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ABSTRACT

The purpose of this document is to develop a usable science teaching guide based on the process skills methodology for the middle school life science teacher. It is intended to provide an efficient and effective tool for the interested teacher to use to develop the skills of the methodology. It could also be used as companion to the latest set of science and health competencies issued by the New Mexico State Department of Education, and as a supplement to life science textbooks. Part I, "Science in the Contemporary Classroom," presents a theoretical foundation for teaching science in a middle school classroom. Part II, "Life Science in the Las Cruces (New Mexico) Middle School Classroom," provides a model for incorporating process skills into teaching. Both parts are an effort to further the use of the process skills approach in a middle school life science program, which will be achieved as teachers come to believe that the outcomes justify the effort. A summary is provided in the form of a concept map, developed to show the relationships between the key ideas. (TW)

A PROCESS SKILLS FIELD GUIDE TO TEACHING LIFE SCIENCE

by

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Presented to

Las Cruces Public Schools

Middle School Committee

New Mexico State University

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PART I

SCIENCE IN THE CONTEMPORARY CLASSROOM

INTRODUCTION

Most teachers teach in the same manner they were taught. Thus, educational pedagogy has remained constant, archaic, or at best evolving slower than nature. Behind today's science classroom doors are traditional teaching methodologies that frequently fail to direct the student beyond the acquisition of simple facts. Too often the traditional teacher completes instruction of a unit by dogmatically requiring students to read the chapter, memorize vocabulary, and answer questions at the end of the chapter. Occasionally, the regiment is interrupted by a filmstrip or a laboratory exercise designed to please the school evaluator. While this teaching approach shortens the teacher's preparation time and efficiently hurries the student through the curriculum, it is often found to be trying, tedious, and unstimulating by the student.

The drawbacks of the traditional approach just described are easily surmounted with the use of the "process skills" approach. Using the "process skills" approach in science instruction places the teacher and his or her teaching methodology into the twentieth century by a quantum leap. The benefits of this methodology can be surmised as follows:

1. It allows the student to be actively involved in the learning process and the teacher to direct actively the process to a desirable educational end.

2. It places the student in an environment similar to that of a scientist.

3. It helps the student develop the scientific point of view for problem solving.

4. It helps the student develop higher level thinking skills such as inferring and predicting.

5. It assists the student in discovering the intrinsic value and self-pride of successfully solving scientific problems.

While the benefits to students of using the process skills approach are many, it also provides special opportunities for the teacher. It provides the teacher with the curricular vehicle to update continually the ever changing subject matter. With this approach, both the teacher and the student will progress together in their separate roles. The science process skills approach is the new wave in science education for it meets the needs of the learner and the professional educator.

PURPOSE

The process skills approach is the most effective tool in teaching life science. With the emergence of a middle school concept in the Las Cruces Public Schools, science teachers need an alternative teaching method that provides the student with an opportunity for many hands-on science experiences. The current national trend in science education to develop students' process skills rather than their ability to absorb and memorize information requires all science teachers to familiarize themselves with this teaching approach.

The purpose of this FIELD GUIDE, therefore, is to develop a usable science teaching guide based on the process skills methodology for the middle school science teacher. This condensed handbook or field guide to life science instruction is an efficient, effective, and time saving means for the interested teacher to develop the teaching skills of this methodology. It can be used as a companion to the latest set of science and health competencies of the State Department of Education and as a companion to the most recently published textbooks.

Part I, Science in the Contemporary Classroom, reveals the theorical foundation for teaching science in a middle school classroom. Part II, Life Science in the Las Cruces Middle School Classroom, provides a practical model for incorporating process skills into teaching. Both parts are an attempt to further the renaissance of using the process skills approach in a middle school life science program as teachers come to believe that the outcomes justify the effort.

The summary takes the form of a concept map. It was developed as a visual or organizational roadmap and shows the relationships between the key ideas presented.

RATIONALE

FIELD GUIDE TO TEACHING LIFE SCIENCE is written for many people. Its condensed format is useful for student teachers who need a starting point and direction in their first efforts at teaching. Assistance is provided to first year science teachers who are often burdened with responsibility and lack for sufficient time and resources. With the national shortage of science teachers, newly certified teachers of science could use this handbook as a lifeline in getting their new career off to a healthy start. Established science teachers could cope with the call for educational accountability and shortages of resources (time, money, and materials) with which they may be faced. At every stage of their professional careers science educators can benefit from this booklet.

The typical teacher is burdened with curriculum guides that are 2-3 inch thick notebooks with curriculum to be taught in a fully prescribed manner. This FIELD GUIDE is a curriculum handbook. Handbooks are simple, concise reference books, the type of booklets that science teachers show their students how to use. This FIELD GUIDE for life science teachers is small enough to carry. It is written to be used to trigger the mind as a reminder of information that science educators need at their fingertips. This handbook is written to remind the professional biology or life science teacher of what is to be taught and ways in which it might be taught and evaluated.

