ELEMENTARY SCIENCE IN A SPACE-LIKE SETTING

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ELEMENTARY SCIENCE IN A SPACE-LIKE SETTING

A Creative Project
Presented to
the Faculty of the Graduate School
Austin Peay State University

In Partial Fulfillment
of the Requirements for the Degree
Education Specialist

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by
Kay Ray Putty
May 1976

To the Graduate Council:

I am submitting herewith a Field Study written by Kay Ray Putty entitled "Elementary Science in a Space-Like Setting." I recommend that it be accepted in partial fulfillment of the requirement for the Specialist in Education degree.

Bryan Crutcher
Major Professor

We have read this field study
and recommend its acceptance:

Elsie P. Oakley
Second Committee Member

Joe Filippo
Third Committee Member

Accepted for the Graduate
Council:

Wayne E. Hoenig
Dean of the Graduate
School

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Chapter 1

INTRODUCTION

Science rooms are all often too dingy, smelly, and drab. Students and others may conclude that only persons with a peculiar interest would find satisfaction in working in such surroundings. Actually interest in science is widespread among youth, and the dingy and drab appearance of science rooms may serve to thwart and offend this interest. Well-designed and decorated classrooms and modern science laboratories reveal ways to make science rooms pleasant and attractive while being highly serviceable. This change can be achieved through wide use of colors. Some of this color applies to ceiling, walls, floors, and table tops, while some is evident in furniture and fixtures, and much is evident in displays, pictures, maps, charts, posters, living things and use of colored lights. The general design of the room and the furnishings also helps to determine attractiveness. If there is a conglomeration of various types of furniture the result is seldom very pleasing. If the arrangement of even well-designed furniture is without rhythm and imagination the result also lacks a full degree of attractiveness.[1]

R. Will Burnett said that the ideal classroom is very large, has easily moveable furniture, and plenty of storage space. He also stated that the ideal classroom has a sink with running water, Bunsen burners, and facilities for cleaning up. He concluded that the ideal classroom has adequate bulletin board space and shelf space for exhibiting student work.[2]

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[1]Philip G. Johnson, School Facilities for Science Instruction (Washington, D. C.: The National Science Teachers Association, 1961), p. 14.

[2]R. Will Burnett, Teaching Science in the Elementary School (New York: Rinehart & Company, 1953), pp. 136-137.

PURPOSE OF THE STUDY

The author felt that a creative project of establishing a space-like environment for fifth graders at Crofton Elementary School at Crofton, Kentucky, would result in increased student interest in science space experiments, more creative teaching, and student achievement in science.

The author felt that this project enabled her to work closer with the students not only in science experiments but in simulating a space-like environment to improve learning and create more interest in science.

DEFINITIONS OF TERMS

Many terms were used in the literature reviewed for this project. In order to communicate the meaning of the author, definitions of some of the terms were listed.

Biologistics is the maintenance of an adequate supply of food, oxygen and water.[3]

Creativity is individual discovery using both conscious and unconscious efforts in dealing with feelings and ideas which need to come to realization in producing desired forms of expression.[4]

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[3]Louis Alcorta, Life Science in a Space Age Setting (Detroit: National Aeronautics and Space Administration, 1970), p. 284.

[4]Geraldine Dimondstein, Exploring the Arts with Children (New York: Macmillan Publishing Co., 1974), p. 15.

Kinesthetic Sense is the perception of balance, body position, weight and muscular movement.[5]

Orientation is an adjustment or adaptation to a new environment, situation, custom, or set of ideas.[6]

Physiological Stress is a stress that includes temperature fluctuations and accelerations on the human body.[7]

Psychological Stress is a stress that includes anxiety, disorientation and isolation in the human body.[8]

Toxicology is the reduction of the hazards associated with carbon dioxide, carbon monoxide and other toxic gases, and the control of sanitary waste materials.[9]

METHODOLOGY

The purpose of this study was to rearrange the classroom to simulate a space laboratory for life science experiments.

Before and after photographs were taken of the classroom to illustrate the creative arrangement of facilities.

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[5]Charles A. Ford, John S. Richardson, and Leo Charles Fay. Compton's Illustrated Science Dictionary (Chicago: Encyclopedia Britannica Educational Corporation, 1971), p. 13.

[6]William Morris, The American Heritage Dictionary of the English Language (New York: American Heritage Publishing Co., Inc., 1969), p. 43.

[7]Alcorta, op. cit., p. 14.

[8]Ibid., p. 15. [9]Ibid., p. 13.

A survey was made of the students' impressions of the classroom and what changes they would like made before the rearrangement began. Students wrote their impressions of the room after the project was completed. Comparisons were made of students' reactions to the space-like laboratory arrangement.

The teacher gave a science interest inventory to determine student interests.

A pre-test was administered to sixty-three fifth graders at Crofton Elementary School at Crofton, Kentucky, on December 1, 1975. The pre-test was designed to assess beginning behavior. The eight life science experiments and other related activities were presented for a period of six weeks, and then a post-test was administered. The post-test was identical to the pre-test and assessed learned behavior. As the author was unable to obtain standardized pre-tests and post-tests, they had to be teacher-made.

A teacher-made test was also administered to measure the effectiveness of the life science experiments that were attempted. The topics of the life science experiments were biologistics, toxicology, radiation, physiological stresses, and psychological stresses.

Following are some of the things the author did to carry out the creative project:

1. Walls were painted with aluminun paint to resemble steel.

2. The ceiling was rounded to resemble a space lab.

3. Mirrors were attached to the four corners of the room for light and reflection experiments.

4. Mobiles of planets were hung to show relativity of the planets to the sun.

5. Furniture and waste cans were painted to add color and a more modern atmosphere.

6. Student desks were replaced with rectangular tables and chairs.

7. Cabinets, baseboard trim, blackboard trim, and bulletin board trim were painted in bicentennial colors.

8. A student planetarium was constructed by the students for studying the movement of the Earth around the sun.

9. The marred window panes were painted over with tempera paint using the space theme. Students did this.

10. The window shades had pulls put on them, and constellations drawn by the students were painted on the shades.

11. Several unwanted items of furniture were removed.

12. The pencil sharpener was painted and lowered.

13. Charts depicting the astronauts in training and scenes of blast-off were placed around the room.

14. Learning centers pertaining to foods in space, the astronauts' suit, and planet-sun relativity were set up for student participation.

SIGNIFICANCE TO EDUCATION

The author felt that this creative project enabled her to be a more creative teacher and not become so reluctant to change.

This project also enabled the author to work more closely with the students not only in the classroom situations but in jobs that were done together to make the classroom a better learning environment which incorporated the space-like theme.

Further, the research the author did on related literature and materials gave a better insight about what makes for good learning and what avenues to pursue to update the project in the future.

Finally, the creative project made the students want to investigate further about some of the problems of the space age that will affect them as they continued their study in this area.

LIMITATIONS

Since this was a creative project, the author reviewed the related literature, used past experiences as a science teacher, and realized a need to make the science classroom more stimulating for fifth graders.

Since many physical facilities of the classroom were irreversible, the author had to use the present ones and work with problems that could be improved. These problems included painting the room, rearranging and changing the furniture, and building a few new science experiment centers and displays.

Since no funds were available from the school's budget, many additional ideas could not be implemented.

Another limiting factor was the length of time to conduct the experiment for achieving measurable results.

Finally, the author was unable to secure a pre-test and a post-test which were standardized; so a teacher-made pre-test and post-test had to be prepared.

Chapter 2

INQUIRY EXPERIMENTS

According to Louis Alcorta, the major problem that faced the classroom teacher in this space age was a difficult and personal concern. The problem was a psychological one. For the most part, a teacher's view of the universe beyond our Earth's atmosphere consisted of the moon, stars, planets, and somewhere up there, other galaxies. To our students, that same view was filled with orbiting satellites, astronauts, future space platforms and space stations. Anthropologists had commented on this phenomenon pointing out that, as young adults in our society, we tended to migrate to a new location and raised our children in the new environment. Similarly, we had, as a society, entered a new age in which our students were the "natives" and the teachers were the "migrants". Mr. Alcorta concluded that some reorientation was needed so that the students may gain the benefits of a mature perspective while retaining their natural curiosity and enthusiasm to be active participants in the exciting days before them.[10]

The following inquiry experiments were taken from Louis Alcorta's report that he submitted to the National

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[10]Louis Alcorta, Life Science in a Space Age Setting (Detroit: National Aeronautics and Space Administration, 1970), pp. iv-v.

Aeronautics and Space Administration.[11]

INQUIRY NO. 1

MA, PLEASE PACK ME A LUNCH-
I'M OFF TO THE MOON

With the coming of the space age, mankind has been faced with new problems in food storage. Extended periods of time will pass as man travels the great distances between planets. Food storage will be a factor which will need to be considered and may limit the extent to which man will be able to wander among the stars. The requirements for food and its storage can be determined with some precision. The food must contain food nutrients in highly concentrated form per gram of weight as room is limited. The stored food must look tasty, and must be able to withstand radiation and extremes of heat and cold. In trying to solve these space problems, scientists look to the way we store food in our everyday life. Some foods are frozen and then stored. They are eaten after they thaw out. Other foods are put in sealed cans and are exposed to great heat. They are then cooled and stored. In any grocery store, one can see vegetables and many other types of food stored in both ways. Also, many materials are used to keep the heat out and the cold in - ice cream sacks and tin foil

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[11]Ibid., pp. 50-239.

are two examples.

Many of the ways we keep foods from spoiling in our everyday lives cannot be used in space travel. Some of the materials we use cannot stop radiation, or else, they cannot stand changes in temperature which may exceed hundreds of degrees. Radiation may affect the food, changing its chemical composition so that some food essentials, such as amino acids, may be converted into nonusable form for cell growth and development. A further complication is the food's consistency. Visualize a broken cracker eaten during a weightless state. The cracker crumbs would float about creating a fascinating but potentially dangerous "fog" until a gravitational field removed them from the atmosphere.

In this inquiry your capacity for original thinking will be tested. Can you devise a method for food processing and packaging which provides for maximum food value for the least weight and bulk, with packaging to protect against radiation, temperature extremes and yet, when the food is eaten, the packaging can be readily disposed? As an afterthought and yet of major importance, can you provide food which is tasty and appealing?

INQUIRY NO. 1 MA, PLEASE PACK ME A LUNCH- I'M OFF TO THE MOON

Basic Concepts:

Types of food, packaging and palability are major problems in providing food for any self-contained unit and in the exosphere.

The goals of food provision include maximum food value for minimum weight and bulk, packaging for protection, multiple utility and ready disposability.

Sequence - Summary

Food, if preserved and packaged properly, can withstand wide variations in temperature.

Extended periods of food storage may adversely affect the taste and nutritional value of foods.

The use of dehydrated foods has the advantage of low weight and bulk, rapid reconstitution, long storage period potential, and it may be pre-cooked.

Activities - Illustrations

Discuss with students how food packaging can insulate food against heat ahd cold; how packaging can be durable yet light in weight; how packaging can have some further use after the removal of the food; how packaging can be designed to withstand low levels of radiation.

Expose many kinds of food to extremes of heat and cold.

