Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching

Classroom Compass

Winter 1998 • Volume 4, Number 1

HIGHLIGHTS

Developing Curriculum across the Disciplines

Choices about what to teach are some of the most important decisions that educators make. While national and state standards and district curriculum frameworks can give general guidance, teachers make the final decisions for day-to-day instruction. The following hypothetical story presents one way teachers might work together to develop curriculum. This scenario could fit in some settings and with some teachers, but, since schools are unique places and teachers have individual preferences for balancing independence and collaboration in their professional lives, not all teachers would work well with this model. Problems of logistics or organization are not covered here.

Evelyn Madison, a life science teacher at Elmore Middle School, and Diane Rainey, the mathematics teacher, had often worked together, sharing ideas and trying to be sure their instruction was complementary. They benefited from Elmore's commitment to professional time for teachers—one afternoon a week was set aside for planning, meetings, and conversations that helped the faculty explore ways to improve their teaching. The two teachers had often planned shared student work that usually lasted a week or two and focused on an issue in science with extensions in mathematics. They had never attempted a long-term project together, but their thinking seemed to be leading them to share one that embedded basic science and mathematics concepts. If they extended it over time, perhaps a six-week unit, they thought they would be able to introduce and pursue themes rather than discrete components of content. They wanted to design a unit that enabled students to explore ideas, pose problems, and work toward their own solutions.

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Integrating Design Technology

A mention of their discussion interested Will Hooks, Elmore's technology education teacher. Hooks was not the computer teacher, although he included computers in much of his instruction. He taught about systems—their design, development, and influence. He was particularly interested in the connections between classroom instruction and the world of work. Listening to Madison and Rainey discuss their ideas he realized that students involved in this work could build their understanding of systems development. He suggested combining the efforts of the three classes—mathematics, life science, and technology—in a way that would emphasize the connections among disciplines. The school's scheduling would accommodate a shared group of students—the school called it a student "family"—who would attend all three classes.

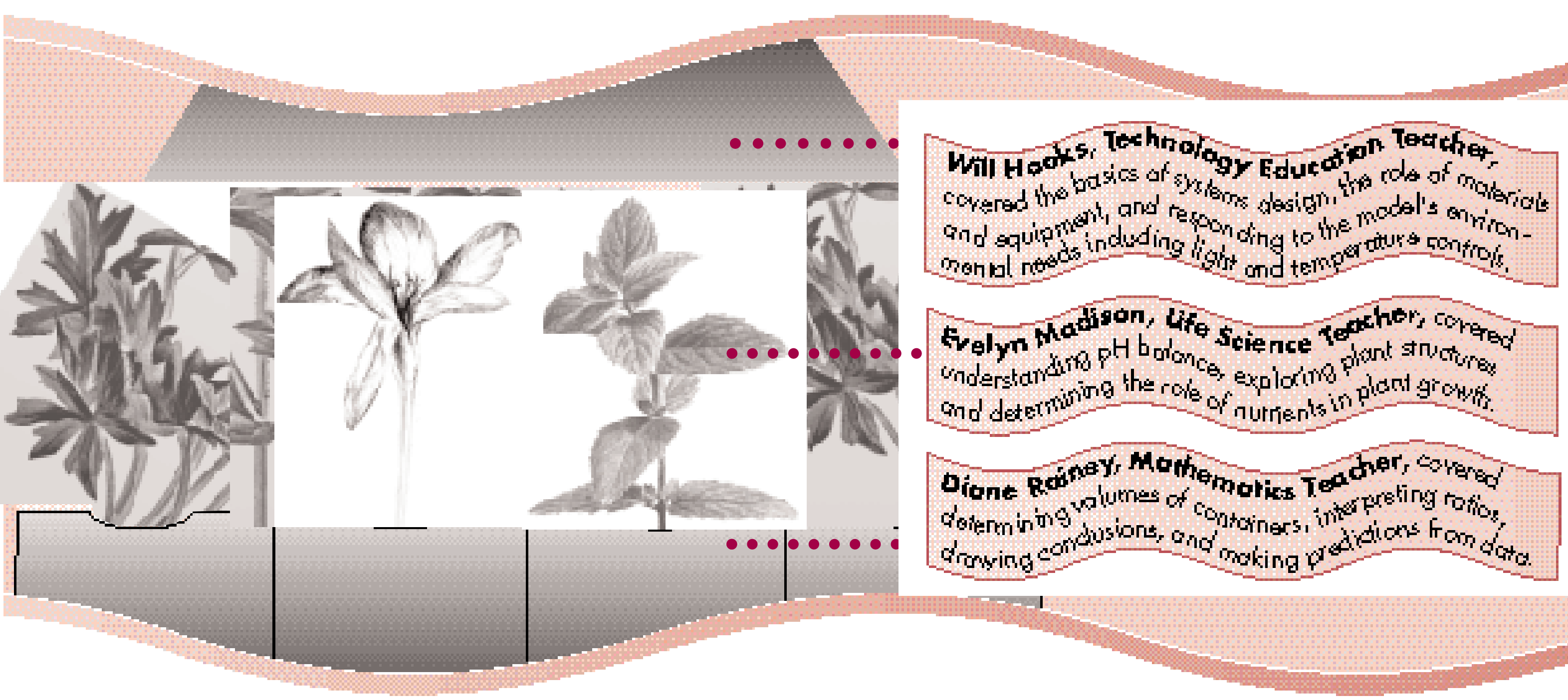
The teachers' thoughts coalesced into the idea of designing and building a model hydroponics farm. Madison had seen a similar project at last year's state science teachers' conference and liked the way it demanded understanding of both mathematics and science. She suggested to the other two that they try a similar idea. They searched an online database offered by the Eisenhower National Clearinghouse (**<http://www.enc.org>**) and found a very helpful notebook, the *Technology Science Mathematics Connection Activities Binder* (available from Glencoe/McGraw Hill). With its purchase, the teachers had detailed instructions for six long-term projects, including a hydroponics farm, that integrated science, mathematics, and technology and included suggestions for subject emphasis in each discipline.

