on the growth of oat plants were studied.

These effects were studied using two types of oat plants. In the first type, the oat plants were grown in a nutrient solution containing water and nutrient solution. In the second type, the oat plants were grown in a nutrient solution containing water and nutrient solution.

The results of these studies showed that the oat plants grown in the nutrient solution containing water and nutrient solution grew taller and had a greater number of leaves than those grown in the nutrient solution containing water only.

These findings were further supported by the results of a series of experiments conducted under controlled conditions.

In January, the three sessions were held on January 16, 17, and 18. Each session consisted of three parts: one each week, each thirty minutes long. The study consisted of thirty lessons, presented over three weeks.

Arrest of the Study

Extraction from these respective circumstances for this study shows that the duration of the investigation they were determined to respect the quantity and the number of science integration methods used. The students employed in the study were from two different classrooms and respected no other science integration methods.

Our experimental environment, the science was explored and the importance of mcrocoaching in our environment. The data collected in the study are the association of the students of microcoaching with the effect in our environment. By the student of microcoaching with the effect in the association and manipulation existing conditions.

Data with problems of the environment must be ink. Inadequate and made By them. The overheard expressions need to illustrate various concepts and were of a testament to the experimental method. The grey macrocoaching were employed. The table went as it was to be read and are the data.
two weeks after the students had returned from their Christmas vacation. In the interim, they had an opportunity to once again become oriented to classroom instruction and rediscover the routine of school living. The final session was held on March 24, 1972. The half hour sessions were held from 9:30 to 10:00 A.M. for Group I and from 10:00 to 10:30 A.M. for Group II. This schedule was utilized to avoid confusion and to cause the least amount of interruption to the regular teaching schedule.

Both groups performed the same experiments, used the same equipment, answered identical questions, and completed the same pre and post test. A pretest was administered on January 14, 1972, and the posttest on March 24, 1972. (Appendix B)

The physical setting was a regular classroom, not a science laboratory. Every effort was expended to create a laboratory-like setting. Scientific equipment such as beakers, test tubes, petri dishes, flasks, glass rods, etc. as well as ordinary household items to be used in the experiments were available to the participants.

During every fifth lesson, two questions were asked each student. One question was stated so that the cause was given and the response involved the effect. The second question was the reverse of the first, the effect stated and the cause requested. The questions and answers were recorded on a cassette tape to provide for accurate analysis. (Appendix C)
In cases of absence, the student received an explanation of the lesson(s) from the teacher. The absentee was encouraged to ask questions and was also prompted to observe the results of another student's experiment.

Summary

This study was essentially concerned with evaluating the assumptions that science could help the EMR student develop an awareness of cause and effect relationships and that mental age was a factor in this development. Simple scientific experiments were employed for this evaluation.

The investigator devoted this chapter to the purpose of the study, a detailed account of the population, a statement about the teacher, and explanation of the conditions for the study, and the methods of conducting this research.
CHAPTER IV

INTERPRETATION OF DATA

Question One Data

"Does science help the BHR student to develop the ability to perceive cause and effect relationships?" is the first question to be considered in this study.

To determine the answer to this question the investigator administered a pre and a post-test. The pre-test, composed of twenty questions, was given at the outset of the investigation to the participants. At the conclusion of the research, an identical post-test was administered to the students.

Each student had an answer sheet for the pre- and post-test. The answer sheet included the possible answers; the pupil merely had to circle the correct response. Since some of the students had difficulty with reading, the investigator read the questions and the possible answers to the group, thus abolishing dependence on reading skills.

In order to assure greater accuracy and understanding during the testing sessions, only four students were tested at a time. Through this method the investigator could be certain that each pupil had sufficient time to answer each
question, was at the correct place on the test, and understood the question.

Group I, the group whose mean mental age was calculated to be 11.7, received a mean score of 7.55 on the twenty question pre-test. Their mean score was 15.73 on the identical post-test. The t-ratio was 10.79 and the level of confidence .001.  (Table II)

TABLE II
Group I Pre-Test, Post-Test Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>SEm</th>
<th>Difference</th>
<th>Ssd</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>7.55</td>
<td>2.79</td>
<td>.83</td>
<td>8.18</td>
<td>.76</td>
<td>10.79</td>
<td>.001</td>
</tr>
</tbody>
</table>

Group II, the slower group, obtained a mean score of 6.67 on the pre-test, and 14.33 was the mean score on the corresponding post-test. The t-ratio was calculated to be 4.464 and the confidence level, .001.  (Table III)

