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ABSTRACT

Performance objectives are stated for each of the three secondary school units included in this package prepared for the Dade County Florida Quinmester Program. The units all concern some aspect of instruction in scientific method. "The Scientific Approach to Solving Problems" introduces students to the use of experimental testing of hypotheses in areas other than the traditional sciences; "Who's Who" uses a biographical approach to emphasize the role of scientific method; and "What in the World's Going On?" bases a study of the importance of separating inference from observation, controlling experiments, and hypothesizing on current science news articles. All booklets contain lists of suggested instructional activities, resource lists, state-adopted texts, and where relevant, possible audio-visual aids available from the county. Most suggested activities are citations of texts and teacher sourcebooks. Except for the current event unit, a master sheet relating each suggested activity to the stated objectives is appended. (AL)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

DADE COUNTY PUBLIC SCHOOLS

SCIENCE

Scientific Approach To Solving Problems

(Experimental)

5311.01
5312.01
5313.01

DIVISION OF INSTRUCTION • 1971

SCIENTIFIC APPROACH TO SOLVING PROBLEMS

5311.01
5312.01
5313.01

SCIENCE

(Experimental)

Written by Bettie Lou McCollum

for the

DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida
1971

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THE SCIENTIFIC APPROACH TO SOLVING PROBLEMS

COURSE DESCRIPTION

Students will be introduced to the idea that the scientific approach to solving problems is not limited to the field of science. Students will make hypotheses, state and identify problems that can be solved by use of a controlled experiment, identify controls and variables, and reach conclusions that are based on systematic observations and careful collection of data. Many experiences will be provided to develop habits of good observation, both qualitative and quantitative in nature. Students will use multiple forms of presenting data in laboratory investigations and in reports given before the group.

ENROLLMENT GUIDELINES

None, however, recommended for all students.

STATE ADOPTED TEXTS

Thurber and Kilburn, Exploring Physical Science, Atlanta: Allyn and Bacon, Inc., 1966.

Abraham and others, Interaction of Matter and Energy, Chicago: Rand McNally, 1968.

Fisk and Blecha, The Physical Sciences. Atlanta: Laidlaw Brothers, 1971.

Intermediate Science Curriculum Study. Probing the Natural World, Morristown, N. J.: Silver Burdett, 1970.

PERFORMANCE OBJECTIVES

1. Students will practice using laboratory equipment.

2. Students will apply the metric system in laboratory investigations.

3. Given a list of problems, students will select those that can be solved by use of a controlled experiment.

4. Students will identify the parts of a controlled experiment: controls, independent variables, dependent variables, and variables to be held constant.

5. Students will formulate hypotheses that take into consideration all known facts and make predictions.

6. Students will practice systematic observations.

7. Students will work in small groups in laboratory investigations to promote cooperative approach to solving problems.

8. Students will record data of class demonstrations and investigations.

9. Given a variety of laboratory experiences, students will differentiate between quantitative and qualitative data.

10. Given a variety of forms for presenting data, students will select the form that is suitable for a particular investigation.

11. Students will plan their own controlled experiments.

12. Given an opportunity to share controlled experiments, students will discuss critically other student experiments.

13. After studying the work of scientists, students will discover how scientists build on the knowledge accumulated by workers of the past.

14. Students will identify ways that the scientific approach to solving problems can be used in everyday life.

COURSE OUTLINE

I. Use and Care of Basic Laboratory Equipment

II. Measurement

- A. Metric
  1. MKS (Meter - kilogram-second)
  2. CGS (Centimeter - gram - second)
- B. English

III. Scientific Approach to Problem Solving

- A. Testing of hypothesis
- B. Unbiased observation
- C. Negative results and affirmative support of hypothesis

IV. Controlled Experiments

- A. Parts of a controlled experiment
  1. Statement of problem
  2. Formulation of hypothesis
  3. Controls
  4. Independent and dependent variables
  5. Variables to be held constant
  6. Collection of data
     a. Quantitative
     b. Qualitative
- B. Forms for presenting data
  1. Graphs
  2. Tables
  3. Drawings

V. Research and Analysis

- A. Controlled experiments planned by students

B. Critical analysis of student work

VI. Contributions of Scientists

A. Individual contributions

B. Scientists build on knowledge accumulated by workers of the past.

LABORATORY INVESTIGATIONS

Science Lab; 7 and 8, Laboratory Activities ITV Teacher's Guide. Miami: Dade County Board of Public Instruction

1. Introduction to the Laboratory (pp. 3-6)
2. Use of the Microscope (pp. 177-186)
3. What Factors Will Change the Period of a Pendulum? (pp. 258-259)
4. What Effect Does Increased Surface Area Have On the Rate of a Reaction? (pp.228-229)
5. How Can We See Molecular Movement in a Liquid? (p. 216)
6. How Does the Space Between Moelcules Affect the Total Volume of a Mixture of Two Different Substances? (pp. 214-215)
7. Surface Tension: What Part Does Surfact Tension Play in the Forming of Water Drops? (pp. 210-211)
8. How Does Temperature Affect the Rate of Chemical Reaction? (pp. 232-233)
9. How Does the Concentration of Reactants Affect the Rate of Chemical Reaction? (pp. 230-231)

Bulletin 8 G. Laboratory Activities for Science Students Junior High School Level, 1968 Experimental Edition. Miami: Dade County Board of Public Instruction.