Find out which types of foods last longest without preservation under varying conditions of heat and cold.

Freeze- drying (sometimes called freeze dehydration) is superior to canning in that the food retains its size and shape but is less in weight due to water loss.

Recycling systems, whereby algae, and sanitary wastes are used to provide protein for use by man, are being developed for use on extended trips or on planetary stations.

Try available packaging materials under varying temperature conditions.

Raise the question: What would happen to egg white in the presence of dry ice?

Finely divided food particles can be a problem in a space craft in which the oxygen content is higher than our own atmosphere.
Demonstrate the effect of dust in the air by blowing finely divided flour past a flame. Discuss coal mine dust explosions, grain mill explosions.

Secure samples of the following types of food preservation:

a. dehydration
b. freeze dehydration
c. vacuum packing
d. radiation
e. salting
f. smoking
g. others suggested by the students.

INQUIRY NO. 2

THERE SHE BLOWS!

"There she blows!" is a familiar expression used by whalers when a whale's warm exhaled breath becomes a spout of condensed water vapor. Shortly thereafter the whale will refill his large lungs and disappear below the water's surface into the depths of the ocean. Have you ever wondered how a whale can withstand the tremendous pressures which the water, pressing on him from all sides, exerts on his body? Similarly, what is the effect of the water on the hull of a submarine? Perhaps you have been fishing in a deep lake and have seen someone bring up a fish from a depth of 150 or 200 feet. How does a fish manage to move up and down in the water? Have you ever heard of sandhogs? That is the name given to men men who work on the building of tunnels under rivers. They are required to work in an atmosphere in which the air pressure may be four or five times greater than our atmospheric pressure of 14.7 pounds per square inch. In the mining industry, such men are called groundhogs. What is common to all the examples and questions which have been raised? You've guessed it, it is pressure. How each organism is able to adjust to changes in pressure is of vital importance if it is to survive in the environment. We have learned how to protect the human from too much pressure, as in the case of submarine construction. What other examples can you suggest in which man has had to develop ways to protect himself from either too much or too little air pressure in his environment?

Another area in which pressure is important to us can be found in our daily lives. People living at elevations of four or five thousand feet find that it takes a longer time to cook foods such as potatoes than when they try the same thing at sea level. If you are driving over a high mountain pass, you may find that the air pressure in your family car's tires is much higher at the top of the pass as compared with your home or at sea level. If you keep a record of the readings on a mercury or aneroid barometer over several weeks, you will find that the readings go up and down. As in the first paragraph, the question is: What do these events have in common?

In this inquiry you will be encouraged to find examples of what you have read about and to suggest ways whereby man has learned to live with the problem of an adequate air supply in limited spaces such as self-contained units represent. In your findings you will have identified some of the problems and directions for solutions which face the scientists and engineers as they look to the stars and plot our future explorations into space.

INQUIRY NO. 2 THERE SHE BLOWS!

Basic Concepts:

Pressure is the force per unit area acting on a surface.

Atmospheric pressure fluctuates.

Air pressure can be measured with a number of instruments.

When the pressure is decreased on a gas, the volume increases (temperature is assumed to remain constant) and the density of the gas decreases uniformly.

Sequence - Summary

Air pressure has an effect on:
- a. food
- b. water
- c. air (O_2, N_2, CO_2)
- d. temperature
- e. psychological reactions

Air pressure varies from the surface of the earth upwards (also downwards)

Activities - Illustrations

Place a balloon in a bell jar on a vacuum pump plate and observe it as the amount of air in the bell jar is reduced. Try this with the balloon inflated to various drgrees.

Repeat the balloon experiment using a pan of water which has been slightly warmed.

Encourage the students to try to train fish in the aquarium to come to a particular spot in the fish tank for food when a small change is made in the atmospheric pressure above the tank.

Place balloons in the refrigerator in various stages of inflation. Affix a balloon to the top of a bottle which has been previously heated. Place it in the refrigerator. What is the relationship observed between volume and temperature?

Boil water at different levels within the same building. Determine the differences in elevation. Be sure to take the temperature reading for each sample in the steam above the water, <u>not</u> in the water itself. (Why?) Use an anaeroid barometer to establish the differences in air pressures between the two locations.

Try the boiling water experiment on different days; at different times of the day.

Encourage the students to find information on the air pressure conditions on the moon, other planets, inside various self-contained units such as submarines, high altitude aircraft, and others the students may suggest.

Place a cork on a gallon jug filled with water. Strike the cork a sharp blow with a hammer. Help students interpret the results. (CAUTION: Place the gallon jug inside a waterproof container to avoid a deluge or injury.) Discuss Pascal's Law and its applications with the class.

Explore with students the reasons for, and examples of pressurized foods. (Tie this in with Inquiry No. 1 - Ma, Please Pack Me a Lunch - I'm Off to the Moon.)

INQUIRY NO. 3

A DROP IN TIME . . .

Not too long ago, a small private plane with a man and woman aboard crashed in Northern Canada. They both survived the accident with the only injury being a sprained ankle by the woman. It was winter and the area was isolated and uninhabited. They were stranded for forty-one days before an aircraft spotted them and a rescue crew reached them. In that time period, they had eaten a couple of candy bars, several bottles of vitamin pills and water secured by melting snow over a continuous fire. Doctors reported that, because both were overweight, because they did very little strenuous activity, and because they were able to supplement their enforced "dieting" with vitamin pills and ample water, they were in good physical condition upon their rescue! In many ways, their's was a self-contained universe, even though not one of their own choosing. The combination of factors which enabled them to survive is worth examining as we consider, in this inquiry, how isolated units, such as a dirigible, submarine, or underwater home, can be supplied with an adequate supply of water, one of the necessary elements for survival.

In a confined area, man will require water for drinking, washing and food preparation. What could be your prediction for each need? Express your guess in pounds per man per day. To do so, use the rough value of nine pounds as equal to a gallon of water. An estimate of these requirements includes two and one-half pounds per man per day. To do so, use the rough value of nine pounds as equal to a gallon of water. An estimate of these requirements includes two and one-half pounds per man per day for drinking water, four pounds per man per day for washing, and two pounds per man per day for food preparation (regular food weighing one and one-half pounds). This totals nine pounds or roughly one and one-third gallons (5-1/2 quarts) of water. With such values to work from, it would seem a reasonably simple task to work out some type of storage facility for water and then move on to some other more complex problem. However, it is not all of the story. Everytime you exhale, one of the waste products you are discharging is water. For the same person that we provide eleven pounds of water per day, he releases two and one-fifth pounds of water vapor per day! This figure also includes the water loss from the body due to perspiration. An additional three pounds per man per day can be accounted for from the urine and the water in the feces, both sanitary wastes which, on short trips in self-contained units, can be stored. Let us illustrate these values in tabular form:

Illustration No. 6 Comparison of Water Intake and Water Output for a Man

		Water Intake (lbs./man/day)	Water Output (lbs./man/day)
1.	Drinking	2.5	-
2.	Washing	4.0	4.0
3.	Food Use	2.5	-
4.	Exhalation and Perspiration	-	2.2
5.	Urine Feces	-	3.0
	Total	8.5	9.2

Are you surprised that the water intake and water output are not equal? In the process of converting food to usable substances such as glucose, fatty acids and amino acids, water is a by-product. It accounts for about a half pound of water per man per day. The remainder represents water in the food which was not measured in the water input column. You can explore similar input-output problems using a mouse, rat, guinea pig or hamster. It would be interesting to design a cage so that the waste materials would be collected, weighed, and compared with the water and food intake of the animal. Various diets can be tested. If you use a young animal, which is still growing, what predictions would you make as to the kinds of results you are likely to get? Will the water and food input equal the output? Why?

INQUIRY NO. 3 A DROP IN TIME . . .

Basic Concepts:

Under all conditions, water must be provided for human use.

Water is both necessary and essential for life and a waste product of metabolic activity.

Sequence - Summary

Sources for water for self-contained units:
1. storage tanks
2. desalination
3. distillation

Methods of storage needed to satisfy these requirements:
1. Materials must be light in weight.
2. Size and shape must be considered.
3. Material must be evaporation and expansion proof.
4. Design of container must provide for flow while in weightless state.

Activities - Illustrations

Encourage students to design or build a self-contained unit from cardboard. Have a student spend some time in it and then report on his reactions (increase moisture in air, "stuffiness", etc.)

Fill a gallon jug with tap water and let it stand for several weeks. Observe, taste, and discuss the problems associated with storage of water for extended periods of time.

Encourage students to bring in dehydrated foods, explore the amount of water needed to reconstitute them.

INQUIRY NO. 4

FIRST, YOU PUSH THE DAMPER IN . . .

The blood of city dwellers regularly contains over one per cent of the total hemoglobin as carbon monoxide hemoglobin; tobacco-smoking may increase this to five per cent. What does this mean for you? The presence of carbon monoxide in the atmosphere of a community with heavy industrial operations may well account for part of that one per cent. But, you will notice that the statement is not limited to city dwellers in heavily industrialized areas. Therefore, we shall have to seek elsewhere to find a way to account for the carbon monoxide which, once it enters our blood stream through our lungs, has a two hundred-fold attractiveness over oxygen for the hemoglobin. What other sources for carbon monoxide can you identify? A list of causes for accidental asphyxiations covering one year for the state of Ohio included as sources, from the most frequent to the least frequent: gas water heaters, automobile motor exhausts, room heaters, kitchen stoves, bathroom heaters, and bedroom heaters. In that one state for one year there were seventy two deaths and two hundred and thirty seven partial asphyxiations due to carbon monoxide poisoning by accidental causes!

If you were to design a self-contained unit in which a number of people were to stay for an extended period of time, some system for venting gases of the unit would be needed. If the surrounding atmosphere were at the same pressure as the self-contained unit, some type of fan or blower system could be improvised. However, when you have a variation in pressure, such as could be the case for a submarine or high altitude airplane, the problem becomes more complex. Have you read stories of submarines and of their problems during wartime when under attack? The crew of a submarine, resting at the bottom of some bay, engines shut off to prevent detection by sonar, is in a rather touchy situation. Without engines to generate electrical current, the operation of the ship is dependent upon the current from the electrochemical action of the batteries. This energy source will provide the needed current but also releases hydrogen gas, a by-product of the electrochemical process. If you have had some chemistry, you will recognize the problem: free hydrogen gas, oxygen gas and a match - BOOM!! - and you have water. The final product is not the concern of the submariner, it is that BOOM!! which can be quite destructive. A second problem is the possible release of chlorine gas from the batteries. This problem depends upon the acid being used, and whether any type of gas absorber is in use. Fortunately, with the advent of the nuclear submarine, this type of problem may be out-of-date.

In this inquiry, you will explore safety techniques.

Basic Concepts:

A system of venting and filtering air for reuse in a self-contained unit is required. Such a system must be able to remove the carbon dioxide, carbon monoxide and build-up of other toxic gases.

Toxicological products must be protected against temperature extremes.

Sequence - Summary

For conditions of continuous exposure (90 days), the maximum allowable concentration (MAC) of carbon monoxide is fifty parts per million.

