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AUTHOR Wilkinson, Gayle A.
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ABSTRACT

This curriculum guide begins with classroom and text study of plants and develops into an individual research project that continues throughout the school year outside the regular biology or botany teaching plan and text. The project uses about one class period every 2 weeks for group discussions, evaluations, and suggestions for the individual projects in progress. The culminating activity of the project is a written report and a project display of information on a poster and project plants at the final stage of change which are displayed for the school and community at a science exposition or science fair. The students involved in this project could be any high school or early college student who could benefit from an enrichment project. This curriculum was written for gifted students at the ninth grade level. A general overview of the project, umbrella cluster objectives, student responses to Students Adopt Plants (SAP), and factors to consider in co-curricular projects are included. The curriculum is organized in six clusters: plant anatomy and physiology, resource research, experimental design, data collection and procedure redesign, data analysis and research conclusions and project report and display. Each cluster includes a list of student learning outcomes and two activities along with an evaluation activity. (33 references) (KR)

S.A.P. Students Adopt Plants: A Curriculum Guide for Independent Research Projects in High School Biology

Dr. Gayle A. Wilkinson
Visiting Assistant Professor
Department of Educational Studies
School of Education
University of Missouri-St. Louis
8001 Natural Bridge Road
St. Louis. MO 63121
(314) 553-5951

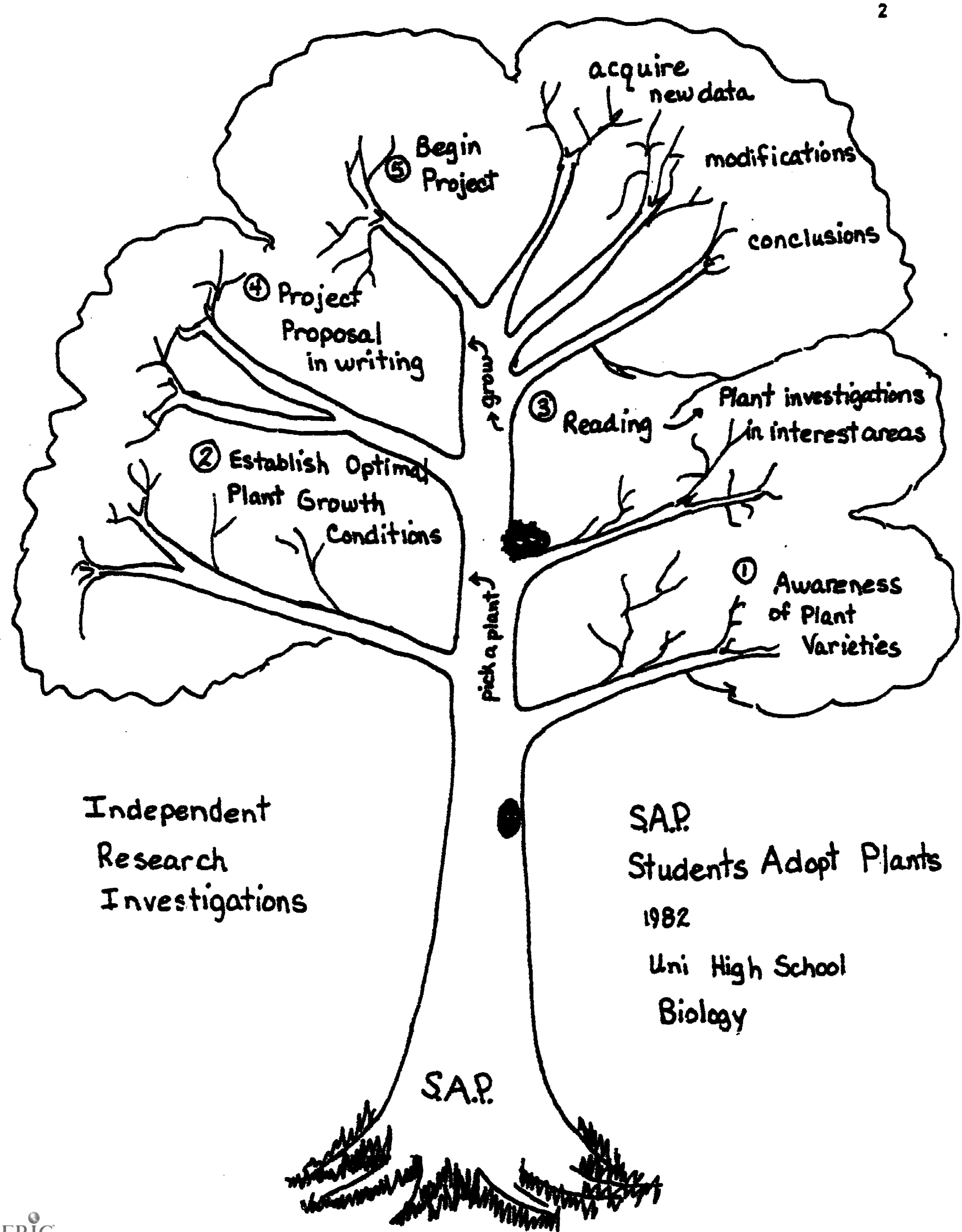
2730 Radcliffe Dr.
Florissant. MO 63031
(314) 839-8348

