SCIENCE AND SUSTAINABILITY

Science and Sustainability is a full-year, integrated high school science curriculum in which hands-on activities predominate. The program includes concepts and topics from physics, chemistry, biology, and earth science within four modules. Each module concentrates on a broad theme involving local and global issues related to sustainability. The modules are intended to be followed in sequence, with early assignments providing references to and a foundation for later activities. The entire program includes a hardcover student textbook, a Teacher's Guide, and an equipment kit. _Science and Sustainability_ is intended to be used in heterogeneously grouped classes, with many lab experiences designed to challenge higher performing students.

Publisher:	Lab-Aids	Grade level:	9–12
Year Published:	2000	Scientific Domain:	Integrated
Developer:	University of California at Berkeley, Lawrence Hall of Science	Web Sites:	www.sepup.com

CONTENTS *Science and Sustainability* organizes its content according to four major themes, each of which is then divided into around 10 groupings, which are comparable to textbook chapters. These groupings are called Activities, comprising two to four lessons each. These lessons are each focused on a particular topic or question related to the overall Activity.

UNIT THEME	CHAPTER ("ACTIVITY") TITLES
LIVING ON EARTH Focuses on the survival needs of all organisms and the influence of science, technology, and culture on survival. Major topics include population growth, food, thermodynamics, and energy.	▪ Sustainable Living ▪ Survival Needs: Food ▪ Survival Needs: Temperature ▪ Energy Transfer ▪ Designing an Insulation System ▪ Living in Today's World ▪ Modeling Human Population Growth ▪ Population Dynamics ▪ Changing Populations ▪ Providing for the Population
FEEDING THE WORLD The context of this module is food production. Major topics include chemical bonding, elements and molecules, genetics, plant biology, and energy transfer.	▪ Food Production ▪ Necessary Nutrients ▪ Cell Structure and Function ▪ Earth's Components ▪ Classifying Elements ▪ Photosynthesis ▪ Plant Genetics and the Green Revolution ▪ Breeding Improved Crops ▪ Genetically Engineered Food ▪ The Role of Cloning in Food Production
USING EARTH'S RESOURCES The focus of this module is the use of materials and energy to improve the quality of life. Topics include petrochemicals, polymerization, energy from chemical reactions, and catalysis.	▪ Identifying and Separating Hydrocarbons ▪ The Chemistry of Hydrocarbons ▪ Clothing Materials ▪ Materials Resources: Metals ▪ By-Products of Materials Production ▪ Catalysts, Enzymes, and Reaction Rates ▪ Breakdown! ▪ Food Preservation ▪ Refrigeration Technology ▪ Economy of Material Use

UNIT THEME	CHAPTER ("ACTIVITY") TITLES
MOVING THE WORLD The focus of this module is fuel and energy resources. Topics include mechanics, energy, nuclear chemistry, irradiation, and gas laws.	▪ Fueling Trade-Offs ▪ Fuel from Food ▪ Exothermic and Endothermic Reactions ▪ Energy from the Nucleus ▪ Mechanical Energy ▪ Trade-Offs of Energy Use ▪ Global Perspectives on Sustainability

FORMAT

The three major components of this curriculum are:

- a student book and accompanying Sierra Club book of photographs,
- a two-binder Teacher's Guide, and
- an equipment kit containing all the specially designed and hard to find materials and supplies that would be needed for three classes of 32 students each.

The Student Book provides the resources and assignment instructions for each lesson. It guides the investigations and provides related readings that expand upon investigation topics. It also presents secondary evidence that is not possible or safe to collect directly. Of the two to four lessons in each Activity, at least one is a hands-on or, more often, laboratory experience. Often another lesson in each Activity asks students to debate or research some problem or issue of social significance either locally or globally.

Many of the lessons that refer to social issues depend upon a Sierra Club book of photographs called *Material World: A Global Family Portrait*. (Sixteen copies are included with each equipment kit, or they may be ordered separately.) This book is used for class assignments and is intended to be shared by two students.

The Teacher's Guide comes in two loose-leaf binders. For each Activity, the Guide provides an Overview with general information. It also has a section on Teaching Procedures, which gives step-by-step suggestions for accomplishing the Activity lessons as well as answers and probable responses to assignments and questions. The Guide also provides guidelines or support for advance preparation of equipment; materials, resources, and organisms; links to other lessons and Activities; Key Concepts and Vocabulary; Background Information for the teacher; and Teaching Procedures. Blackline masters for overheads and student sheets are also provided.