The body's metabolism, through the breakdown of hemoglobin, is continuously producing and exhaling small amounts of carbon monoxide. The rate of release is such that, unless removed, it will build up to fifty parts per million in five days.

If the amount of carbon dioxide gas in the air is not controlled, its increase will stimulate an increase in the production of carbon monoxide by the body's metabolism.

Organic vapor-producing compounds can be serious toxic gas sources in self-contained units.

Activities - Illustrations

Place ammonia in a beaker. Observe the diffusion of the gas at different temperatures.

Place carbon dioxide in lime water. Place filters to slow down CO_2 diffusion and observe at different temperatures.

Chart observations as to speed of gas diffusion at the different temperatures.

Read account, "The Fog" to the class. Story is taken from, Eleven Blue Men, B. Rouche, Berkley Medallion Books, New York, 1953, pp. 171-189.

INQUIRY NO. 5

GOPHER HOLES ON THE MOON

Skiing has undergone an explosion of popularity in many of our northern states recently and many people now enjoy exciting week-ends on the sloping hillsides. Even though skiing does offer an excellent opportunity for exercise, it may lead to harmful or dangerous effects.

Most skiers will be quick to tell you that the dangers from falling are greatly minimized by learning how to fall, but falling is not the only danger involved. Occasionally skiers have gone blind, especially after a day of cross-country skiing on bright sunny days. The cornea of the eye actually turns cloudy or opaque, although this usually does not last more than a few days. We refer to this temporary clouding of the cornea as snow-blindness. A cause-effect pattern between bright sunshine and snow-blindness might easily be established, yet the cause of blindness is not the intensity or the brightness of the sunlight, but rather radiation which accompanies the sunny conditions. Ultra-violet light injures the delicate tissue of the cornea and the damaged cells cause the cornea to become cloudy. If they are injured extensively, scar tissue may be formed, resulting in permanently impaired vision.

Ultra-violet light is only one of many types of radiation. Radiation can be either natural or man-made, and both types will cause damage to living cells, as was illustrated by the example of snow-blindness. Much natural radiation is filtered by the atmosphere before it ever reaches the earth's surface; however, we are undergoing continuous bombardment by particles from outer space known as cosmic rays. Our satellites and other space explorations have shown that many regions of space are intensely radioactive. Three large radiation belts surrounding the earth, called Van Allen belts, once led some scientists to suggest that space-craft with living specimens could never pass through these radioactive belts and survive.

Our inquiry will lead us into discussing the basic principles of radiation, especially in space travel, and we will try to solve some of the problems radioactivity causes in space travel.

INQUIRY NO. 5 GOPHER HOLES ON THE MOON

Basic Concepts:

Particle and electromagnetic radiation are present in space at far greater intensities than under the earth's protective shield of atmosphere and ionized layers.

Man in space must be shielded from high-intensity radiation, or, if not possible, the time of exposure must be kept at a minimal level.

Sequence - Summary

Human body must be insulated to protect from radiation. Temperature changes must be maintained within certain limits. (Ionizing types)

During solar flare periods, radiation greatly increases over normal levels. Within the Van Allen belts, radiation is constantly at a far higher level than elsewhere in space.

Long-flight vehicles, space stations or moon colonies would need special shielding during solar flares.

Activities - Illustrations

Experiment with any ionizing radiation on fruit flies in an enclosed, isolated box. Observe cumulative effects of radiation at different temperatures.
Determine lethal rate at temperatures.
Note mutation incidence at various temperatures.
With prolonged exposure, note any differences in sterility at the different temperatures. Do the same with plant life.

The Van Allen belt is expected to be passed through rapidly enough so that extra shielding will not be necessary. (Time of exposure a factor)

Magnetic field around spacecraft may shield astronauts from high-intensity radiation.

The lunar surface has been acted upon by radiation from the sun, including ultra-violet light, x-rays and cosmic particles. All of these forms of radiation may have had an effect on the chemical composition of the surface.

Use:

1. Charts of solar flares (11 year cycles).
2. Charts of Van Allen Radiation Belts.
3. Charts on solar magnetic fields.

Encourage students to find and experiment with effective shields of ultra-violet light, visible light, and infra-red rays.

To demonstrate time of exposure as a factor, a wood splint passed through candle flame does not ignite, although if left within the flame for a few seconds, it easily ignites and burns. Discuss.

Use "tuning eye" radio tube, or oscilloscope or T. V. tube, to illustrate how magnetic fields deflect charged-particle radiation.

INQUIRY NO. 6

EXPLORING BIOTHERMAL EXTREMES

Have you ever thought, as your family car was moving down the highway, "Gee, if we could only take off into the wild blue yonder and see the world that the astronauts talk about!" If such a thought has occurred to you, you may even have gone a step further and looked around you in the car to see how it, as a self-contained unit, might be modified for the trip. The car has been designed to provide for your comfort and safety under terrestrially-limited conditions. However, some of the techniques which have been perfected for the car may help you identify some of the problems which exist in the design of temperature fluctuation controls for any self-contained unit (dirigible, submarine, bathyscope, transcontinental airplane, etc.) or exospheric device.

Let us assume that you are going for a vacation and plan to travel by car from Alaska to the tip of South America. Such a trip would take you through the entire gamut of temperature conditions found in the world. What are some of the ways you will be able to insure your personal comfort over such a range of temperature fluctuations? A second problem to be considered is the "greenhouse effect". Have you heard of it? When infra-red rays pass through the glass panes of the automobile, they warm the surfaces they strike, including the seat covers and your skin. These surfaces, in turn, give off heat radiation which warms the air in the car and causes convection currents of air to form. So what? If the windows are kept closed, this extra heat in the air cannot escape from the car. Why? Right! It is because your skin and the seat covers give off heat radiation of longer wave lengths than the infra-red rays. The infra-red rays were able to pass in and out of the car through the glass; the longer wave lengths cannot. The car is thus a heat trap. How would you suggest the designers of a space craft handle this problem? Eliminate all windows? Use glass which blocks the passage of these undesirable wave lengths? Certain chemicals absorb radiant energy undergoing a change in their capacity to absorb light. Such a process, which is reversible, is referred to as photochromism and may be an avenue for the resolution of the "greenhouse effect." In this inquiry, you may wish to explore this type of problem.

To encourage your thinking about the type and design of space craft and space suits, the following points are listed; they represent some of the conditions which must be satisfied for effective performance of such aids in an outer space setting:

1. In the absence of an atmosphere, the sole form of heat loss is by radiation.

2. Radiant energy travels in waves along straight lines, its intensity at any distance from a source is inversely proportional (if you go twice the distance from the object, the intensity is one-fourth; if three times the distance, one-ninth; etc.) to the square of the distance from the object.

3. The more nearly vertical the rays of radiant energy, the greater the number that will fall upon a flat surface, and the greater is the amount of energy that will be received.

4. Dark, rough, or unpolished surfaces absorb or radiate energy more effectively than light, smooth, or polished surfaces.

5. Temperature control for space suits should be effective for outside temperatures of 215^{0} F. and -250^{0} F. To further this goal, it should be heavily insulated, power-heated and cooled.

Basic Concepts:

The human organism functions best within certain ranges of temperature and humidity.

Heat radiation from normal body activity may build up excessively unless transferred.

Planets and moons are unevenly warmed.

Sequence - Summary

Compare regions of the earth regarding density of population, temperature fluctuations, and rainfall.

Review body mechanisms which aid in temperature control.

Review concepts of humidity and the procedure for determining relative humidity.

Discuss temperature extremes possible in space, and particularly, on specific planets.

From a temperature fluctuation viewpoint, consider:

Activities - Illustrations

Design a space suit to withstand temperatures from +215° F. to -250° F.

Encourage students to investigate the extremes of temperature of both liquids and solids. Examples of cold materials would include liquid nitrogen, oxygen, solid carbon dioxide; hot materials would be liquid metals such as sodium, magnesium, and superheated gases. Help them to chart upper and lower temperatures. Discuss 0° Kelvin or "absolute zero".

1. day and night on earth
2. winter and summer on earth
3. polar and equatorial regions
4. hot and cold sections of lunar surface
5. hot and cold sections of other planets
6. thermal plight of space travellers

Secure a sling psychometer and show its use. Permit students to use it for various places and times. Help them use chart showing wet and dry bulb temperatures.

Have each student take his own body temperature at various intervals (assign). Compare readings in the group to show individual differences.

To illustrate the role of the skin as a means of controlling temperature, put ether or water on arm, blow gently, note cooling. Do same with plastic bag over arm after application of ether or water.

Compare functions of student's body (heart beat rate, respiration, recovery time, temperature, feeling of well-being, and any other "tests" the class wishes to compare) by collecting data from areas where environmental conditions could represent natural world environments.

Encourage students to recount unpleasant experiences they have had with hot and cold temperatures.

Have child wear plastic raincoat in sunlight, in the classroom, or in dark room. (Observe effects).

Ask child to sit in a non-ventilated room for brief period. Ask him to recount sensations.

Wrap a small piece of tissue around the bulb of a thermometer. Soak the tissue with ether, acetone, or water. Then blow gently on paper. Why did the thermometer indicate a drop in temperature? Boil water in a teakettle. Where does steam go? Let it condense on various surfaces, including one with ice enclosed; empty; with warm water. Why does most condensation occur on a vessel with ice in it?

Put table of "gases-in-air" on board, for student information.

INQUIRY NO. 7

THE VIEW FROM OUR EIGHTY-SEVEN MINUTE WORLD

In order for an organism to survive in its environment it must be equipped with some mechanism or mechanisms that respond to stimuli from the environment. These responses enable the organism to orient itself to its surroundings and to react to all things, both inside and outside of itself.

One of the many special features of protoplasm is its property called irritability. In the higher animals a vast, intricate system of highly irritable tissue has developed which we call nerve tissue. The structure of nerve tissue is such that its very low irritability threshold (low level of stimulation produces a reaction) allows the organism to react rapidly to changes in its environment. Activities such as walking and talking depend on proper responses to stimuli. However, response in itself is meaningless and might even be useless or destructive unless it was properly interpreted and then acted upon. Not only must a system receive the stimuli, it must be able to interpret it rapidly and correctly in order to produce a desirable reaction. Most of us have either experienced or witnessed examples of misinterpreted stimuli due to the effects of fatigue, drugs or illness, which in some way has affected the body's ability to correctly interpret stimuli.

Stimuli are received and acted upon either consciously or unconsciously. Unconscious responses are called reflex actions. The human body is arranged in such a manner that damage to one or even more than one sensory mechanism does not necessarily mean we would be unable to continue to act within our environment. We are able to substitute other mechanisms to compensate for a loss. However, the greater the loss, the more difficult it is to compensate for the loss.

The ear is an organ of hearing and equilibrium, with the hearing portion being a rather recent evolutionary acquisition. In the lower vertebrates, such as the shark, the inner ear labyrinth are three semi-circular canals. Each of these canals is oriented in a different direction so that any movement by the head affects one or more of the canals. Each canal is filled with fluid so that as the head moves, the movement of the fluid acts on nerve endings which then 'tell us', through interpretation by the brain, how we are oriented in relation to the earth.