10. Laboratory Techniques - Measuring and Transferring Solids and Liquids (p. 23)
11. Laboratory Techniques - Heating Liquids in a Test Tube and Water Bath. (p. 24)
12. Laboratory Techniques - Preparing Laboratory Glassware: Cutting Glass Tubing,Fire Polishing and Making Droppers (p. 25)
13. Laboratory Techniques - Bending Glass Tubing and Inserting Glass Tubing (p. 26)
14. Distillation Apparatus (p. 27)
15. Introduction to Measurement: Length (p. 4)
16. Introduction to Measurement: Volume, Regular

Shaped Object (p. 9)
17. Introduction to Measurement: Volume, Irregular Objects (p. 10)
18. Introduction to Measurement: Weight (p. 12)
19. What Effect Does the Length of a Pendulum Have on the Rate of Swings? (p. 16)

Oxenhorn and Idelson, Pathways in Science, Chemistry 1, New York: Globe Book Company, 1968.
20. What Effect Will Heat Have on a Mixture of Iron Filings and Sulfur? (pp. 61-63)
21. How Will Water be Affected When a Current of Electricity is Sent Through a Mixture of Water and Sulfuric Acid? (pp. 139-140)

Thurber and Kilburn, Exploring Science Seven, Atlanta: Allyn and Bacon, 1966.
22. How to Do an Experiment: (Testing a Hypothesis) (p. 5)
23. The Experimental Variables: A Practice Experiment (pp. 14-15)

Thurber and Kilburn. Exploring Physical Science, Atlanta: Allyn and Bacon, 1966.
24. Testing a Hypothesis: Purple Cabbage Juice (pp. 40-41)
25. What Effect Does the Height of the Liquid in a Container Have on the Flow of Water to a Second Container? (pp. 90-91)
26. Observation of a Candle Flame (p. 66)
27. How Can Length of a Pendulum Affect Its Rate of Swing? (Use of Graphs and Tables) (pp.10-11)

Abraham and others. Interaction of Matter and Energy, Chicago: Rand McNally, 1968.
28. Inventing a Simple Timing Device (Investigation 21, pp. 133-134)
29. Determining the volume of solids (pp. 118-122)
30. Measurement of Length and Area (Investigation 16, p. 117)

Weisbruch and others. Patterns and Processes of Science, Laboratory Text No. 1, Lexington, Mass. D. C. Heath Co., 1969.
31. What Do You See? (Ex. 1, pp. 2-3)
32. How Much? (Ex. 4, pp. 7-8)
33. Observe Particular Qualities and Samples and

Determine the Method of Observation (Ex. 7, pp. 24, 25, 26)

34. Which is Which? (Ex. 5, pp. 8, 9)
35. Measurement of Linear Dimensions (Ex.6, Part I, pp. 10, 11)
36. Measuring Volumes of Liquids (Ex. 6, Part II, pp. 12, 13, 14)
37. The Use of a Balance (Ex. 6, Part III, pp. 16, 17)
38. Time and Rate (Ex. 6, Part IV, pp. 17,18,19)

Intermediate Science Curriculum Study. Probing the Natural World, Volume 2A. Morristown, N.J.: Silver Burdett, 1970.

39. Nailing Down Some Particles (pp. 4 -1 ---4-6)
40. Predicting What Will Happen When Nitric Acid is Added to Nail Coatings. (pp. 4-8 --- 4-13)
41. Variables, Experimentals, and Controls (E 4-1 pp. 1-5)

DEMONSTRATIONS

Thurber and Kilburn. Exploring Physical Science. Atlanta: Allyn and Bacon, 1966.

1. Are round cans or cans with flat sides more easily crushed by atmospheric pressure? (p.108)
2. How reasoning can be wrong - candle experiment (pp. 96-97)
3. Card on inverted glass of water demonstration (pp. 84-85)
4. Water to wine demonstration (p.45)

Tracy and others. Modern Physical Science. New York: Holt, Rinehart and Winston, 1970.

5. Copper spiral will extinguish flame (p. 52)
6. Sulfuric acid and sugar demonstration (p.66)
7. How is a neutral object affected when touched by a charged object? (p. 47)

Fisk and Blecha. The Physical Sciences, Atlanta: Laidlaw Brothers, 1971.

8. What effect will the removal of air from a bell jar have on the size of a balloon that is placed inside? (p. 67)
9. Which gas is heavier, air or carbon dioxide? (p. 68)

10. Iron - sulfur demonstration (p. 72)
11. Which mixtures are solutions? Which suspensions? (p. 76)
12. Investigating a column of air (p. 429)

Abraham and others. Interaction of Matter and Energy, Chicago: Rand McNally and Company, 1968.

13. Separating components of matter (p. 40)
14. Force and stretching (p. 147)
15. The action of membranes (p. 313)

PROJECTS

(Students will plan their own controlled experiments. These are only a few suggestions that might be used.)

Abraham and others. Interaction of Matter and Energy. Chicago: Rand McNally and Company, 1968.

1. How does formalin affect the germination of wheat grains? (pp. 274-274)
2. How does formalin affect the activity of a yeast culture? (pp. 272-273)
3. What effect does changing the height of a falling object have on the speed produced: (pp. 175-182)
4. What effect does light have on the presence of starch in a green leaf? (pp. 307-308)
5. How does the presence of chlorophyll affect photosynthesis in a leaf? (pp. 305-306)
6. What factors affect the motion of an object? (pp. 142-143)
7. How do different colored surfaces affect the reflection of light? (pp. 253-256)
8. How can one test for the presence of sugar in various substances? (pp. 290-291)
9. What effect does saliva have on starch? (pp.292-293)

Thurber and Kilburn, Exploring Physical Science. Atlanta: Allyn and Bacon, 1968.

10. Which liquids affect the rusting process of steel wool? (pp. 52-53)
11. Are soaps generally acidic, neutral or basic? (p. 43)
12. How does the kind of liquid affect the refraction of light as it passes through the liquid? (p. 226)

13. What kinds of liquid conduct low voltage electricity? (pp. 268-243)
14. How effective is charcoal in removing tars from cigarette smoke? (p. 429)
15. What is the effect of natural and synthetic dyes on different fabrics? (p. 429)

REPORTS

1. History of the metric system.
2. How models are useful to the scientist.
3. Science builds on the findings of past workers.
4. Individual oral reports by students on controlled experiments.
5. The place of negative results in scientific research.
6. Why are controlled experiments difficult to carry out with human populations? (Examples: Cigarette smoking will cause cancer; marijuana smoking, over a long period of time, does damage to chromosome #13.)
7. Scientific research on hurricanes.
8. Scientific research on seeding clouds.
9. Why scientists are interested in the pH of soil?
10. Explain the upward movement of water in a coffee percolator.
11. How the fuse is used as a circuit breaker.
12. Report on kinds of birds seen in your yard over a period of two weeks. Compile data on a chart.
13. Keep a record of the temperature, atmospheric pressure, and precipitation in a city of your choice for a two week period. Compile your data
14. Report on Koch's postulates.
15. Report on important scientific discoveries that have practically eliminated certain diseases.
16. Peacetime uses of atomic energy.
17. Things that can be done to stop air pollution.
18. Things that can be done to stop water pollution.
19. Uses of satellites
20. The South and Central Flood Control Districts and their affects on the Everglades.
21. Problems that scientists must solve before man can travel to other planets.
22. What can be done about the infusion of salt water into fresh water wells?
23. Collect data on safety practices in your school.

