NSTA Guide to PLANNING SCHOOL SCIENCE FACILITIES

2nd Edition

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PREFACE

For over 50 years, the National Science Teachers Association (NSTA) has been providing information to teachers and schools regarding science facilities and equipment. To provide assistance in the design of secondary school science facilities, NSTA in 1954 published its first book on facilities, *School Facilities for Science Instruction*. This publication was revised and updated in 1961. Although the Association subsequently released several related pamphlets, it became evident by the end of that decade that an updated document was needed.

With new science curricula being published in the 1960s and early 1970s, supported by the National Science Foundation (NSF), a renewed interest and concern for updated and appropriate science facilities was created. In April 1970, NSF approved a grant to NSTA to study exemplary science facilities and identify emerging trends in facility design and use. The publication, released in 1972, *Facilities for Secondary School Science Teaching: Evolving Patterns in Facilities and Programs*, was a result of a project directed by Joseph Novak, of Cornell University.

In 1988, as NSTA president, I established the Task Force on Science Facilities and Equipment. The charge to this task force was to develop a publication or publications on instructional science facilities for elementary and secondary schools and to encourage and assist educational institutions in securing the best facilities possible for science instruction.

The task force was chaired by Ronald Converse, coordinator of K–12 science, Conroe Independent School District, Conroe, Texas. Other members were Dorothy Barton, curriculum coordinator, Beers Middle Elementary Science Program, District of Columbia Public Schools, Washington, D.C.; Tony Beasley, coordinator of K–12 science, Metro Nashville Schools, Nashville, Tennessee; Thomas Gadsden, director of science, K–12, Richardson Independent School District, Richardson, Texas; Ronald Maxwell, independent facilities consultant, Lake Leelanau, Michigan; Ronald Sass, professor of science education, Rice University, Houston, Texas; Victor Showalter, director, Center for Unified Science Education, Capital University, Columbus, Ohio; Jon Thompson, director, Kalamazoo Area Mathematics and Science Center, Kalamazoo, Michigan; Marlin Welsh, director of science, K–12, Shawnee Mission Unified School District, Shawnee Mission, Kansas; and Phyllis Marcuccio, director of publications, National Science Teachers Association.

This task force spent several years studying trends and directions in the design and implementation of elementary and secondary science teaching and learning facilities. They invited school districts to submit videotapes of their exemplary science facilities.

In 1992, a new NSTA Task Force on Science Facilities and Equipment was established, with myself as chair. This group met in Charlotte, North Carolina, and outlined a new beginning and direction for a publication on kindergarten through grade 12 science facilities. The members of this task force were Dorothy Barton, Tony Beasley, and Ray Filipiak, Sheldon Laboratory Systems; Jim Biehle, American Institute of Architects, Saint Louis, Missouri; Thomas Gadsden, Ronald Maxwell, Ronald Sass, Victor Showalter, Jon Thompson, Marlin Welsh, and Phyllis Marcuccio. This meeting produced a pamphlet, *Facilitating Science Facilities: A Priority*. This publication was a checklist for administrators and boards of education, and was disseminated via the NSTA journals and newsletters as well as through various elementary and secondary school journals and newsletters.

During an NSTA Convention in Phoenix, the task force met and established a working outline for the current publication, and several representatives from national science facilities manufacturers joined in the discussion of the outline.

Several task force members were then invited to write recommendations on science facilities for the National Science Education Standards (NSES). The result was the development of guidelines for elementary, middle, and high school science facilities based on NSES Program Stan-

dard D: Resources, and published in NSTA's three-volume publication *Pathways to the Science Standards.*

This second edition of the *NSTA Guide to Planning School Science Facilities* includes updated information about planning facilities design, budget priorities, space considerations, general room and laboratory design, furnishings for the laboratory/classroom, safety, ADA, and much more. This edition represents the cooperative input of hundreds of hours and the effort of many individuals.

First acknowledgement and gratitude must go to the NSTA publications staff for all of their efforts and assistance in completing this guidebook. Special thanks go to Andrew Cocke, who guided us through this project, and whose expertise in editing assured us a fine product.

A number of interested people submitted suggestions and references, and provided valuable reviews of the manuscript.

A deep sense of gratitude is extended to James T. Biehle, AIA, and president, Inside/Out Architecture, Kirkwood, Missouri, for his untiring support, interest, and tremendous contribution to the writing of the publication. A special thank you is also extended to Sandra West for her outstanding contributions to the development of the manuscript, especially in the areas of science safety and safe laboratory designs, and to Juliana Texley for her contributions to the inclusion of ADA guidelines as they relate to the planning and designing of school science facilities. Additional thanks goes to Da-Shawn Coleman for her outstanding technical assistance in orchestrating the format and layout of this publication.