TABLE III
Group II Pre-Test, Post-Test Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>SEm</th>
<th>Difference</th>
<th>Ssd</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>6.67</td>
<td>3.39</td>
<td>1.20</td>
<td>7.66</td>
<td>1.72</td>
<td>4.46</td>
<td>.001</td>
</tr>
<tr>
<td>Post-Test</td>
<td>14.33</td>
<td>3.77</td>
<td>1.26</td>
<td>1.72</td>
<td>1.72</td>
<td>4.46</td>
<td>.001</td>
</tr>
</tbody>
</table>
When Groups I and II were combined and considered as a single group the mean score on the pre-test was 7.45 and 15.25 on the post test. Again the level of confidence was .001, the t-score was 7.80. (Table IV)

**TABLE IV**

**Combined Group Pre-Test, Post-Test Data**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>S_em</th>
<th>Difference</th>
<th>S_sd</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>7.45</td>
<td>2.56</td>
<td>.59</td>
<td>7.80</td>
<td>1.00</td>
<td>7.80</td>
<td>.001</td>
</tr>
<tr>
<td>Post-Test</td>
<td>15.25</td>
<td>3.53</td>
<td>.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These results indicate that the teaching of science does help the ENR student to develop the ability to perceive cause and effect relationships. This conclusion was also based on the fact that nineteen of the twenty students involved did considerably better on the post-test than on the pre-test.

However, when Group I and Group II were compared the results were different. In the pre-test comparison, the t-ratio was .60 indicating a non-significant difference. (Table V.) Likewise on the post test there was no significant difference in mean scores between the two groups. (Table VI).
TABLE V
Group I, Group II Pre-Test Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>$s_{km}$</th>
<th>$s_{rd}$</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>7.55</td>
<td>2.79</td>
<td>.83</td>
<td>.88</td>
<td>1.46</td>
<td>.60 non-significant</td>
</tr>
<tr>
<td>Group II</td>
<td>6.67</td>
<td>3.59</td>
<td>1.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE VI
Group I, Group II Post-Test Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>$s_{km}$</th>
<th>$s_{rd}$</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>15.73</td>
<td>3.12</td>
<td>.94</td>
<td>1.37</td>
<td>1.56</td>
<td>.87 non-significant</td>
</tr>
<tr>
<td>Group II</td>
<td>14.33</td>
<td>3.77</td>
<td>1.26</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The investigator had failed to consider the I.Q.'s as a variable and this may have been the reason for these last conclusions. The mean I.Q. of Group I was 74.73; the mean I.Q. of Group II was 56.67. The t-ratio of 1.56 indicated no significant differences in the I.Q.'s between the two groups. (TABLE VII)

TABLE VII
I.Q. of Group I and Group II

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>$s_{km}$</th>
<th>$s_{rd}$</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>74.73</td>
<td>10.58</td>
<td>3.31</td>
<td>18.06</td>
<td>11.54</td>
<td>1.56 non-significant</td>
</tr>
<tr>
<td>Group II</td>
<td>56.67</td>
<td>4.64</td>
<td>1.64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question Two Data

Question two of the study stated: "Is mental age a critical factor in the development of ability to perceive a cause and effect relationship?" To obtain the answer to this problem the investigator asked each student individually two questions during every fifth lesson. One question was stated so that the cause was given and the response involved the effect. The second question was the reverse of the first, the effect stated and the cause requested.

The questions asked were similar to the following: "What causes body odor?" and "What does washing our hands with soap and water do?" (Appendix C). Twelve cause and effect questions were asked the students during the investigation period of thirty lessons.

The number of correct responses for Group I, the group with the higher mean mental age, ranged from 3 to 11, with a mean of 8.09. Whereas Group II, the slower group, had correct responses ranging from 1 to 8, with a mean of 5.33. The t-ratio between the two groups was 2.28 which is significant at the .05 level. (Table VIII)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>S_Em</th>
<th>Difference</th>
<th>Sgd</th>
<th>t-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>8.09</td>
<td>2.31</td>
<td>.73</td>
<td>2.76</td>
<td>1.04</td>
<td>2.28</td>
<td>.05</td>
</tr>
<tr>
<td>Group II</td>
<td>5.33</td>
<td>2.08</td>
<td>1.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The above calculations indicate that mental age is a critical or significant factor in the development of ability to perceive a cause and effect relationship.