This FIELD GUIDE credits the teacher with the ability to make curriculum decisions and use judgement in his approach to teaching; however, it does go further. It is an attempt to give the teacher accountability. This FIELD GUIDE along with process skills activity sheets (in Part 2) and an up-to-date gradebook should be sufficient resources for the teacher in explaining to a parent or administrator the reasons for curricular decisions as well as charting student progress. Being able to justify decisions and actions using reasoning gives the teacher credibility as a professional and accountability if proper records are kept. Having a defensible program is especially important in times of educational reform, accountability, and financial retrenchment.

SCIENCE PHILOSOPHY

Science must be part of the school's curriculum or educational program in order to move this country forward into the future. The essence of science is such that it provides students with knowledge, skills, and attitudes that they will learn in no other course of study. They will develop their perceptive abilities so they learn optimally from their environment. They will come to understand how things work in their lives and how science affects them. They will strive to use high level thinking skills allowing them to solve problems and responsibly decide scientific issues. In short, science teaches students to take control of their lives and surroundings in a manner that will contribute to the well-being of the people of this country/world. Because science is a unique, productive discipline, it must be given priority resource allocation.

SELECTED SCIENCE TEACHING MODELS

This FIELD GUIDE presents seven teaching models or theories. They were selected because they are appropriate for the science curriculum. They are presented in a very basic outline format with the understanding that should a teacher need more detailed information, it could be obtained using the bibliographic reference. Using the outline format allows the teacher to select the teaching style with which she feels the most comfortable. It also shows the teacher the specific research or academic foundation of her selected teaching method should this ever be in question. The order of presenting of models is from general to more specific i.e. more directly applicable to a science curriculum.

PHENIX - REALMS OF MEANING. These 6 Realms of Meaning show us how the essence of science (concepts and skills) fit into the whole human endeavor called learning.

1. SYMBOLICS - Verbal and body language, mathematics, and rhythms.
2. EMPIRICS - The science of the living and physical world of humans.
3. ESTHETICS - Perceptions through the visual, performing, and literary arts.
4. SYNNOETICS - Personal knowledge, insights, an awareness.
5. ETHICS - Morality as expressed by an individual's obligation to morals rath than facts alone.
6. SYNOPTICS - Integrating the above realms of meaning in order to view the world comprehensively, the "Big Picture" idea.

BLOOM'S TAXONOMY - A Hierarchy. This traditional classification of levels of learning includes 3 domains, cognitive (facts), affective (feelings), and psychomotor (physical skills). Although not a new educational model, Bloom's taxonomy continues to have implications for the science curriculum and is in common use.

1. COGNITIVE DOMAIN

   A. Knowledge-memorizing facts and figures
   B. Comprehension-understanding the meaning relationships of facts and figures
   C. Application-ability to use facts and figures
   D. Analysis-breaking down an idea into smaller parts
   E. Synthesis-putting ideas together to form a new entity
   F. Evaluation-judging the newly created entity for it's worth (Bloom, 1956)

2. AFFECTIVE DOMAIN

A. Receiving-awareness of (scientific) activities
B. Responding-motivation to do something with or about a scientific phenomenon
C. Valuing-having a preferance for a scientific approach rather than other ways of looking at phenomenon
D. Organizing-bringing scientific values into the realm of personal values
E. Characterizing-developing a lifestyle based on preferred scientific values (Krathwohl et al., 1964)

3. PSYCHOMOTOR DOMAIN

A. Moving-coordinating gross body movements
B. Manipulating-coordinating fine body movements
C. Communicating-getting ideas and feelings across using body language
D. Creating-using new ideas (Krathwohl et al., 1964)

<u>HARM'S 3 STAGE LEARNING CYCLE</u>. This is an inquiry method for teaching and learning science developed by the Science Curriculum Improvement Study (SCIS). This project was based on Piaget's developmental stages which follows a progression from concrete to abstract (Atkins and Karplus, 1962).

1. EXPLORATION-Students are given unfamiliar materials and instructed to discover everything that they can about the object. The students observe and proceed given a clear, but open-ended task statement.

2. CONCEPT INTRODUCTION-The teacher introduces the concept by readings, lecture, discussion, audio-visuals, or investigation. The concept is defined in terms of the experiences the student had during exploration. Different aspects of the concept are given names or labels for vocabulary development.

3. CONCEPT APPLICATION-The student is allowed to transfer her new knowledge to a new learning experience. Students see practical applications of science and technology in their own lives.

<u>GOWIN'S CONCEPT MAPPING</u>. A concept is an idea that ties together related facts (Funk et al, 1985). Concepts are designated with a label. A concept map is a visual roadmap that shows the relationship between a small number of key ideas as related to a larger more general concept. These maps are a way to help students and teachers "to penetrate the structure and meaning in the knowledge they seek to understand." (Gowin, 1977). An example of a concept is

digestion. A concept map of digestion is a graphic that shows relationships between the different components of the digestive system. This map might include sections on the organs of the digestive system, the nutrients to be absorbed and show the part of the digestive system that is responsible for breaking down each nutrient. An example of a concept map is in the summary of this FIELD GUIDE.

BUDD ROWE'S 3 MODELS OF TEACHING INQUIRY. Before Budd Rowe's models are explained, it would be helpful to understand phrases as used in this text.

Nature of Science or the essense of science is discovery, to gain insight for the first time. Discovery as Dewey espoused places greater emphasis on logical thinking processes by which new knowledge can be gained and less emphasis on information to be memorized. People who think as scientist do are curious, willing to suspend judgement, open-minded, and skeptical or questioning (Rakow, 1986).