Man is most frequently involved in movements in the horizontal plane, as in walking, and for some poorly understood reason, movements in the vertical plane tend to produce sensations of nausea. This is a factor in seasickness, which can be greatly alleviated by lying down, thus changing the movement of the fluid in the canals from the vertical to the horizontal. Perhaps you have "left your stomach downstairs" while standing in a rapidly rising elevator. If so, you have experienced a sensation based on the same principle of disturbance caused by rapid vertical motion.

Destruction of the inner ear causes profound equilibrium disturbances. An experiment performed on a pigeon, in which the semi-circular canals were destroyed, resulted in the animal's inability to either stand or fly, although in time it relearned how to maintain equilibrium through the substitution of another sensory mechanism; sight. However, if it were blindfolded, the pigeon had the same equilibrium (balance) disturbances again.

The proper use of all our sensory mechanisms is developed through the learning process. Experience has taught us to evaluate stimuli, and, therefore, the more receptors we have in good functioning condition, the faster we are able to collect information and correctly interpret the nature of the world around us.

In this inquiry, you will test your own orientating senses and explore the problems which are associated with the operation of self-contained units when accelerative factors are present. In your mind's eye, you may join one of the astronauts and get his view of our eighty-seven minute world.

Basic Concepts

The human body includes systems which, operating together, provide orientation information.

Sequence - Summary

Three systems provide orientation:

1. Inner ear (vestibular)
2. Sight
3. Kinesthetic (muscle sense)

The three systems are known as the orientation triad. Any two of the triad will suffice for ordinary situations.

The orientation triad, under certain conditions, will produce false information.

Activities - Illustrations

Discuss with the students:

1. How so we know we are standing upright?
2. Can we still tell our position without the information provided by our eyes? How?
3. Are we able to tell we are moving in a car when our eyes are closed?

Revolve partner on rotating stool (20-25 revolutions), stop suddenly. Ask him to walk in a particular direction. With partners, blindfold seated student and tilt his chair in several different directions. Can he orientate? While student is revolving clockwise on chair, ask him to look quickly over his left shoulder. Sensation? Possible cause?

INQUIRY NO. 8

THROUGH RAIN, SLEET, OR SNOW . . .

The history of our country contains many stories of instances of man's devotion to duty in the interest of our country's growth. The first Pony Express rider crossing hostile territory, and the Lindbergh solo flight represent outstanding examples of individual performances where endurance while isolated from one's fellow man was required. Less glamorous but equally significant examples can be found in military and civilian occupations, perhaps best exemplified by the postman's motto: "Through rain, sleet, or snow, the mail goes through."

In this inquiry, you shall be examining how man in his progress toward space conquest, will need to cope with extended periods of isolation. The following excerpt, taken from "The Mind and Its Integration", by Donald O. Hebb, was reported in the book, Man and Civilization: Control of the Mind; it sums up the nature of the problem to be solved:

> An outstanding feature of the isolation experiment was the demonstration that intellectual work - mental activity initiated from without - is wholly essential to the human being. Now, in one way this is nothing new, except for showing how strong such a need can be; but mostly we have concealed the fact from ourselves, in the first place by giving a special name, "play", to work that is done for its own sake, thus not classing it as work, and in the second place by assuming, when the question comes up of the man who likes useful work, who likes his job

and does not want to retire, that this is an acquired motive, the result of long-established habit.

. . . One strategic consideration in the control of the mind, then, is man's insatiable need for intellectual activity, environmentally initiated but self-paced. It is, of course, equally obvious that there is a great deal of intellectual activity that he is opposed to: he objects to work when it is imposed from without, when it is not of his own choosing, and especially when it is in any way monotonous.

Basic Concepts:

An individual's inner motivation affects his attitudes toward his circumstances.

Sequence - Summary

Knowledge eliminates fear...so,

1. Study research.
2. Create appropriate types of recreational activity.
3. Experiment.

List reasons that enable an individual to survive in conditions of extreme temperatures.

Because of lack of atmosphere and the period of revolution, temperature changes would be more easily compared to day and night temperature rather than seasonal temperatures. (Day and night temperatures in desert vs. seasonal changes in any location).

Activities - Illustrations

Discuss pictures - showing men involved in occupations involving extremes of temperature.

1. Blast furnace
2. Dairy refrigeration

Why are they so occupied?

Observe dry ice:

1. Would you like to touch it? How does it feel? Discuss.
2. Place dry ice in liquid (water). Why does this now bubble? Touch knife to ice. What do you hear?

Assign pupils to space trip. "You are the astronaut of the day! Are you ready to go?" Record reactions - positive; negative.

Design your own space suit to fit your own personal needs (as to heat and cold). Present chart with large design of space suit.

1. Analyze each part (helmet, gloves, boots, etc.)
2. Relate to why you wear each now on earth.
3. Discuss related research on each, relating to heat and cold and physiological reactions.

Construct your own space cubicle so it meets personal safety requirements for heat and cold extremes.

1. What temperatures at home are most comfortable?

2. Discuss with reference to men vs. women.

3. Make charts.

The students worked on a group project entitled _Lost on the Moon_. The following was the problem they had to solve:

You are in a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Mechanical difficulties, however, have forced your ship to crashland at a spot some 200 miles from the rendezvous point. The rough landing damaged much of the equipment aboard. Since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200-mile trip. The fifteen items left intact after landing are listed below. Your task is to rank them in terms of their importance to your crew in its attempt to reach the rendezvous point. So place number 1 by the most important item, number 2 by the second most important, and so on through the least important, number 15.

_____ Box of matches

_____ Food concentrates

_____ 50 feet of nylon rope

_____ Parachute silk

_____ Portable heating unit

_____ Two .45 caliber pistols

_____ One case dehydrated milk

_____ Two 100-pound tanks of oxygen

_____ Stellar map of the moon's constellation

_____ Life raft containing CO_2 bottles

_____ Magnetic compass

_____ 5 gallons of water

_____ Signal flares

_____ First-aid kit containing injection needles

_____ Solar-powered FM receiver-transmitter

The students' results were taped on a cassette recorder.

Other activities students participated in were setting up learning centers pertaining to the ordering of the nine planets and their relation to the sun, food and drink in an outer space atmosphere, and space suits and equipment an astronaut might need in space. The students also made reports on how space travel has contributed to science, meteorology, engineering, medicine, and ecology and saving the environment.

Individual activities and projects included the making of a student planetarium showing how the Earth travels around the sun, diaramas of dolls dressed as men and women astronauts manipulating their space equipment, and a table display of what an outer space terrain on another planet might look like.

Students related space science to other areas of the curriculum by composing their own space poetry as well as looking up other poems about space, singing songs and listening to popular music related to space travel, finding stories about space in their own reading texts, drawing space pictures and charts, and clipping news articles related to space from their Weekly Readers and newspapers.

Finally, the students made a thorough search to find out all they could about planetariums. They did this because they were planning a field trip to the Hardin Planetarium in Bowling Green, Kentucky.

Chapter 3

EVALUATION

The creative project was a success. One of the main reasons the project was a success was that the recommendations of the students were carried out thoroughly.

Following is a list of things the students wanted changed:

1. They wanted the smeared plexiglass windows changed.
2. They wanted the room painted red, white, and blue.
3. They wanted the furniture, cabinets, and trim painted.
4. They wanted the heating unit disguised.
5. They wanted murals on the chalk board.
6. They wanted some flowers in the room.
7. They wanted posters mounted up in the room.
8. They wanted the waste cans painted.
9. They wanted the window shades changed and string pulls fixed on them.
10. They wanted the pencil sharpener lowered.
11. They wanted the picnic table removed.
12. They wanted the T. V. case moved out.
13. They wanted a better pencil sharpener.
14. They wanted the orange pulpit chairs moved out.
15. They wanted new or different furniture for seats.

After the changes were made in the classroom, the students were surveyed to see how they felt about the classroom environment.

Following are the questions the students were asked and their responses:

1. Do you like the changes that were made in your science classroom?

Response: 49 - yes; 11 - in-between; 1 - no.

2. Do you like the tables and chairs better than the desks you used to sit in during class?

Response: 54 - yes; 1 - in-between; 6 - no.

3. What do you like best that was changed about the classroom?

Response: 31 - the new paint; 19 - the tables and chairs; 4 - everything; 4 - the cabinets; 2 - the windows and shades; 1 - the mirrors.

4. Can you learn better now in this room?

Response: 48 - yes; 7 - no; 6 - no difference.

5. Would you like to change anything else now?

Response: 42 - no; 7 - the paint colors; 6 - the tables and chairs; 2 - the windows; 2 - the shades; 2 - the mirrors.

Plans were made for the next school year to further implement and complete the suggestions of the students. One of the things they wanted to work on for the future improvement of their classroom was to do something with the floor.

There was quite a bit of improvement in the students' knowledge as was seen when the pre-test and the post-test were compared. There was an improvement of 23.17%. Every student improved some, and some greatly improved. Following is a comparison of the two tests, as well as the actual test given:

THE PRE-TEST AND THE POST-TEST

1. Place planets in order of position.

2. True - False The moon is made of green cheese.

3. True - False The moon has dark areas that look like oceans. They are commonly called seas. The moon has liquid water on its surface.

4. True - False The moon is less dense than the Earth because it is made of dust.

5. True - False The moon has more atmosphere today than it had a million years ago.

6. True - False Much of the moon is made of hard rock.

7. True - False Many meteorites strike the moon's surface.

8. True - False Some rock on the moon was once very hot.

9. True - False Rocks of the moon are much like those of the Earth.

10. True - False Erosion has made the moon's surface rough.

Putty's Homeroom	PRE-TEST GRADE	POST-TEST GRADE
Doug Barnett	50	70
Rudie Bender	50	70
Glenda Brown	60	80
Becky Byrum	40	70
Jeff Cansler	50	70
Barry Carroll	40	60
Tonya Chandler	60	90
Cheryle Cole	40	70
Bill Crick	40	60
John Croft	60	70
Melanie Dew	70	70
Greg Fleming	60	90
Tammy Gilkey	40	70
Shea Gregg	60	70
Justine Helms	40	60
Lonnie Herndon	40	70
Jackie Hickman	40	70
Sheila Johnson	50	60
Jeff Ladd	60	80
Mamie Lamb	40	80
Susan Long	30	60
Kenny Mast	60	80
Teresa Matheny	30	50
Annette Maypray	40	50
Jeff Meredith	50	80

Elvis Orten	60	70
Kenneth Rice	60	70
Troy Rogers	50	70
Cindy Seay	50	80
Janice Taylor	40	70
Candy Wilson	60	100

Wagoner's Homeroom	PRE-TEST GRADE	POST-TEST GRADE
Lorrie Allen	60	80
John Barnett	40	70
Tammy Cansler	30	50
Wayne Clark	60	70
Laurie Crick	70	90
Randy Crick	50	60
Sharon Croney	30	50
Robert Dickerson	30	80
Lisa Dillingham	30	50
Kirk Dulin	40	80
Karen Gentry	50	70
Sherry Gregg	50	70
Kathy Hamby	20	30
Daniela Hartman	30	60
Robbie Holibecki	40	80
Alan Ladd	30	60
Mitch Lancaster	50	70
Vivian Lovan	20	40
Tim Manire	60	80

	PRE-TEST GRADE	POST-TEST GRADE
Gary Matheny	50	60
Tracy McBride	40	70
Charles McIntosh	30	70
Kim Mock	60	90
Tony Moore	60	70
Karen Owens	40	80
David Pace	50	60
Ramona Powell	40	60
Tina Putty	60	90
Michelle Sharber	50	80
Donnie Snead	60	70
Alan Vandiver	60	70
Lou Willis	40	90

THE INTEREST INVENTORY

Jobs and occupations in areas such as the Armed Forces, Education, the Humanities, the Labors, Politics, Professional Sports, and the Professions were discussed thoroughly. Charts depicting the various types of jobs were discussed. The results of the test were as follows:

1. Twelve students chose Educational jobs.
2. Nine students chose jobs in the Humanities.
3. Fifteen students chose jobs from the Labors.
4. Five students chose a job from the Professions.
5. Twenty students chose a job in Professional Sports.