Can this data bring about change?

24. Express your opinion on the following: Scientists should not get involved in politics or community action groups.

FIELD TRIPS

1. Weather Bureau, University of Miami, Main Campus, Coral Gables. 666-0413

2. Computer Center, University of Miami, Main Campus, Coral Gables. 661-2511.

3. U. S. Department of Commerce Weather Brueau, University of Miami, Computer Building, Fifth Floor. 666-2044. (For collecting and charting weather reports, weather radar)

4. City of Miami Water Plants, 6800 S. W. 87 Avenue, Miami, or Okeechobee Rd. and W. 2nd Ave., Hialeah. Contact: Planning Engineer.

5. Florida Power and Light Company, Cutler Plant and Miami Plant 374-5333
   Contact: Community Service Department (Production of electricity explained in detail.)

6. Museum of Science and Natural History, 3280 South Miami Avenue, 854-4242.

7. Southern Bell Telephone and Telegraph Co., 36 N. E. 2nd St. 350-8616
   Contact: Public Relations Supervisor (School Representative)

8. Miami Glass Blowers, 921 S. W. 27 Ave., 444-5402
   Contact: Manager (Manufacturing of glass novelties from glass tubing and rods.)

SPEAKERS

Museum of Science and Natural History, 3280 South Miami Avenue. 854-4242
Contact: Any office personnel

1. Pollution lectures
2. The atom
3. Chemistry
4. The gyroscope
5. Aerodynamics

Southern Bell Telephone and Telegraph Company, 36 N.E. 2nd Street, 350-8616
Contact: Public Relations Supervision (School Representative)

6. The laser
7. Down to business in the oceans

FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1. Edison, Thomas
   AV#1-31548, 26' BW

2. Aristotle and the Scientific Method
   AV#1-12492, 14' C

3. Darwin and Evolution
   AV#1-30553, 28' C

4. How to Observe
   AV#1-00514, 10' BW

5. Scientific Method
   AV#1-00183, 11' BW

6. Scientific Method in Action
   AV#1-10079, 19' C

7. Visual Perception
   AV#1-10667, 19' C

8. Sense Perception (Part I)

The Wonder of the Senses
AV#1-30024, 28' C

9. Sense Perception (Part II)
The Limitations of the Senses
AV#1-30025, 27' C

10. Force of Gravity,
AV#1-30285, 29' C

11. Galileo
AV#1-12494, 14' C

12. The Metric System
AV#1-00894, 11' BW

13. Newton, Isaac
AV#1-12468, 13' BW

14. Mystery of Time
AV#1-40017, 40 ' C

15. Mystery of the Sun
AV#1-30220, 26' C

16. Cosmic Rays
AV#1-30330, 29' C

17. Restless Sea, Part I
AV#1-30369, 30 ' C

18. Restless Sea, Part II
AV#1-30371, 30' C

19. Weather Research
AV#1-30380, 27', BW

20. Regeneration
AV#1-30607, 28' C

21. Penicillin (First Major Test)
AV#1-30729, 28' BW

FILMSTRIPS

Encyclopaedia Britannica Educational Corporation

Organizing a Science Project, No. 1154 (Set of 8 Filmstrips)

1. Preparing Your Science Project
2. Exhibiting Your Science Project
3. Pitch Discrimination: A Project in Audiology
4. Experiments with Euglena: A Project in Zoology
5. Locating a Cell Enzyme: A Project in Biochemistry
6. Identifying Polyploid Orchids: A Project in Genetics
7. Learning and Unlearning: A Project in Psychology
8. Corrosion: A Project in Electrochemistry

Hand Lens and Microscope Techniques (Set of 5 Filmstrips) (No. 11600)

9. How to Use a Hands Lens
10. How to Use a Microscope
11. How to Stain Microscope Specimens
12. How to Mount Microscope Specimens
13. Microreplica and Coal Ball Peel Techniques

Great Names in Biology (Set of 6 Filmstrips) No. 8260

14. William Harvey
15. Anthony Van Leeuwenhoek
16. Carolus Linnaeus
17. Charles Darwin
18. Louis Pasteur
19. Gregor Mendel

SUGGESTED DISCUSSION QUESTIONS

1. The scientist's system of measurement. (Ref. 14, pp. 20-23)
2. History of metric system - Compare English and metric systems. (Ref. 4, pp. 5-8)
3. The meaning of measurement (Ref. 1, pp. 109-134)
4. Systems of units (Ref. 2, pp. 48-61)
5. What are some reasons for favoring the introduction of the metric system in the United States? What are some objections? (Ref. 13, pp. 4-10)
6. The scientific method (Ref. 2, pp. 35-39)
7. What is the difference between supportive evidence and proof? (Ref. 11, pp. 22-23)
8. How to do an experiment (Ref. 12, pp. 9-16)
9. How to do field research (Ref. 10, pp. 9-16)
10. How are models useful to the scientist? (Ref. 1, pp. 15-25)
11. Are negative results as helpful as positive support of hypotheses?
12. How facts are changed when new evidence is made available.
13. How scientists study matter and energy (Ref. 2 Ch. 2)
14. Careful observation requires time and patience (Ref. 5, pp. 5-14)
15. Observation of a sunset - Which description is more scientific? (Ref. 14, pp. 4-5)
16. Can you make a clear distinction between what you see (observation and the meaning you draw from it (interpretation)? (Ref. 1, pp. 19-25)
17. Interpretation of data (Ref. 11, pp. 14-16)
18. Incorrect assumptions may lead to wrong conclusions. Look for assumptions in student reports.
19. Is the interest in ecology only one of many trends that will soon fade away? What part should the scientist play in this area? How can you contribute?
20. Discuss different kinds of data that might be collected on space trips.
21. What are the different areas of science that are involved in space travel?
22. Can you think of any problems in your school that might be solved using the scientific method?
23. How can the scientific approach to solving

problems be used in changing patterns of traffic in a city?

