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Recommendations from the Minnesota Industry-Education Board

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Minnesota Industry-Education Board

Minnesota Academy of Science

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INTRODUCTION: Recognizing the need for preliminary planning for secondary school science facilities, a list of recommendations is offered which present in broad outline the minimum requirements of such a facility. The facilities (i.e., fixtures, physical setting, etc.) alone cannot insure an adequate science program in secondary schools; the value of any facility, however thoughtfully designed, is determined almost entirely by the competence of the instructional staff and the content of the curriculum. While specific curriculum recommendations are beyond the scope of this report, the belief that laboratory experience must be central to the science curriculum at *all* levels of learning strongly flavors these science facility recommendations.

The recommendation is made that the central facility be a single room with provision for lecture-demonstration and designed for student performance of laboratory exercises. Adjacent to this room must be facilities designed for activities which supplement the basic activities of the principal lecture room.

It is important that the instructor be able to interweave the lecture-laboratory activities to best suit his needs. To accomplish this, the instructor must have full control over his lecture and laboratory facilities at all times.

In making these recommendations it has been kept in mind that there are a variety of schools and large or small numbers of students taking science, and all variations must be considered. We would suggest that any school planning expansion consider the desires and suggestions of the science teachers already in the system. The suggested facilities must take into consideration the educational background of the individual instructors. It is also felt that in the event that in the future other fields of science receive attention to the extent that they become separate courses, the facilities must allow for them, and so be flexible, meaningful, practical and adaptable.

This proposal makes recommendations that are by no means intended to be utopian, but only to provide minimum standards for effective instruction.

The really *essential* component of a successful secondary school science program is an adequately trained instructor. The minimum background of such an instructor cannot be less than the equivalent of an undergraduate major in his teaching field. The efforts of this adequately trained instructor, if he is to be allowed to produce most effectively, must be supplemented by secretarial and laboratory assistance specifically under his directions. Superiors must recognize that creative science teaching cannot be done on a crowded and rigid time schedule; consequently, teachers must be given a teaching load permitting adequate preparation time. A realistic load might well be four classes per day with twenty-four students per class. To relax any of the requirements that the instructor be adequately trained, adequately assisted, and given adequate time to do his job insures mediocrity at the heart of the science program.

II. BASIC RECOMMENDATIONS:

A. Facilities for each classroom:
   1. A 2′ x 3′ laboratory bench space per student.
   2. 110 AC, water, gas and available sink at each student laboratory station.
   3. One special project room, with two exits, for each classroom.
   4. Overhead shower, CO_2 fire extinguisher, and adequate ventilation (especially for chemistry).
   5. Provision for projection, photo image multiplication, with or without closed circuit TV.
   6. At least one preparation room for every two classrooms, a rolling cart (with brakes and

electrical outlets) for transferring materials to classrooms. (This necessitates wide doors and elimination of steps and moldings.)

7. Demonstration desk with 110 AC, water, gas, and sink.
8. Science workshop available for all sciences.
9. Office for two teachers with view of their respective rooms.
10. A minimum of 6 lineal feet of bulletin board space.
11. A minimum of 16 lineal feet of chalkboard space.
12. Storage space provided wherever appropriate and possible.
13. Movable student chairs with attached writing surfaces.
14. Provision for display of large charts or pictures at the front of the room.

B. Facilities common to two science rooms should be:
   1. Preparation room.
      a. To provide storage
      b. With bench for work space.
      c. With 110 AC, gas, water, and one large sink.
      d. With drying rack.
   2. Teachers office.
      a. Should have window looking into lecture-laboratory area.
      b. Large enough for one desk per teacher, several chairs, filing cabinet and coat rack.
      c. Should include a small blackboard.

C. Facilities which should be available to each individual lecture-laboratory room are:
   1. A small library area located in the main classroom or in the office at the discretion of the instructor, for shelving current periodicals and reference books in addition to those in the school library.
   2. Special project room.
      a. 110 AC, gas, water, student sinks, and one large sink with drying rack.
      b. Laboratory bench space for approximately 10 students.
      c. Adequate ventilation (hood for chemistry).
      d. In the interest of safety there should be two exits.
      e. Apparatus rack with gas, water, 110 AC available (for chemistry)

D. A facility which might be common to all science rooms is the science work shop. This work shop should include: (1) hand tools, (2) drill press, small metal lathe, metal band saw, (3) modest quantities of metal and wood stock, and (4) a bench for soldering and glass blowing.