Chapter 4

SUMMARY AND CONCLUSIONS

The author found that the creative idea of incorporating the space-like theme in the fifth grade classroom was successful, even though the results of the interest inventory did not support the thesis that students would choose a space career in preference to other occupations.

More and varied learning took place than when the traditional methods had been used in the past.

There was a more cooperative attitude between the students and the teacher. They learned to work together and plan together and to experience new methods of learning together for the benefit of all concerned.

The results of the redecorating and changing of the furniture was favorably commented on by all including students, other teachers, parents, and administrators.

Students and teacher worked hard and long to complete the painting and making of the models and learning centers. All concluded that they appreciated the completed products and tasks.

For a treat and as a culminating activity, the students and teacher took a field trip to the Hardin Planetarium in Bowling Green, Kentucky.

The total creative project was an enjoyable learning experience for all involved and one that could be built upon and added to for future learning and benefits.

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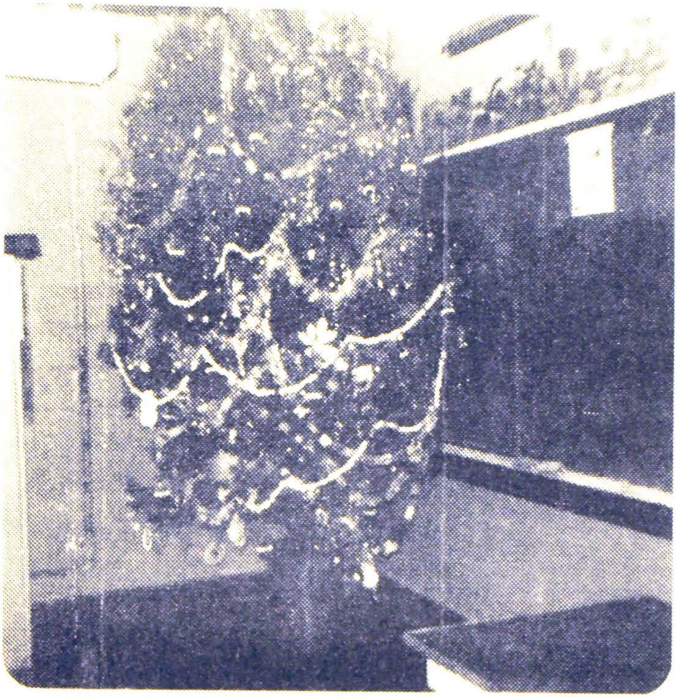

