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Scope of Study: The laboratory in high school biology has failed to achieve its goals in some instances. This study has made an attempt to determine what objectives the laboratory will achieve and what will constitute an adequate laboratory for the high school biology course. The study was divided into three phases. The first dealt with the historical development of the laboratory in educational institutions, its present use and the laboratory method compared to other teaching methods. The second phase dealt with the goals and objectives of the high school biology laboratory. The third phase attempted to determine what measures could be taken in order to gain the maximum benefit from the laboratory.

Findings and Conclusions: In many instances, the laboratory has not been fully utilized. The laboratory should be used only when a definite need arises. The laboratory may achieve specific and general goals at the same time. Proper planning and supervision is of prime importance to the proper functioning of the laboratory. Equipment and time for teacher preparation are contributing factors to the present state of the high school biology laboratory.

ADVISER'S APPROVAL James H. Zant

THE USE OF THE LABORATORY IN HIGH SCHOOL BIOLOGY

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J. B. G.

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CHAPTER I

INTRODUCTION

Science has played an outstanding role in our lives in recent years and is now changing our entire way of life in such important aspects as health, transportation, communication and power. We are living in an age where boys and girls are literally forced to be concerned with some principles of science and their applications in every day living.

In order to do the very best with the students of today, teachers must make the most of all existing opportunities. The laboratory method of teaching is one such opportunity. It is frequently neglected altogether or conducted in a way which will not achieve the intended goals.

Purpose of Study

It is the purpose of this study to determine what objectives the laboratory method will achieve and to determine what constitutes an adequate laboratory for high school biology.

Relation to Teaching Field

The writer teaches general biology at the secondary level. He believes that the laboratory will be of great help in the teaching of high school biology because it will

make for a better and more ready understanding of the subject.

Limitations

This is neither intended to be a comprehensive study on methods of teaching nor a guide for conducting a high school biology laboratory. The findings of this study are primarily concerned with the improvement of the teaching ability of the writer.

CHAPTER II

THE LABORATORY METHOD AS A TEACHING AID

The development of the laboratory in educational institutions has been a gradual process. It grew out of the experimental methods used in the German schools in the seventeenth century.

It was not until the nineteenth century that students were brought into the laboratory for practical instruction on a wide-spread basis. Before this time, only the outstanding students were permitted to do laboratory work and then only in their professors' own private laboratory.

In high school, the teaching of biology, in 1904, consisted of separate courses of botany and zoology, each a semester or year in length. Up to this time botany was largely a subject for girls.[1] Although a few schools retain separate courses in botany, zoology and physiology, biology is found in the curriculum of ninety-five per cent of the public secondary schools today.[2]

The use of the laboratory has been traditional in the

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[1] F. E. Floyd and M. A. Bigelow, The Teaching of Biology, (New York, 1904), p. 61.

[2] W. E. Martin, The Teaching of General Biology in Public High Schools in the United States, (New York, 1946), p. 3-4.

biological sciences. After the laboratory method was firmly established in the colleges, it began to develop rapidly in the secondary schools. College graduates who went into the high schools took with them strong feelings for the importance of laboratory work.[3] Laboratory work was also prevalent in early courses in botany and zoology. Bullington relates that laboratory work was the basis of the course, and the text was used to verify and supplement.[4]

Trends in the Use of the Laboratory in High School

There has been a trend, in past years, to drift away from the laboratory method to the recitation method. This trend has been criticized by many; however, in some instances it is the only method of instruction.

What are some possible reasons for this trend? All too often teachers who have a few college credit hours in some particular field, find themselves assigned to teach in that area. This may be the case in many small high schools. Many small schools, staffed by three or four teachers, attempt to teach all courses from grade nine through twelve. The lack of preparation to teach high school biology may be one contributing factor in the trend away from the laboratory method in some schools.

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[3]A. J. Ihde, "The Development of Scientific Laboratories," The Science Teacher, 23(November, 1956), p. 325.

[4]Robert A. Bullington, "Trends in the Teaching of High School Biology," School Science and Mathematics, 56(February, 1956), p. 100.

In some cases, teachers are assigned to teach five or six classes daily. They may have as many as three or four preparations. This is also a factor which causes some teachers not to use the laboratory as much as they would, had they time to prepare.