III. Biology:

A few principles and general statements apply to the planning and provision of facilities that are to be used in teaching biological science to secondary school students. Such statements must relate the various branches of biological science to the facilities that are used in teaching them, and also to the special abilities of any teacher who may be asked to use those facilities.

So-called "permanent" facilities must outlive specific teachers and must therefore provide, as completely as possible, for teaching all branches of biological science – even though the special interests and abilities of many teachers cover only various segments of those branches.

Three major branches are microbiology, macroscopic plants, and macroscopic animals. The first uses microscopes, autoclave, refrigerator, freezer, incubator, etc. The last two use terraria (damp and/or dry) and aquaria (with heated or unheated, and salted or unsalted water). The second uses windows, a plant room or controlled environment equipment, and chart storage space. The third uses "pickling" containers, a possibly windowless animal room (with cages and sink), and storage space for charts, skeleton, and/or a mannequin.

The teacher and his better students should also have a special project room. If biology is to be a science course then certainly research must be an integral part of its teaching, and proper facilities must be available.

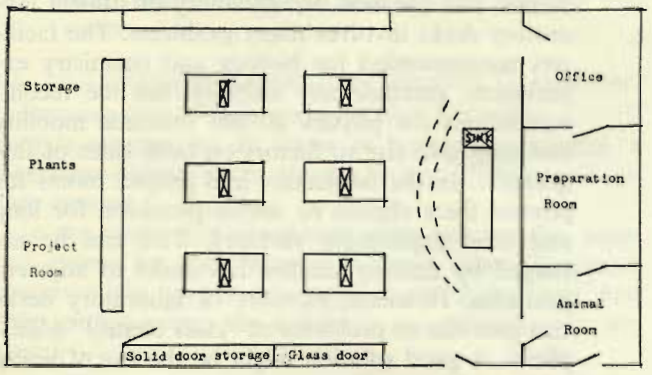
The presence of the laboratory in the lecture room is ideal for the integration and utilization of a truly experimental approach to biology. To carry this idea further implies a low pupil-teacher ratio for truly individualizing instruction and experience.

As a further comment on peripheral facilities for biology, (mainly in adjacent rooms), it should be noted that previously uncommitted space can easily be used to provide for some types of work but not for others. For example, plant growth can be arranged for in either the special project room or the classroom – by means of either lighted window ledges, specially illuminated racks, or portable controlled-environment set-ups. Thus previously uncommitted space can be used for plant growth – but not for the housing of animals, because of odors. Thus a provision for animal culture requires a separate, well-ventilated, and easily-cleaned room – unlike a plan for plant or microorganism culture.

Special Provisions for Biology.

1. One storage wall should have part glass door and part solid door storage equipped with locks for protecting microscopes, binoculars, microtome, etc.
2. The windows can be utilized for plant growth by either shelves or controlled environment units.
3. The small animal room should be accessible to the custodial staff, be constructed with floor surface, floor drain and walls that can be washed and scrubbed. Ventilation, temperature and humidity control are vital. A window between this room and the classroom would facilitate viewing from

BIOLOGY



Student Desks 4′ x 8′
Student Sinks 3′ x 10″ x 8″
Demonstration Desk 3′ x 10′
Demonstration Sink 3′ x 2′ x 1′

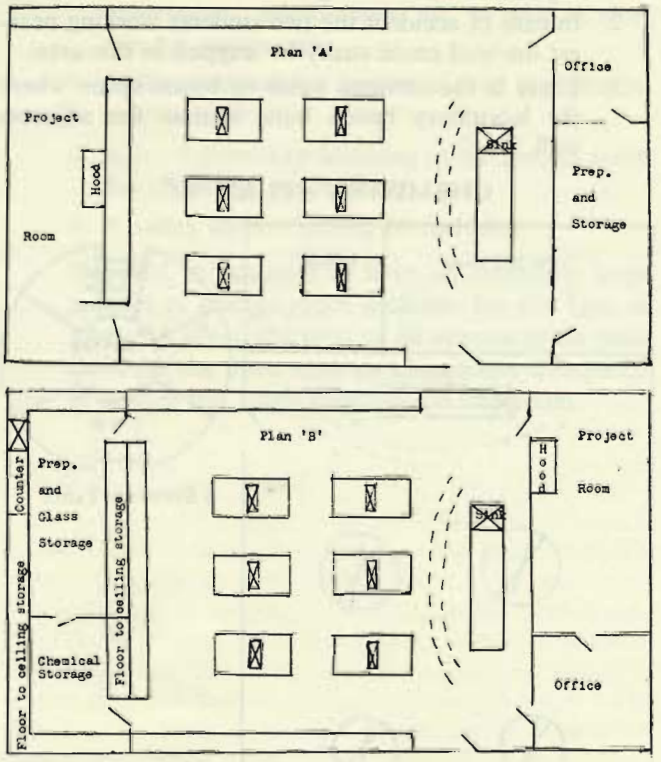
the classroom, yet keep the animals isolated. A shade to darken the animal room should also be considered.