Table of Contents

Introduction

This curriculum guide begins with classroom and text study of plants and develops into an individual research project that continues throughout the school year outside the regular biology or botany teaching plan and text. The project uses about one class period every two weeks for group discussions, evaluations, and suggestions for the individual projects in progress. The culminating activity of the project is a written report (perhaps an English project, also) and a project display of information on a poster and project plants at the final stage of change which are displayed for the school and community at a science exposition or science fair.

The students involved in this project could be any high school or early college student who could benefit from an enrichment project. This curriculum was written for gifted students at the 9th grade level. Many of their reactions to the projects are included as direct quotes in the Student Response section.


acquire new data
modifications
conclusions
⑤ Begin Project
④ Project Proposal in writing
grow
③ Reading
Plant investigations in interest areas
② Establish Optimal Plant Growth Conditions
pick a plant
① Awareness of Plant Varieties
Independent Research Investigations
S.A.P.
Students Adopt Plants
1982
Uni High School
Biology
S.A.P.

S.A.P. GENERAL OVERVIEW

BACKGROUND RESEARCH

1. Plant description-picture in native location if possible
2. Classification and family description
3. Propagation methods (commercial and others)
4. Establish optimal growing conditions
   soil and light requirements; temperature and humidity ranges

GOALS

1. Develop individual interests
2. Use newly acquired knowledge in designing and performing an experiment
3. Learn to identify and remain within limits of your skills, facilities, equipment and time
4. Practice the scientific method of investigating a question

SUGGESTED AREAS OF PROJECT INVESTIGATIONS

1. Soil and nutrient effects
2. Blooming time and photocycles
3. Light and color effects
4. Pollution effects on plants
5. Sectioning and staining of plant parts
6. Ecological relationships
7. Uses for plants and plant producte
8. Pollination or reproduction of plants
9. Life cycles, growth cycles or variations
10. Photosynthesis and plant pigments

EVALUATION

1. Background research and bibliography
2. Experimental design
3. Data collection
4. Data analysis
5. Written report with photographic record of plant changes
6. Class presentation and display

MATERIAL RESOURCES

1. Greenhouse
2. House plants or seeds from home
3. School laboratory

Umbrella Cluster Objectives

At the end of the individual research investigation the students should:

1. evaluate and realize their own assumptions that science can fix anything.

2. see that scientific thought is not smooth and unerring, routine or inevitable.

3. see science as a creative way to solve problems.

4. recognize the limitations and usefulness of science and technology in advancing human welfare.

5. be able to cope better with an increasingly technological world.

6. improve performance in creativity in science, perception of science, and logic in scientific thinking.

7. increase positive attitudes toward learning science.

8. develop interest in science through their personal interests.

9. increase achievement in biology by increased involvement in scientific investigations.

10. learn how to improve reasoning skills.

11. know how to use familiar living organisms and processes to understand scientific principles.