Teaching Science means providing an appropriate learning environment so those who have or are developing a scientific nature encouraged (Rakow, 1986).

Learning Science means using science process skills as spelled out in the 1960's curriculum reform programs, Science-A Process Approach (Rakow, 1986).

Inquiry Teachers are those that 1)model scientific attitudes, 2)are creative problem-solvers, 3)show flexibility, 4)use open-ended questioning strategies. (Rakow, 1986).

Budd-Rowe believes that inquiry teachers have 3 tools that enable them to conduct inquiry science programs. All 3 can be used or they can be selected singly or in pairs. (Budd Rowe, 1973).

1. RATIONAL INQUIRY - employs questioning and reinforcing techniques to direct students toward solving a problem. Inquiry is teacher directed.

2. DISCOVERY - has the teacher giving students materials and guiding them in their observation and reasoning process. Discovery is student directed.

3. EXPERIMENTAL INQUIRY - is the process of making a statement that you think is true and finding a way to test that statement. Experiments can be teacher or student directed.

EVAN'S PROBLEM-SOLVING. Problem-solving in a classroom setting refers to looking at an issue related to science and a given population such as school, community, state, national, or global concern. Problem-solving implies that conditions exist that warrant some action to reduce or do away with these conditions. The formal steps are those involved in any decision-making process.

1. JUSTIFICATION A PROBLEM EXISTS - gather data
2. DETERMINE PROBLEM CAUSES - brainstorm
3. CONJECTURE SOLUTIONS - brainstorm
4. SCREEN SOLUTIONS - see if solutions will work, are legal, and are practical
5. DEFINE SOLUTION - see the implications of putting the solution into effect
6. DETERMINE AREAS OF CONCERN - see effects, fairness, and feasibility of solution
7. OBTAIN PREDICTED CONSEQUENCES - predict positive and negative outcomes
8. DETERMINE PRIORITIES - see what are the most important positive and negative outcomes
9. ASSESS SOURCES - use experts and other resources to develop confidence ratings of competing solutions
10. DECIDE - weigh important positive against negative outcomes and select the solution

SHOWALTER'S SCIENTIFIC and TECHNOLOGIC LITERACY MODEL. For Showalter literacy goes beyond language and computer literacy to extend to the realm of science. Science literacy is the understanding and abilities in science that allow people to solve the complex problems associated with a rapidly-changing, technologically-advanced society. He believes scientific and technological literacy are quite interrelated and closely allied. Literacy is divided into 7 dimensions. Each dimension is composed of many specific factors that he has labeled quite clearly in his publication. The 7 dimensions are:

1. Knowlege and Structure
2. Concepts
3. Processes
4. Values
5. Science and Technology in Society
6. Positive Predisposition toward Science
7. Manipulative Skills

SCIENCE IN THE MIDDLE SCHOOL

Perspective. As a member of the Las Cruces Public Schools (LCPS) Middle School Transition Team, I have had the opportunity to listen and talk directly with many of the state, regional, and national proponents of the middle school movement. Also, I have been able to observe two successful middle schools. These include Desert View Middle School in El Paso, Texas, and a middle school in which science is of top priority, Los Alamos Middle School in Los Alamos, New Mexico. Two things should be kept in mind about the Los Alamos visitation. First, it gave the observer the unique opportunity of seeing a middle school in action whose science staff was the state's most active and influential group in developing the science competencies for the State of New Mexico. Second, the Los Alamos Middle School has a model science program rather than a typical one.

Middle School Concept. The LCPS are committed to converting from the current junior high school concept to middle schools. They intend to do so by not simply renaming them, but by applying the basic tenants of the middle school movement in this country. I believe that five of these seven tenants (as espoused by Elliot Merenbloom of Pikesville Middle School in Maryland) have very direct impact on middle school science programs and science teachers. These will be briefly described in an expanded outline format. Middle schools are intended to be a personal and positive experience for each student. Five hallmarks of middle schools are:

1. A RESPONSE to these needs of early adolescents

    A. Social and emotional needs for a positive self-image, peer group acceptance, and family support
    B. Moral development so they will reason and act in an appropriate manner
    C. Physical/sexual maturation
    D. Intellectual growth at a time when other development may be taking precedence, namely A,B, and C above.

    Note: Aspy's studies of the relation between cognition, emotional functioning, and physical functioning show that these are strongly an positively related.

2 A FLEXIBILITY in response to student needs so that they are comfortable in "their" school which is designed to offer the warmth of a home/family environment instead of the emptiness of a government institution

3. A PLAN for curriculum in response to learner's needs that go from concrete to abstract thinking (Piaget). Three curricular components according to Saylor and Alexander are:

   A. Information - how to collect and learn it in each required course
   B. Skill development - hands-on experiences that allow students to understand and use what they were taught
   C. Personal development - information and activities to help with understanding changes, problems, and decisions in their lives

4. An EXPLORATORY PHASE - Students are exposed to a variety of experiences in classroom learning, avocations, and vocations. These activities should be appropriate to their abilities and interests. Specialization is left to the high schools an colleges.