This second edition could not have been completed without the ideas and support and assistance from various manufacturers of science facilities and equipment. Our special thanks to the late Raymond Filipiak, of Sheldon Laboratory Systems, for whom this edition is dedicated.

The support and encouragement of many teachers, supervisors, curriculum directors, and other administrators of science education kept our task focused and moving toward completion of this second edition.

To Gerry Wheeler, David Beacom, and Claire Reinburg, thank you for the contributed counsel and ideas, as well as the administrative and editorial assistance.

To all of these and many others, the authors owe much for their valuable contributions.

LaMoine L. Motz
White Lake, Michigan
March 2007
Bibliography

DEDICATION

Dedicated to the memory of Raymond E. Filipiak, whose knowledge, insights, and contributions to school science facilities were exemplary and are greatly appreciated. He directly and indirectly made significant contributions to this book.

INTRODUCTION

Through the National Science Education Standards, our profession has called for learning environments in which students explore, inquire, and construct their own knowledge about the physical world. Good science programs require the uniquely adaptable learning space we call a laboratory, as well as access to both indoor and outdoor space for research, environmental studies, and reflection. Yet the vast majority of communities moving toward the Standards will find their progress limited by the facilities available in their schools.

Today, across the country, large numbers of school buildings are in disrepair. The General Accounting Office (1996, 3.1) reported that over one-third of our schools, serving over 14 million students, need either extensive renovation or reconstruction, and another one third have at least one major structural flaw, such as a leaky roof, outdated electrical systems, or dysfunctional plumbing. Many of the remaining schools were planned without any consideration of what we consider as the requirements for effective science education. The National Clearinghouse for Educational Facilities reports that more than 122,000 public and private school buildings in the United States are, on the average, more than 45 years old. More than a quarter of them were built before 1950, and 73% date from before 1970. American school districts spend between $20 billion and $30 billion each year on new school construction. Renovations add even more to this expenditure (National Clearninghouse for Educational Facilities 2006).

Numerous studies confirm that the school environment strongly effects student performance. One such study found that students in the best-designed schools scored between 5 and 17 points higher on standardized tests than kids who attended class in substandard buildings (Lyons 2001). Good school design also includes outdoor areas, which offer space for group activities and environmental studies. Innovative schools use their buildings and grounds as giant science labs—"three-dimensional textbooks," the American Architectural Foundation (AAF) calls them—that teach lessons in biology, Earth science, and physics.


A laborartory/classroom

Sustainability is emerging as an overriding principle in architecture and design, and is greatly informing school design and construction. Sustainability is about meeting current needs without depleting resources or harming natural cycles for future generations. In school science design, this means paying attention to the kinds of materials used in the construction, how the building is positioned on the grounds, how waste gets handled, and also the ease with which renovation might occur in the future.

Over the past few years, many school communities have experienced growth in student population, and have had to add to or expand their existing facilities.

In the eight years since the first edition of this book was published, the authors have toured hundreds of schools with new or newly renovated science facilities. Many were planned using the recommendations outlined herein and the students and science teachers using them are benefiting from safer, more flexible and functional spaces. However, many new facilities are still being planned as new versions of long-outdated designs with little flexibility and a lack of the space and equipment needed to make hands-on, inquiry-based science education a safe reality.

As we move toward the National Science Education Standards, we must accept the challenge of revitalizing both our science teaching and our facilities. Just recently legislation was introduced under bills being considered by both the U.S. House of Representatives and Senate to upgrade high school science classroom/laboratory facilities, increase training in laboratory safety, better integrate lab lessons with other academic science content, and use labs to encourage students to pursue science study in college. The National Science Foundation would oversee this new program.

NSTA believes that the science facilities in our nation's schools deserve a strong commitment and continuous attention. It is in science classrooms that students work, learn, and experience real science, using the tools and practicing the skills and habits of mind that encourage science learning. Students form their first and most lasting impressions of the importance of science there. The attention that our communities pay to good science classrooms is a measure of the level of our regard for science education.

The ideas and guidelines for remodeling and replacing facilities presented in these pages are compatible with the principles of the National Science Education Standards, which detail expectations for teaching and programming at all school levels.

Those who are planning facilities for science education will want to weigh their plans in relation to the requirements of the Standards and to trends in science teaching. The resulting facilities should serve both the present and the evolving science programs of the future.

The purpose of this book is to familiarize educators, administrators, and citizens with the stages of the process of planning for new and renovated science facilities and to provide specific, detailed information on many items and aspects of the planning and design phases. This information will also be useful to facilities planners and architects.