Data on Individual Students

The following sampling of individual students illustrates some of the extremes encountered in the two groups.

Blake, a member of Group I, scored only five correct on the pre-test. His chronological age is 15.7, mental age is 15.3, and he has an I.Q. of 101. However on the post-test his score was perfect, 20 out of 20 correct, and he was able to answer 11 of the 12 cause and effect questions correctly. Blake was interested in the entire unit but was especially concerned about germs as they related to his health and body. This teenage youth had the potential and proved this in the post-test, in the answering of the cause and effect questions, and also in his questioning attitude and ability to participate in discussions.

Laura, on the other hand, has a chronological age of 15.2 years, a mental age of 10.1 years and an I.Q. of 71. Her mental age was the lowest of Group I. On the pre-test Laura scored only five but on the same post-test she raised the score to ten. In answering the cause and effect questions she was able to answer 6 of the 12 correctly. She was very interested in science and shed tears when the group was told that this type of science instruction would cease after the
completion of this unit. However, Laura was subject to seizures and was not as attentive as she might have been at certain times. Her progress illustrates the value of teaching science and one must remember in considering her scores that she had the lowest mental age in her group.

Vast progress was illustrated by Mary Ann, who scored only 8 on the pre-test. Mary Ann was 15.4 years chronologically, 10.2 was her mental age, and her I.Q. was 70. This I.Q. being the lowest in the Group I. After scoring 8 on the pre-test, she scored 18 correct on the post-test and was able to answer 10 of the 12 cause and effect questions correctly. This adolescent was always eager to try and master. In view of her comparatively low I.Q. and low mental age Mary Ann demonstrated that science can aid in developing cause and effect relationships.

Janis, a very quiet young lady, was a member of Group II. Her chronological age was 15.7, her mental age was 9.2, and her I.Q. was 62. Janis scored 7 on the pre-test and succeeded in obtaining 19 on the post-test. She was able to give correct responses to 8 of the 12 cause and effect questions. Janis could have easily participated in class discussions for she knew the material when called upon, but failed to volunteer.

John, a quiet member of Group II, had the lowest pre-test score, 3. His chronological age is 16.3, mental age 9.0, and his I.Q. is 58. After the unit was taught on the post-test he scored 16 out of a possible 20. However, on
the cause and effect questions, John was only able to answer 3 of the 12 correctly. Although interested in the material John had only a mental age of 9.0 which may illustrate that mental age is a factor in the ability to perceive cause and effect relationships.

Susan, who is 16.1 years chronologically, has a mental age of 8.1 and an I.Q. of 53. She was the only student who scored lower on the post-test than on the pre-test. Her pre-test score was 7 and post-test test score was 6. A member of Group II, Susan was the only participant of both groups that scored less than 10 correct on the post-test. When the 12 cause and effect questions were administered to her, she was able to answer only 3 correctly. Although a quiet young lady, Susan is easily distracted. This case further indicates that mental age has an effect on the individual's ability to perceive cause and effect relationships.

Progress was noted in the case of Sissy, a Group II student with the lowest I.Q., 50. Her mental age was 7.6 and her chronological age was 16.2. Sissy answered 5 of the 20 questions correctly on the pre-test and was pleased when she scored 14 on the post-test. On the twelve oral cause and effect questions she answered 4 correctly. The teaching of science may have aided in developing causal relationships in this case, but the mental age may have been a limiting factor.
Investigator Observations

From this study the investigator observed that the students had a keen interest in science. As stated previously all children are interested in the phenomena of nature and the environment in which they live and EMR children are no exception. Each day the participants entered the simulated science laboratory with enthusiasm. They were eager to examine the experiments of the previous session and curious about what they would discover at this session.

Everyday commodities and occurrences became scientific investigations for the students. They questioned where germs come from; deodorants and antiseptics, were some better than others; what does yeast do to grape juice and the ingredients of bread; and even whether the proper nomenclature was germ jello or germ jelly.

The current study of ecology by all today also interested these EMR students. They were especially interested in their miniature garbage pits. They raised questions concerning the disappearance of some of their garbage while other types still remained.

The students were especially inquisitive when some scientific equipment was available and utilized. This is true of normal students, too, thus illustrating the fact brought forth earlier that EMR students closely resemble normal students when their environment is involved.
No severe discipline problems were encountered with either group. At times the group became somewhat noisy, but this was due to their enthusiasm relating to their experiments. The actual participation in experimentation was new to them and they thoroughly enjoyed this experience.