5. ORGANIZATIONAL OPTIONS - unique to each school

   A. <u>Block of time scheduling</u> for flexibility and for group identity. Classes can meet for as short as 15 minutes or in hour blocks.

   B. <u>Team planning</u> for coordination of curriculum and for early diagnosis of an individual student's problem.

   C. <u>Interdisciplinary teaching</u> so students see the relationship between different subjects. This team generally consists of teachers from each academic discipline. An example would be a science, math, social studies, and language arts teacher coordinating curriculum together during a team planning period. They could use a variety of methods such as:

      1. A theme approach like a careers
      2. A cultural approach like social issues
      3. A historical approach like inventors
      4. A problematic approach like deficencies in study skills

   D. <u>Student scheduling groups</u> usually consist of about 150 students. The groups can be homogenous for required classes as long as there is the possibility that the student can be regrouped based upon demonstrated ability. Elective classes are heterogenously grouped. Student scheduling groups are also referred to as "schools within a school" for an individual student hopefully feels a group or family identity. They should also sense that their team of teachers knows, understands, and has a positive regard for them in the spirit of Carl Rodgers. This then fosters a desire for cooperation rather than the competitiveness that is felt in a junior high school. Student scheduling groups are also an attempt to treat each student humanely, with respect on the part of the other students and their assigned teachers. A sense of ownership and a sense of caring make middle schools very special places for students.

<u>The Role of Science in the Middle School</u>. Science programs and science teachers have a very important role in middle schools. Science has renewed importance in the future of this country. It is an academic course and, as such, is considered essential to the intellectual progess of students.

How may science programs be different in a middle school than in a junior high school? The answer is in what Nike Pike, principal of Desert View Middle School, as the "profile of a middle school teacher". The qualities that make a contented middle school teacher apply likewise to a middle school science teacher. A middle school teacher should 1) understand and like this age student, 2) understand and philosophically agree with the middle school idea, 3) be flexible, 4) be cooperative and able to work closely with others, 5) have a sense of humor.

How does a middle school curriculum differ from a junior high school curriculum? The written curriculum might be similar to the junior high curriculum if students had been allowed to do activities and labs. Both the planned and the unwritten curriculum could have subtle changes that frankly would be hard to document in a research paper or difficult to pinpoint as resulting in higher standardized test scores. In a word, students are <u>involved</u> in their own education, their own school, and with others that may not have mattered previously. Learning is active and their own responsibility. The written curriculum, the unwritten curriculum, and teaching methods are different in a middle school and in a junior high school. The best way to detect the differences is by directly observing students and teachers interacting in a middle school classroom.

PART II

LIFE SCIENCE IN THE LAS CRUCES MIDDLE SCHOOL CLASSROOMS

The purpose of Part II is to develop a process skill model for teaching life science in middle school classrooms.

GOALS

The primary goals of a life science curriculum are:

1. To learn the basic information, terms, and concepts of biology.

2. To develop the basic and integrated skills that biologists use in the conduct of their profession.

3. To practice the writing skills necessary to meet the needs of a technical discipline.

4. To develop critical thinking skills.

5. To explore a creative approach to solving problems related to contemporary and future life science issues.

6. To become aware of the way science is integrated into daily living.

7. To begin to appreciate the living world.

8. To begin to develop an attitude of adaptability to change and new ideas.

9. To consider a science or related career.

SCIENCE PROCESS SKILLS

Science process skills are now considered the core of any laboratory science class. They are "the things scientists do when they study and investigate," according to Funk et al. The materials for doing science can be ordinary, inexpensive items that could be found at home, in a supermarket, or hardware store. The development of science skills is a primary goal of any contemporary science program. Nothing clarifies goals as effectively as demonstrating their achievement. This is apparent when science process skills are mastered. It is then that the real purpose of a science course becomes clear.

There is a process skills videotape available for self in-service that shows teachers specifically how to teach process skills. It shows activities that can be used in a classroom setting that are aimed at mastering the skills. The video also shows the teacher how to evaluate the degree of mastery of these skills. The video is available from NMSU's School of Education, Dep't of Curriculum and Instruction thru Dr. Carol Stuessy.

What is the purpose of incorporating science process skills into the curriculum? What are science process skills? Padilla provides the most comprehensive answer to these questions.

> One of the most important and pervasive goals of schooling is to teach students to think. All school subjects should share in accomplishing this overall goal. Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data.
>
> The scientific method, scientific thinking and critical thinking have been terms used at various times to describe these science skills. Today the term "science process skills" is commonly used. Popularized by the curriculum project, Science, A Process Approach (SAPA), these skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists. SAPA grouped process skills into two types--basic and integrated. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills. These skills are listed on the following page.

BASIC SCIENCE SKILLS

Observing - using the senses to gather information about an object or event. Example: describing a pencil as yellow.

Inferring - making an "educated guess" about an object or event based on previously gathered data or information. Example: Saying a person who used a pencil made a lot of mistakes because the eraser was well worn.

Measuring - using both standard and nonstandard measures or estimates to describe the dimensions of an object or event. Example: Using a meter stick to measure the length of a table in centimeters.

Communicating - using words or graphic symbols to describe an action, object or event. Example: Describing the change in height of a plant over time in writing or through a graph.