The Equipment Kit comes in several boxes that fit directly into a storage system mounted on wheels. Several pieces of specially designed laboratory equipment are included, particularly for chemistry investigations. The Teacher's Guide clearly identifies necessary equipment that is not provided in the kit, such as Bunsen burners and glassware. Each kit contains materials for three classes of 32 students (students working in pairs). Some of the reagents and consumables must be replenished every year, and order cards for organisms would also need to be re-purchased.

INSTRUCTIONAL DESIGN

Science and Sustainability is an integrated, inquiry-based, high school science program that anticipates classes of heterogeneously grouped students. It integrates curriculum around environmental themes associated with the over-arching concept of sustainability.

Virtually all of the lessons in *Science and Sustainability* ask students to engage in aspects of scientific inquiry. Some lessons focus on planning for collecting evidence and observations. In others, students carry out

investigations, many of which require precision and quantitative problem solving. Other lessons require students to decide about important issues based on evidence. Students are expected to keep a science journal in which they record their investigations and reflections. The lessons in each Activity often address a variety of concepts drawn from all the major domains of science. The format of the lessons is flexible to facilitate adaptation to needs of individual students within a heterogeneously grouped class. The readings are at a high school level.

Each of the hands-on or lab-based lessons is formatted according to the stages of scientific method. It begins with the purpose statement and introduction, followed by an explanation of the procedure. In earlier lessons, students are given the procedure. As the year proceeds, they are expected to take increasing responsibility for creating their own procedures and are given less and less direction. The Teacher's Guide includes many alternate suggestions for carrying out investigations, and teachers are expected to tailor the approach and/or the printed materials to meet the needs and interests of their classes. After the procedure, each lesson requires students to record their observations or data. Lessons conclude with Analysis Questions, which include questions for cooperative group discussion and those for individual analysis. The analysis questions ask students to draw conclusions from their experiences and to communicate what they have learned.

Cooperative learning formats are used throughout *Science and Sustainability*. Lessons encourage informal discussion and comparison of ideas. They frequently lead to compilation of data collected by all teams in the class and class discussion of its meaning and implications. The program provides a generic rubric for assessing group interaction.

ASSESSMENT *Science and Sustainability* uses embedded assessments. Teachers can assess students' progress on their investigations and associated discussions through their journals, and the program provides a generic rubric for assessing their cooperative learning skills. Students' responses to the group and individual analysis questions also form a major source of assessment information. The Teacher's Guide provides answers to all of the embedded and analysis questions.

Students are assessed according to five major variables. The first three are associated with the scientific process: *Designing Investigations*, *Analyzing Data*, and *Evidence and Trade-Offs*. The remaining two are associated with scientific concepts: *Understanding Concepts* and *Communication of Scientific Information*. The Teacher's Guide classifies the various assessment items and tasks integrated into the materials, especially the analysis questions, according to which of these five variables is being assessed. A five-level rubric is used to measure each of these five variables. Assessment tasks related to one or another of the variables are distributed throughout the course, and the Teacher's Guide provides a blueprint of which variables are tested in which Activities. Sample student responses for each level of each of the five rubrics are provided in the Teacher's Guide. The Teacher's Guide also contains an Item Bank containing three to five additional questions for each of the Activities that could also be used for tests and quizzes.

Each of the course's four theme-based modules includes one strongly recommended, benchmark assessment task and at least two additional such

tasks for each of the five variables. Use of the appropriate scoring rubrics to evaluate each of these benchmark assessment opportunities should provide teachers with a year-long record of a student's progress in each of the variables.

RESOURCES AND SUPPORT

The Teacher's Guide provides a Key Skills matrix, a glossary, and guidelines for preparing chemical solutions. Although calculators, probes, or computers are not required for any lesson, the Teacher's Guide indicates where they could be used. The guide also indicates where appropriate videos could be purchased, simulations or software products ordered, and Web sites found to fit the instructional program.

The *Science and Sustainability* Web site is designed to provide frequently updated information to teachers, such as assistance with the use of technology, A/V and WWW resources, and assessment item files that can be easily modified.

The program recommends two software packages. The first, STELLA®, suggested for several lessons, is modeling and simulation software derived from the theory of dynamic systems. It must be purchased separately. The second, Progress Portfolio, a special version of which was developed for *Science and Sustainability*, can be downloaded from www.progressportfolio.nwu.edu using a user code provided on purchase of the program. This software helps students conduct long-term inquiry projects using computers, including visualization projects, Internet-based research, explorations with CD-ROMS, simulations, etc. An appendix of the Teacher's Guide provides help with using Progress Portfolio in the course.