The investigator felt that Group I, the group with the higher mean mental age, asked a greater number of questions and more meaningful questions. This group also seemed to be able to discuss the problems, experiments, and facts better. However, both groups definitely showed interest in the unit.

The students in Group I displayed great disappointment when they were informed that they would no longer have regular science sessions with the investigator. One of the girls in the group was crying as she left the class.

When many of these students were involved in tutoring sessions outside of the study, they expressed interest in items considered in the study. Some of the students questioned and became engrossed in things such as vitamins and germs in their tutoring sessions. The tutors reported this interest to the investigator.

These observations relate to the Review of the Literature that the ENR student is interested in science and is eager to learn about his environment.
Summary

This chapter presented the data established by this investigation. This data was obtained by two methods. A pre-test and post-test was administered to research the question, "Does science help the EMR student to develop the ability to perceive cause and effect relationships?" The study indicated that the EMR student does benefit from science in developing causal relationships. Cause and effect questions were asked each student periodically to obtain data for the second question, "Is mental age a critical factor in the development of ability to perceive a cause and effect relationship?" The results indicated mental age to be a factor in this development.

Samples of the extremes encountered among the individual students participating in this research were presented. Also, investigator observations which could not be presented statistically were discussed.
CHAPTER V

SUMMARY

Problem

In this study the investigator attempted to answer the following questions:
1. Does science help the EMR student to develop the ability to perceive cause and effect relationships?
2. Is mental age a critical factor in the development of ability to perceive a cause and effect relationship?

The investigator used a pre- and post-test and two cause and effect questions during each fifth lesson to obtain data for the above research.

Population

The study was undertaken with twenty Educably Mentally Retarded students at St. Coletta School, Jefferson, Wisconsin. The school is a small, private, mainly residential center for mentally retarded students.

The twenty pupils were divided into two groups according to mental age. The eleven members in Group I had mental ages ranging from 10.1 to 15.3 years; the mean
mental age being 11.7 years. Group II was composed of nine members, whose mental ages ranged from 6.8 to 9.8 years; the mean mental age was 8.7 years.

The two groups participated in the same research program. Identical experiments, materials, methods, explanations, questioning, and tests were used with the groups to avoid variance.

Treatment of Data

The data on the two groups was compared by statistical analysis to determine the t-ratio and level of confidence or significance.

Statistical evaluation was applied to determine the mean mental age of each group, the t-ratio, and the significance or level of confidence. This same type of evaluation was used for comparison of the mean number of cause and effect questions answered by each group.

For the statistical evaluation of the pre- and post-tests, the mean score of Group I pre-test was compared with the mean score of Group I post-test. A corresponding comparison was calculated for Group II. Then an analysis was derived using the scores of the entire population of the study. The mean t-ratio, and level of significance were calculated. The scores of Group I pre-test were compared with Group II pre-test, and a corresponding comparison made with the post-test. The evaluation again involved the mean, t-score, and
level of significance.

Finally the I.Q. scores of Groups I and II were analyzed to determine the mean, t-score, and level of significance.

Results

The statistical evaluation of the results for comparison purposes of the correct responses on the pre-test and the post-test for both Group I and Group II indicated that the level of significance was .001. Likewise, when the total population of the study was taken into consideration the level of significance or confidence was .001. The pre- and post-test were administered to furnish data for the question: "Does science help the EHR student to develop the ability to perceive cause and effect relationships?" and the .001 level of confidence would strongly indicate that science does.

There was no significant difference in the scores when Group I was compared with Group II. This suggests that some other factor was operating in the study. This may have been the fact that there was no significant difference in I.Q. scores; the investigator had failed to take this into consideration.

In comparing the mean of the correct responses on the cause and effect questions of Group I with Group II, the t-ratio was 2.28 which was significant at the .05 level. This indicated a significant difference between the groups and
upheld the hypothesis that mental age is a critical factor in the development of ability to perceive cause and effect relationships.

Implications

This study indicated that it is imperative that the material to be dealt with in science for the EMR student be relevant, preferably dealing in the phenomena of nature and the environment in which we live. The material must be covered at a slower pace with a great deal of repetition.

The students enjoy and profit from experiments, but the laboratory equipment that is to be used must be easily manipulated for effective use. The experiments must be geared to the level of the students. Concrete objects and illustrations should be utilized in order to strive toward the abstractions the mentally retarded can grasp.