Classifying - grouping or ordering objects or events into categories based on properties or criteria. Example: Placing all rocks have a certain grain size or hardness into one group.

Predicting - stating the outcome of a future event based on pattern of evidence. Example: Predicting the height of a plant in two weeks time based on a graph of its growth during the previous four weeks.

INTEGRATED SCIENCE PROCESS SKILLS

Controlling variables - being able to identify variables that can affect an experimental outcome, keeping most constant while manipulating only the independent variable. Example: Realizing through past experiences that amount of light and water need to be controlled when testing to see how the addition of organic matter affects the growth of beans.

Defining operationally - stating how to measure a variable in an experiment. Example: Stating that bean growth will be measureed in centimeters per week.

Formulating hypothesis - stating the expected outcome of the experiment. Example: The greater the amount of organic matter added to the soil, the greater the bean growth.

Interpreting data - organizing data and drawing conclusions from it. Example: Recording data from the experiment on bean growth in a data table and forming a conclusion which relates trends in the data to variables.

Experimenting - being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a "fair" experiment, conducting the experiment, and interpreting the results of the experiment. Example: The entire process of conducting the experiment on the affect of organic matter on the growth of bean plants.

Formulating models - creating a mental or physical model of a process or event. Example: The model of how the processes of evaporation and condensation interrelate in the water cycle (Padilla, 1987).

PROCESS SKILLS ACTIVITY SHEET

How does a teacher ensure that process skills are an ongoing and integral part of his daily lessons? On the following page is a process skills activity sheet (Rowland, Stuessy and Vick, 1987) that is used as the basis for planning a science lesson, activity, or experiment.

PROCESS SKILL ACTIVITY SHEET Name______________________

Process Skill:

Concept:

Objectives:

Procedures:

<u>What the teacher does</u> | <u>What the student does</u>

Materials:

Time required:

Evaluation: I will know that the student has mastered the process skill by the student doing the following things:

A LIFE SCIENCE PROGRAM

How does a middle school life science program that uses process skills differ from a traditional program? There are no radical or highly innovative differences. One of the main distinctions is that all three learning domains are incorporated into the curriculum. In the traditional program the cognitive domain is often the entire basis for the whole program. The unequivocal strength or many science programs has been their attention to Saylor and Alexander's first curricular component, science knowledge and structure, i.e. the cognitive domain. In the one being proposed, all three domains (cognitive, psychomotor and affective) are essential components. The inclusion of the psychomotor and affective domains are believed to be essential to the aims of both the middle school concept and the process skills concept.

The current, written life science curriculum for the Las Cruces Public Schools (LCPS) focuses on the cognitive domain as shown in sections I through X. Sections XI, XII, and XIII have been added in this proposal as a way to encorporate the psychomotor and affective domain.

COGNITIVE DOMAIN

I. Scientific Tools
  - A. Scientific method
  - B. Microscope
  - C. Dissecting equipment
  - D. Measuring equipment

II. Simple Biochemistry
  - A. Matter
    - 1. Mass
    - 2. Volume
  - B. Energy
  - C. Compounds
  - D. Symbols
    - 1. C, H, N, and O
    - 2. Other symbols
  - E. Formulas (not balanced)
    - 1. Photosynthesis
    - 2. Respiration
  - F. Cycles
    - 1. Carbon/oxygen
    - 2. Nitrogen

III. Classification
  - A. History
  - B. Linnean system

IV. Cellular Structure and Function
   A. Cell parts
   B. Cell division
      1. Mitosis
      2. Meiosis
   C. Cell specialization
   D. Tissues, organs, systems
   E. Photosynthesis
   F. Respiration
   G. Osmosis
   H. Protein synthesis

V. Microoorganism Structure and Function
   A. Virus
   B. Bacteria
   C. Algae
   D. Protozoa

VI. Plant Structure and Function
   A. Non-vascular
      1. Fungi
      2. Moss
      3. Other
   B. Vascular
      1. Ferns
      2. Gymnosperms
      3. Angiosperms
      4. Others

VII. Animal Structure and Function
   A. Invertebrates
      1. Sponges
      2. Coelenterates
      3. Flatworms
      4. Roundworms
      5. Mollusks
      6. Annelids
      7. Arthropods
      8. Echinoderms
   B. Vertebrates
      1. Fish
      2. Amphibians
      3. Reptiles
      4. Birds
      5. Mammals
   C. Dissections
      1. Invertebrates
      2. Vertebrates
      3. Others
      4. Examples-worm, crayfish, grasshopper, starfish, mussel, and frog

VIII. Human Body Structure and Function
- A. Systems
  1. Integumentary
  2. Skeletal
  3. Muscular
  4. Digestive
  5. Circulatory
  6. Respiratory
  7. Excretory
  8. Endocrine
  9. Nervous
  10. Reproductive
      - a. Asexual
      - b. Sexual
- B. Growth and Development
  1. Embryo and fetus
  2. Birth
  3. Childhood
  4. Adolescence
- C. Health
  1. Nutrition
  2. Drugs
  3. Disease

IX. Genetics
- A. Mendel's Laws
- B. Genes
- C. Chromosomes
- D. DNA
- E. Recessive and dominant characteristics
- F. Monohybrid and dihybrid crosses
- G. Mutations
- H. Predictions