12. learn how to solve problems they have set for themselves.

13. understand that the quest for knowledge is the main goal of investigating a problem in science.

14. learn how to transfer the ability to solve theoretical problems to solving other problems involving the use of laboratory techniques and research design.

15. understand that results from scientific investigations are not always predictable.

16. learn how to benefit from mistakes by using errors to eliminate certain possibilities as solutions to the problem.

17. learn that intelligence is not static, but changes in relation to experience, environment, and development.

18. know that they can develop alternative cognitive learning styles.

19. be able to distinguish the differences between problems and the anxiety that the results from the problem.

20. be aware that anxiety has a positive effect on physical performance, but a negative effect on academic performance.

21. learn how to adjust their anxiety level by controlling their preparation, rest, and nutrition.

22. learn that the student as well as the teacher is responsible for dealing with personality and attitude differences.

23. know that certain materials are necessary for learning to take place, but the lack of some materials fosters creativity.

24. learn that intelligence is based on both nature and nurture and can be improved by the student's own effort.

25. know that they can control their study environment to promote learning, compensating for their own physical disabilities.

26. understand that self-concept can change through the effort of the student.

STUDENT RESPONSES TO S.A.P. INDIVIDUAL PROJECTS

"Most of the problems were unpredictable for me, but would probably not have been if I had grown more than a very few plants in my entire life. I found that growing plants and tending them takes much more time than I thought, and sometimes because they are living, plants do what they theoretically should not do. I now know for the future, the basics of taking care of plants. Doing this project will be useful one time or another in my future, even if it is simply to know how to perform a long term science project."

"I learned mainly what a tough job it is to keep experiments under "controlled conditions". This has been a great help in research skills and was somewhat fun."

"From all of this experimenting, I have learned that although projects may sound simple, when the project is actually carried out, there are many complications and difficulties that were not considered before. I would like to try this same project again sometime in the future, modified or not, to see if I can't get similar or different results."

"I learned a lot more than I expected from this experiment. In addition to the reading and research on plants, I learned a lot about plant growth. Mistakes generally happened in areas I didn't plan well."

"Also I learned that a plant can raise to looking perfectly healthy from looking perfectly dead in less than one hour."

"My learning did not occur in the experiment itself. It was quite straight-forward. My real learning was just trying to do something like this almost all on my own. Although this sounds corny, I do think I benefited."

"During the course of this experiment, I learned that scientific investigations aren't always as easy or successful as they seem. In the future, I think it would help if the experiment were more carefully planned."

FACTORS TO CONSIDER IN DESIGNING CO-CURRICULAR PROJECTS

1. Students involved

   a. entire class - a requirement
   b. interested volunteers
   c. highly motivated, interested students from all science classes

2. Purpose

   a. skills development
   b. short and long range goals for application of learning

3. Time line

   a. class time devoted to discussions and instruction
   b. length of time during the semester or year
   c. teacher's personal time investment for individual help
   d. due dates for each step of the project

4. Boundaries

   a. amount of lab equipment for student use
   b. what range of topics available for investigation
   c. cost to individuals
   d. detail required on data collection, analysis, report and presentation
   e. individual, pairs or group involvment in projects

5. Motivation

   a. grades, extra credit
   b. display for science fair or exposition
   c. beginning interest development
   d. parental support and cooperation

CLUSTER ONE

PLANT ANATOMY AND PHYSIOLOGY

SIX WEEKS

LEARNING OUTCOMES:

Students should:

1. accept the view that science investigating can take place outside the classroom without discontinuing regular learning activities in the biology curriculum.
2. become motivated to investigate as area of interest in biology in an individualized setting.
3. develop criteria for selecting reasonable goals and appropriate materials for an investigation.
4. develop a positive attitude toward knowing how to plan and execute a research project on their own.
5. become motivated to develop imagination and interest in biology.
6. be able to use the computer tutorial to check understanding of plant classification, structures, functions, and responses.
7. Develop self-sufficiency and self-motivation in learning.
8. understand the power of peer approval at this time in their lives.
9. recognize that they have to balance pressure from peers and other sources such as parents, teachers, etc.
10. understand that their own body chemistry is changing at this age and can cause emotional flucuations.
11. understand that signals of acceptance from others do not determine their ability to succeed.
12. realize that the teacher has broader knowledge and skill in the subject than the student, but in significant areas these are limited.
13. become aware of the variety of multicellular plants that exist in our world.
14. understand the basic classifications of multicellular plant groups.
15. become aware of the characteristics of plants that are used for classification.
16. understand the structure and the functions of plant organs such as leaf, stem, foot, flower and seed.
17. understand the process of photosynthesis.
18. understand and identify the differences between monocots and dicots.
19. understand the relationship between the plant and the water cycle.
20. understand plant growth and responses to external and internal influences.
21. understand asexual and sexual forms of plant reproduction.

ACTIVITY ONE

Students and teacher take a field trip to a local botanical garden for an introduction to the variety of plants and how they are grouped according to certain similar structures. The guide will inform students of the many unusual plants and varieties found within each group of plants. This will provide also a resource in the community for the students to acquire information, assistance and in some cases , plants for the research project.

LEARNING FUNCTIONS:

DIAGNOSTIC: Discuss attitudes, knowledge, skills currently possessed.

CONNECTIVE: Review of past learning, and demonstrate future needs.

PROVOCATIVE: Arouse interest, identify needs, discuss functional significance of learning, establish goals, and identify rewards.

PRECEPTIVE: Provide background experiences.

OUTCOMES ACHIEVED: 1,2,5,12,13,15.

ACTIVITY TWO

Using a mechanical osmometer, a carrot filled with molasses, and a semi-permeable membrane tube filled with a starch solution, show how water moves through membranes and cells due to osmotic pressure. Students will follow a laboratory procedure for setting up the experiment and will make predictions on what will result from the experiment in each of the situations. The following day the students will observe the examples of osmosis and compare their predictions to the observable results. Discussion of the experiment will include the difference between the opinion and fact.

LEARNING FUNCTIONS:

DIAGNOSTIC: Discuss attitudes, knowledge, skills currently possessed.

CONNECTIVE: Establish relationship between known and unknown.

PROVOCATIVE: Arouse interest, discuss functional significance of learning, identify needs.

PRECEPTIVE: Provide background experiences, knowledge, skills.

DEVELOPMENTAL: Introduce new skills, knowledge, attitudes, provide practice situations.

OUTCOMES ACHIEVED: 1,3,5,8,11,12,19,20.

EVALUATION ACTIVITY

Three unit tests over all of the chapters that include plant classification, structure and function of plant organs, photosynthesis, plant responses to internal and external influences and plant reproduction. Each test will include a command of the new vocabulary, an understanding of plant functions, structures and their relationship to each other, and the importance of plants in our world of living things. Test questions will be matching, diagram labeling, essay, and short answers to hypothetical situations.

LEARNING FUNCTIONS:

CULMINATING: Diagnostic evaluation, summative evaluation, set future goals, and provide new use of learning.

OUTCOMES ACHIEVED: 7,8,12,14,16,17,18,19,20,21.

CLUSTER TWO

RESOURCE RESEARCH

SIX WEEKS

LEARNING OUTCOMES:

Students should:

1. learn how to find information in texts, periodicals, and community resources such as facilities, services, and people.
2. identify problems that are similar in nature to those pursued by authentic researchers as an emulation of the professional investigator.
3. develop the desire to investigate an idea thoroughly by making a personal committment to involvement of time and thought.
4. be familiar with recent professional investigations that are similar inquiry to their own projects.
5. develop a non-competive attitude in their investigations which will allow co-operation and sharing of ideas with others.
6. learn how to develop library skills necessary for investigating basic facts and processes involved in a scientific problem.
7. be able to use a computer tutorial program to gain possible solutions to research technique problems.
8. improve the ability to read science literature as well as science textbooks.
9. become aware of the current sources of science information through the use of scientific periodicals.
10. learn to use the bank of biological knowledge that is already available to determine where to begin developing a research problem.
11. know how to use their curosity in science to formulate researchable questions.
12. understand specific gender stereotypes and how these stereotypes can act as unnatural boundaries for academic pursuits.
13. understand that gender stereotypes do not grow out of actual physical and mental limitations, but are learned form out culture.
14. accept that they are in a stage of development that is changing in all areas, social, moral, and physical.
15. be able to use the computer tutorial for evaluation of their refernce material and manipulation of informantion.
16. know how to develop a hypothesis.
17. understand the different cognitive learning styles.
18. decide their own cognitive learning style and its consequences to their learning.
19. know how to initiate their own learning.