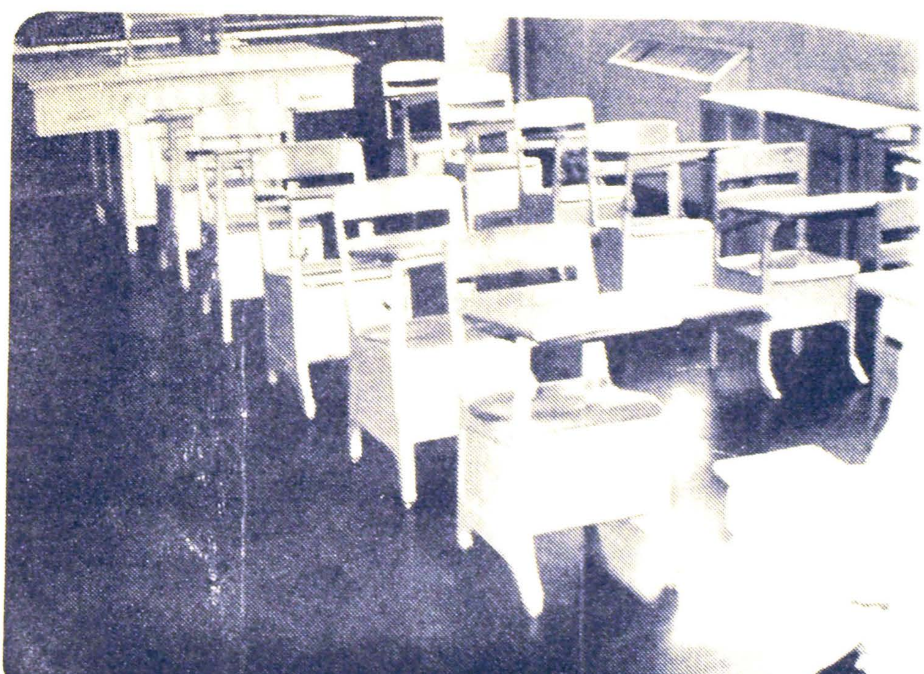

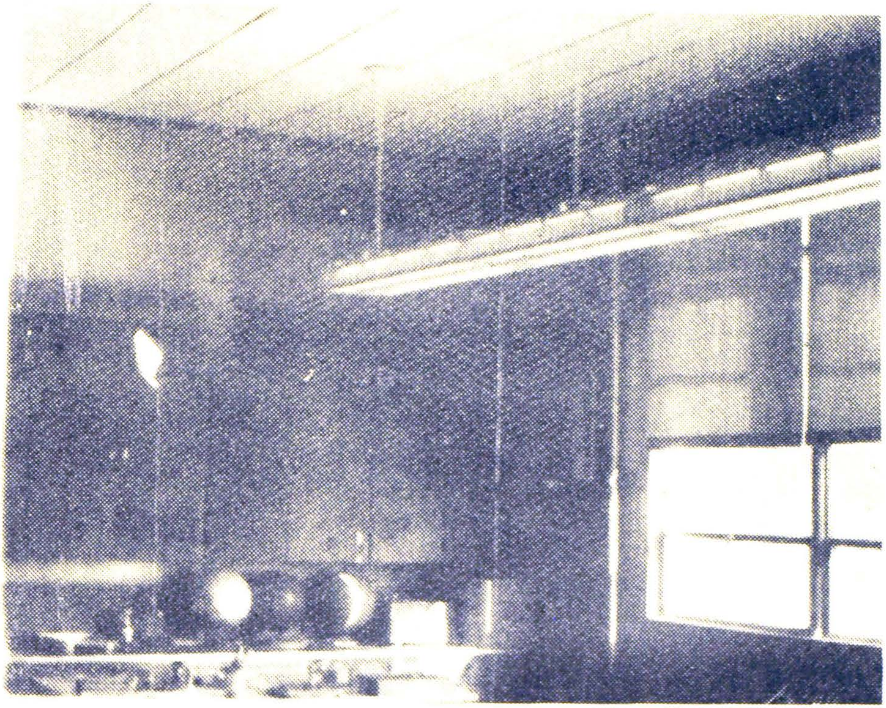

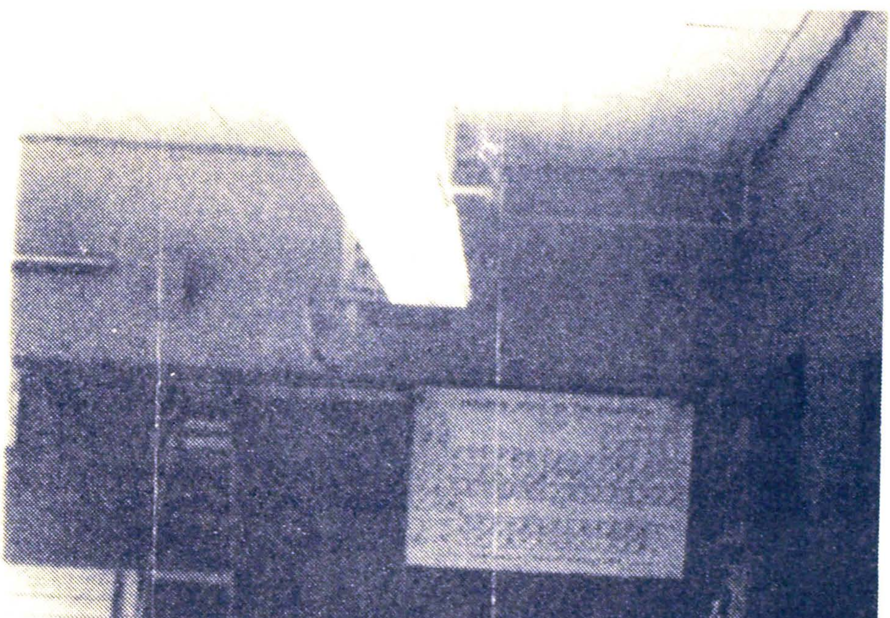

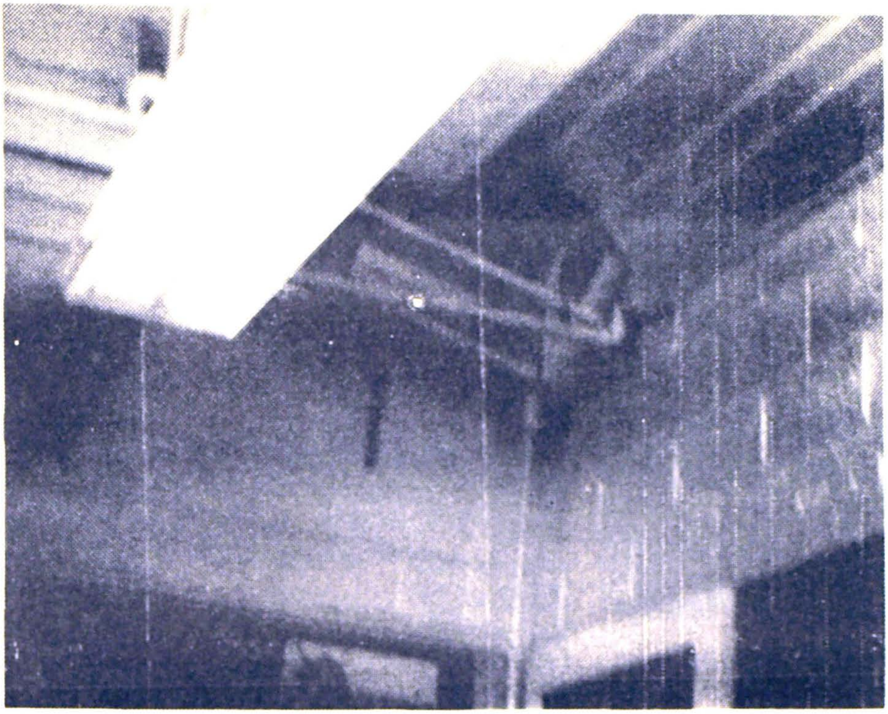

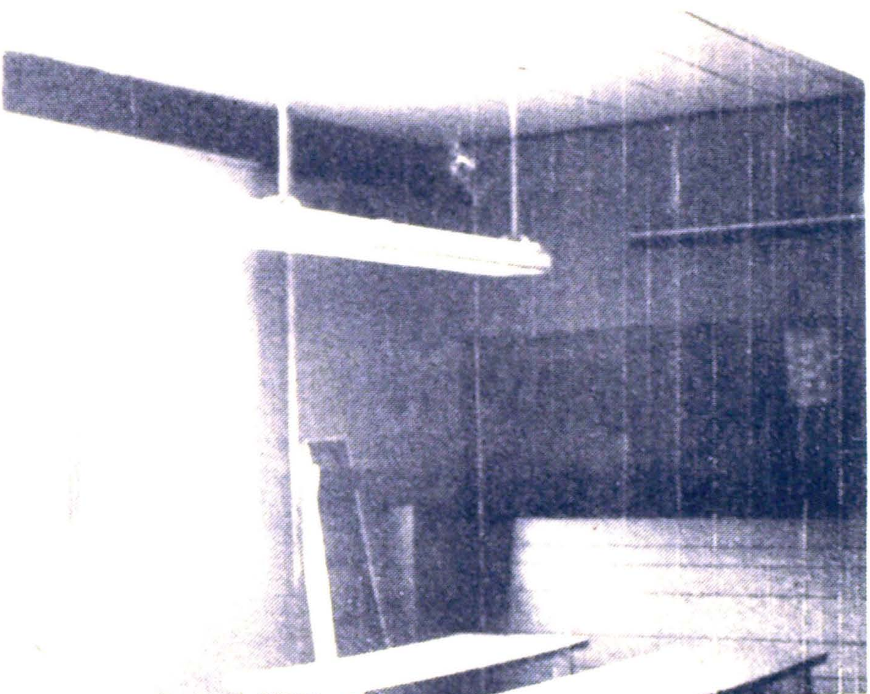

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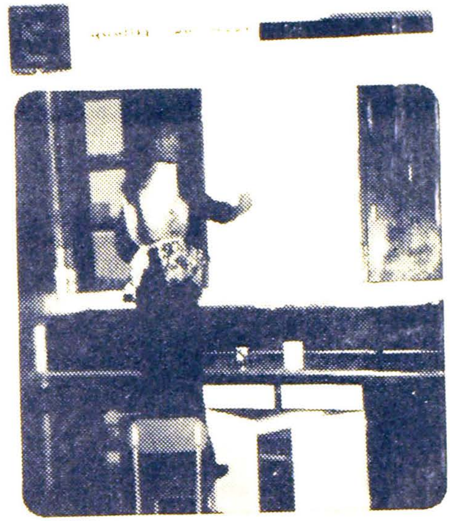

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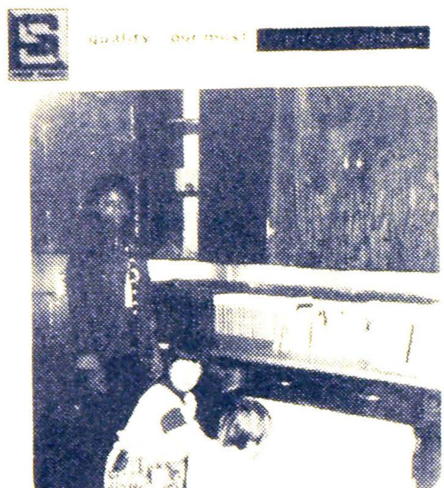

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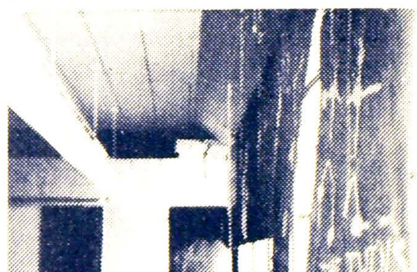

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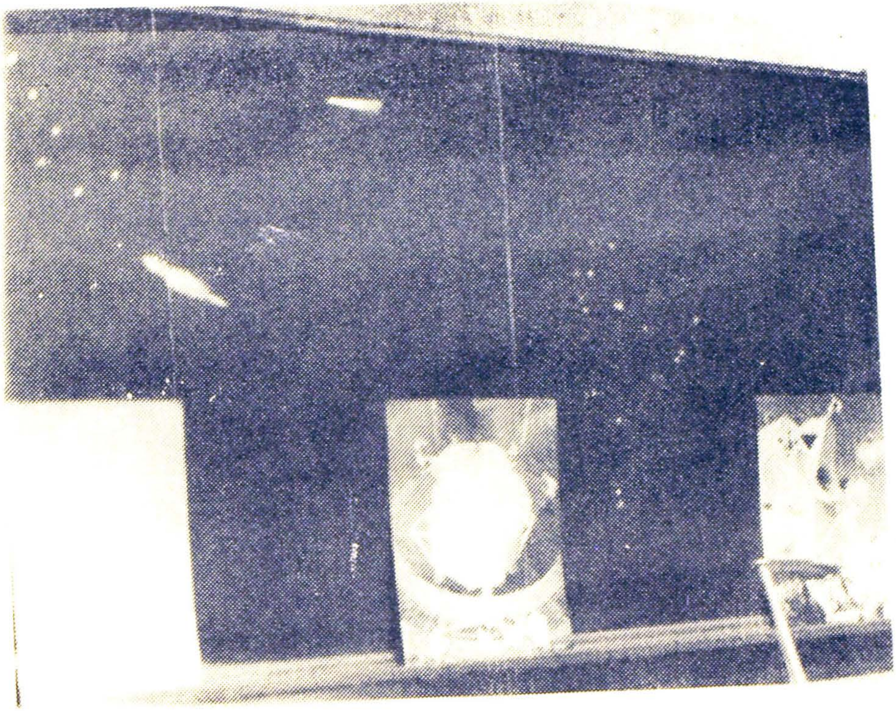

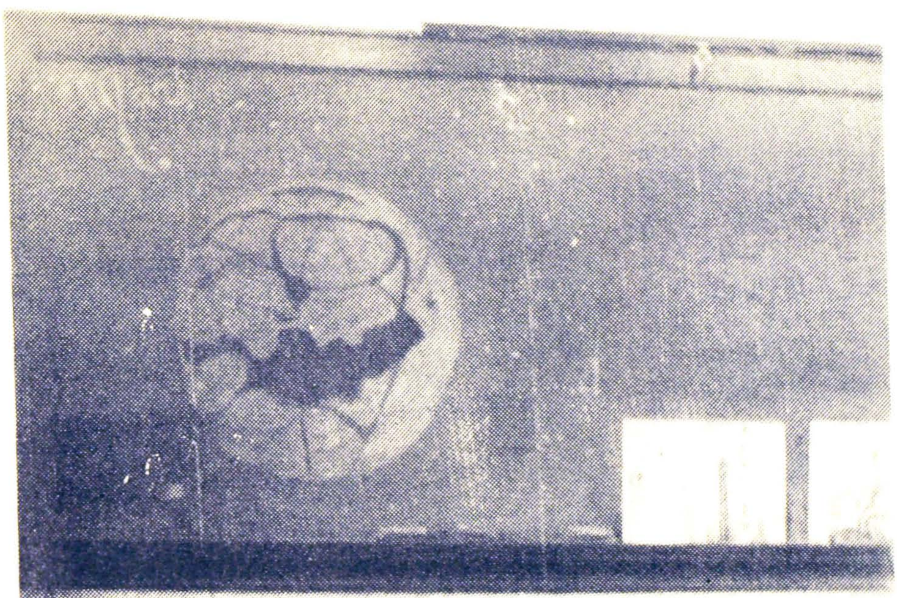

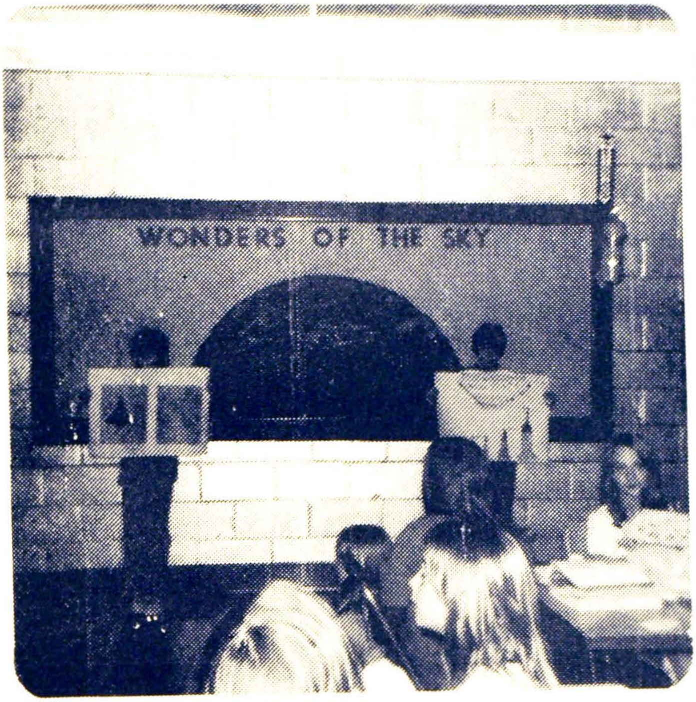

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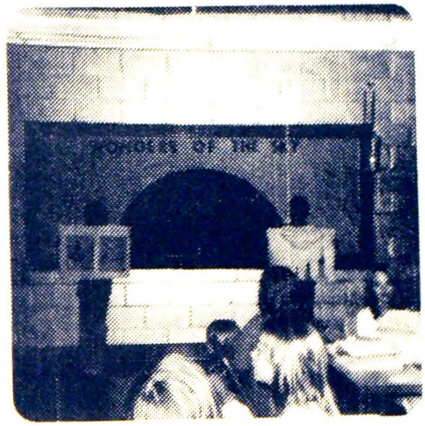

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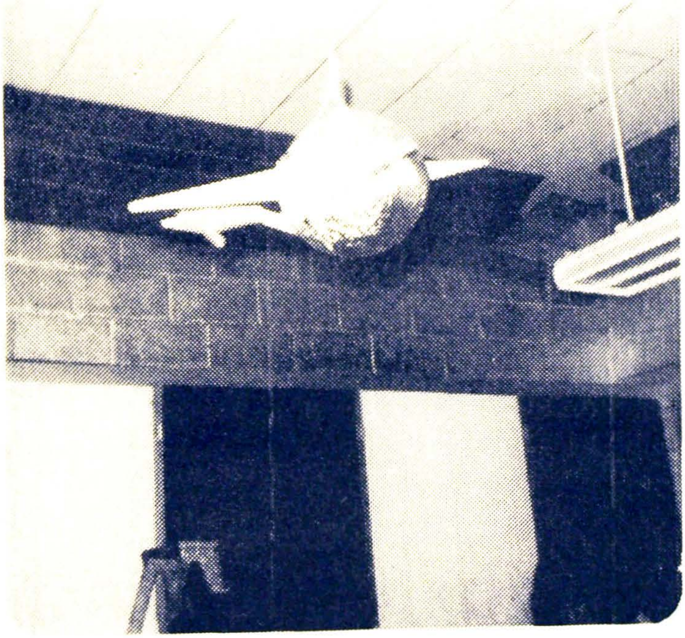