Building on the Curriculum Framework

The teachers knew that they needed to ground their plans in the district's curriculum framework, and that some eighth-grade topics outlined for each discipline fit quite nicely. An understanding of biological and physical properties were key components for producing the farm's products. In mathematics, concepts of determining volume, interpreting ratios, and analyzing data were essential to the model's development and the interpretation of its results. Hooks knew that basic design elements—understanding environmental requirements, analyzing materials and equipment, sketching and refining designs—were fundamental to developing the model.

Remembering the Big Ideas

With such a complex undertaking the big ideas in each lessons can be overlooked, so the teaching team set regular meetings and continually reminded themselves of the areas they wanted to cover in the work. For Madison, these included understanding pH balance, exploring plant structures and determining the role of nutrients in plant growth. Rainey's class would concentrate on determining volumes of various containers, interpreting ratios, drawing conclusions, and making predictions from data. Hook's focus would be on the basics of systems design, the role of materials and equipment, and responding to the model's environmental needs including light and temperature controls. While the project involved many activities, the three



were determined to focus on the encompassing ideas, rather than on disconnected pieces of information and skill learning.

In their first meetings, the team established their learning goals, based on curriculum requirements. Their choices for specific learning activities and classroom events emerged from their understanding of their students' interests and inclinations and the requirements of the model. While goals were set in these first meetings, the three came back to them many times over the semester, not only to see if the goals were being met but also to revise and expand them.

Early in their planning, the teachers outlined ways they might assess students' understanding. While the students' completion of the model would be tangible proof of some forms of mastery, the specific goals of content understanding also needed to be addressed along the way. The teachers agreed that each class period would provide time for the students to keep journals that would include a short log of that day's activity and learning. Rainey asked her students to include their calculations for determining container volumes and ratio

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Learning Goals based on Curriculum Requirements

The school librarian had brought the value of using the Internet to the attention of the three teachers. The first site he suggested to them was the Eisenhower National Clearinghouse (ENC, **<http://www.enc.org/>**), which proved particularly relevant to their work. They downloaded parts of the NCTM *Standards* and the *National Science Education Standards* and also found several good articles on curriculum design that helped focus their thinking.

Cook, G. E. & Martinello, M.L. (1994). Topics and Themes in Interdisciplinary Curriculum. *Middle School Journal,* 25 (3), 40-44.

Nelson, J. R. & Frederick, L. (1994, February). Can Children Design Curriculum? *Educational Leadership* 51, 71-74.

House, P. A. (1997). Integrating mathematics and science in the light of current reforms. *Reform in Math and Science Education: Issues for the Classroom.* Columbus, OH: Eisenhower National Clearinghouse.

The ENC site lists science and mathematics web addresses that link students and teachers to exciting work from around the world. The ENC "Digital Dozen" gives favorite sites every month, and an archived collection of locations is a handy resource for any topic. As part of the hydroponics project, Elmore's librarian helped the students find several sites in addition to the Collaborative Ukrainian Experiment.