LEARNING ACTIVITY ONE
Prepare a bibliography of references and write a summary for each that is used in learning about the student's particular plant used in the project and experimental factors that would change the plant's otimal environmental conditions enough to cause a gradual response by the plant that could be measured as a change in plant growth. This activity will ensure library research adequate for the student to understand the factors involved in the individual investigation that provide insight into the type of project that could be done with observable results.

FUNCTIONS

CONNECTIVE: Establish relationship between known and unknown and demonstrate future needs
PROVOCATIVE: Arouse interest, identify needsestablish goals
PRECEPTIVE: Provide organizer, provide background experiences, organize resources
OUTCOMES TO ACHIEVE: 1,4,5,6,8,9,10,19

ACTIVITY TWO
Students write a list of questions that have formed in their minds because of the reading done. This list will be used to select an area of interest for their individual investigation. From this list they will investigate other sourses, feasibility of experimentation, and time constraints.

FUNCTIONS:

CONNECTIVE: Establish relationship between known and the unknown, demonstrate future needs.
PROVOCATIVE: Arouse interest, identify needs, establish goals, identify rewards.
PRECEPTIVE: Provide organizer, develop learning schedule, organize resources
OUTCOMES TO ACHIEVE: 2,3,4,5,7,10,11,12,15,16,19

ACTIVITY OF EVALUATION
Students will write a report of his bibliography and list of questions prepared in the learning activity that utilized the background reading done in the project interest area. The teacher will evaluate the depth of the questions, amount of knowledge required and the reasonableness of the proposed investigation according to required facilities, degree of difficulty, and amount of time required to complete the investigation.

FUNCTIONS:
CONNECTIVE: To establish relationship between known and unknown.

PROVOCATIVE: Identify needs, establish goals, identify needs

DIAGNOSTIC: Discuss attitude, knowledge, skills currently possessed.

OUTCOMES TO ACHIEVE: 3,5,11,14,15,16,18,19.

CLUSTER THREE

EXPERIMENTAL DESIGN

SIX WEEKS

LEARNING OUTCOMES:

Students should:

1. understand the order of scientific thought and investigation: insight, hypothesis, investigation, data collection, evaluation and analysis, conclusion, and theory.
2. develop intellect through their creative thinking in organizing the method of scientific investigation of a problem.
3. cultivate special abilities and techniques for learning independently.
4. learn how to develop learning strategies for solving experimental design problems.
5. become motivated using the computer to develop decision-making skills in experimental design of science problem-solving.
6. know how to determing the scope of a research project with a fixed deadline for the project in mind.
7. know how to develop the ability to pace their learning in an independent learning situation.
8. know how to develop a personal method of solving research problems.
9. learn to increase engagement rates in research and increase intellectual skills in research planning techniques.
10. understand that internal or self-determined rewards can be as satisfying as external rewards.
11. learn how to make an accurate photographic record of plant growth.
12. learn how to desire feedback and understand that feedback is essential to improving their performance.
13. learn to utilize feedback for learning.
14. accept that they have made and will make choices that determine their states of health.
15. understand the limit on movement that physical structure of surroundings make.
16. learn how to develop a step by step procedure that will test and follow the design of an experiment.
17. learn how to design and build, or find and collect the necessary equipment for investigating a scientific problem.
18. be able to use the computer tutorial for evaluation of their experimental design, procedure, and progress estimation of time.
19. learn how to design a method of collecting data and determining a desired experimental outcome.