Regrettably, in some cases, teachers asked to join a planning committee serve only as token members. Yet, the active participation of science teachers and leaders is key to a successful project.

This book is designed to provide teachers, curriculum leaders, and administrators with a broad vision of the role of facilities in science teaching, as well as the background they will need to become valuable contributors to any facilities project team. It also reflects the most up-to-date research on best practice and environments for science learning. We hope that the book will help planning teams design effective spaces that meet their objectives for teaching and learning science.

LaMoine L. Motz

Reference

American Architectural Foundation and Knowledge Works Foundation. 2006. Report from the National Summit on School Design: A resource for educators and designers.

General Accounting Office. 1996. *School facilities: America's schools report differing conditions*. GAO Report No. HEHS-96-103. (June 14). Washington, DC: Author.

Lyons, J. B. 2001. Do school facilities really impact a child's education? CEFPI *Issuetrak* (November).

National Clearinghouse for Educational Facilities. 2006. Average construction cost for elementary, middle and high schools in 2005.

CHAPTER 4

Designing Facilities for the Elementary School (K–5)

K–5

Key ideas in this chapter:

- Room design should be determined by space needed for safety, class size, and technology.
- Multiple-use classrooms should have highly flexible space allowing for science integration.
- Extended exploration rooms are worthy goals.
- Furnishings and utilities should meet specific requirements.
- Technology needs should be determined early in the planning stage of design.

Elementary school science programs vary widely, but are important in laying the foundation for secondary science programs. Some schools prefer using teams of teachers, whose members can specialize, while others stress the integration of subjects by offering all content instruction in the self-contained classroom. Whichever of these approaches is taken will influence decisions concerning the settings for instruction. Because trends will always change, even within the same school system, the challenge to those charged with creating elementary facilities is to plan for the present with an eye toward flexibility in the future.

The most basic decision at the elementary level is whether to build separate science facilities or to make all classrooms—or one of each shared pair of classrooms—science-friendly. Most schools that have the resources opt to do both, putting the basics for science in every room, while creating a special place for more in-depth discovery. This approach facilitates science's integration with other subjects, while stressing the unique characteristics of the science environment.

The essential facilities for science, including hot and cold running water and flat work surfaces, are reasonable for every general education classroom, while the specialized storage and instruments that support special adventures can find a home in that special science area.

Whether science is taught in the general classroom or in a dedicated science room, there are some similar guidelines that must be followed. Space, flexibility, and safety are among the most important considerations. The following sections offer detailed suggestions and information for designing and equipping these learning environments and for providing the other resources that a good science program requires.

Space Requirements, Room Design

To accommodate current technology needs and teaching practices,

- a good science room will require a minimum of 40 square feet of floor space per elementary student, or 960 square feet for 24 elementary students.
- a multiple-use classroom in which science is taught will require a minimum of 45 square feet of floor space per elementary student, or 1,080 square feet for 24 elementary students.
- an additional 10 square feet of space per student will be needed for preparation space for the teacher and separate storage space (240 square feet for a class of 24).
- an additional 24 square feet minimum should be added to a multiple-use classroom to accommodate two 4-foot-wide, tall storage cabinets for science-related storage in the classroom.

The 2006 NSTA Position Statement on laboratory science recommends a maximum class size of 24 students in an elementary school.

If fixed computer stations are used, an additional 15 square feet is needed for each desktop computer station or equipment such as an electronic marker board. However, fixed stations are not recommended for tomorrow's classrooms. (See Chapter 2 on Technology.) Add 15 square feet for a laptop computer storage cart and approximately 20 square feet to accommodate a student with disabilities.

For safety and flexibility, a rectangular room at least 30 feet wide, without alcoves, is recommended. A ceiling height of 10 feet is desirable. The science room should have two locking entrances, doorways and a lab station that accommodate persons with disabilities, and adequate ventilation. It should also have projection equipment rather than suspended televisions, for both safety and accessibility.

The Multiple-Use Classroom

To maximize the relevance of authentic science experiences to young children, it is important that science can happen in self-contained classrooms. In the early years—prekindergarten through grade 2—science should be integrated with other subjects and activities throughout the day. The self-contained classroom will require plenty of tables and uncarpeted floor surfaces where messy activities can be conducted easily. Sinks and counters at student-height are also needed, so that frequent hand washing and cleanup can be accomplished with minimal assistance. It is also important that every classroom have hot and cold running water and soap.

In the upper elementary grades (3–5), the classroom should have a greater capacity to accommodate science activities, even if some of those activities will be performed in a dedicated science room. Provisions should be made to integrate science into classroom projects by providing hot and cold running water with soap, flat surfaces, electricity, connectivity ports, and provisions for overnight storage of projects in the classroom. Specialized storage for chemicals should be considered, even though the recommended stock of chemicals in the elementary level is very limited.