Equipment and facilities for laboratory work are not always available. Many teachers have used this for an excuse for not using the laboratory. With respect to apparatus and supplies, Ihde has this to say:

> Educators must not become overwhelmed by costly and intricate apparatus. The instructional laboratory can still function most efficiently by remaining simple and exploring fundamentals. Sticks, pieces of string and backyard insects can still teach and inspire, often better than the most expensive instruments. The alert mind guided by the enthusiastic and understanding teacher is still needed in laboratory training.[5]

Laboratory Method Compared to Other Methods

There has been many an idea for and against the laboratory method of instruction in the secondary school. Some contend that the laboratory method has little value and that good demonstrations are superior. Numerous studies have been made as to which is the best method to use. The findings of these studies seem to indicate that there is no best method. In deciding what method to use, the major consideration would be apparently, which is most convenient and inter-

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[5]A. J. Ihde, "The Development of Scientific Laboratories," The Science Teacher, 23(November, 1956), p. 328.

esting to the instructor.[6]

Manivaller gives three reasons why laboratory activities should be carried out in any science course. These are:

1. They should be included in a program of science because they incorporate to a very high degree acceptable principles of learning.
2. They are planned to enhance beliefs basic to a democratic society.
3. The fundamental and ultimate reason for having laboratory activities is that they are indispensable for teaching the scientific method.[7]

The Laboratory as an Aid to Teaching General Biology

It has been noted that the use of the laboratory in teaching general biology aids in various ways. It gives students a chance to learn by doing. Many students may gain understanding from lectures, by reading and/or asking questions. However, if a suitable laboratory exercise is performed, most students learn points quicker and remember them longer. Diagrams, filmstrips, demonstrations and the like are all good, but none can take the place of the student doing an exercise by himself. The laboratory brings into use all of the students' senses. He not only looks

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[6]Herbert Frimp and J. K. Hichar, "An Experimental Study of Laboratory Teaching Methods in General Zoology." Science Education, 42(April, 1958), p. 255.

[7]Lloyd V. Manivaller, "Laboratory Activities, Why?" School Science and Mathematics, LVI(February, 1956), p. 85.

and listens, but feels, smells and perhaps tastes the material as well. Some students, when given a chance to perform, do much better work than when tied down by the daily routine often found in some high school biology classes. The laboratory aids the teacher in at least the following ways:

1. Break from routine class work and thus stimulates interest.
2. Brings all of the students' senses into use.
3. Allows individual work and learning by doing.
4. Makes for individual differences.
5. Helps students to understand principles and concepts better and more quickly.
6. Gives student an incentive to look farther into a problem on his own.

CHAPTER III

GOALS AND OBJECTIVES OF THE LABORATORY METHOD OF TEACHING

Many principles of science are quite abstract to high school students who are meeting them for the first time. Students try to learn important laws and generalizations by memorizing them. Well-planned and first-hand experiences in the laboratory can make important principles and applications more meaningful than oral or written explanations.

The aim of practical work in biology is not only to illustrate principles and encourage interest. Practical work attempts to train pupils to suspend judgment until they have facts to guide them, and to leave them ready to modify their opinions when new facts arise.

All exercises should be planned with definite objectives and learning outcomes in mind. The laboratory exercise may be planned to accomplish specific objectives and at the same time will accomplish broad objectives. The broad objectives achieved in the laboratory have been summarized by Blanc as follows.

1. Gain functional information and facts.
2. Gain functional concepts.
3. Achieve instrumental skills.
4. Gain experience in problem solving skills and techniques.

5. Aid in the development of the scientific attitude.

6. Help students acquire an appreciation for science.

7. Help develop an interest in certain fields of science.[8]

Franzen maintains that an efficient laboratory will develop the scientific attitude, a respect for truth and accuracy, an appreciation of the work of scientist, and the spirit of investigation and research.[9]

Wendt relates that the laboratory will help the teacher to discover aptitudes and abilities in pupils, and direct these into useful channels.[10]

Leighton points out that the laboratory will achieve the following objectives in the teaching of general biology:

1. Teach more completely by increasing the number of senses used in experiments.

2. To give concepts as well as definitions.

3. To develop self reliance.

4. It will develop initiative.

5. Teach the problem solving technique.

6. Teach the value of scientific vocabulary for concise expression.

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[8]Sam S. Blanc, "Review of the General Goals in Science Teaching," Science Education, 36(February, 1952), p. 47.

[9]Carl G. Franzen, "The Place of the Laboratory in the Teaching of Science," School Science and Mathematics, 51(December, 1951), p. 708.