An experiment conducted by Louisiana State University with plants aboard the Mir space station resulted in the first reproduction of plants in space, even though the plants had been considered casualties of the Mir accident. Go to **<http://www.agctr.lsu.edu/agcenter>** and search using "Mir."

The Astro Plants Project at the Wisconsin Center for Space Automation & Robotics examines plant growth under space conditions. **<http://www.engr.wisc.edu/centers/wcsar>**

A search with the term "hydroponics" using several search engines turned up many sites including:

- a hydroponics business **<http://www.genhydro.com/>**
- a search engine on hydroponics **<http://www.aqueous.com/aq148.shtml>**
- and a working hydroponics farm **<http://www.arches.uga.edu/~mocat/tpi/links.html>**

interpretations in these journals. She read the journals weekly.

Rainey scheduled discussion times throughout the unit for teams to respond to specific questions, such as

- What do we mean by pH level?
- What happens if a plant receives a nutrient solution with a pH level that is too acidic? too basic?
- What function do root hairs serve in the plant?
- What factors make it difficult for root hairs to grow?

Following each of these discussions, students wrote short essays to respond to questions that stretched their understanding.

At the end of every other week, Hook asked each student team to prepare a summary of their learning, responding to specific questions, such as

- What changes did you make to your original design, and why?
- How would you describe the hydroponics farm model in terms of these four characteristics: input, process, output, and feedback?

The summary was signed by every team member. Three teams were then selected each time to present their responses during class.

Through these assessment approaches the teachers hoped to keep track of student progress and understanding.

Linking with the Community

At the beginning of the unit, the teachers scheduled a formal weekly meeting to be sure that the project was progressing and that their original goals were addressed. At the beginning the teachers had set one goal of establishing links with the world outside their school. They believed that students needed to understand how the experience of designing, building, and observing their model could be useful beyond the immediate classroom experience. One afternoon Hooks invited several guests to the class, including a local farmer, an instructor from a nearby agricultural college, and a friend, who was a systems engineer and consultant to a variety of local and national businesses. Before the visit the guests had talked with the three teachers about the project and what the students should accomplish. The teachers posed several specific requests to the guests, asking them to comment on changes they had seen in their work in the past 10 years, the effect of the use of technology in their work, and how science and mathematics affected what they did. With these guiding questions, the guests were able to focus their comments and connect with the students' work. The students were ready with questions of their own and the initial visit resulted in return observations from the systems engineer and a final visit from all three guests at a concluding presentation.

To get a look outside their town, the students spent some time on the Internet and found, among other resources, an international study of fast-growing plants in space that was called the Collaborative Ukrainian Experiment (see **<http://fastplants.cals.wisc.edu/cue/cue.html>**). That study was collecting data similar to the information the students would be gathering from their model.

Keeping the Focus

As the project progressed, the teachers tried to maintain a classroom atmosphere that encouraged inquiry and exploration. Bringing in community guests and surfing the Internet further broadened the students' horizons and increased their queries beyond the unit's original plan. They posed new questions, such as

- Does growing in space affect plants in a different way from growing on the surface of the earth?
- What is the economic impact of farming on our town?
- Is there a computer game that simulates plant growth and environmental impact?

The students' explorations were suggesting so many avenues to pursue that the teachers began to fear that the learning would become scattered. If less is more is a guiding principle for in-depth understanding, the breadth of content must be limited to allow continued, thoughtful exploration of specific content. While the state standards or the district's curriculum framework give some general guidance about what content areas to cover, those documents are too broad to give direct advice for day-to-day classroom direction.

Steven Levy in his book *Starting from Scratch* (1996) describes his method of classroom curriculum development. He calls his method finding the *genius* of the topic—determining the essence of what makes the content unique and letting that essence steer the development of the lesson. This *genius* helps him decide which questions and ideas will lead the students to a closer understanding of the topic and which will lead them away. So, while communicating electronically with the Collaborative Ukrainian Experiment about growing plants in space might be fascinating, the teaching team or students must determine first if it contributes to their learning goals and, if it does, how to guide the exploration so it is productive. Will communicating with the Ukrainian group enhance our knowledge about systems, experimentation, ratios, pH balance, or plant structures? If links are legitimate, the space experiment could extend the classroom learning.