4. The preparation room should include provisions for storing preserved animals, charts, mannequin, skeleton, incubator, refrigerator, freezer, autoclave, etc. A stainless steel storage tank would be ideal for the storage of preserved animals. The presence of a sink, work space and supplies would all aid the instructor in setting up demonstrations and carrying on personal research.
5. The project-plant-storage room should include storage for models, preserved plants and animals in addition to space for individual student projects. Again ventilation, temperature and humidity must be controlled. Here as in the main lecture-laboratory room shelving or controlled environment units or a small window ledge type greenhouse should be provided.

IV. CHEMISTRY:

1. In addition to the items mentioned as basic recommendations, each student should have a suitable ringstand and support and a locked drawer for equipment, sink, balance, centrifuge, and cupboard space should be available to small groups of students, perhaps a group of four.
2. A fire extinguisher (CO_2) and a safety shower are necessities in this room.
3. Stockroom area and storage for the usual glassware and chemicals should be provided for every two chemistry rooms. The semi-micro approach would offer real benefits here (see number 10 below).
4. A separate, ventilated, storage area should be provided for volatile chemicals. The volatile chemical storage area should contain a minimum of 16 square feet of shelf space.
5. Space should be provided for storing glass tubing. The storing of glass tubing may be accomplished by providing a minimum of four horizontal bins 1 foot wide, 8 inches high and 4 feet long.

CHEMISTRY



Student Desks 4′ x 8′
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6. In the interest of safety there should be two exits each for the preparation and project rooms.
7. The project room should have good ventilation and a hood which could be observed, perhaps through a window, from the main classroom.
8. There should be a hood in the preparation room.
9. To anticipate future needs space for an instrument room should be provided.
10. Semi-micro laboratory procedures should be strongly considered. Advantages of using this method are:
    a. Saving a teacher time in preparations of solutions and other chemicals.
    b. Requires shorter experiment time.
    c. Saving of student time because there is a complete chemical supply at each student station.
    d. Lower cost on breakage.
    e. Greater safety factor with smaller quantities, also adequate ventilation is more easily obtained.
    f. Better use of storage and stockroom areas.
    g. Less student movement necessary in laboratory (which adds to greater safety).

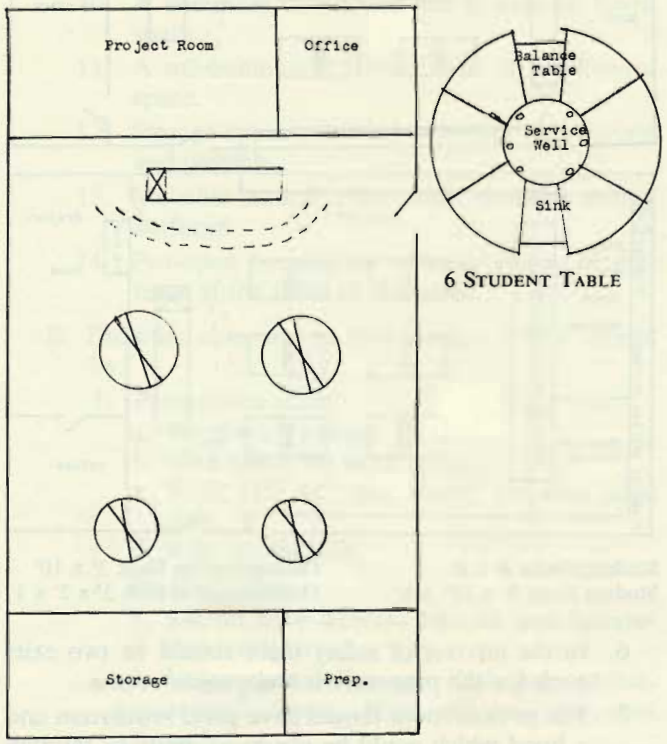
This committee would not recommend the perimeter arrangement of student laboratory stations for the following reasons:

1. In order to get to sinks, chemicals, etc., student must go around other students to get to these

areas. This causes undue student movement, wasting time and increasing the chances of accidents.