24. How can the scientific approach to solving problems be used in lessening the drug abuse problem in a community?
25. How can the scientific approach to solving problems be used when decisions are to be made on the building of new schools? (population changes in a community; number of classrooms available; more efficient use of present buildings)

REFERENCES:

1. Abraham, Norman and others. Interaction of Matter and Energy, Chicago: Rand McNally and Company, 1968.

2. Fisk, Franklin, and Blecha, Milo. The Physical Science. Atlanta: Laidlaw Brothers, 1971.

3. Intermediate Science Curriculum Study, Probing the Natural World, Volume 2A. Morristown, N.J.:

4. Laboratory Activities for Science Students Junior High Level, 1968, Bulletin 8G, Dade County Board of Public Instruction.

5. Oxenhorn, Joseph M. and Idelson, Michael N. Pathways in Science, Biology I. New York: Globe Book Co., 1968.

6. Oxenhorn, Joseph M. and Idelson, Michael N. Pathways in Science, Biology 2. New York: Globe Book Co. 1969.

7. Oxenhorn, Joseph M. and Idelson, Michael N. Pathways in Science, Biology 3. New York: Globe Book Co., 1970.

8. Oxenhorn, Joseph M. and Idelson, Michael N. Pathways in Science, Chemistry I. New York: Globe Book Company, 1968.

9. Science Lab 7 and 8 Laboratory Activities ITV Teacher's Guide, Dade County Board of

Public Instruction.

10. Thurber, Walter and Kilburn, Robert. Exploring Life Science. Atlanta: Allyn and Bacon, 1966.

11. Thurber, Walter and Kilburn, Robert. Exploring Physical Science. Atlanta: Allyn and Bacon, 1966.

12. Thurber, Walter and Kilburn, Robert. Exploring Science Seven. Atlanta: Allyn and Bacon, 1965.

13. Tracy, George R. and others. Modern Physical Science. New York: Holt, Rinehart and Winston, Inc., 1970.

14. Weisbruch, Fred T. and others. Patterns and Processes of Science, Laboratory Text No. 1. Lexington, Mass. D. C. Heath, 1969.

MASTER SHEET - SCIENTIFIC APPROACH TO SOLVING PROBLEMS

Objectives	Experiments	Student Text	Supplementary References	Films	Film Strips	Field Trips	Reports	Demonstrations	Projects	Discussion Questions	Speakers
1	1, 10, 11, 12 13, 14	5 pp464-472	2 pp22-27 9 pp28-33 9 pp81-86		9, 10, 11, 12, 13						
2	15, 16, 17, 18, 19, 28, 29, 30, 35, 36, 37, 38	6 pp109-134 10 pp48-61	2 pp5-8; 11; 15 8 pp4-11	12			1			1, 2, 3, 4, 5	
3	20, 21	14 pp4-7 5 pp9-1 10	10 pp35-36, 39				6, 14, 21			6, 7, 19	
4	3, 4, 23, 25, 39, 41	5 pp9-10	4 pp9-16 13pp9-16	5, 20			14	12		8, 9	
5	3, 24, 4, 22 40	5 pp9,16					2, 9, 10	1, 2, 3, 4, 5, 8, 10,11,12		10,11, 12, 19	1
6	26, 31	6 pp1,3, 6,18, 19,22 23,26	7 pp4-5 10 Chap. 2 9 pp5-14	4, 7, 14, 8, 9		8	11	9, 6, 7, 10, 12, 15		13, 14, 15, 16	3, 6
7	All Labs						5			19	
8	All Labs	5 pp9-16						13		20	
9	5, 6, 7, 27, 32, 33, 34, 39	5 pp9-16, 476-478	7 pp4-5					10, 11, 13, 14		13, 14, 15, 16	
10	8, 9, 25, 27	14E-7 pp1-10 5 pp9-16			2	3	12, 13	14		17	
11					1, 2		4		All Listed		
12					3, 4, 5, 6, 7, 8					18	
13		10 pp39, 123,311, 395,479	10 Chap. 2 7 pp37,103 189,247, 291,385	1,2 3, 6,10, 11,13, 15,16 17,18, 19,21	14,15,16, 17,18,19	1,2,3,4, 5,6,7	3,7,8, 14,15			20,21	2,4, 5,7
14		10 pp35-36 6 pp10-11 13pp443-460		4,8,9		1,3,5	16,17, 18,19, 20,22, 23,24			19,22, 23,24, 25	1

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

DADE COUNTY PUBLIC SCHOOLS

WHO'S WHO

5311.09
5312.09
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SCIENCE
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DIVISION OF INSTRUCTION • 1971

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SCIENCE

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Written by Ted Boydson and Key Reese

for the

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WHO'S WHO

COURSE DESCRIPTION

This course is to acquaint the student with the significant contributions of scientists throughout history. The importance of the scientific method and the role of failure in scientific discovery is emphasized.

ENROLLMENT GUIDELINES

No prerequisite courses necessary

STATE ADOPTED TEXTS

1. Biological Science Curriculum Study, Biological Science: Molecules to Man (Blue Version) Boston: Houghton Mifflin Co., 1968.