Looking Back

By the conclusion of the project, the three teachers and their students had faced many practical and theoretical issues. The teachers had anticipated some of the practical problems they encountered—How will we find sufficient light sources? Is there space for all the plants in the science room? Can the school be flexible enough to accommodate some scheduling changes? These concerns were discussed when the team met that summer to think about the next year. The strengths of their work became apparent as they reflected on their experience. First, the benefits of their **teamwork** and **sharing across disciplines** was paramount. They were also convinced that student **learning was enhanced through practical experience.**

The project forced the students to understand and use mathematics, science, and technology concepts that might never have found meaning in a more abstract context. The teachers liked the notion that, while they had designed a firm, flexible structure for student work, much of the learning was directed by **student inquiry and exploration** that emerged naturally. The hard work of setting up and working through a logical sequence of activities had resulted in a rewarding experience for the students and the school.

The teachers decided to use some of the summer after their first year to learn about embedded assessment and developing rubrics for measuring student work. Their reading and discussions had already convinced them that these assessment methods might be more useful for their work than traditional methods had been. They were already looking forward to improving and extending their learning in the coming year.

Quick Takes

The second number in the *Quick Takes* series deals with Calculators in the Classroom and has just been released. Paper copies are available from SCIMAST and copies can be downloaded directly from the SCIMAST web page **<http://www.sedl.org/scimath/>**. Just follow the links.

Quick Takes are designed to be used by schools to communicate with their publics—parents, school board members, journalists, and other members of the community. You may download the material from the web site and use it on your own letterhead or as part of a school newsletter or in other appropriate ways. We only ask that you credit SCIMAST and that you let us know how you used the material. Please look at the web site and let us know if you have any topic suggestions for this series.

References for Developing Curricula

Braunger, J. & Hart-Landsberg, S. (1994). *Crossing boundaries in explorations in integrative curriculum.* Portland, OR: Northwest Regional Educational Laboratory.

Cook, G. E. & Martinello, M.L. (1994). *Interdisciplinary inquiry in teaching and learning.* New York: MacMillan College.

Levy, S. (1996). *Starting from scratch: one classroom builds its own curriculum.* Portsmouth, NH: Heinemann.

Short, K. & Burke, C. (1991). *Creating curriculum: Teachers and students as a community of learners.* Portsmouth, NH: Heinemann.

More information on hydroponics farms can be found in these two sources by David R. Hershey:

Pardon me, but your roots are showing (February 1990). *The Science Teacher* 57:42-45.

Culturing *Brassica* by hydroponics (fall 1993). *Carolina Tips* 55, no.1.

Welcome to LEERIC

Eisenhower SCIMAST welcomes the Louisiana Environmental Education Resources Information Center (LEERIC) as the first ENC state access center in our region. Located on the Lousiana State University campus in Baton Rouge, LEERIC provides information and resources to educators throughout the state. As an ENC access center, LEERIC will be a source for ENC materials (such as the *Guidebook* and the *ENC Focus* discussed on p. 10) and information about ENC's online services. **To contact, write to LEERIC, 1 East Fraternity Circle, LSU, Baton Rouge, LA 70803-0301 or visit their web site at <http://www.leeric.lsu.edu/>.**

The Hydroponics Farm

A DESIGN EXPLORATION FOR MIDDLE SCHOOL

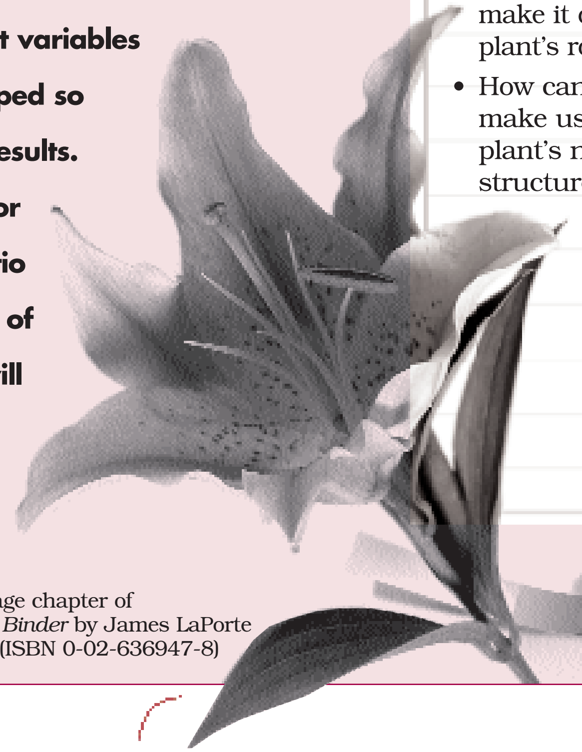
This brief summary gives a glimpse of lessons that might occur while the model is being developed and maintained.