Since reading is often a severe handicap for the EMR student, the science curriculum should not be based entirely upon reading.

If possible individualized instruction should be one of the objectives. If this is impossible, small groups should be utilized so that each student understands the lesson.

Suggestions for Further Research

The investigator feels that research may be carried
on to determine the use of science to the EMR student in developing mathematical concepts such as linear and cubic measurement. Another possible area of investigation and one closely related to the one just stated would be to determine if the EMR student can relate and adjust to the metric system of measurement. This system of measurement may replace the English system now used in our country.

Does science encourage the EMR students in communication skills, such as reading, questioning, listening, and discussing, might also be investigated. Through the inborn science interest can the EMR student be encouraged to develop his reading skills especially.

The EMR students are interested in the phenomena of nature and the environment in which they live, and, therefore science is of natural interest. Moreover many other areas, such as phases of citizenship, social situations, and consumer education could also be effectively used to develop cause and effect relationships.
APPENDIX A

Sample Lesson Plans

Lesson Plan Number 1: Friday, January 14, 1972.

Objective: To give each student an opportunity to see agar, "germ jello", prepared, and to pour "germ jello" into three petri dishes.

Materials: 1 quart of water
2 tablespoons nutrient agar ("germ jello")
hot plate
container to boil water in
3 petri dishes per student
masking tape for labeling dishes
1 - 250 ml beaker per student
small glass plate
glass stirring rod

Motivating Question: How do you think we can grow germs?

Procedure: Before class begins, have enough supplies set out on the counter for each student and begin to heat the water.

Begin by saying:

What do you think germs need in order to grow?

Expected response: food, water, air, I don't know.
If students do not suggest food, ask: What do you need to grow? Expected response: food.

Then what do you think germs need to grow?

Expected response: food.

Distribute petri dishes to each student. Then say: In the laboratory, people grow germs in these covered dishes, which are called petri dishes. (Hold up a petri dish.) Why do you suppose they grow them in covered dishes? Expected responses: "So they don't get sick," "So they don't spread," "So they don't get out," "I don't know."

The people who work in laboratories grow germs on a special kind of jello. Can someone describe what jello is like? What does it feel like? Expected responses: wiggly, bouncy, etc.

How do you make jello? Expected response: varying responses depending upon their previous experiences.

If someone knows how to make jello, give him a chance to explain the procedure to the class. Students will probably point out that you add jello to hot water and when it cools it hardens.

If they do not relate this, then an explanation is necessary about the procedure for making jello. Have the students observe as you make the "germ
jello". Add two tablespoons of nutrient agar
to one quart of boiling water. Add the agar slow-
ly to prevent lumping. (Caution: Stir the agar
continuously since it burns easily in the bottom
of the pan.) As soon as the agar is dissolved,
remove the container from the heat source as it
will easily boil over. Cover the container with
a glass plate to keep out germs.
Instruct each student to secure three petri dishes
and a 250 ml beaker. Dispense about 50 ml of the
agar solution in each of the student's beakers.
While it is cooling, so they can pick up the beaker
with their hands, demonstrate how to pour the agar
into a petri dish.
Explain to them that you do not want to get a lot
of germs in their dishes. They should not open
the dish except when absolutely necessary.
Demonstrate that you can pour agar into the dish
by raising the cover of the dish very slightly.
Instruct them to put only enough solution in the
dish to cover the bottom. Make sure the dishes
are level when agar is put in. Do not move them
until the agar hardens. Students should pour the
proper amount of agar into the plates and allow it
to harden.
Have students label their dishes with their names.
Store them upside down to avoid condensation of
water on the agar surface. Tell students that at the next lesson they will collect some of their own germs to grow on the plates. Since these dishes are not sterile you must store them in a refrigerator until the next lesson. If you do not, they will have bacteria growing in them before the students put in their own. Uncover the dish only enough to pour the agar. Keeping the dish covered as much as possible reduces contamination.
Lesson Plan Number 2: Monday, January 17, 1972

Objective: To have each student collect bacteria from 3 different places on their body, using Q-tips and the previously prepared petri dishes of "germ jello", and place them in an incubator box overnight.

Materials: Approximately 24" x 24" x 18" box
100 watt bulb
extension cord with socket
piece of aluminum foil
yardstick or piece of wood
thermometer °F
3 agar dishes per student (prepared in previous activity)
3 Q-tips per student
clinical thermometer
alcohol

Motivating Question: Where do you think we could find germs on our bodies? and How can we make these germs grow?