2. Earth Science Curriculum Project, Investigating the Earth. Boston: Houghton Mifflin Co., 1967.

3. Thurber and Kilburn, Exploring Physical Science. Allyn, Bacon Co., Boston, 1966.

PERFORMANCE OBJECTIVES

1. The student will define the steps of a scientific approach, define, and give an example of each.

2. The student will define inductive, deductive and empirical reasoning.

3. Given a great discovery, the student will identify the different reasonings involved in the development of the great discovery.

4. Given examples or following approaches to knowledge; trial and error, hunch-intuition and authority, the student will identify each.

5. Given a significant discovery, the student will reconstruct the experiment in a laboratory situation.

6. Given a list of names and contributions, the student will match the scientist's name with his contribution.

7. Given an example, the student will construct a chronological chart showing the development of ideas in each specific area of study.

8. Given a list of scientists and their contributions, the student will identify those contributions applicable today.

9. Given a list of scientists and their contributions, the student will propose the possible outcome if those contributions had never been formulated.

10. Given a specific example of a scientific hypothesis, which is today considered invalid, the student will construct hypothetical experiments which would show the hypothesis to be invalid.

11. Given a specific example, the student will discuss critically the role of failure in the development of a scientific discovery.

PERFORMANCE OBJECTIVES (CONT'D)

12. Given the history of the development of the telescope and the microscope, the student will describe three (3) effects that the development of these tools had on physics and biology respectively.

COURSE OUTLINE

I. The Nature of Science - a Discovery Method

- A. Introducing a scientific approach
  - 1. Definition
  - 2. Progressing development
  - 3. Types of reasoning involved
    - a. Bacon, Francis - inductive methods
    - b. Newton - reasoning in philosophy
    - c. Einstein - philosophic consideration
  - 4. Other approaches to knowledge
    - a. Trial and error
    - b. Hunch - Intuition
    - c. Authority
- B. Solutions for problems
  - 1. Ptolemy
  - 2. Johann Baptista Van Helmont -- role of water in the growth of plants
- C. Role of experimentation
  - 1. Hippocrates - scientific approach in study of the treatment of disease
  - 2. Aristotle - habits of marine animals described
  - 3. Archimedes - law of lever and application

II. The Scientific Revolution

- A. The great world system
  - 1. Copernicus - solar system
  - 2. Galileo - telescope and astronomy

3. Kepler - orderly universe
4. Isaac Newton - laws of motion

B. The physically small world
1. Gilbert - magnetism and electricity
2. Galileo - laws of acceleration of falling bodies
3. Boyle - gas laws
4. Hooke - law of electricity
5. Newton - white light - prism

III. The Question of Life

A. The origin of life
1. Redi - development of maggots into flies
2. Leeuwenhoek - microscopic work bacteria and protozoa
3. Lazaro Spallanzani - experimentally refuted spontaneous generation

B. The structure of living things
1. Robert Hooke - cell
2. Theodore Schwann - cell theory
3. Ernest Just - structure of the cell

C. The functions in living things
1. Harvey - circulation of blood
2. Hales - transport system in plants
3. Johannes Muller - largely responsible for determining the direction of modern experimental work in physiology

D. The development and evolution of life
1. Linnaeus - Binomial system of classification
2. Lamarck - inheritance of acquired characteristics
3. Darwin - theory of natural selection
4. Mendel - fundamentals of inheritance with garden peas

E. Disease and man
1. Jenner - vaccination
2. Koch - methods of studying disease -- producing bacteria

3. Pasteur - prevention of rabies
4. Lister - antiseptic principles in surgery
5. Hinton - originated Hinton test for syphilis
6. Drew - used sodium citrate to preserve blood
7. Williams,Daniel - performed first successful heart operation

IV. Development of Chemistry

A. The question of burning
1. Joseph Black - chemistry of fixed air
2. Priestley - O_2 preparation
3. Lavoisier - O_2 in combustion

B. The emergence of modern chemistry
1. Dalton - foundations of atomic theory
2. Gay-Lussac - combination of gases with each other
3. Avogadro - atom distinct from molecule
4. Mendeleev - relationship between properties and atomic weights of elements

V. Electrons and Smaller Particles

A. Electrons
1. Franklin - kite experiment
2. Volta - voltaic pile and battery
3. Faraday - electromagnetic induction

B. Rays
1. Roentgen - X Ray discovery
2. Marie Curie - discovery of Polonium and Radium
3. Rutherford - nature and causes of radio-activity

VI. Discoveries Continue

EXPERIMENTS

Weisbruck, Donovan, Hinger, Timker, Palmer. A Laboratory Text for Physical Science (Pilot Edition) Boston: D. C. Heath & Co., 1966.

1. Observation and Hypothesis - A Study of the Pendulum Cycle (p. 5)
2. Effect of Variables on the Period of the Pendulum (p. 12)
3. Observation and Inferences Made on a Burning Candle (p. 21)
4. Albert's Drinking Problem - An Exercise in Deductive Reasoning (p. 24)
5. Cause and Effect Relationships - The Bottle Imp (p. 29)
6. Boyle's Law (pp 169-172)
7. Acceleration (pp. 254-259)
8. Motion with Uniform Speed (pp. 248-252)
9. The Refraction or Bending of Light (pp. 236-245)

Biological Science Curriculum Study, Biological Science: Molecules to Man. (Blue Version) Boston: Houghton, Mifflin Co., 1968.

10. Redi Tests the Idea of Spontaneous Generation (p. 91)
11. Leeuwenhoek: Microscopic evidence (p. 92)
12. Needham and Spallanzani Test the Idea of Spontaneous Generation (p. 93)
13. Hooke's Microscope (p. 275)
14. Harvey Discovers Blood Circulates (p. 483
15. Investigating Capillary Circulation (p. 488)
16. Radiation Is Shown to Cause Mutation (p. 434)
17. Natural Selection Observed - Investigation 9 - Teacher's Guide (p. 198)
18. Mendel Performed Many Experiments (pp. 383-385)

Schwartz and Bishop. Moments of Discovery. Vol II, New York: Basic Books, Inc., 1958.