A hydroponics farm could be an ambitious science activity without organizing connections to any other classroom. The project described in these pages is a collaborative effort that crosses three disciplines. In some schools logistical and bureaucratic problems might create difficulties for such a project, but this description does not deal with these problems.

Working on the hydroponics activity, each student may independently design and explore questions that he or she finds intriguing. Individual insights will often follow such work. Each student project would be different from all others. To realize the possibilities of this activity, the three teachers will need to synchronize content and to collaborate closely to manage scheduling, subject continuity, and thematic integrity throughout the project.

Designing and building the model may be the extent of the project, but the farm can also serve as a laboratory. If investigation is a goal, the students will need to manipulate a critical variable while observing the responses of the plants. Early in the design phase they must determine what variables to study and the model must be developed so the observation produces comparable results. They might, for example, choose a factor in the nutrient solution—perhaps the ratio of materials or pH levels or the amount of light provided for the seedlings. They will need to understand the concept of the control group as well as other facets of setting up an experiment.

A detailed guide to this activity is available in a 52-page chapter of *Technology Science Mathematics Connection Activities Binder* by James LaPorte and Mark Sanders. New York: Glencoe/McGraw-Hill (ISBN 0-02-636947-8)

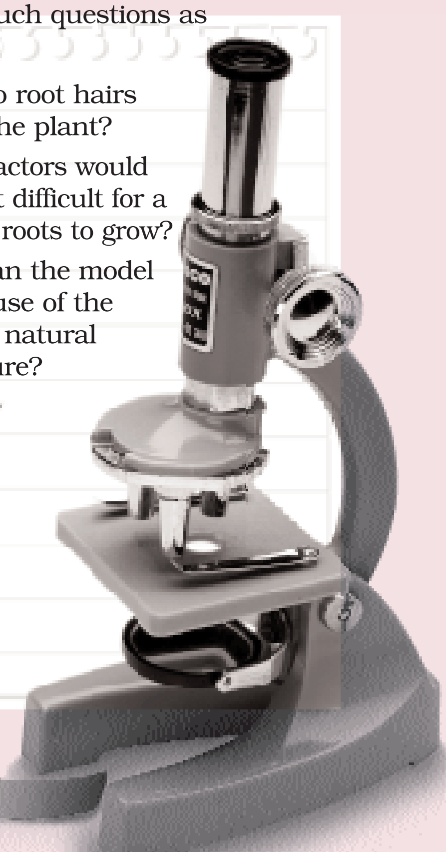


Science Explorations

In science class, a review of pH may be helpful, since students will be monitoring their plants' pH levels. If the students need a refresher on pH, let them use test paper to measure familiar solutions—tap water, a white vinegar solution, a baking soda solution. They can then measure the pH of several fertilizer solutions similar to the plant food that will be used in the model. Compare these data to the pH preferences of selected vegetables and herbs and discuss the choices for nutrient solutions that will be most favorable for the seedlings.

Understanding plant structure, particularly the role of roots in nourishment, is basic to the design of the hydroponics model. The students can observe the roots and stems of various plants and compare similarities and differences. Prepared slides of longitudinal and transverse cross sections of a root tip will illustrate the role of individual cells and their functions. A discussion of plant structures can include such questions as

- How do root hairs serve the plant?
- What factors would make it difficult for a plant's roots to grow?
- How can the model make use of the plant's natural structure?



Thoughts from Mathematics

In mathematics class students can use their work with the nutrient solution to expand their understanding of ratios and proportions. The solutions that provide food for the seedlings are expressed as ratios. To concoct an appropriate balance that will nourish the plants, the teams must understand the correct proportions for their plants' needs. Commercial plant foods provide an analysis of their ingredients and different formulas are suggested for different plants. For example, one product, the Hydrogreen™ Plant Food, provides nitrogen, phospheric acid, and potash in the proportion of 10:8:22. The teams can investigate their understanding of how a ratio reflects the nutrient balance by exploring such questions as

- What does it mean for the compounds to be in equal proportion? For example, is there any difference between 1:1:1 and 2:2:2?
- If a mixture has the ratio A:B:C=3:1:4 and you have only 2g of compound B, what amounts of A and C are needed?
- If the supplies of A, B, and C are 120g, 250g, and 180g, is it possible to use all the nutrients in the 3:1:4 ratio? If not, what limitations are present? What is the most nutrient (in grams) that you could make from these supplies?