X. Science/Technology/Society (Integrated)

- A. Current issues-examples include sexually transmitted diseases, genetic engineering, nuclear energy, and pollution
- B. Impacts on society-examples include safety, consumerism, careers, computers, and energy.
- C. Limitations of science
- D. Contributions of science/scientists
- E. Truth-seeking nature of science

PSYCHOMOTOR DOMAIN

XI. Skills

- A. Process skills (including identifying, recording, calculating, graphing, designing models and experiments).
- B. Communicating
  - 1. Verbal
    - a. Reports
    - b. Discussions
  - 2. Written
    - a. Lab reports
    - b. Abstracts of articles
    - c. Outlines
    - d. Bibliographic references
  - 3. Reading
    - a. Journal or magazine articles
    - b. Charts, tables and graphs
    - c. Instruction booklets
    - d. Computer documentation
  - 4. Listening
    - a. Instructions
    - b. Opinions of others
    - c. Differentation between sounds (sensory)
  - 5. Computing/word processing

AFFECTIVE DOMAIN

XII. Personal Development

- A. Getting along with others
- B. Developing leadership skills
- C. Developing study skills
- D. Organizing projects
- E. Solving problems
- F. Making decisions
- G. Working to completion
- H. Meeting deadlines
- I. Becoming aware of careers in the life sciences

XIII. Enrichment

- A. Science fair
- B. Science Olympiad
- C. Science club
- D. Gifted and talented education
- E. Field trips
- F. Mentorships
- G. Career fair

SCIENCE COMPETENCIES IN LCPS

These are the basic science competencies endorsed by the Las Cruces Schools as required by the State of New Mexico, State Department of Education. Specific measurable competencies for each grade level are available thru Las Cruces Schools Administrative Offices.

A. OBSERVING

1. Describe the objects and event on the basis of observable characteristics.
2. Use indirect methods if direct sense experience is insufficient to describe objects or events.
3. Describe and report data quantitatively.
4. Distinguish between observations and inference.

B. CLASSIFYING

5. Classify objects and events based on observable similarities and differences of selected properties.
6. Use classification keys to place items within a scheme or to retrieve information from a scheme.
7. Construct 2 or more classification schemes for the same set of objects and develop a classification system.

C. INFERRING

8. Draw logical conclusions or interpretations of events based on given data or premises.

D. PREDICTING

9. Suggest the outcome of an event based upon previously observed conditions.
10. Suggest cause and effect relationships within a scientific problem solving situation.

E. MEASURING

11. Measure properties of objects or events by direct comparison with standardized units of measurement.
12. State the parameters of a designated measurement.

F. COMMUNICATING

13. Keep accurate records of observation for checking and rechecking others.
14. Construct a simple data table containing 2 variables, label columns and rows, and accurately enter data.

15. Make graphic representations of accumulated records of observations and communicate this information clearly and meaningfully.
16. Construct a simple bar, line and/or pie graph properly labeled and scaled.
17. Integrate written work with subject matter to improve technical writing skills.

G. INTERPRETING DATA

18. Use processes such as classifying, predicting, inferring, and communicating to interpret data.
19. Revise interpretations of data based on new information or revised data.
20. Formulate conclusions when given appropriate data, tables, and graphs.
21. Abstract important ideas from reading, listening to or watching a presentation.

H. MAKING OPERATIONAL DEFINITIONS

22. Describe a variable or event in observable and measurable terms to differentiate information from other phenonmena.

I. FORMULATING QUESTIONS and HYPOTHESES

23. State questions on the basis of obervations.
24. Devise a statement which can be tested by experiment.
25. Construct hypotheses from information given in a data table, graph, or picture.
26. Revise hypothesis based on new information.

J. EXPERIMENTING

27. Design data gathering procedures as well as test an hypothesis.
28. Conduct simple experiments to make obervations or to confirm a prediction.
29. Be able to identify variable and the control aspects of an experiment.
30. Consider limitation of methods and apparatus of experimentation.
31. Demonstrate lab safety procedures.
32. Demonstrate error analysis and information analysis.

K. MODELING

33. Devise models on the basis of an acceptable hypothesis or hypotheses that have yet to be tested.
34. Use models to describe and explain inter-relationships of ideas.
35. Use a model to visualize the solution to a problem.

L. USING QUANTITATIVE APPLICATIONS

36. Represent scientific principles using mathematical format.
37. Record measurement using appropriate scientific notation.
38. Identify and demonstrate a relationship between 2 variables that can be used to make a prediction.
39. Read and interpret numerical values from charts, tables, or graphs, and apply results to answering questions.

M. RECOGNIZING IMPACTS

40. Identify, describe, and discuss contemporary issues in science, such as family planning, patterns of socially transmitted diseases, genetic engineering, pesticides, nuclear energy, and pollution as they relate to humans.
41. Recognize the role of the political process in the advancement of science.
42. Describe the effects of science in: consumerism, safety, careers, computers, solar energy, synthetic fuels, and fossil fuels.
43. Recognize the limitations of science.
44. Recognize the impact of the accumulation of new evidence on scientific thought.
45. Recognize how the contributions of science lead to the development of new ideas.
46. Recognize the truth seeking nature of science. (Graham,1985)

STUDENT PROGRESS

Student levels of achievement could be evaluated in the traditional ways. Giving students a test at the end of each unit would help determine if program goals are being achieved. Final examinations are required at the end of each semester by the LCPS.