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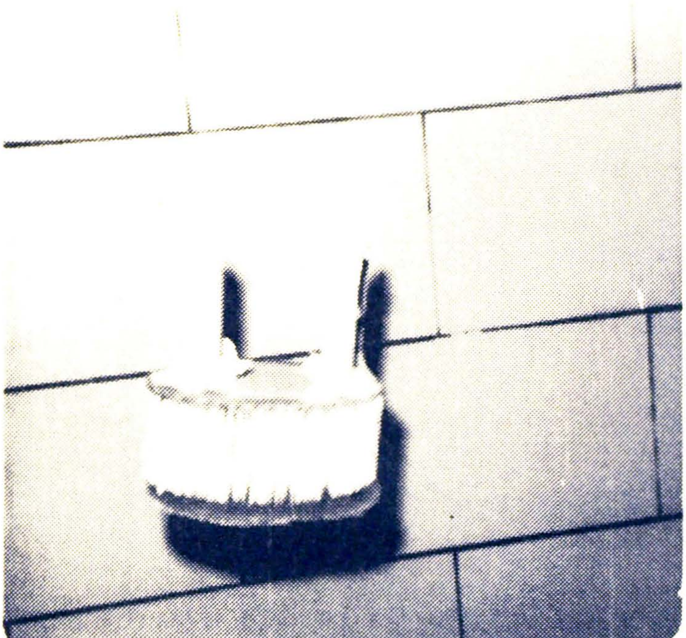

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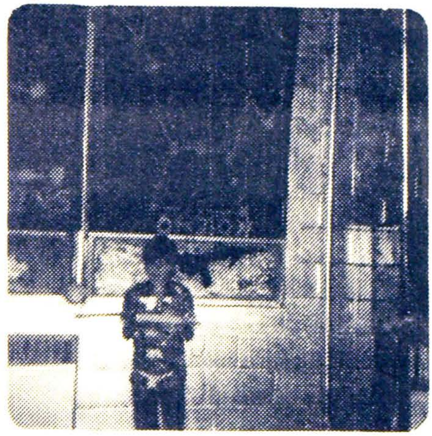

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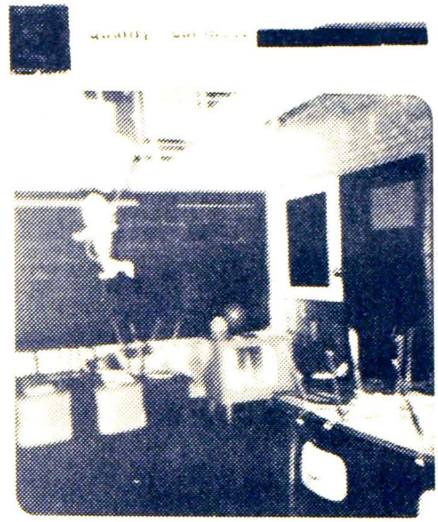

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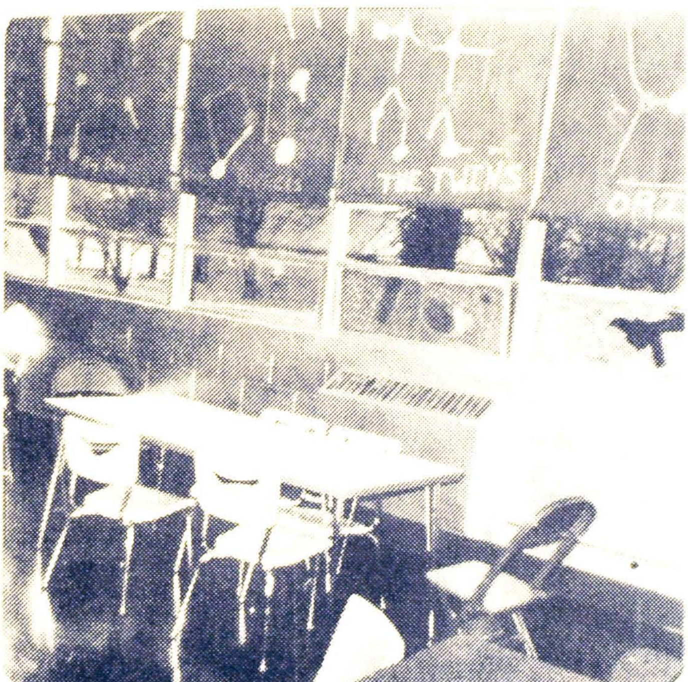

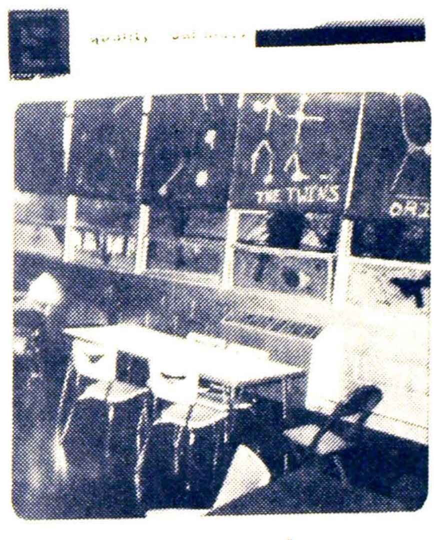

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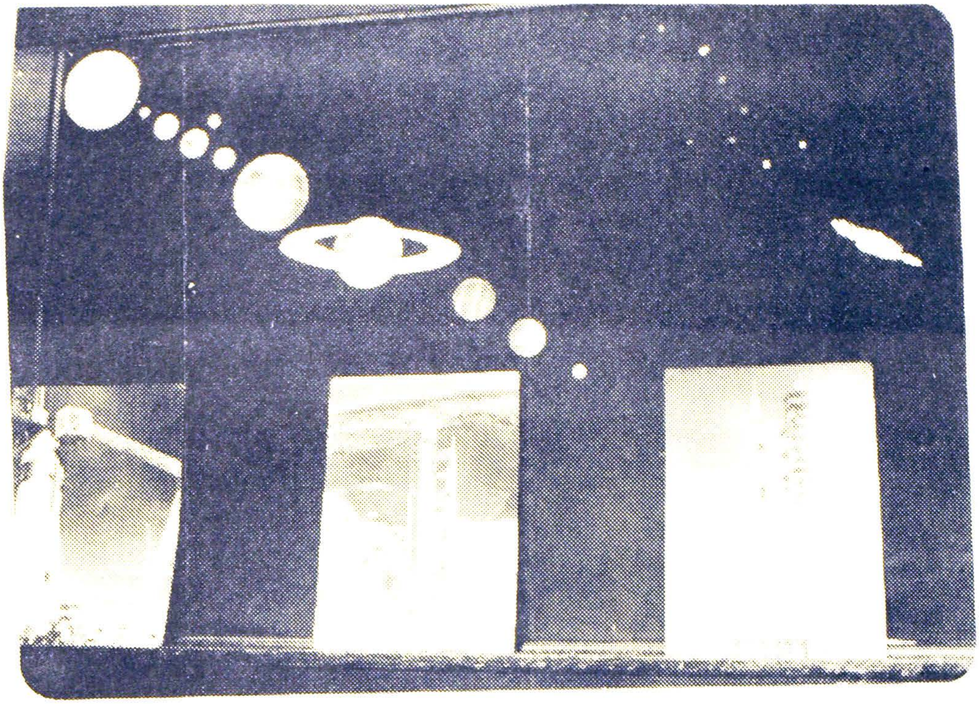

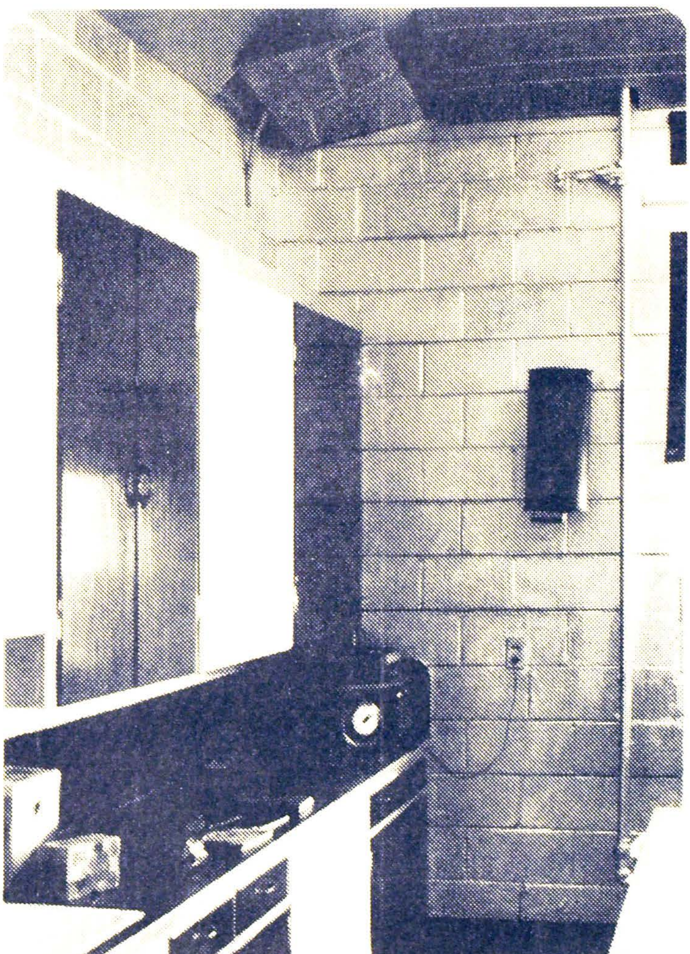

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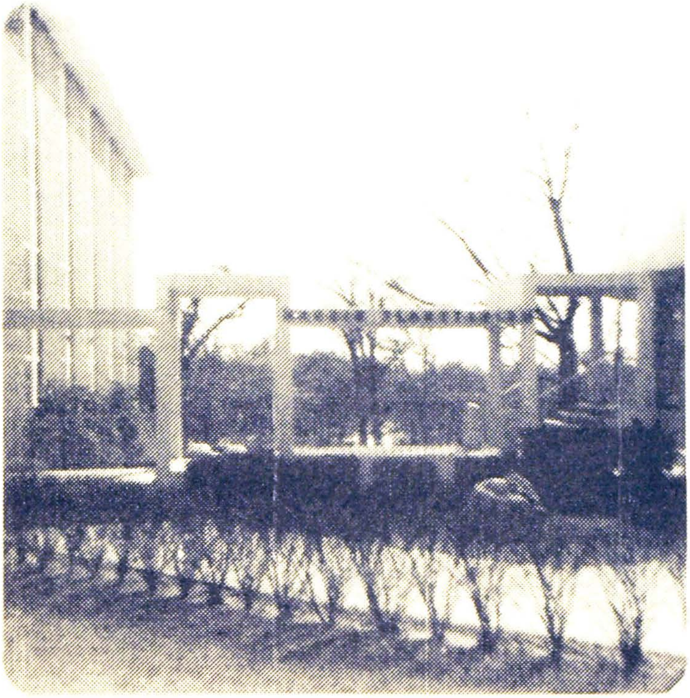