The students will be using containers to feed their model's plants, and will need to predict volume capacity for a variety of containers. They can explore shapes and containers in mathematics class. Examining the surface area, dimensions, and volume of prisms, pyramids, cylinders, and cones will help them understand the relation between shape and volume. They should think about volume in terms of a container's height and the area of its base and develop mathematical models that reflect that relation. After they seem comfortable with their findings, let them test their mathematical models by predicting the volume of an irregularly shaped container (such as a soft drink bottle) and measuring the volume of water needed to fill it (for water 1 cubic centimeter=1 milliliter).

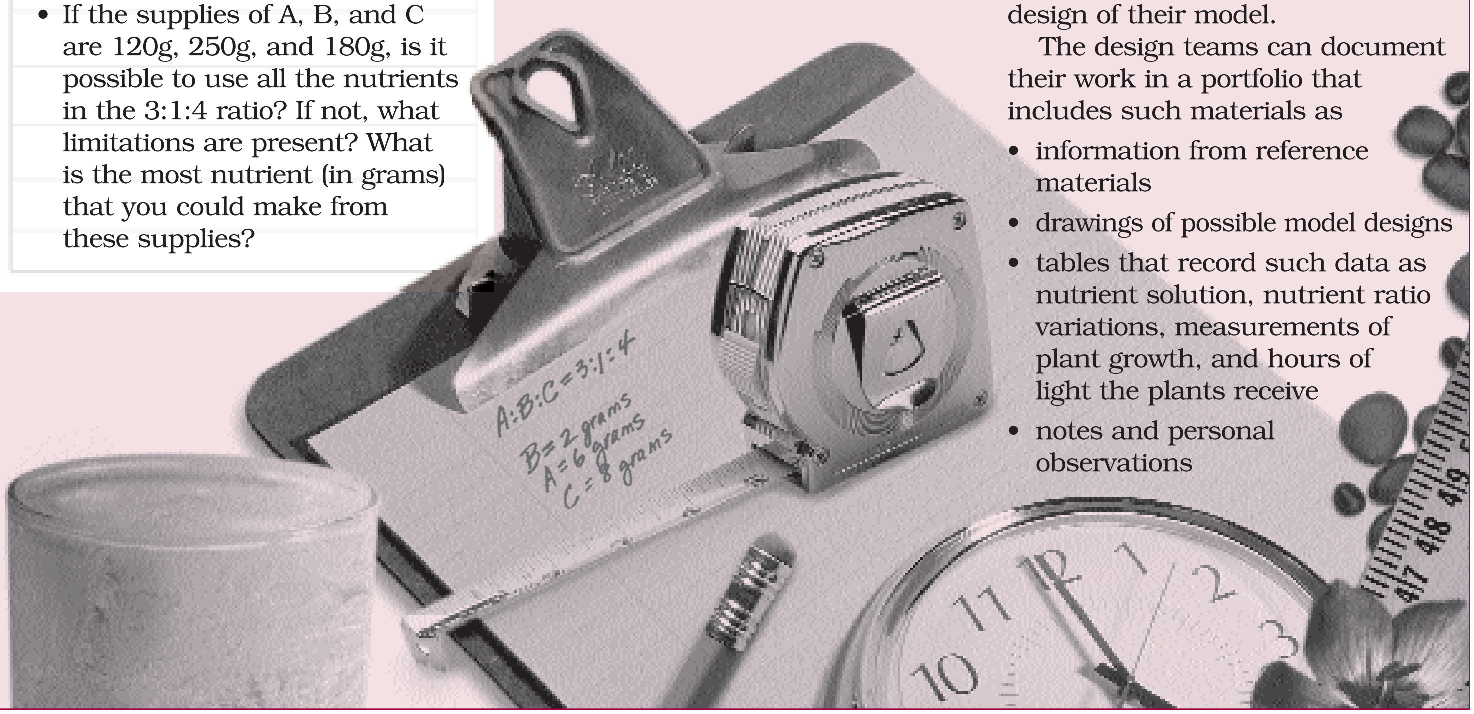
Issues in Design

During the first stages of design the student teams can examine possible models for their systems. Most hydroponics farms are either water cultures (the plant roots are submerged in water) or aggregate cultures (the roots are surrounded by sand, vermiculite, gravel, or similar materials).