2. In case of accident the two students working nearest the wall could easily be trapped in this area.
3. There is the obvious waste of bench space where the laboratory bench butts against the adjacent wall.

CHEMISTRY – PLAN "C"



6 STUDENT TABLE

Gas, water, electricity at each student station plus drain cup.

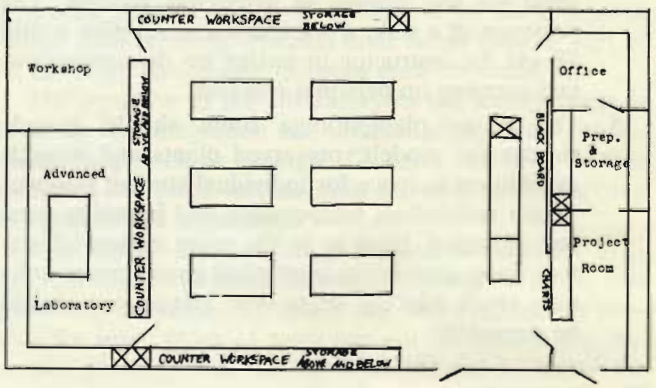
Tables should be oriented to teacher focus, either in middle or front of laboratory.

A circle with pi feet radius will give each student a space of about 3′ x 2′.

V. PHYSICS:

1. Provisions must be made for ceiling support of apparatus above the demonstration desk.
2. The demonstration desk should be designed with a minimum of 8 lineal feet of unobstructed and unbroken surface. The location of the sink at one end of the demonstration desk and below the table level might be an aid in accomplishing this.
3. Provision must be made for some method of drawing graphs on the chalkboard. The hanging of a roll-down graph stencil above the chalkboard is one suggestion.
4. The physics classroom should be located and designed so that it may be easily darkened while maintaining adequate ventilation for comfort. This suggests that a southern exposure may be undesirable.
5. Student work space on movable desks should provide a minimum of 8 lineal feet of unobstructed work space. This is necessary for motion experiments. The question of movability of student laboratory desks involves many problems. The facilities recommended for biology and chemistry experiments preclude any mobility, but the recommendations for physics do not preclude mobility and may give rise to factors on both sides of this question. In the lab-lecture and project rooms for physics there should be ample provision for long and level experiment surfaces. This can be arranged by moving smaller lab desks to adjacent positions. However, mobility of laboratory desks can give rise to problems of "class control" (discipline). A good solution might be the use of heavy tables with non-slip rubber feet.
6. Student facilities for 100 v. AC and gas should be provided along the periphereal work area. A large central facility for AC-DC current is unnecessary. Batteries or mobile rectifier and transformer sources are a better provision for this need.
7. Storage in both the laboratory and the storage room must include accommodations for large vol-

PHYSICS



Student Desks 4′ x 8′

Demonstration Desk 3′ x 12′
Demonstration Sink 3′ x 2′ x 1′

ume apparatus such as vacuum pumps, wave tanks, etc.

8. The advanced laboratory room must include provision for total darkness. Electricity and gas should be provided at intervals along a peripheral work space. A sink and water, and a movable table of the type used in the laboratory room should be present. This special laboratory room will be necessary for optics experiments involving spectroscopes, photometers, etc. that are affected by other light; photographic analysis of motion; advanced experiments in all phases of study in physics; and minimum darkroom use.
9. The preparation and storage room must include a bench for soldering and a place for storage and use of small tools such as pliers, screwdrivers, wrenches, etc., for assembly, adjustment, and maintenance of equipment.
10. The project room should be easily viewed from

the office, contain storage areas, have a soldering area, and be supplied with 110 v. AC, gas and water.

VI. Multiple-use Laboratory-Lecture Classroom:

Because this committees feels that laboratory experience is essential to all levels of learning in science, a laboratory-lecture room should be provided for *all* science courses.

In the event that enrollment does not warrant separate rooms for each science, or even that all science courses might have to be taught in the same room, and only in that event, the following recommendations are made:

1. The same basic physical set-up as already described for biology, plus:
   a. Ledge (and storage underneath) around the edge and across the back of room for motion experiments, microscopes, etc. as well as storage for equipment.
   b. Ceiling support for apparatus over the demonstration desk.
   c. A hood should be included in the project room for chemistry experiments.
   d. A safety shower should be included.
2. It would be essential to have an especially large amount of storage space available for this type of room. In effect, the total of all storage space indicated for the three separate classrooms is required to service this single multiple-use classroom.