[10]Gerald Wendt, "The Role of Science Education in a Democracy," National Association of Secondary School Principles Bulletin, 37(January, 1953), p. 18.

7. Develop powers of observation.

8. Teach caution in forming conclusions.

9. Provoke thought.[11]

During the past several decades, the major goals for science education have been stated many times and in various ways. An examination of these statements reveals a unanimity of opinion. This opinion seems to be, "the development of a scientific attitude and the development of an understanding of the scientific methods."[12]

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[11] F. W. Leighton, Studies of Laboratory Methods of Teaching, (Ann Arbor, 1935), p. 20.

[12] E. D. Heiss, "Helping Students Develop a Scientific Attitude, Science Teacher, 25(November, 1958), p. 371.

CHAPTER IV

ORGANIZING FOR AN EFFECTIVE LABORATORY FOR HIGH SCHOOL BIOLOGY

If the laboratory is going to be effective in achieving the intended goals, some prior planning is an absolute necessity. Laboratory work may easily degenerate into "busy work" if it is not planned and administered properly.

In planning for laboratory activities, one should ask himself several questions. The answers to these questions should go a long way in helping the teacher plan an effective laboratory exercise. The following questions may prove to be helpful.

1. What goals and objectives does this exercise intend to accomplish?
2. Does the student have the necessary background information to successfully carry out the assignment?
3. Is the necessary equipment available? If not, can it be improvised?
4. How is this exercise related to class activities?
5. How can this exercise help students in out-of-school situations?
6. How much time should be alloted for this exercise?
7. Have the students been instructed on the proper use of equipment so that it may be used without damage?
8. Has the class been instructed on all safety measures in relation to the experiment?

9. What material should be prepared beforehand to insure that everything needed will be available?

10. Should instructions for the experiment be written on the chalkboard or should they be prepared for student handout?

11. Should a written report be required at the end of this experiment or would a short quiz serve the purpose?

12. Is the necessary reference material available? If not, what steps must be taken to obtain such material?

13. What follow-up activities would be desirable? (Test, film, outside speaker, student reports, etc.)

14. How much should this exercise count toward the students' marks?

The planning on the students' part is also important. The teacher may sometimes lose the student in a maze of directions. Too many directions may not be desirable. If the student is to do individual work, much of the planning must be done by him. To do this, the student will need various sources of reference material. During the planning, the student should confer with his teacher for the elaboration and emphasis of various points.

Faults and Weaknesses of the Laboratory

Several faults and weaknesses have become apparent in the high school laboratory. Of these faults, one that is mentioned often is the way in which the laboratory activities are carried out. The average high school laboratory has become stereotyped in the minds of many. The following statement, by Dr. Bentley Glass, sums up the usual

opinion of the average high school laboratory today.

> To a very great extent the key to understanding lies in laboratory and field study, which scarcely exist in most secondary schools today. For what most commonly passes as "lab" is most often a routine conduction of exercises that are no more scientific than following a recipe in a cook book, or, what is even worse, a mere naming of structures on blank drawings and answering of questions by looking them up in a textbook.[13]

The purpose of doing laboratory work should be to find solutions to problems, to verify principles and to develop skills and techniques. In carrying out laboratory exercises, laboratory manuals may or may not be used. The intended purpose of the laboratory manuals has not been criticized as much as the way in which they are used. There is adequate reason to believe that slavish following of direction, with the repetition of steps in a process, not only is a waste of time, but serves to rob the student of initiative.[14] Douglas and Mills has this to say about the use of laboratory manuals.

> One of the greatest limitations and dangers in laboratory direction is the unintelligent use of a manual without clear-cut realization of the purpose of the units of learner activity and of their relation to the rest of the work of the course. Learners follow blindly the instructions in the manual and fall far short of the skills and understandings intended.[15]

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[13]Phillip R. Fordyce, "The Work of the BSCS Which May Lead to Content Adjustment on the Horizon," School Science and Mathematics, 61(February, 1961), pp. 121-130.

[14]J. S. Richardson and G. P. Cahoon, Methods and Materials for Teaching General and Physical Science, (New York, 1951), p. 31.

[15]Harl R. Douglas and Hubert H. Mills, Teaching in High School, (New York, 1948), p. 497.

The use of laboratory manuals can be of much help in some situations. The teacher who teaches six classes daily has little time to prepare exercises of his own. Laboratory manuals may prove to be very helpful to new and inexperienced teachers. These manuals have been used by some students for the purpose of making up work they may have missed during a period of absence.