Every hydroponics design must account for the essentials of plant biology and the requirements of a delivery system. Students will also need to think about the physical possibilities in their school—how much space is available? What is the light source and how many hours will the plants receive light? What are the temperature requirements and how can the appropriate temperature be maintained? The class can use reference materials and explore examples of materials they will use for construction, such as plastic pipe, tubing, and aggregate materials. The class can also develop an idea of how the nutrient will move through the system by observing an aquarium pump aerate a fish tank. The students can study different examples of materials and processes used in various hydroponics systems and then begin to sketch ideas for the design of their model.

The design teams can document their work in a portfolio that includes such materials as

- information from reference materials
- drawings of possible model designs
- tables that record such data as nutrient solution, nutrient ratio variations, measurements of plant growth, and hours of light the plants receive
- notes and personal observations



Standards

Standard 5: Number and Number Relations

from the NCTM Standards

In grades 5–8 the mathematics curriculum should include the continued development of number and number relationships so that students can

- **understand and apply ratios, proportions, and percents in a wide variety of situations.**

In the middle school years, students come to recognize that numbers have multiple representations, so the development of concepts for fractions, ratios, decimals, and percentages and the idea of multiple representation of these numbers needs special attention and emphasis. The ability to generate, read, use, and appreciate multiple representations of the same quantity is a critical step in learning to understand and do mathematics.

To provide students with a lasting sense of number and number relationships, learning should be grounded in experience related to aspects of everyday life or to the use of concrete materials designed to reflect underlying mathematical ideas. Students should encounter number lines, area models, and graphs as well as representations of number that appear on calculators and computers (e.g., forms of scientific notation). Students should learn to identify equivalent forms of a number and understand why a particular

Standard 13: Measurement in the Middle School

from the NCTM Standards

In grades 5–8 the mathematics curriculum should include extensive concrete experiences using measurements so that students can

- **extend their understanding of the concept of perimeter, area, volume, angle measure, capacity, and weight and mass**
- **develop formulas and procedures for determining measures to solve problems.**

The development of the concepts of perimeter, area, volume, angle measure, capacity, and weight is initiated in grades K–4 and extended and applied in grades 5–8. From their exploration, students should develop multiplicative procedures and formulas for determining measures. The curriculum should focus on the development of understanding, not on the rote memorization of formulas (page 116).

As students progress through grades 5–8, they should develop more efficient procedures and, ultimately, formulas for finding measures. Length, area, and volume of one-, two- and three-dimensional figures are especially important over these grade levels (page 118).

Reprinted with permission from *Curriculum and Evaluation Standards for School Mathematics.* Order from NCTM, 1900 Association Drive, Reston, VA 22091. Telephone:

Science Education Program Standards

Excerpts from the National Science Education Standards

The program standards are criteria for the quality and conditions for school science programs. They focus on issues at the school and district levels that relate to opportunities for students to learn and opportunities for teachers to teach science.

In an effective science program, a set of clear goals and expectations for students must be used to guide the design, implementation, and assessment of all elements of the science program. A science program begins with the goals and expectations for student achievement; it also includes the selection and organization of science content into curriculum frameworks, ways of teaching, and assessment strategies. The goals for a science program provide the statements of philosophy and the vision that drives the program and the statements of purpose that the program is designed to achieve.

Curriculum frameworks should be used to guide the selection and development of units and courses of study. The curriculum framework provides a guide for moving the vision presented in the goals closer to reality. Teachers use the guide as they select and design specific school and classroom work. By specifying the sequence of topics in the curriculum, the guide ensures articulation and coherence across the curriculum. Using the framework, teachers design instruction that is based on the prior experiences of students but avoids unnecessary repetition. The framework guides the students as they move through their schooling.

S C I M A S T

Teaching practices need to be consistent with the goals and curriculum frameworks. The program standards do not prescribe specific teaching behaviors, nor should district or school policies. There are many ways to teach science effectively while adhering to the basic tenets of the *National Science Education Standards,* but they must be consistent with the goals and framework of the district.

Support systems and formal and informal expectations of teachers must be aligned with the goals, student expectations, and curriculum frameworks. An effective science program requires an adequate support system, including resources of people, time, materials and finance, opportunities for staff development, and leadership that works toward the goals of the program. It is encoded formally in policy documents such as a teacher's handbook and informally in the unwritten norms that determine routines. The support system must support classroom teachers in teaching science as described in the *Standards* (page 210–211).