ACTIVITY ONE

Using the scientific method, students will plan an experiment that will test the hypothesis that was developed after the investigation of scientific information in their interest area. Included in this plan will be the plant species chosen, the place where the experiment will be accomodated during the winter months, equipment needed to provide the adequate environment for the plants, and a description of the measuring and data collecting method.

LEARNING FUNCTIONS:

CONNECTIVE: Review of past learning, establish realationship between known and unknown, and domonstratye future needs.
PRECEPTIVE: Develop learning schedule, provide organizer, organize resources.
PROVOCATIVE: Identify needs, establish goals,discuss functional significance of the learning.
DEVELOPMENTAL: introduce new skills,provide practice, apply learning to a new situation.
OUTCOMES TO ACHIEVE: 1,2,4,6,7,8,10,15,16,17,19.

ACTIVITY TWO

Guest speaker addresses the class to explain his scientific research, discuss common research strategies and problems including ways to solve problems that can redirect the experiment. Students will be able to ask questions that can help them find solutions to their own problems in investigative design.

LEARNING FUNCTIONS:

CONNECTIVE: Establish relationship between known and the unknown, demonstrate future needs.
PROVOCATIVE: Arouse interest, identify needs, discuss functional significance of learning, establish gaols, identify rewards.
PRECEPTIVE: Provide background experiences, provide organizer.

OUTCOMES TO ACHIEVE: 1,3,4,6,7,8,9,10,16,19.

EVALUATION ACTIVITY

Students will explain their experiment to small groups of peers and will be asked questions by the peers about their investigation stragety, equipment necessary, data collection and recording methods. After the small group discussion, each student will revise his experimental design which will be reviewed by the teacher. A conference with the teacher will follow if it is necessary to change the design of the experiment.

LEARNING FUNCTIONS:

DIAGNOSTIC: Discussions of attitudes, knowledge, skills currently possessed.

CONNECTIVE: Review of past learning, establish relationship between known and unknown, determine future needs.

PROVOCATIVE: Discuss functional significance of the learning, identify needs, identify rewards, establish goals.

PRECEPTIVE: Provide organizer, develop learning schedule, organize resources.

DEVELOPMENTAL: Provide practice situation, apply learning to a new situation, evaluate learning through peer assessment.

CULMINATING: Provide for new use of learning, set future goals, diagonostic evaluation.

OUTCOMES TO ACHIEVE: 1,2,3,4,7,8,9,12,13,16.

CLUSTER FOUR

DATA COLLECTICN AND PROCEDURE REDESIGN

TWELVE WEEKS

LEARNING OUTCOMES:

Students should:

1. be able to establish criteria for distinguishing between evidence and opinion.
2. see that new observations can stimulate the formation of new investigations and change the direction of the investigation.
3. learn how to use a group of students to improve the design of an individual experimental investigation.
4. learn to use a computer tutorial to verify procedures used in research techniques in solving a scientific problem.
5. practice and become comfortable in questioning a scientific theory or procedure using their own experience and knowledge as a guide for accepting or rejecting some other opinion.
6. "learn to make choices and decisions based on self-knowledge of needs and interests."
7. Learn to improve record-keeping skills by logging data and information from individual research in an organized manner.
8. learn how important it is to strengthen character traits, such as persistance and self-direction.
9. increase science knowledge by increasing time spent in personal involement in scientific research in the group.
10. learn how to accept criticism from their peers which will help make changes and improvements in the experimental design of the research.
11. be able to graph data to show a visual representation of the results of the control group compared to the results of the experimental group.
12. know how to collect accurate data and record it accurately.
13. be able to use a computer tutorial for evaluating data collecting method.
14. be able to use the computer to develop the collected data into understandable statistics.

For each plant to be measured, the students will make a data table that has the appropriate categories and form for the type of measurements being recorded in the investigation. Each student will work out a schedule for measuring and recording measurements that best fits the time schedule of the student and will mark those dates on a calendar over the several weeks that data is collected. Also on this calendar dates should be marked in equal intervals for the photographs to be taken of the plants of both the experimental conditions and control conditions.