Hoff believes that these published guides are far superior to those prepared by the teacher. They should secure these helps and spend their time supplementing the prepared material.[16]

Although the laboratory manuals are justifiable if used correctly, they must not be allowed to dominate the science program. Teachers who for one reason or another are dependent upon them should work towards the day when they are free to use them only to the special contributions they may make.[17]

It is interesting to note the major faults of the high school laboratory which existed in 1934. Upon examination of some of these items, it is apparent that many of the same conditions are present in the high schools of today. Cole has listed these faults in the following manner:

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[16]Arthur G. Hoff, Secondary School Science Teaching, (Philadelphia, 1950), p. 183.

[17]Walter A. Thurber and Alfred T. Collette, Teaching Science in Today's Secondary Schools, (Boston, 1959), p. 126.

1. Lack of purpose, or objectives, in laboratory work, and lack of recognition and explanation of objectives when present.

2. Slavish dependence upon outlines, workbooks, etc., by both teacher and pupil.

3. The performance of laboratory work, the results of which the pupils already know.

4. The tendency to teach laboratory work detached from the rest of the course.

5. Requiring pupils to do laboratory exercises or projects which have been selected on the basis of their adaptability to experimental procedure rather than on the basis of pupil interest and needs.

6. Loss of time in the laboratory due to poor planning, inadequate arrangement, apparatus and directions.

7. Careless selection of projects, experiments or exercises.

8. Improper equipment and general lack of equipment and materials, even those which can be obtained locally without cost.

9. Teacher domination, and the tendency for the teacher to do too much work for the pupil.[18]

Duties of the Teacher in the Laboratory

The duties of the teacher during the laboratory exercise are many and varied. After the teacher has properly planned for the exercise, it must be supervised and directed properly to be most valuable. If there is a lack of supervision, many times there will be an excessive waste of time. Much time will be lost if inadequate directions are

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[18]William E. Cole, The Teaching of Biology, (New York, 1934), p. 98.

given. However, the teacher must guard against too many instructions. The instructions should only be a means to an end, and of a type which will require the pupils to think for themselves.

In order for the laboratory exercise to be most meaningful, there should be a high degree of correlation between laboratory activities and class work. The laboratory exercise should be scheduled when the need arises. There is no need for strict schedule of laboratory periods. The schedule should be such that it will provide for maximum flexibility. For example, when studying the process of photosynthesis, a laboratory exercise should not be carried out dealing with the morphology of insects.

Before the laboratory exercise begins, all students should be as adequately prepared as possible. If students are not familiar with a topic, the objectives of the exercise will not be achieved. If the laboratory is to be a problem solving tool, then it is the teacher's duty to see that the students are armed with the pertinent background information before the exercise is attempted.

In group work, the teacher should discuss the problem with the class. During this discussion, it is appropriate to make various explanations as to the performance of various portions of the exercise, safety precautions and other recommendations which may save time and energy.

If any danger is evident in the course of an exercise, students must be warned to prevent accidents and/or con-

fusion. Most accidents result from cuts, burns and bites. Broken glass, razor blades and the like are potential hazards if the proper care is not exercised at all times. When working with burners or acids, attention should be focused on safety measures. If burns should occur, the first-aid measures that might be used should be pointed out. The improper handling of laboratory animals often results in bites that may otherwise be avoided.

It is the duty of the teacher, during the laboratory period, as well as during any class, to maintain absolute order and freedom from confusion. This will permit students to accomplish more in less time, not to mention the undesirable results which might occur during unsupervised or disorderly proceedings.

The teacher should post himself in a position such that all pupils may be observed. If any seem to be experiencing too much difficulty, assistance should be given. However, one should guard against giving too much help to the student.

Scientific Attitudes and the Scientific Method

The laboratory is in an advantageous position to help develop scientific attitudes and habits of independent thinking. With regards to the scientific attitudes, Heiss has this to say:

> Considerable attention has been given to the method of teaching scientific methods. Much less attention has been given to the scientific attitude. This raises some

doubt, since a person without a scientific attidude will probably not use the scientific method.[19]

Some of the basic attitudes that the laboratory should strive to instill into the students are:

1. An attitude of lively curiosity about the world in which we live.

2. The belief that truth itself never changes, but our ideas of what is true are likely to change as our knowledge becomes more exact and complete.