19. Investigating the Compound Microscope (p. 21)
20. "The Pressure on Sap in Plants" (p. 499)

Feifer, Nathan. Let's Explore Chemistry. New York: Sentinel Books, Inc., 1959.

EXPERIMENTS (CONT'D.)

21. We Make Pure O_2 (p. 19)
22. What Really Happens to a Material When It Burns? (p. 14)

Eckert, Theodore, Discovery Problems in Gen. Science Workbook, New York: College Entrance Book Co., 1964.

23. What Is a Voltaic Cell (p. 81)
24. How Is a Storage Battery Made? (p. 82)
25. How Can Electricity Be Used to Make a Magnet? (p. 87)
26. What Kind of Machine Is a Lever? (p. 119)
27. How Are Magnetism and Electricity Related? (p. 87)

Earth Science Curriculum Project, Teacher Guide To Investigating the Earth, Part II, Boston: Houghton, Mifflin Co., 1967.

28. Creating a Model of the Solar System (pp. 633-635)

Morhold, Brandewein, Joseph, A Source Book for the Biological Science, New York: Harcourt, Brace & World, 1958.

29. Redi's Experiment (pp. 151-152)
30. Use of Telescope

DEMONSTRATIONS

Schwartz, George and Bishop, Phillip W. Moments of Discovery, Vol. 1, New York: Basic Books, Inc., 1958.

1. Is Wood Made of Water? (p. 200)
2. Observations of Marine Animals (p. 133)
3. Kepler's Laws (p. 265)
4. Chemistry of Fixed Air (p. 431)

Schwartz, George and Bishop, Phillip W. Moments of Discovery, Vol. II, New York: Basic Books, Inc. 1958.

5. Gay-Lussac Combination of Gases (p. 789)
6. Avogadro's Number (p. 804)
7. Franklin's Kite Equipment (p. 846)
8. On a New Kind of Rays (X-Rays) (p. 869)

PROJECTS

1. List all possible evidence to uncover the flaw in Ptolemy's Geocentric Theory.
2. Solve word problems by the various methods of reasoning.
3. Diagram the laws of the lever.
4. Draw a cartoon series depicting the scientific ideas we consider invalid.
5. Class discussion "Should doctors be made to pledge to the Hippocratic Oath?"
6. Build a telescope.
7. Devise a simple experiment to show the relationship between magnetism and electricity.

PROJECTS (CONT'D.)

8. Make a model planetarium.

9. Draw a series of posters illustrating Newton's Laws of Motion.

10. Draw a series of posters illustrating the different types of bacteria.

11. Trace on a map Darwin's voyage on the "Beagle" noting significant findings.

12. Debate "Over-population."

13. Investigate the role of infections in hospitals.

14. Make a family pedigree for one inherited trait.

15. Class discussion: "Role of the atom in the future."

16. Make a periodic chart of the elements.

17. List the names of 25 living things and try to devise your own system of classification.

FIELD TRIPS

1. Museum of Science
2. Planetarium
3. Hospital X-Ray Laboratory
4. Hospital Bacteriology Laboratory
5. Mount Sinai Nuclear Research Laboratory

GUEST SPEAKERS

1. American Society for Microbiology
   Dr. Bennet Sallman, University of Miami
2. Dade County Medical Association
   2 S. E. 13th Street
3. American Institute of Industrial Engineers, Inc.
   Mr. R. B. Levin
   Standard Chemical Co., P. O. Box 667
   Northwest Station, 33147

REPORTS

1. Report on the scientific contributions of one of the individuals listed below.

2. Prepare a biographical report on one of the following:

1. Francis Bacon
2. Albert Einstein
3. Ptolemy
4. Johann Baptista Van Helmont
5. Hippocrates
6. Aristotle
7. Archimedes
8. Copernicus
9. Galileo
10. Kepler
11. Isaac Newton
12. Gilbert
13. Boyle
14. Robert Hooke
15. Redi
16. Leeuwenhoek
17. Spallanzani, Lazars
18. Theodore Schwann
19. Harvey
20. Hales
21. Johannes Muller
22. Linnaeus
23. Lamarck
24. Charles Darwin
25. Gregor Mendel
26. Edward Jenner
27. Joseph Black
28. Joseph Priestley
29. Antoine Lavoisier
30. John Dalton
31. Gay-Lussoc
32. Avogadro
33. Mendeleev
34. Benjamin Franklin
35. Volta
36. Faraday
37. Roentgen
38. Marie Curie
39. Rutherford
40. George Washington Carver
41. Daniel Hale Williams
42. Charles R. Drew
43. Granville T. Woods
44. Percy Julian
45. William Hinton
46. William Barnes
47. Any Living Scientist
48. Any Black Scientist

RELATED PROBLEMS

1. Newton's laws of motion.
2. Kepler's laws of motion.
3. Problems involving ideal gas laws.
4. Development of atomic electronic orbits and periodic chart.
5. Problems involving Ohm's law.
6. Problems involving Archimede's principle.
7. Problems involving basic types of levers.
8. Problems involving acceleration.
9. Problems involving refraction and reflection.
10. Problems involving calculation of astronomic distances.
11. Gentic monohybrid and dihybrid crosses.
12. Work with classification keys for animals and plants.