The State Department of Education is making an effort to address the accountability intent of the educational reform act. They are writing competency tests to correspond to their science competencies. These will be administered by the local schools. The SDE will also establish acceptable levels of achievement. If a student does not pass at this pre-determined percentage level s/he could be retained or the information could be placed on the student's record as being weak in that particular competency. This is the current plan as explained by Lynn Mulholland of the LCPS Science Curriculum Committee.

Student levels of performance can be evaluated in a less traditional ways like asking students to identify specimens or establishing criteria on which lab grades are to be based. Whether the evaluation is traditional or not, the evaluation should be of such a nature that the student and/or parent could be informed of the progress made versus the progress expected. A Scorecard of Practical Work is a device designed to inform the student before labs begin of what skills should be learned and a device to inform them later of their progress. Checkmarks indicate if the student has the skill or needs to improve it.

SCORECARD OF PRACTICAL WORK

Practical work is both objectively and subjectively graded.

SKILLS

Manipulative Skills

1. To set up apparatus safely and according to directions.
2. To use basic equipment.
3. To work safely and methodically to completion.
4. To improvise, use, or construct "non-standard" apparatus as necessary.

Communication Skills

5 To present on paper a complete account of experimental work.

6. To describe and discuss experimental work.

Observation Skills

7. To observe fully and accurately.
8. To observe unexpected outcomes.

Planning Skills

9. To plan experiments, given a problem.
10. To choose equipment and methods appropriate for the problem.

Interpretation

11. To process raw data.
12. To generate hypotheses or ideas to explain observations.
13. To evaluate ideas as a result of experiments or tests.
14. To appreciate the limitations of experimental work.

Attitudes

15. To show persistence in following tasks through to conclusion.
16. To demonstrate cooperation in lab work.
17. To develop initiative and resourcefulness of approach to lab work.

PROGRAM EVALUATION

Evaluating the success of a middle school program will take several forms. The teacher evaluates on a continuing basis. The teacher along with the principal evaluates during annual review of the Professional Development Plan. The disciplinary team of all science teachers also exchanges ideas and improvements. The following are strategies that would assist in a more concrete approach to program evaluation.

Class Records. In addition to evaluating students' levels of achievement and performance, the teacher keeps a journal assessing the success or failure of each activity, lab, or project to determine it's relative merits to program goals.

Feedback from Students. This feedback could be both formal and informal. The fundamental question students will be asked is, "Did this course meet your expectations for a life science course?" They could respond formally to a questionnaire at the completion of the course and informally after completion of each activity thru discussion.

Peer Evaluation. The members of the science department could be asked to read this FIELD GUIDE and make suggestions regarding additions or deletions from the proposed course. At the comletion of the course, these individuals will be asked to rate the program on it's relative merits or improvements to be made in meeting their expectations.

RESOURCES

The following types of resources can be utilized and expanded as the program progresses.

1. Textbooks

   The primary text purchased by the LCPS is Silver Burdett and Ginn's Life Science. A supplemental text or resource text is Merrill's Focus on Life Science.

2. Magazines

   Magazines purchased by the science department and the school library will give the student an idea of current and future topics being studied by men and women in the biological fields. They are an excellent resources for careers and from which to develop writing and reading skill assignments.

3. Transparencies

   These would be prepared or purchased to help students organize information and see relationships between ideas or events. Curriculum maps and advanced organizers on transparencies are quite beneficial in clarifying more difficult concepts.

4. Computers, software, and student disk

   It is critical that the students perform as closely to real-life situations as is possible because science is a dynamic field that determines societal change. Ideally, each student should have his or her own disk on which to record data and learn word-processing.

5. Videos

   These should not be the backbone of the curriculum but are helpful in 1)bringing the field into the classroom, 2)seeing the latest technological developments, and 3)observing animal behavior. They are available through the Instructional Service Center of LCPS. Films are also available, without charge, from NMSU's Film Library in the College of Agriculture.

6. Charts and Posters

These visual aids enliven the curriculum and the classroom according to Harry Wong, educational consultant and science teacher. He believes these type of things are very important for student motivation (Wong, 1985). They are, of course, available not only through educational supply companies, but some of the best quality can be obtained through the various science and biology associations. Teacher-made or student-made charts and posters are very appropriate because of budget constraints.

7. Supplies, models, samples, and specimens

These are at the heart of any biology program for it is best for students to "do science" not simply study science. These items can be purchased through educational supply companies, can be designed as part of the lesson or supplied by nature.

8. Community Resources

These are an important component of successful middle schools programs. Guest speakers, field trips, mentorships are memorable events that potentially can cause students to have a lifelong interest in science.

There will undoubtedly be other resources needed for a Life Science Program, but their development will come as need is perceived and financed.