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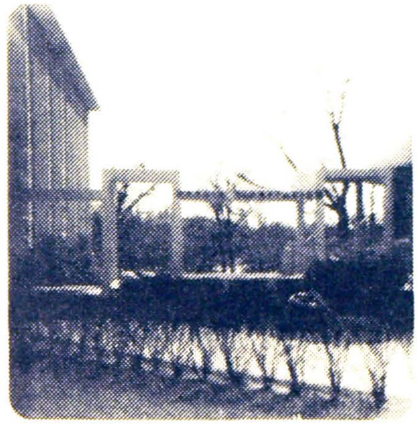

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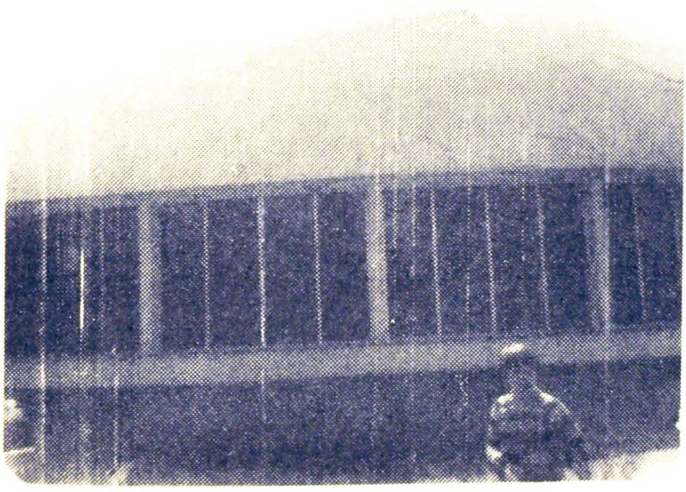

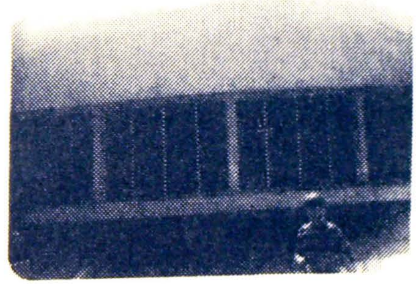

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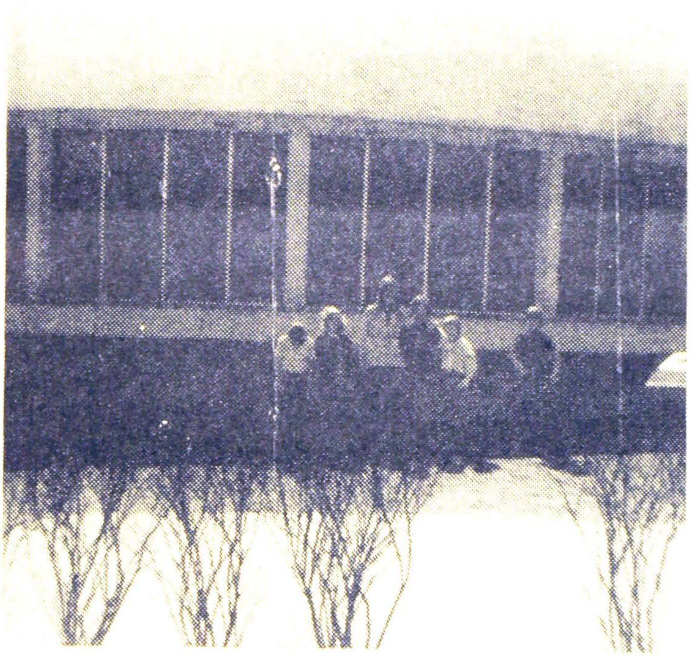

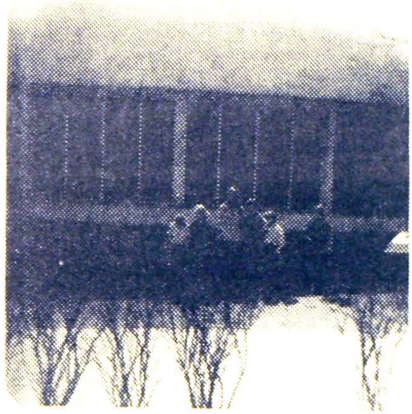

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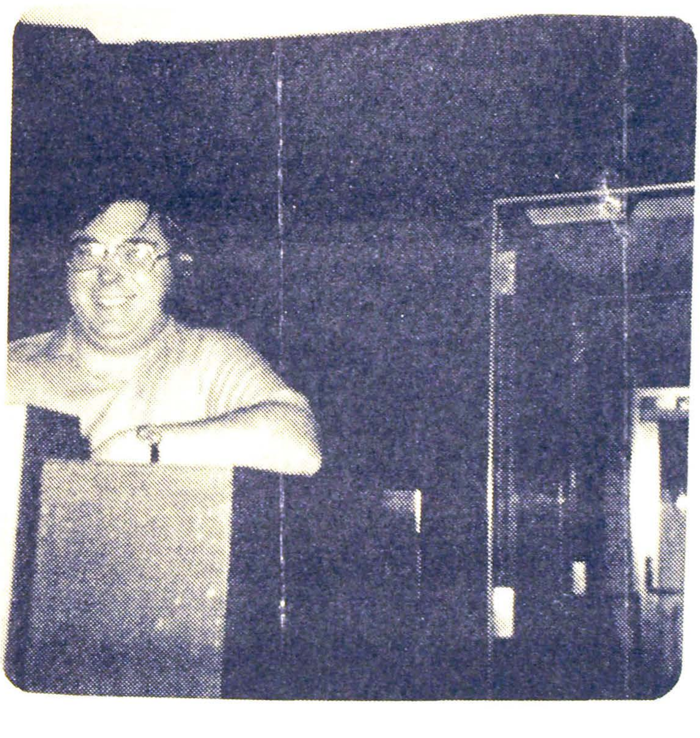

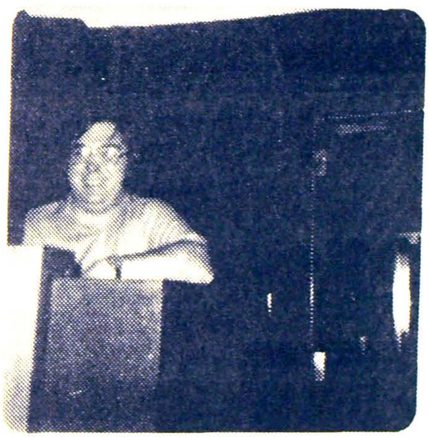

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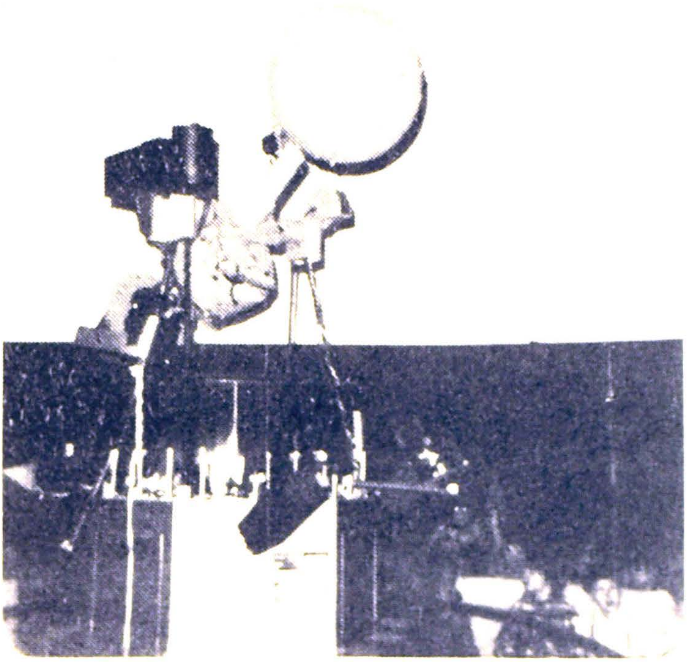
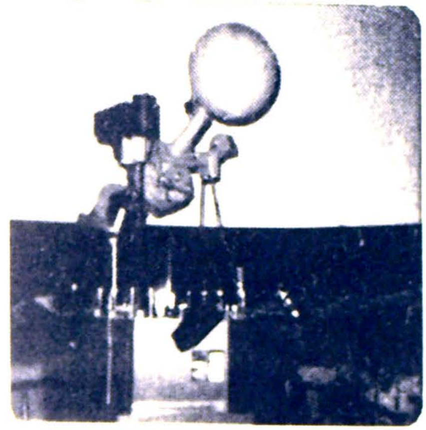
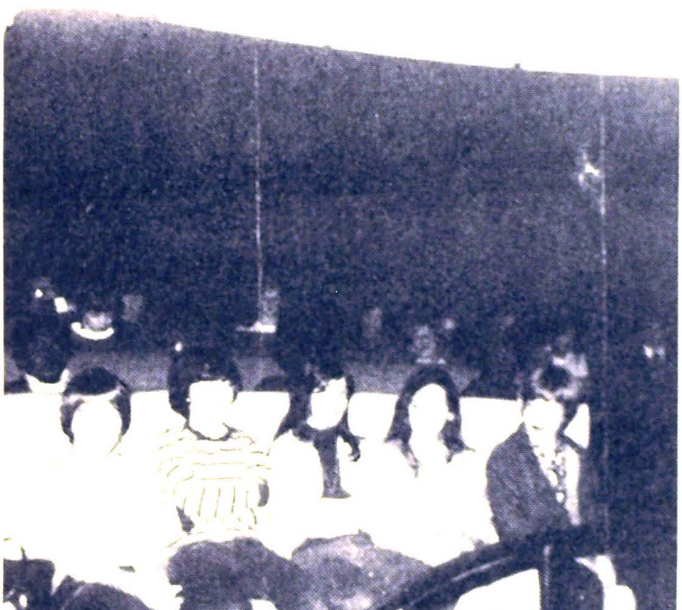
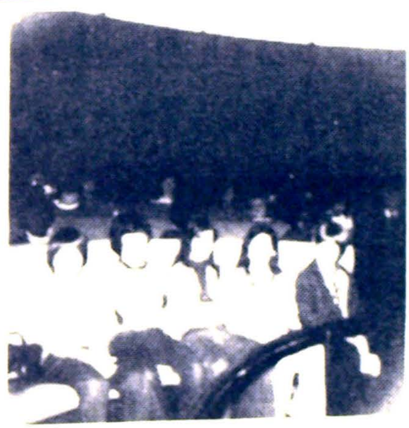




MAXI-MINI prints





MAXI-MINI prints