Eisenhower SCIMAST supports mathematics and science education in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas with a combination of training, technical assistance, networking, and information resources. The project is funded by the U.S. Department of Education's National Eisenhower Program and works in partnership with the Eisenhower National Clearinghouse (ENC), a national resource center for increasing the availability and quality of information about instructional resources for science and mathematics educators. In cooperation with SCIMAST, the Louisiana Environmental Educational Information Center (LEERIC) is a state access center for ENC.

The SCIMAST resource center, located in Austin, is open to visitors Monday through Friday, 8:00 A.M. to 5:00 P.M. The center houses a multimedi collection of science and mathematics instructional materi for grades K–12. It is located at the Southwest Educatic Development Laboratory, on the fourth floor of 211 East Seventh S ı, Texas 7870 free number, **-201-7435,** es callers witl ıation and ınce concerni ctional materi ıthematics an e classrooms.

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Resources and Opportunities

Tenth Planet Software

Tenth Planet produces interactive software that introduces mathematics concepts through lively, interesting scenarios focused on content. The content is presented through stories, videos, and animation, which provide practice with problem-solving activities. Students can manipulate shapes, group objects, create patterns, and write in online journals. The software CD is a Macintosh-Windows hybrid. The following investigations are available:

Geometry

- Spatial Relationships (preschool–first grade)
- Introduction to Patterns (preschool–first grade)
- Combining Shapes (first–second grade)
- Creating Patterns from Shapes (first–second grade)
- Shapes within Shapes (second–fifth grade)
- Mirror Symmetry (second–fifth grade)

Number Investigations

- Number Meaning and Counting (preschool–first grade)
- Combining and Breaking Apart Numbers (first–second grade)
- Grouping and Place Value (second–third grade)

Prices (which may change) are

- each investigation: $79
- classroom pack (five copies of the software CD, one teaching guide, one technical guide): $149
- site license (25 copies of the software CD, one teaching guide, one technical guide): $499

For more information contact
Tenth Planet
25 Miramontes Street
Half Moon Bay, CA 94019
1-800-695-6117
<http://www.tenthplanet.com>

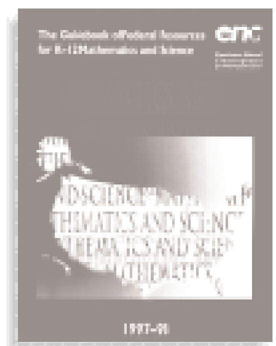
ENC Focus

The latest issue of the *ENC Focus,* a resource catalog of mathematics and science instructional materials, presents ideas for using children's literature in mathematics and science. The *Focus* provides some helpful advice from Jane Hickman, an associate professor of children's literature at Ohio State University, about choosing materials that support effective instruction. A bibliography of professional readings is included, as well as references to sources for reviews and title lists for children's literature. The heart of the Focus is its collection of annotated references to books, kits, videotapes, and journals that offer teachers ways to incorporate literature into their teaching. A sampling of the titles includes "Exploring the World of Animals" from the *Literature Bridges to Science* series from Teacher Ideas Press, *Story Stretchers: Activities to Expand Children's Favorite Books* from Gryphon House publishers, and "Exploring Algebraic Patterns through Literature" an article from *Mathematics Teaching in the Middle School.* A helpful list of children's titles includes picture books, biographies, fiction for grades seven through twelve, counting books, books that build children's number sense, and measurement and geometry and multiplication and division books. Previous issues of *ENC Focus* include

- New Approaches to Assessment in Science and Mathematics
- CD-ROMs and Laserdiscs for Science
- Equity in the Classroom: Mathematics and Science Materials
- Real Data Resources for Teachers
- Integrating Math and Science
- Active Learning with Hands-On Resources

Copies of the ENC Focus are free and available from SCIMAST. **Call 1-800-201-7435 or e-mail a request to lsnider@sedl.org.**

The Guidebook of Federal Resources for K–12 Mathematics & Science



The 1997-98 issue of this useful reference provides current information about federally funded organizations at the national and state levels. Each of the offices listed supports mathematics and science education. The front of the guide gathers federal agency information, such as a listing of the regional offices of the Environmental Protection Agency (EPA), how EPA programs are administered, and such specific EPA efforts as the Environmental Education Grants Program. State-level programs funded by federal entities, such as wildlife refuges which are funded by the Department of Interior, are also presented.

This is the fourth edition of this book, which was originally titled *The Guidebook to Excellence.* Copies are available free (but supplies are limited) from SCIMAST. **Call 1-800-201-7435 or email a request to lsnider@sedl.org.**