Furnishings

All multiple-use classrooms used for science will need:

- movable, flat-topped tables of appropriate size for the students;
- a large sink (15 × 25 × 10 inches) with hot and cold water, mounted at student height, with an attached, hands-free tepid water eyewash;
- additional sinks or "wet areas;"
- counters, base and wall cabinets, and adjustable shelves of various depths to house science-related equipment and materials;
- some form of lockable storage;
- tote-tray storage units or carts;
- a marker board and tackable wall surfaces for displaying charts and posters, photographs, and maps;
- a projection screen and digital projector;
- electrical outlets with ground-fault-interrupter (GFI) protection; and
- connectivity, preferably wireless.

Many of the suggestions and ideas presented below for room arrangements and furnishings for specialized science classrooms apply to multiple-use classrooms as well.

The Specialized Science Classroom

See Table of Critical Dimensions in Appendix C for specific dimensions.

As enthusiasm for science grows, so do expectations of students and teachers. Some schools are lucky enough to have a science specialist, but even if such a staff member is not available, the existence of a special space for extended exploration is always desirable. The elementary science laboratory, often called the "discovery room," is a large, well-equipped, and well-lit classroom with 4–5 sinks and extensive storage for science equipment and kits. These materials may be used in the room or checked out for follow-up activities in the homeroom. This specialized room should be accessible to those with disabilities. While a discovery-room approach requires cooperation and schedule coordination among the elementary staff, most teachers feel that the academic advantages of this specialized science room outweigh any administrative requirements. Discovery science rooms have the unique capacity to reflect the school community and the environment, by incorporating local weather monitoring and astronomy equipment and collections from local strata and native plant gardens.

Because of differences in both the students and their science programs, there are advantages to having separate science classrooms for kindergarten through second-grade students and for third- through fifth-grade students, although the facilities are very similar. The furnishings for each are described below.

A specialized science classroom

Furnishings (K–2)

The type and arrangement of space desirable for students in kindergarten through second grade requires great flexibility. Fixed student workstations should be avoided in favor of flat-topped movable tables. For safety reasons, there should always be a minimum of 4 feet between the perimeter counters and the tables. It is important for planners to verify that the floor space will be suitable for small-group arrangements around a central, movable teacher's table or cabinet, as well as for traditional classroom seating and other arrangements. Allow at least 4 feet on all sides around each grouping of tables. In the classroom-type arrangement, provide a minimum of 8 feet from the front wall of the classroom to the first row of tables. The teacher will then be able to move around

A multiple-use classroom planned for science

easily, have the use of a table, instruct at the board, and use a projector.

Sinks (K–2)

Several sinks with tall, swiveling, aerated faucets should be inset in the student-height, perimeter countertops. The number of sinks depends on the number of students and the types of activities that are expected to require sinks. A good rule of thumb for kindergarten through second grade is one sink for every four to six students. Standard stainless-steel kitchen sinks are acceptable, but they should be large—15 × 25 inches, for example—and have fairly deep (10 inches) bowls. It is best to provide hot and cold water and soap (not alcohol gel) at all sinks, for safe hygiene. A drinking fountain and dual hands-free tepid water eyewash can be provided at one sink and a hand-held, pullout body drench shower at another.

The teacher will need a portion of counter space at least 6 feet long and an adjacent sink at the standard adult standing height of 36 inches.

Work Space (K–2)

The height of counters along the classroom perimeter should be 24 inches. It may be necessary to provide some variety of counter height to accommodate students of different heights. Watch for sharp corners, especially at this primary level.

In order to allow the flat-topped tables to be level when they are pushed together and to compensate for variations in students' size, adjust the tables to the same height and order chairs or stools of various heights. A good height for the tables is 20 inches. Square tables, 30 inches on a side, work well, as do rectangular ones that are small enough to be moved easily, yet large enough to permit students to spread out their work. Chairs or stools can be used for seating. Many teachers prefer stools without backs, because they can be pushed under the tables when not in use, freeing up floor space.

The teacher should have a movable table or cabinet in which materials may be stored. At this level the table rarely needs utilities.

Storage (K–2)

Casework should include base cabinets with student-level counters along two walls for additional work and preparation space. Wall cabinets should be placed above base cabinets for safety reasons. Most counters will be 24 inches deep. Even though chemicals and cleaning supplies are to be stored in another room, teachers will want some lockable classroom cabinets, because even relatively innocuous materials such as glues and paints can tempt students and result in poisoning.