DADE COUNTY 16mm FILMS

1. Archimede's Principle
   AV#1-10712, 13', BW

2. Archimede's Principle
   AV#1-01797, 7', BW

3. Aristotle and the Scientific Method
   AV#1-12492, 14', C

4. Cathode Ray Tubes: How It Works
   AV#1-12974, 15', BW

5. Chemical Change
   AV#1-02844, 12', C

6. Circulation
   AV#1-03089, 10', C

7. Circulation
   AV# 1-12977, 16', C

8. Color and Light, an Introduction
   AV#1-01857, 11', C

9. Darwin and Evolution (A.B.S.)
   AV#1-30553, 28', C

10. Electricity: How It Is Generated
    AV#1-03530, 11', BW

11. Explaining Matter: Atoms and Molecules
    AV#1-10777, 13', C

12. Falling Bodies
    AV# 1-01786, 10', BW

13. Force of Gravity
    AV#1-30285, 29', C

14. Galileo
    AV# 1-12494, 14', C

FILMS (CONT'D)

15. Galvani and Volta: An Early Debate in Science
AV# 1-10752, 15', BW

16. Gas Laws and Their Applications
AV# 1-10720, 16', BW

17. Germ Theory of Disease, The (AIBS)
AV# 1-30730, 28', C

18. Gravity
AV# 1-01787, 10', BW

19. Gravity the Mighty Pull
AV# 1-10705, 13', C

20. How We Know the Earth Moves
AV#1-01631, 11', C

21. Inclined Plane, Wedge and Screw
AV# 1-10706, 12', C

22. Infectious Diseases and Man-Made Defense
AV#1-03409, 11', C

23. Laws of Conservation of Energy and Matter
AV#1-01753, 8', C

24. Laws of Gases, The
AV#1-01831, 10', BW

25. Light and Its Story
AV# 1-10737, 13', C

26. Magnetism
AV# 1-01899, 10', BW

27. Magnetism Force
AV#1-30321, 29', C

28. Mendel's Recombination
AV# 1-30592, 28', C

FILMS (CONT'D)

29. Mendel's Segregation
AV#1-30582, 28', C

30. Newton, Isaac
AV# 1-12468, 13', BW

31. Pasteur, The Benefactor
AV# 1-12471

32. Penicillin (First Major Test)
AV# 1-30729, 28', BW

33. Science of Light
AV# 1-03160, 11', C

34. Scientific Methods in Action
AV#1-10079, 19', C

35. Scientific Method
AV# 1-00103, 11', BW

36. Science and Superstition
AV# 1-01331, 10', BW

37. Solar System, The
AV#1-01543, 10', BW

38. Story of the Blood Stream, Part I
AV# 1-30714, 29', C

39. Story of the Blood Stream, Part II
AV# 1-30715, 24', C

40. Understanding Color
AV#1-10738, 14', C

SUGGESTED DISCUSSION QUESTIONS

1. Discuss the steps of the scientific method.

2. What is the value of a controlled experiment?

3. Can trial and error experimentation be avoided completely?

4. Why must a scientist be very much aware of the assumptions he makes?

5. Are people today more scientific in their attitudes than people who lived five or six hundred years ago? Give your reasons.

6. Compare the theories of biogenesis and evolution.

7. Discuss the theory of spontaneous generation; its rejection; its revival by Leeuwenhoek and its final rejection.

8. Attempt to explain how the cell theory fits with the theory of evolution to form a broader structure of ideas than either theory alone. How does it fit with the theory of inheritance?

9. Give an example that illustrates that we have much more theoretical and factual knowledge of the cell than was available ten years ago.

10. Why was the development of the cell theory spread over almost 200 years?

11. What were some of Harvey's observations that led him to the idea of the circulation of blood?

12. Could a classification system exist that had no connection with observational knowledge? Would it be very useful? Explain.

13. Describe how Linnaeus used an interaction of facts and ideas to develop his system of classification.

SUGGESTED DISCUSSION QUESTIONS (CONT'D.)

14. What are some of the things that Darwin saw that convinced him that species of organisms undergo change?

15. Why is Mendel's experiment considered a landmark in genetic studies? Give your opinion as to the importance of this experiment.

16. Discuss the role of the miscrscope in the conquest of disease.

17. Discuss various types of immunity.

18. Discuss the problems arising from short observations, and the basis for very general concluding statements, as in the case of Aristotle.

19. What were the main theoretical flaws of the Ptolemic view of the universe?

20. What was a main flaw in Copernicus' view of the universe?

21. How did Kepler's math solve the problem for Copernicus?

22. What are the main factors that influence a falling body?

23. What is the difference between a conductor and a non-conductor?

24. Describe how a white object is a combination of the three primary colors.

25. Describe how metals can become magnetized.

26. Compare the burning of paper and the rusting of iron.

REFERENCES

1. Asmiov, Isaac. Breakthrough in Science. New York: Scholastic Book Service, 1961.

2. Carre, Phillip. Giants of Science. New York: Grosset and Dunlap, 1962.

3. Cunningham, Dale. Pioneers in Science. New York: Sterling Publishing Co., 1962.

4. Eckert, Theodore E. Discovery Problems in General Science, Workbook. New York: College Entrance Book Co., 1964.

5. Evans, H. M. Men and Monuments in the History of Science. Westwood, Connecticut: Greenwood Publishing Co., 1959.

6. Feifer, Nathan. Let's Explore Chemistry. New York: Sentinel Books, Inc., 1959.

7. Henahan J. Men and Molecules. New York: Crown Publishers, 1966.

8. Hoyt, Edwin P. A Short History of Science. Vols 1 and 2. New York: John Day Co., 1956.

9. Morholt, Evelyn et al. A Sourcebook of Biological Science. New York: Harcourt, Brace and World, 1958.

10. Sand, S. Lives in Science. New York: Scientific American Resource Library, 1957.

11. Schwartz, G. L. and Bishop, P. W. Moments of Discovery. Vols. 1 and 2, New York: Basic Books, Inc., 1958.

12. Theiler, C. R. Men and Molecules. New York: Apollo Books, Division of Coshad, Inc., 1967.

13. Turner, D.M. The Book of Scientific Discovery. New York: Everyday Handbooks, 1960.

MASTER SHEET - WHO'S WHO?