LEARNING FUNCTIONS:

CONNECTIVE: Establish relationship between known and unknown, demonstrate future needs.
PROVOCATIVE: Identify needs, discuss functional significance of learning, establish goals.
PRECEPTIVE: Provide organizer, develop learning schedule, organize resources.
DEVELOPMENTAL: Introduce new knowledge, provide practice situations, apply learning to a new situation.

OUTCOMES TO ACHIEVE: 6,7,8,9,11,12.

ACTIVITY TWO

Students will use the data collected to make graphs of the responses of the plants measured on each plant or groups of plants. Students will be able to use graph paper, or computer graphics to show the responses caused by the effects of the experimental factors and compare these graphs to the graphs of the measurements recorded from the control plant.

LEARNING FUNCTIONS:

PROVOCATIVE: Discuss functional significance of the learning.

DEVELOPMENTAL: Introduce new skills,knowledge, attitudes, provide practice situations, and apply learning to a new situation.

CULMINATING: Provide for new use of learning, set future goals.

OUTCOMES ACHIEVED: 1,2,4,7,8,9,11,12,13,14.

EVALUATION ACTIVITY:

Each student will explain the data collected and the graphs that resulted to his small discussion group of peers. This group will ask questions and make suggestions for possible improvements in measuring methods or graphing techniques. Each student then will make the necessary changes before giving the data tables and graphs to the teacher for evaluation of correct methods used.

LEARNING FUNCTIONS:

DIAGNOSTIC: Discussion of attitudes, knowledge, and skills currently possessed.

CONNECTIVE: Review of past learning, demonstrate future needs.

PROVOCATIVE: Identify needs, discuss functional significance of the learning, establish goals.

DEVELOPMENTAL: Provide practice situations, evaluate learning through peer assessment.

CULMINATION: Provide new use of learning, set future goals.

OUTCOMES ACHIEVED: 3,4,6,7,8,9,10,11,13,14.

DATA ANALYSIS AND RESEARCH CONCLUSION

TWO WEEKS

LEARNING OUTCOMES:

Students should:

1. be able to evaluate and examine their own stereotyped image of what a scientist is and does.
2. understand that scientists are people who spend countless hours investigating a problem with a few answers resulting and sometimes no answers result.
3. understand that science does not have the objectivity that it sometimes claims to have.
4. be able to justify the investigation of a biological problem as being beneficial to their community.
5. "learn to assume responsibility for choices and decisions by completing all activities at a satisfactory level of acheivement and in an acceptable time frame."
6. be able to interpret data collected from the project in terms of biological responses by the plant.
7. be able using the control, to compare the results of the data collected to prove or disprove the hypothesis for the project.
8. understand how to design a program to help analyze research data as well as logic of an experimental design.
9. improve their problem-solving skills using the computer.
10. be aware of the process of and the difficulty in making moral decisions.
11. place a positive value on their physical selves.
12. take individual responsibility for moral and social decisions.
13. become aware of how they determine their value of others (appearance, social status, personality, intellect, and moral attitudes.)
14. understand that physical health and condition affects their learning in a positive or negative way.
15. understand as fully as possible the biolcgical processes invclved in the project that could affect the project results.

ACTIVITY ONE

Each student makes a photographic record of plant growth by taking close-up photographs of the experimental and control plants at equal distances from the camera and at equal intervals of time between photographs. It would be helpful to include some kind of scale in the picture to check enlargement accuracy.

LEARNING FUNCTIONS:

DEVELOPMENTAL: Introduce new skills, knowledge, attitudes; provide practice situations, apply learning to new situation, self-assessment exercise.

OUTCOMES ACHIEVED: 3,5,7,8.

ACTIVITY TWO

Using graphs made for cluster 4, students will interpret data into observable trends of plant responses by each experimental and control group of plants. The students will explain to their small discussion groups how the results prove or disprove the hypothesis of the experiment. The group will ask questions and make suggestions for improving the experiment design, graphing method, or interpretation of the results. The teacher will provide directions that are verbal and written which will be a guide for evaluating the graphed results and significant differences in results.

LEARNING FUNCTIONS:

PROVOCATIVE: Identify needs, discuss significance of learning.