3. The firm belief that nothing, no matter how strange and mysterious, ever happens or could happen without a cause.

4. The intention not to believe in any superstitions.

5. The intention to accept no statements as facts unless they are supported by sufficient proof.

6. The intention to make and carry through complete and careful plans for solving our problems, and not to try to solve them in a careless, hasty way.

7. The intention always to make our observations carefully and accurately.

8. The intention to seek evidence as long as may be necessary to find a true answer to a problem. Don't jump to conclusions or base your conclusions on a few observations.

9. A strong wish to gather our own facts by experimentation and observation. But be willing to use the results and facts obtained by others.

10. The intention always to change an opinion or a conclusion if later evidence shows it to be wrong.

11. The intention to weigh all the evidence.

12. The intention to face facts no matter how unpleasant they may be.

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[19]E. D. Heiss, p. 371.

13. The intention to respect other people's ideas, opinions and ways of life that are different from our own.

14. The intention not to allow our judgment to be influenced by our likes and dislikes.[20]

When doing laboratory work, the student should be guided by a scientific attitude and follow a scientific method. The scientific method has been defined in various ways all of which seem to be essentially the same. The first step in the scientific method is to define the problem. After the problem has been defined, the student should gather all the available facts relating to the problem. With these facts as a basis, the student then makes a scientific guess or forms a hypothesis as to the correct solution to the problem. He then devises experiments to prove or disprove the hypothesis. After various experiments have been performed, the student then should be able to form a conclusion as to whether the hypothesis was right or wrong.

Note Books, Notes and Laboratory Reports

During the course of a laboratory experience, it is often necessary to record observations. For this and other reasons, students should be encouraged to keep a notebook. It is usually helpful to the student if he keeps a notebook on each science course that he takes. Thurber points out the

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[20]Francis D. Curtis and George Mallinson, Science in Daily Life, (Boston, 1955), p. 535.

value of notebooks in the following manner.

> The science notebook is a valuable teaching device, suitable for a wide range of interests and abilities. It is a place to keep records, a summarization of learnings, and exercise in organization, a medium for self-expression, and indication of progress, and an accomplishment in which to take pride.[21]

In most instances, students should prepare a written report of the laboratory exercise. This may or may not be included in the notebook. This report may take a form in which there are four major parts. These are:

1. A statement of the problem undertaken.
2. The procedures used.
3. The observations made.
4. The conclusions drawn.[22]

In the report, other parts are often added when and if necessary. A list of apparatus used or a drawing is frequently included.

The making of drawings has been traditional in the high school biology course in past years. There has been a trend, in recent years, away from so many required drawings. In many cases the students concentrate on making an excellent drawing and forget the reasons for which it was intended. Studies have shown that in studying the structures of organisms, there was no significant difference between the grades of pupils who make drawings and those

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[21]Walter A. Thurber and Alfred T. Collette, p. 231.

[22]John S. Richardson, Science Teaching in Secondary Schools, (Englewood Cliffs, 1957), p. 75.

who simply located the structures without drawing.[23] If drawings are to be made, they should be simple representations which will not consume an excessive amount of time.

Equipment

The equipment found in many high school laboratories is indicative of the type of biology course that is being taught. It seems that if adequate material is present, interest is high, and vice versa. Some schools cannot afford to buy very much equipment, but can take advantage of free and inexpensive materials. Many teaching aids can be constructed by the students and teacher. All collected and preserved materials make excellent teaching aids if properly stored, handled and used at the right time.

With the advent of Federal Matching Funds for the purpose of purchasing science equipment, many high school science departments are being improved tremendously. Following is a table of materials and apparatus, suggested by the Oklahoma State Department of Education, for the teaching of general biology.

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[23]A. M. Ballew, "Study of the Comparative Effectiveness of Laboratory Exercises in High School Zoology With and Without Drawings." School Review, 36(April, 1928), p. 284.

TABLE I

SUGGESTED MATERIALS AND APPARATUS FOR THE TEACHING OF GENERAL BIOLOGY

Suggested Quantity	Article
3	Animal cages
1	Animal membrane, bladder
1	Ant nest
1	Aquarium
1	Aquarium air pump
1	Aquarium heater
1	Aquarium thermostat
1	Aquarium thermometer
4	Aquarium filters
1	Aquarium stand
1	Balance, spring
1	Balance, triple beam
1 set	Balance weights
6	Battery jars
18	Beakers, assorted
1	Bell jar
1 set	Biological charts
1	Blood-typing set
1 set	Borers, cork
1 set	Botannical charts
1 doz.	Bottles, Polyethlene
1	Black watch crystal
1	Burette clamp
10	Burners
1	Chart storage rack
1	Chemical garden
1	Collecting case
1 bag	Corks
100	Cover glasses
72	Culture dishes
1	Cutter, glass
12	Dissecting sets
36	Dissecting trays
9	Evaporating dishes
9	Fermentation tubes
6	Flower pots
9	Germination seed outfits
9	Glass funnels
9	Graduates, cylindrical
1 set	Graphic health charts
1	Herbarium
12	Insect spreading boards
2	Insect nets
100	Insect pins

TABLE I (Cont.)