Procedure: Bacteria grow very rapidly at 100°F, which is approximately body temperature. At lower temperatures bacteria will not grow rapidly. Since the temperature of most classrooms is quite a bit lower than 100°F an incubator box must be made in order to maintain the bacteria at the proper temperature.
Directions for preparing an incubator box: The temperature should be adjusted with some dishes and the sheet of aluminum foil in place. Place a yardstick across the top of a box. Suspend a light from the yardstick. Place a thermometer in the bottom of the box and turn on the light. Adjust the light bulb in the box by moving it up or down until a temperature at or near 100°F is maintained. Then tape the light cord in place.

Have the students get their petri dishes. Remind them not to open them. Begin by saying: Where do you think you could find lots of germs on your body? Expected responses, hair, hands, mouth, etc.

List responses on the chalkboard. Continue to pursue this question until many places are named.

How ask: How could we be sure these places really have germs? Suggest growing them on prepared petri dishes.

How demonstrate to students how to streak the bacteria onto the surface of the agar. Simply rub the Q-tips on the selected body part and then gently streak the bacteria onto the surface of the agar, being careful not to dig into the agar. Lift the cover of the petri dish only high enough to streak the bacteria. The bacteria should be streaked in a pattern rather than all over the agar.

Distribute 1 Q-tip per student.

Say: Collect some germs from one of the places we listed on the board. Carefully spread them on one of your dishes the
way I just showed you. Write where the germs were collected below your name on the tape.
When students have completed dish #1, have them discard the first Q-tip and distribute another Q-tip. Have them repeat the procedure selecting a different place to gather germs.
When this is completed distribute the third Q-tip and have them repeat the procedure selecting still a different part of the body.
After this work is completed ask: Is the temperature in our room good for growing germs? Expected response: maybe, yes, no, I don't know.
What is the temperature in our room? Have a volunteer read the room thermometer and record the temperature on the chalkboard.
Now ask: Is the temperature of your body a good temperature at which to grow germs? Expected responses, maybe, yes, no, I don't know.
What is the temperature on your body? Expected responses, 98.6, 98, I don't know.
Shake down the clinical thermometer and sterilize it in alcohol. Take the temperature of a volunteer by having him hold the thermometer under his tongue for 1 minute. Write the body temperature, 98.6° on the chalkboard.
Then ask: Which temperature would be best for growing the germs from our body? Infer that if germs grow on the body then the body germs should grow at a temperature similar to
that of the body.

If the students do not say this, then ask: Where do we get
the germs? Expected response, from our bodies.
So what temperature is probably the best for growing the
germs from our bodies? Infer that germs from the body should
be grown at body temperature.

Show the students the incubator box and the temperature in
it. Have students place their dishes in the incubator upside
down. Stacking them upside down keeps condensation off the
agar surface. (The dishes may be stacked more than one deep.)
Cover the dishes with a layer of aluminum foil explaining
that bacteria grow better in dark. Incubate the dishes until
the next lesson.
Lesson Plan #14, Wednesday, February 16, 1972.

Objective: To have each student observe the preparation of a solution of grape juice, yeast and sugar and to observe a control experiment set up.

Materials: package of dried yeast
2 large bowls
frozen grape juice (non-concentrated juice has preservatives added to prevent fermentation)
table sugar
2 250 ml. flasks
2 rubber stoppers (one-holed)
2 pieces 2" glass tubing
2 pieces rubber tubing (12")
2 400 ml. beakers

Motivating Question: Is yeast a living organism?