K–5

Poster drawers under 3-foot-deep counter

All countertops in classrooms, preparation rooms, and storerooms should have plastic laminate or other durable finishes resistant to water and chemicals. Countertops near a water source should have a backsplash with no seams. Give priority to selecting high-grade cabinets made of hardwood plywood with plastic laminate fronts. Avoid particleboard assembly, because this material reacts poorly to moisture. Flexible storage can be provided by a variety of cabinets with drawers and doors of different sizes. A larger map cabinet is useful for storing instructional posters, maps, etc. Leaving a 30- to 36-inch-wide knee space under a counter will allow students a place to sit at the counter. Drawers in some lower cabinets can provide convenient access to both teachers and students.

One or two tall science storage cabinets, separate from the teacher's personal cabinet and bolted to the wall, will store items of various sizes, especially if it has vertical dividers that hold adjustable shelves. This cabinet should lock. Hinged doors are recommended for wall cabinets, because sliding doors waste about 3 inches of cabinet depth. Typical depths for wall cabinets are 12 and 16 inches, with tall cabinets being 16 or 22 inches deep.

Mounting heights for wall cabinets will depend on whether students are to have access to them: 42 inches from the floor for students, 54 inches for adults. All cabinets should have positive latches that can withstand seismic events without opening. Some cabinets also must meet the Americans with Disabilities Act Accessibility Guidelines (ADAAG). At least 18 linear feet of book shelving, 10 or more inches deep, some at student height and some at adult height, should be provided.

It is important to set aside a suitable area for hats and coats and cubicles (cubbies) for student backpacks so that they will not be in the way. If these "cubbies" are in a L-shaped alcove, make sure the area is visible to the teacher. Large storage bins with lids for recycling paper, cans, and bottles are also a good idea. Plant carts are very useful for growing various flora for instructional uses. Window shelves can also accommodate plants, terrariums, aquariums, and small animal cages, but should not be placed on west walls because of the tendency of overheating. Aquariums are often placed on perimeter countertops. Don't forget to plan for an adequate number of (and safe placement of) GFI outlets to accommodate the need for light and electricity to run equipment such as heaters and filters.

Display Space (K–2)

One wall should be kept largely free of cabinets to allow places to display student's artwork and instructional aids like maps, charts, and posters. Tack boards can be hung in any unused wall space, and tack strips can be installed above cabinets.

Dry-erase marker boards have become standard, because chalk dust can be harmful to both computers and people. However, there is also a concern about the toxicity and odor of the markers, and all manufacturers' information and MSDSs should be studied. Water-based inks are preferable. Sliding, multiple-panel boards can be used to extend the marker board without increasing the amount of wall space used. If a marker board is to be used by students, it should be mounted with the bottom edge 24 inches above the floor. As this is an uncomfortable height for most adults, the board should be taller than standard height to accommodate adults.

Storage behind and beneath the marker board

The space behind and below a marker board can be used for storage or for book shelving by recessing shelves into the wall. The sliding panels of the marker board cover this storage until it is accessed. Drawers below the marker board can add significant highly useful storage capacity. Such storage requires thickening of the wall behind the board.

The instructional focus area must support a variety of instructional presentation formats, including video, DVD, slides, digital projection, projected microscope images, overhead projection, and dry lab activities. Controls, including light switches and dimmers, can be installed—often wall mounted—in the front of the room, easily accessible to the teacher. Electronic control systems, with hand-held remote controls, can be installed to allow the teacher to control lighting, sound and projection systems from anywhere in the room. Permanent mounting of equipment such as those used for projection and sound solve problems including theft and trip/fall hazards.

A projection screen should be mounted on a wall or the ceiling. The screen size should be at least 5 feet by 7 feet, but 6 feet by 8 feet is preferable for best visibility. If the screen is to be mounted on a high ceiling, include an additional “tail” of material at the top of the screen; the bottom of the screen will then be approximately 3 feet above the floor. Mounting a projection screen on a diagonal in a corner of the room can allow use of the marker board at the same time the screen is employed. Marker boards generally do not make good projection screens, because their surfaces do not reflect light well.

Because so many elementary students have temporary, frequency-dependent hearing challenges, it is recommended that every classroom have built-in speaker systems to accommodate field sound systems. These systems make audiovisuals more audible, and can easily be hooked to a lavaliere microphone to help teachers reach students more effectively.

A variety of interactive electronic marker board systems have been developed that allow the user to input data to a computer program using special markers that transmit their movements to a sensor in the system. These can be used in conjunction with a digital projection system to enhance instructional materials. Many of these systems consist of a screen, either mounted on the wall, or on a movable frame; others have sensing devices that mount on an ordinary marker board with suction cups. If use of one of these systems is envisioned, space should be provided for the screen.