Objectives	Experiments	Demonstrations	Projects	Reports	Field Trips	Related Problems	Speakers	Films	Discussion Questions
1	1, 2, 3			1, 2	1,2,3, 4,5		1-12	3,15,34, 35,36	1-5
2	4, 5		2	1, 2	1,2		1-12	3,15,34, 35, 36	1-5
3	1, 2, 3, 4, 5	1-8	2, 11	1, 2	1, 2		1-12	3, 15, 34, 35, 36	1-5
4	4, 5		11	1, 2	1, 2		1-12	1,3,9,14, 15,17,29, 30,31	1-5
5	6-30	1-8	7,9,11, 12,16, 17	1, 2	1, 2		1-12	1-40	*6,7,11,1, 2,13,14,15, 17
6	6-30	1-8	5,7,9, 10,11,12, 13,14,15, 16,17	1, 2	1, 2	1,2,3	1-12	1-40	18,21,22, 23,25,26,27
7	6-30		11,14,15, 16,17	1, 2	1, 2	1,2,3		1-40	
8	6-30	1-8	11,15,16, 17	1, 2	1, 2		1-12	1-40	
9	6-30	1-8	11,13,14, 15,16,17	1, 2	1, 2			1-40	
10	10, 12		4,16,17	1, 2	1, 2			1-40	
11	6-30	1-8	16,17	1, 2	1, 2	1,2,3		1-40	
12	11,13,28, 30		6, 8	1, 2	1, 2	1,2,3	2,9,10	8,20,25, 37	8,9,10,16, 19,20,24

* Discussion questions apply to numbers from 5 through 11.

SE
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CURRENT SCIENCE

What in the World's Going On?

COURSE DESCRIPTION

This course is designed as an elective course in which the content, specific information objectives, and evaluative criteria may be generated by the students from guided experiences in reading, listening and seeing reports of what's happening in the news pertaining to the broad field of science.

ENROLLMENT GUIDELINES

The course is open to all junior high school students.

STATE ADOPTED TEXTS

There are no state adopted texts. Any of the appropriate state adopted science texts may be used as reference for specific background information.

PERFORMANCE OBJECTIVES

1. Given current science 'news' articles similar to those discussed in class, the student will:

   a. Distinguish correctly between the actual content and inferred content of each
   b. Select the more (most) reliable source of additional information on the topic from two (or more) possible choices
   c. Select from the given two or more choices the more (most) probable long range effect of the stated hypothesis, theory, or experimental results
   d. Make a value judgment - "usually accurate" or "often inaccurate" on the validity of the information given the source, author or context of the presentation.

2. Given statements and the 'supporting data' from current science as defined in class, the student will identify each as an "inference" or an "observation."

3. Given 'headlines' and the accompanying 'lead paragraph' from current science sources, the student will indicate whether each 'headline' is "fairly accurate" or "possibly misleading" when compared with the content of the 'lead paragraph'.

4. Given 'inferences' and the 'data' from the same source from current science as defined in class, the student will indicate whether each 'inference' is "supported" or "not supported" by the 'data'.

5. Given 'hypotheses' and the 'observations' and 'inferences' upon which they are based from current science as defined in class, the student will indicate whether each is stated in such a way that it "can be tested" or "can not be tested."

6. Given examples of experiments reported in current science, the student will indicate whether each is "controlled" or "not controlled."

COURSE OUTLINE

I. Presentation of Science 'News'

A. Articles
1. Slides
2. Overhead transparencies
3. Opaque projections
4. Multiple copies
5. Other

B. Broadcasts
1. Radio
2. Television

C. Student
1. Individual
2. Panel
3. Debate
4. Other

II. Discussion of 'News' Articles and Broadcasts

A. Content
1. Observation
2. Inference
a. Supported
b. Not supported
3. Experiment
a. Controlled
b. Not controlled
4. Hypothesis
a. Tested
b. Not tested
5. Theory
a. Historical background
b. Experimental evidence to support

B. Possible long range effects

C. Value judgments
1. General reliability
a. Source
b. Author or researcher
2. Context

D. Comparison of headlines and lead paragraphs

III. Background Information

A. Books

B. Non-current periodicals

C. Resource speakers

EXPERIMENTS AND DEMONSTRATIONS

See the quinmester courses developed for the specific content areas relative to the expressed interests of students.

STRATEGIES

I. Teaching

A. Large group meetings
   1. Student presentation
      a. Individual
      b. Panel
      c. Debate
      d. Other
   2. General interest discussions
      a. Student led
      b. Teacher directed
   3. Resource speakers
   4. Special TV and radio broadcasts
      a. At regularly scheduled time
      b. At extra meetings
   5. Testing

B. Small group meetings
   1. Student input
   2. Special interest discussions
   3. Preparation for student presentations to the large group

II. Learning

Activities from which students may select one or more:

A. Read, summarize briefly in writing, and submit for evaluation a minimum of two articles each week. Use the format prescribed in class. Select the articles from the list of periodicals provided or approved by the teacher(s), and dated not more than two weeks prior to the beginning date for the class.

STRATEGIES (CONT.)

B. Keep a journal or scrapbook of current sources of information on one science topic approved by the teacher. Note bibliographic data, the date(s) of participation in the activity, and reactions to the activity. Have the journal or scrapbook available to be examined by the teacher(s) as specified in class.

C. Submit in writing (on the form provided) at least three current science topics or resources to be considered for a large or small group discussion during the course. Use a separate form for each.

D. Develop a time line for the historical background of a current development in science.

E. Generate a means for meeting individual objectives for studying current science.

F. Generate questions concerning important informational content of current science sources to be part of a pool of questions for the final evaluation device.

III. General

A. Develop a speakers bureau from which to draw potential resource persons.

B. View TV presentations of particular interest and discuss.

C. Submit in the seventh week of the course, a list of student generated questions to the large group and have each student check those he considers important enough to include in the final evaluation device.

RESOURCE LIST FOR PUPILS AND TEACHERS

1. Current Science
2. Life
3. Miami Herald, The
4. Miami News, The
5. New York Times, The
6. Newsweek
7. Popular Science
8. Saturday Review
9. School Science and Mathematics
10. Science
11. Science Digest
12. Science News
13. Science News Letter
14. Science World
15. Scientific American
16. Time
17. U. S. News and World Report

STUDENT SUGGESTION FORM

_____ _____

Student's name Date

(check one)

_____ Topic for discussion in small group

_____ Topic for discussion in large group

_____ Resource speaker

_____ Special broadcast

_____ Information question for final evaluation

State topic and describe briefly.