Suggested Quantity	Article
1	Lever, heart
1	Lever, muscle
18	Microscopes
18	Microscopes lamps
2	Microprojectors
1 set	Microscope slides, animal
1 set	Microscope slides, plant
1 set	Microscope slides, bacteria
1 gross	Bioscope slides, blank
	Models--Animal Kingdom, heart, tooth, lower jaw, brain, head, eye, ear, flower parts, leaf structure, stem structure, generalized cell, human ear, human larynx, amoeba, paramecium.
1	Mortar and pestle
	Mounted or preserved specimens other than those intended for dissection
1	Oven and/or incubator
1	Plant press
1	Platinum wire in handle
1	Phyla display
2	Ring stands and clamps
1 gross	Rubber stoppers
	Science tables, demonstration desk, laboratory desks, storage cabinets, work benches, sinks, fume hood and accessories sufficient for class.
1	Seed mount
1	Specimen case
1	Sphygmomanometer
1	Skeleton (plastic, miniature)
36	Staining jars
1	Stethoscope
1	Sterilizer, pressure, steam
1	Syringe
1	Temperature control, not plate
1	Terrarium or Vivarium
1 gross	Test tubes
3	Test tube brushes
12	Testtube holders
12	Test tube racks
18	Thermometers, centigrade
18	Thermometers, fahrenheit

TABLE I (Cont.)

Suggested Quantity	Article
1	Torso, human
9	Transfer loops
50 feet	Tubing, rubber
10 feet	Tubing, vacuum and pressure
1	Vacuum pump
1 set	Zoological charts

The teacher must be very cautious in purchasing supplies. Buy wisely, improvise where possible, make use of all student-made and -collected equipment, be on the alert for all good industry sponsored teaching aids and material that can be obtained free. By doing these things, the funds set aside for restocking the laboratory might be at least partially sufficient.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine what objectives the laboratory would achieve and what will constitute an adequate laboratory for the high school biology course.

The study was divided into three parts. The first part dealt with the historical development of the laboratory in educational institutions, the use of the laboratory in many high school biology courses today, a comparison of the laboratory method to other methods and the laboratory method as a teaching aid.

The second part dealt with the goals and objectives of the high school biology laboratory.

The third phase attempted to determine what measures could be taken in order to obtain an adequate laboratory for the high school biology course. This part consists of planning for the laboratory exercise, faults to guard against, scientific attitudes and methods taught in the laboratory, the use of laboratory notebooks and finally the problem of equipment.

Conclusions

The findings of this study seem to indicate that:

1. The laboratory found in many high schools is often not conducted in a manner which will allow for maximum learning.

2. The laboratory method is not the best method in all situations. If a demonstration can accomplish the objectives better, then it should be used.

3. The laboratory may achieve specific and broad goals at the same time.

4. The laboratory must be properly supervised to insure that the goals are achieved.

5. Planning and preparation for the laboratory period is of prime importance.

6. The laboratory is an asset to any science course if utilized properly. If not, it may prove to be "busy work" and a waste of time.

7. Some factory-made equipment is desirable, but much material may be improvised by both student and teacher.

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Candidate for the Degree of

Master of Science

Report: THE USE OF THE LABORATORY IN HIGH SCHOOL BIOLOGY

Major Field: Natural Science

Biographical:

Personal data: Born near Holdenville, Oklahoma, September 17, 1934, the son of Walter G. and Iva C. Gordon.

Education: Attended grade school and high school at Spaulding, Oklahoma; graduated from Spaulding High School in May, 1953; received the Associate of Science degree from Murray State Agricultural College in May, 1955; received the Bachelor of Science degree from East Central State College in 1957; completed requirements for the Master of Science degree in May, 1961.

Professional experience: Three years as science teacher at McLoud High School, McLoud, Oklahoma.