Utilities (K–2)

Electrical power should be installed with ground-fault interrupters (GFI) on every circuit. Provide plenty of duplex electrical outlets and data outlets (at least one hard-wired data port equipped with a wireless network) around the perimeter of the room for the movable tables that are brought close to them when power is needed. Three duplex outlets are needed on the instructional wall for the teacher’s administrative and instructional equipment. Overhead, pull-down electric cords, similar to those used in automotive shops, can supply power to the middle of the room, but must be used with extra caution. Power poles are inflexible and generally cannot stand much physical abuse and should be avoided.

Care should be taken to investigate the safety features of any alternative to wall outlets. Everyone, including custodial staff, should be informed of procedures for their safe use. The number of electrical circuits in a classroom should be adequate to power the equipment expected to be used. At least three 20-amp circuits should be provided.

Gas is not used at this level. Flat-top hot plates (not typical kitchen hot plates) that limit heat, a microwave oven and a refrigerator for teachers’ use, are standard equipment. The microwave oven (not for student use) and hot plates are best located in the preparation room, for safety reasons.

Emergency shut-off controls for electrical service should be near the teacher’s station, not far from the door, and not easily accessible to students.

A room exhaust fan will be needed when an investigation or demonstration creates smoke or an unpleasant odor. Exhaust fans are often installed on the roof or in place of a windowpane.

Lighting and Darkening Rooms (K–2)

Many researchers have documented that the best light for learning is natural light. A bright elementary classroom needs at least 50 foot-candles per square foot of floor surface and 75 to 100 foot-candles at the work surface. Lighting design must be handled carefully to avoid washing out projected images while providing enough light to enable students to see their tabletops. If computers are to be used in the room, directional diffusers are recommended, and the down lighting on the work surface can be provided by three-tube parabolic fluorescent fixtures with switches that allow the room to be darkened in stages from front to back. Pendant, indirect fluorescent fixtures supplemented by compact, low-voltage downlights also work well in rooms with computers, but not as well with projectors.

Bulletin boards that roll across the window

Room darkening can be accomplished with blinds or shades. At this grade level, blinds are probably sufficient to darken the room for video projection. Some new schools are being constructed with bulletin boards that are rolled across the windows to darken the room. The

K–5

Blinds

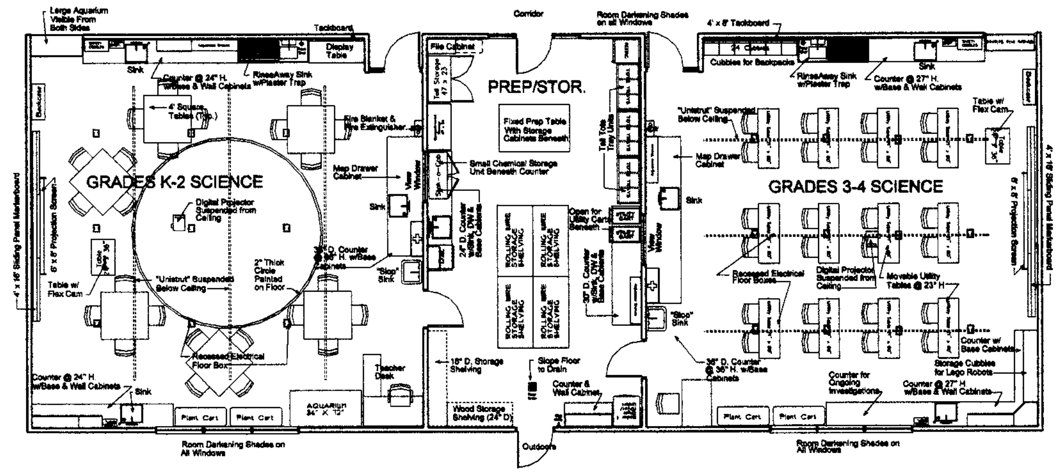

Shades at a greenhouse door

front row of lights in the instructional area can be wired so that they can be turned off when projection is needed, but students need light to take notes or see their paper.

ELEMENTARY SCIENCE SUITE

Room Sizes: Classroom 33' × 32'9" (1,081 SF)
(10m × 10m = 100m^2)
Prep/Storage: 18' × 32' 9" (590 SF)
(5.5m × 10m = 55m^2)

NOTE: Separate dedicated science lab/classrooms for grades K–2 and 3–5 with shared prep/storage space that also serves as a "mud room" for outdoor activities.




Computers, charger, and wireless hub on wheels

Computers (K–2)

Today, connectivity is the norm. New schools are almost universally built with wireless networks. Students are learning to do research, electronically, from very early grades. They gain access from flexible banks of laptops or smaller word processing hardware. It is not recommended that classroom space be limited by many fixed computer stations, because that creates both space and safety problems. Laptops and smaller hand-held computers can be used virtually anywhere, but should be kept away from the faucets. Lockable laptop storage carts, which allow the units to be recharged when not in use, can include a printer and a wireless network hub. Provide floor space for the cart when planning the room layout.