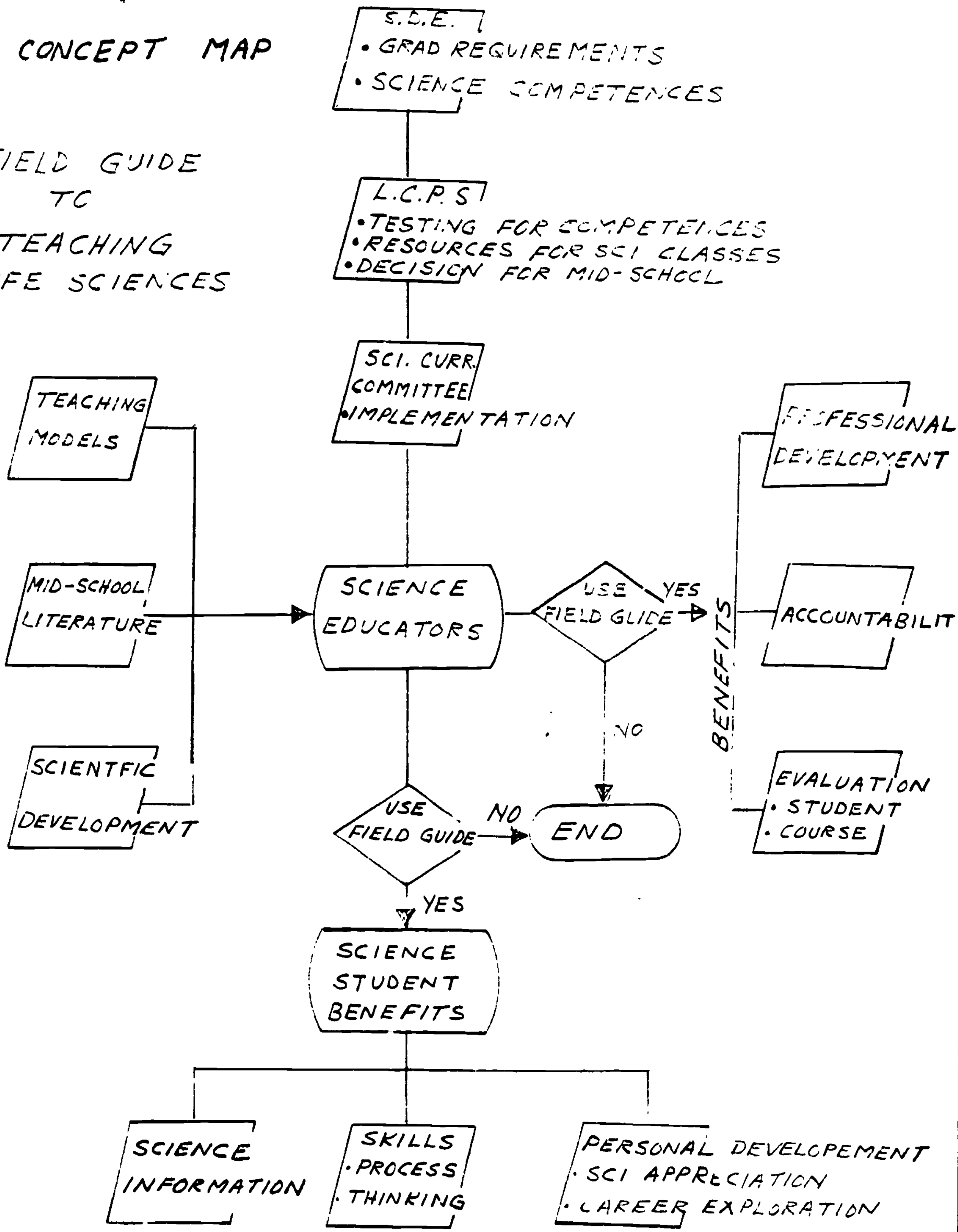
SUMMARY. A CONCEPT MAP

The focal point of this concept map is the science educator. This individual must implement certain institutional decisions that impact upon them from the SDE, the LSPS, and the Science Curriculum Committee. The decisions of these three groups are non-negotiables and are at the top of the map. At the left are those three academic components that impact on the teacher's delivery of the content and the student's involvement in the learning process. These include teaching models, middle school literature, and new scientific developments. On the right of the map are three professional benefits to teachers who decide to adopt this comprehevsive approach to implementing curriculum in a wholesale way by sequentially selecting elements presented in this book that would enhance their program. Benefits to the teacher include professional development, accountability, and methods for evaluation. The bottom of the map contains the reason for being, to benefit students. These include to help students understand their world from a scientific viewpoint, to be able to perform science skills, and to experience personal growth.

SUMMARY

A CONCEPT MAP

FIELD GUIDE TO TEACHING LIFE SCIENCES



CONCLUSION

Science education has many important challanges ahead if it is to attempt to keep pace with science developments. There is a need for a life science process skills course to be taught in the genuine spirit of the middle school. There is a need to fill the many science teacher openings with individuals that know not only their subject matter, but are also knowledgeable of the teaching techniques necessary to achieve the basic goals of science education. This FIELD GUIDE is offered as a means of answering those needs. It is now the responsibility of science teachers to activate any aspects of this proposal that will further the goals of their individual program. A continuing process of curriculum evaluation and revision will result in meeting the students' needs, helping the teacher experience professional growth.

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