DEVELOPMENTAL: Introduce new skills and knowledge, provide practice situations, evaluate learning through peer assessment, apply learning to new situation.

CULMINATING: Diagnostic evaluation, provide for new use of learning.

OUTCOMES ACHIEVED: 1,2,3,5,6,7.

EVALUATION ACTIVITY:

Each student will write a summary stating his interpretations of the results of his experiment, and his evaluation of the data collecting method and accuracy of the analysis of the data. Students will list suggestions for eliminating errors in the procedures that would improve the data collection and accuracy. The teacher will provide a list of factors to discuss in each experiment and ways to check the accuracy of the data collection method.

LEARNING FUNCTIONS:

DEVELOPMENTAL: Provide practice situations, peer and self-assessment, apply learning to a new situation, provide for re-teaching and remediation.

CULMINATING: Diagnostic evaluation, provide new use of learning, set future goals.

OUTCOMES ACHIEVED: 1,2,3,5,10,11.

CLUSTER SIX

PROJECT REPORT AND DISPLAY

FOUR WEEKS

LEARNING OUTCOMES:

Students should:

1. realize that the final product of a totally scientific world would be a rational, intellectual creation which is void of opinion and empty of emotion.

2. become aware of the wide variety of science and related careers open to them in science.

3. develop a sense of shared responsibility for the changes their generation of scientific thought and technology will bring to society.

4. see themselves as a biological organism that is a part of the biosphere of the local community as well as the entire world.

5. realize that individual decisions do have an affect on the future conditions of our community and society.

6. know how to improve problem-solving skills through the evaluation of other student investigation of a problem.

7. know how to improve writing skills to communicate new scientific information to science people and non-science people.

8. "learn to evaluate one's own work and be able to answer the question `How well can I do what I want to do?'"

9. know how to prepare and to present a scientific problem and its solution to a real audience.

10. know how to organize notes, data results, analysis of data and conclusions in a report to others.

11. develop communication skills through sharing ideas and criticisms of ideas orally with other students and teachers.

12. be able to take criticism as a valuable form of feedback and positive factor for improvement.

13. be able to take credit or responsibility for their own individual achievement.

ACTIVITY ONE
Each student will complete a written report of the project that includes the explanation, data and conclusions which will inform fellow students of the scientific procedures, results and interpretation of the results. The teacher will return all previously evaluated summaries for the student to use for this report and give guidance for the kinds of information needed in the report through a guide sheet outlining the requirements for the report.

LEARNING FUNCTIONS:

CONNECTIVE: Review of past learning, establish relationsip between known and unknown.

PROVOCATIVE: Discuss functional significance of the learning, establish goals, identify rewards.

DEVELOPMENTAL: Provide practice situations, self-assessment exercises, provide for re-teaching and remediation.

CUMULATING: Diagnostic evaluation, provide for new use of learning.

OUTCOMES ACHIEVED: 6,7,8,9,10,11,12,13.

ACTIVITY TWO
Each student will prepare a poster that will introduce the theme and basic results of the experiment for a science exposition and display this poster and plants from the experiment for others to see. Students will also answer questions about the experiment for all of the observers at the science exposition.

LEARNING FUNCTIONS:

CONNECTIVE: Review of past learning, establish relationship between known and unknown.

PROVOCATIVE: Discuss functional significance of the learning, identify rewards.

DEVELOPMENTAL: Provide practice situations, evaluate learning through recitation, provide for mastery and over-learning, evaluation through peer-assessment.

CULIMNATION: Summative evaluation, provide new use for learning, set future goals.

OUTCOMES ACHIEVED: 1,2,3,4,5,9,11,12,13.

EVALUATION ACTIVITY
The written report will be graded based on completeness, scientific knowledge, data interpretation, and writing skills. The poster will be evaluated according to preset standards of organization, clarity, information included and asthetic appearance.

LEARNING FUNCTIONS:

CULMINATING: summative evaluation, set future goals.

OUTCOMES ACHIEVED: 7,8,9,10,11,12,13.

STUDENTS ADOPT PLANTS [SAP] CURRICULUM GUIDE

REFERENCE LIST

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