Furnishings (3–5)

Classroom needs are somewhat different for grades 3–5 students, not only because the students are taller than younger students, but because their developmental needs are different and the curriculum is more demanding. In the upper elementary grades, it is even more important for science classes to be held daily.

The arrangement of the science room should be similar to that for the younger elementary students. However, at the fourth- and fifth-grade levels, students often attempt large and long-term projects and conduct independent investigations. Because these activities may involve building tall structures on the floor, ample floor space and storage space for use between classes should be provided.

For information and details on the following, consult the earlier section on furnishings.

Sinks (3–5)

Perimeter countertops at student height should have one sink for every four or five students. Provide one large (15 × 25 × 10 inch) sink and an adjacent 6- to 8-foot section of counter space, 36 inches high, for the teacher's use. Every sink should have hot and cold water. At least one must have wrist blade handles and be accessible to students with disabilities.

"Rinse away" sink

Standard, stainless steel, single- or double-bowl kitchen sinks (15 × 15 inches), with fairly deep bowls at least 8 inches deep, may be used by students. They should have tall, swiveling, aerated faucets, and one of them should have a dual, hands-free eyewash. Another possibility is the "rinse away" sink: a molded fiberglass sloping top with raised edges and curved corners that drains to an integral sink. These units are ideal for messy cleanups and may provide the best location for a hand-held body drench that can also be used as a sprayer to clean up the sink. A plaster trap to catch sand or gravel that may otherwise be washed down the drain is a good idea. However, some plaster traps may not fit under 27-inch-high cabinets.

Plaster trap

Work Space (3–5)

For upper elementary students, 21- to 23-inch-high table heights and 27-inch-high countertop heights are appropriate. At this level, countertops are usually plastic laminate, but if the science curriculum is going to include dyes or caustic materials, the more expensive resin top may be worth the higher cost. Consider also the use of phenolic resin tops, which come in different colors, and are less costly than the epoxy resin. Varying the seating height will help accommodate all students. Since science laboratory casework manufacturers do not usually provide cabinets for 27-inch-high counters (29 inches is the standard), some custom casework may be necessary. Again, flat-topped tables that can be moved easily and rearranged into a number of configurations are recommended. A good size for two-student tables is 24 by 48 inches. If apparatus rods are to be used, sockets may be provided for them in the countertops or tables, because standard plastic laminate countertops are too thick (1 ½ inches) to accommodate most "C-clamp" apparatus rods.

Chairs or stools without backs will provide adequate seating.

Storage (3–5)

As teams plan storage for this level, it is important to establish the guidelines for what will be stored and how much. The general answer is: "As little as possible." Guidelines for limited inventories can be found in the NSTA series on safety.

Library card catalog unit

Each type of chemical or piece of equipment requires its own type of storage. Alcohol, acids and bases, and chemicals that might be potentially toxic (including cleaning materials) each require their own specialized separate storage facilities. So most schools opt to use these chemicals only in a designated science lab or discovery center, and not to distribute them among general classrooms, which won't have the right type of cabinets or security. Flammables should be stored in an appropriately sized, UL-approved, locked flammables cabinet. Corrosives such as acids and bases should be stored in a separate locked corrosives cabinet.

Base cabinets should have several configurations of drawers and doors, and one or more adjustable shelves inside. A 30- to 36-inch-wide knee space should be provided below some lowered counters, for student workstations. Map drawer units are often useful, but the countertops above them will have to be deeper than normal, usually at least 30 inches to allow for the storage of reasonably sized posters or maps. Provide tall storage cabinets, wall cabinets with solid doors, and bookshelves similar to those used in the younger grades. The appropriate mounting height for wall cabinets in this space is 45 inches from the floor for students and 54 inches for adults.

Display Space (3–5)

Ceiling hooks, a 1-inch-diameter steel pipe or an industrial strut system suspended from suitable structures above the ceiling tiles will provide places to hang various items. Each hook should have at least a 50-pound capacity, and the pipe or strut should hold at least 200 pounds per foot.

Utilities, Lighting and Darkening Rooms (3–5)

In general, provide the same wiring, utilities, and lighting as the room for kindergarten through second grade, including a room exhaust fan and GFI protection on every electrical circuit.