Procedure: We have been studying germs to find out where they live and how they affect us. Let's see how many things we can list that we have learned about germs. Make a list on the chalkboard of all of the responses. Then ask, if appropriate, depending on previous responses: Are germs alive? respond, yes. How do you know that germs are alive? cite evidence such as growth, eating germ jello, etc. How do germs affect us? May cause disease, mold, b.o., etc.
Are germs bad for us? Possible response, yes.
Are there any good germs? Possible response, no.
Hold up a package of yeast and ask: Who can tell me what I have here? Expected response, yeast.
Open the package and let the students see it and touch it.
Ask: Does anyone know what yeast is? Expected response, don't know, powder, something you use to make bread, etc.
Are yeasts alive? Expected response, no.
How could we find out if yeasts are alive? Responses will vary; may suggest looking at them, feeding them, seeing if they will grow.
If yeasts are alive, what would they have to do to grow and stay alive? Expected response, they would have to eat.
We are going to see if we can feed our yeasts grape juice.
What do you suppose will happen if we put yeast in grape juice?
Expected responses, don't know, make wine.
To set up the demonstration first, prepare only the setup which includes yeast. Prepare the grape juice according to the directions on the container. Fill the flask about half full of grape juice, add one tablespoon of table sugar and one-half teaspoon of dried yeast. When the apparatus is completely assembled, ask: If something happens in our experiment, how will we know if the yeast is causing it? What should we do so that we can tell what effect the yeast has?
Have students recognize the need for a control setup without yeast. Prepare the second setup without yeast. Place both
setups in a place where the students can observe them throughout the day. At the next session allow all students an opportunity to observe the demonstration. Before opening either flask, ask: What happened in the experiment with yeast that did not happen in the one without yeast? Expected response, it breathed, it gave off a gas, it pushed the water down. What evidence do you have that yeasts are alive? Expected response, they breathed.

Open the flasks and allow all students to smell both. Then ask: Do both flasks smell the same? Expected response, no. Which one smells like grape juice? Expected response, the one without the yeast. What does the other one smell like? Expected responses, wine, beer, booze, yeast, baking bread. How can you explain the difference in the two flasks? Expected response, that the difference must have been caused by the yeast.

How could the yeast cause the grape juice to change? Infer that the change must have been caused by something that the yeast gave off.

Discuss all student responses. Finally say: Yeasts are living microorganisms like the other germs we have been studying. When yeasts eat something like grape juice they give off a gas and alcohol. Man uses yeasts to make wine and beer. The smell in the flask with the yeast was due to alcohol. Some kinds of alcohol are poisonous, like rubbing alcohol found in the medicine cabinet at home. It is
dangerous to drink alcohol like that we have produced since it may be poisonous. People who make wine and beer are very careful not to make the kind that is poisonous.

How do you think that all germs are bad for us? Expected response, no. Some students may suggest that yeasts are bad since drinking alcohol may be harmful.

Discuss student responses. If students suggest the harmful effects of alcohol and maintain that germs are bad, ask if they can think of any way that germs such as yeast may help us.

Objective: To have each student prepare two jars of the same kind of food, one to be refrigerated, and one to be left at room temperature.

Materials: Samples of different kinds of food that would be kept in the refrigerator.
Refrigerator
2 baby food jars or milk cartons per student
Saran Wrap

Motivating Question: What would happen if we did not keep food in a refrigerator?

Procedure: Have a variety of samples of food which is kept in the refrigerator. Ask each student to identify the foodstuff he has chosen and explain why he thinks it is kept in the refrigerator. Possible reasons for keeping it in the refrigerator, keep it cold, keep it from rotting, don’t know. Then ask: What would happen if you did not keep it in the refrigerator? Expected responses, I don’t know, melt, rot.

Let’s see what happens if we leave part of your food out of the refrigerator. Have students divide their foods in half in whatever ways are appropriate for the foods they have. Put each half into a jar or milk carton and label with the student’s name, and either refrigerator or room.
Have the students cover the containers with Saran Wrap and place one container in the refrigerator or cooler and the other in the room in an appropriate place. Have the students observe both containers each session for the next week to notice differences. Many interesting changes should take place, depending on the variety of foods that you have. Molds should develop, and some unusual odors. Students can record the results if help is given in spelling. At the end of a week let each student give a report on what has happened to his food, noting changes that have taken place in the two samples. Ask a few unifying questions such as: What happens to most foods if we take them out of the refrigerator and leave them out? Expected responses, many foods spoil, rot, or get overripe. What causes them to spoil? Encourage them to recall past work and answer, germs. Should we eat spoiled food? Expected response, no. Why not? Expected response it would make you sick. Why keep such foods in the refrigerator? Infer that refrigeration reduces spoilage and danger of illness by slowing down the growth of germs. Why do you think that refrigeration keeps food from spoiling? Infer that it is too cold for germs to grow.
Lesson Plan #23, Wednesday, March 8, 1972

Objective: To have each student prepare, in a can of soil, samples of different types of garbage for future observation.