Computers (3–5)

The upper elementary student will have more need for computers, and will use them for more purposes. But the previous recommendations, which include wireless connectivity, flexibility, and the ability to move them around as needed, still apply. More than a decade ago, schools were spending significant portions of their budget trying to channel all video, internet, and other computer use through supervised media sites. As computer use becomes more varied and pervasive, it is clear that this is not a job that can be handled by hardware alone. Software, teacher professional development and training, and well-enforced school policies are all parts of a comprehensive internet security policy, and it is probable that any hardware investment that promises to provide internet security will be dated as soon as it is in place. (See Chapter 2.)

Teacher's Space

In addition to the table or cabinet for demonstrations, a desk with some shelves and a file cabinet in a room corner, or a desk in the preparation room, can serve as a "home space" for the science teacher. This area should be off-limits to the students. Make a telephone, electrical power, and a computer network port available at the desk. Many classrooms with networked computers keep a fast, powerful printer at the teacher's desk for use by the entire class. It is not recommended that printing jobs be sent out of the classroom.

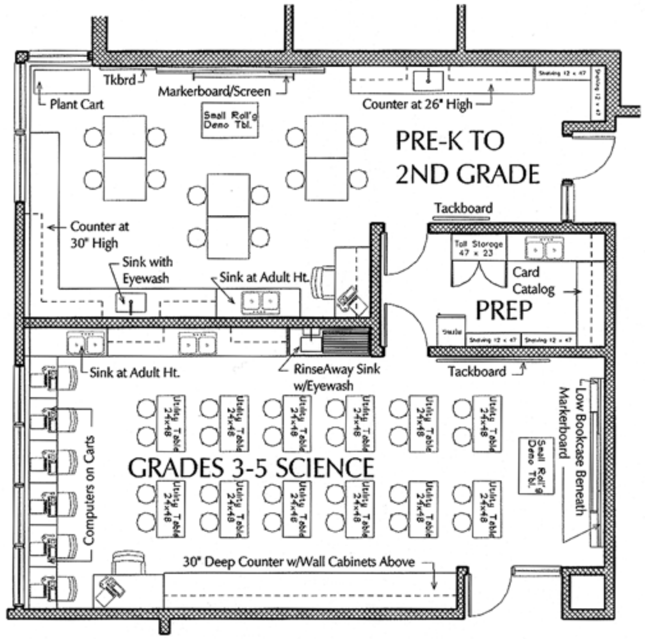
Preparation and Storage Areas for K–5

Teachers need space to prepare activities at the beginning of the day for the different classes that will visit the science room. For kindergarten through second-grade classes, this area should contain base cabinets with counters at adult height, a sink, and space for several rolling utility carts used to move chemicals and equipment in and out of the classroom. A refrigerator and a microwave oven are desirable. If windows occupy much of the exterior wall of the science room, provide additional storage space in the preparation area. Tote-tray storage units and cabinets of various sizes, with adjustable shelves and some lower cabinets with drawers allow teachers to store the items related to a particular lesson in a single container that can be pulled out at the appropriate time. A recycled library card catalog or an industrial bin unit can be useful for storing the many small items that may be used in an elementary program in labeled compartments.

For grades 3–5, a separate preparation room next to the science room is needed for an effective science program that provides students with the concrete learning experiences required to learn about the natural world. Many K–5 science programs utilize hands-on materials kits, which require special open storage areas. Storage for these special kits should be planned for in the regular classroom, in a special storage room, or placed in the science discovery room. A view window between the preparation room and science room facilitates supervision of students. The room should have base and wall cabinets of various sizes; one or two tall, compartmentalized storage cabinets; a desk with a telephone and electrical and network connections; and counter space with a large sink, and a spark-free refrigerator with an icemaker. The storage space needs open shelves, where the prepared materials for another class can be safely stored. In seismically active areas, installing lips on the shelves will help prevent breakage and accidents. Adequate ventilation and safety equipment are required. Storage rooms provide needed security and specialized storage for large, expensive, or sensitive equipment.

Hazardous materials should be very limited at this age level. But dilute acids for rock identification and alcohol are often included in inventories, so it is important to recognize that they need special, secure cabinets. A secure cabinet in the preparation area, 3 feet by 3 feet, for the lower grades and larger for the upper grades will suffice. If flammables, such as alcohol, are used, an appropriate storage cabinet should be available. In some cases, depending on the types and amounts of chemicals the curriculum calls for, a separate, secure, ventilated, chemical storeroom may be needed. However, a cabinet containing flammables should never be vented. Flammables, such as alcohol, must be stored in either a UL-approved flammable storage can or small cabinet. Corrosives should not be stored in a flammables cabinet, but in a specifically designed corrosives cabinet.

Preparation and storage space for grades K–2 and grades 3–5 can be shared successfully if the location is appropriate and sufficient space is provided for concurrent use.



Elementary science suite with shared prep room