Materials: Small garbage samples, such as metal, plastic, paper, food materials, etc.
Beaker (250 ml) or other suitable container full of soil, one per student.
2 or 3 pound coffee can per student

Motivating Question: What would happen to this garbage if we put it outside? - predict, it would make a mess, it would stink.

Procedure: The samples should remain buried several days before comparison is made. If desired the samples may be reburied and observed at weekly intervals for a period of time.
Have the students bury samples of food, metal, paper, plastic, and other things to make a comparison. What do you think is going to happen to the garbage if we leave it buried for a week?
Expected responses, nothing, it'll rot, I don't know.
A week later begin class by having the students obtain their cans of soil and garbage, and see what they can find. Have the students explain what happened to their garbage, and then ask:
Why did the food items change? Expected response infer that germs ate them. Have the students speculate about what happens to garbage they throw away by asking: What happens to garbage produced at home? Expected response, it's picked up, taken to the dump. What happens to garbage at the garbage dump? Expected response, it gets buried, they burn it. What do you think happens to all the garbage that everyone throws away? Expected response, some rots, some does not. What happens to the garbage that does rot? Expected response, goes into the soil, disappears. What happens to the garbage that does not rot? Expected response, stays buried. What would happen if none of our garbage rotted? Suggest that there would be an awful pile of garbage. Would you say that germs that rot garbage are harmful germs or helpful germs? Expected response, harmful, helpful.
APPENDIX B

Pre- and Post-test for Science, "Me and My Environment"

1. Which of the following is a microorganism?
   a. an insect  b. a germ  c. a microscope  d. I don't know

2. If germs grow, what makes them grow?
   a. germs don't grow  b. alcohol  c. food  d. I don't know

3. Is one cleaning product as good at killing germs as any other cleaning product?
   a. yes  b. no  c. I don't know

4. Another name for germs is:
   a. bacteria  b. insects  c. very small animals  d. I don't know

5. Are germs found in the air?
   a. yes  b. no  c. I don't know

6. Is yeast a living organism?
   a. yes  b. no  c. I don't know

7. Can germs cause body odor?
   a. yes  b. no  c. I don't know

8. What does yeast make when combined with fruit juice?
   a. lemonade  b. alcohol  c. air  d. I don't know

9. What would happen if yeast were not added to bread dough?
   a. the bread would spoil  b. the bread would be flat  c. It wouldn't make any difference  d. I don't know
10. What effect does refrigeration have on germs?
   a. refrigeration slows down their growth
   b. refrigeration has no effect on them
   c. refrigeration kills them
   d. I don't know

11. Which one of the following products would be most likely to spoil in a grocery store?
   a. canned milk  b. frozen corn  c. meat  d. I don't know

12. All kinds of garbage will disappear if buried in ground for a short period of time.
   a. yes  b. no  c. I don't know

13. What can germs cause?
   a. heart attacks  b. cancer  c. disease  d. I don't know

14. Are there any places that germs can get inside our bodies?
   a. yes  b. no  c. I don't know

15. Which of the following is one of our bodies natural defenses against disease?
   a. our mouths  b. tears  c. our arms  d. I don't know

16. Is one disinfectant just as good at killing germs as any other?
   a. yes  b. no  c. I don't know

17. Which of the following is one of our bodies natural defenses against disease?
   a. ear wax  b. the hair on our head  c. our fingers
   d. I don't know
18. Are all germs harmful to us?
   a. yes  b. no  c. I don't know

19. When food spoils it is due to:
   a. being in the air  b. getting old  c. germs  d. I don't know

20. Does cooking help to keep foods from spoiling?
   a. yes  b. no  c. I don't know
APPENDIX C

Cause and Effect Questions

1. Why did we try to keep the covers on the petri dishes closed as much as possible when we poured the "germ jello" in?

2. How did we help our germs to grow?

3. What causes body odor?

4. What does washing our hands with soap and water do?

5. Why should you cover leftover food if you plan to eat it later?

6. What caused the darkest mold on our bread?

7. What happened when yeast was not added to the bread dough?

8. When we made wine from grape juice what caused the gas to be given off?

9. What effect did boiling the hamburger have on the germs?

10. What caused the food kept at room temperature to spoil?

11. How does the hair in the mose help to keep us healthy?

12. What caused part of our buried garbage to rot?
BIBLIOGRAPHY

Books


Freeman, Kenneth; Dowling, Thomas I.; Lacy, Nan; and Tippett, James. Helping Children Understand Science.


Articles in Journals or Magazines


Curriculum Guides

