Name: Robert J. Tierney Date of Degree: August 5, 1961

Institution: Oklahoma State University Location: Stillwater, Oklahoma

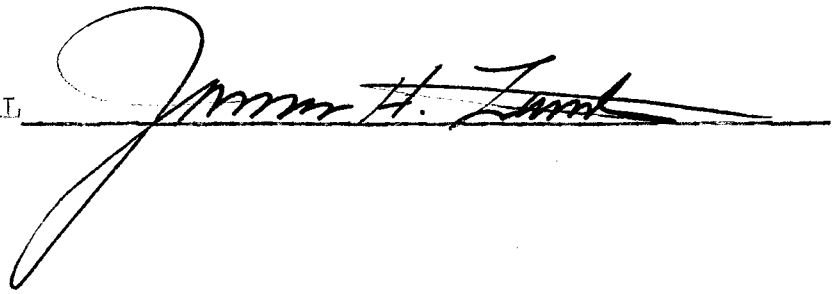
Title of Study: THE GROUP PROJECT IN HIGH SCHOOL BIOLOGY

Pages in Study: 27 Candidate for the degree of Master of Science

Major Field: Natural Science

Scope of Study: The group project in high school biology is used as an effictive teaching device by many teachers. This report endeavors to encourage more teachers to use this device by offering assistance in planning and completing a group study on the high school level. An example of a group project is given in some detail and suggestions for other types of projects are listed. Materials used are chiefly (1) Science Education Journals, (2) the candidates own experience with high school group work.

Findings and Conclusions: The well trained high school biology teacher can make effective use of the group study method. A variety of teaching techniques are essential to the high school biology teacher. The technique employed to teach the subject matter will be dictated by the personality of the teacher and the school environment. Group project work can be used by most well trained biology teachers to good advantage.

ADVISORS APPROVAL 

THE GROUP PROJECT

IN

HIGH SCHOOL BIOLOGY

by

ROBERT J. TIERNEY

Bachelor of Arts
San Francisco State College
San Francisco, California
1954

Master of Arts
San Francisco State College
San Francisco, California
1959

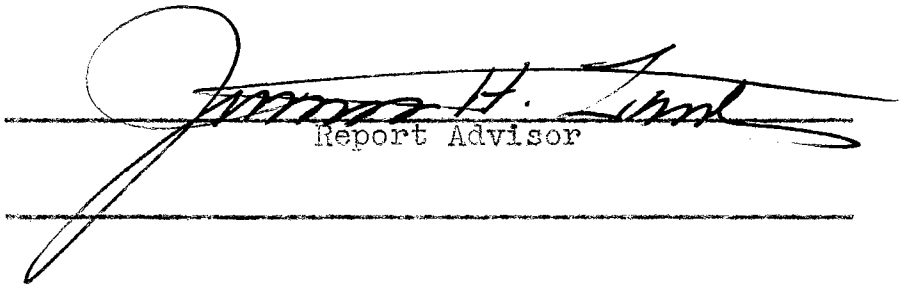
Submitted to the faculty of the Graduate
School of the Oklahoma State University
in partial fullfillment of
the requirements
for the degree of
MASTER OF SCIENCE
August, 1961

THE GROUP PROJECT

IN

HIGH SCHOOL BIOLOGY

Report Approved:



Report Advisor

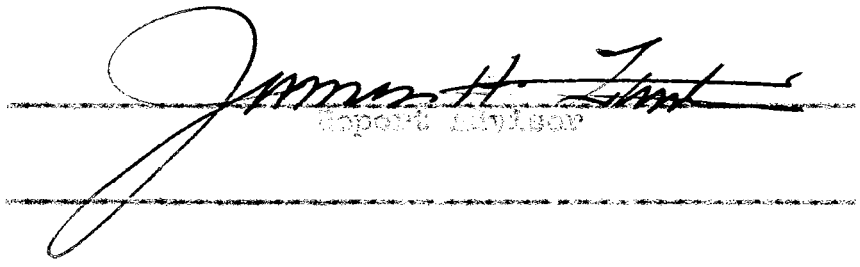
Dean of the Graduate School

THE GRADUATE SCHOOL

OF

YALE UNIVERSITY

Report approved:



Report Adviser

Dean of the Graduate School

PREFACE

The use of project work in the high school biology class provides the student with a realistic concept of what is called the scientific method. It can be an effective teaching device when used properly. It is the purpose of this report to provide information on group projects suitable for high school students. The author also cites an example of a group project that he has undertaken with his students. It is the hope of the author that this information may be of some benefit to those teachers seeking to become better acquainted with project work and its effective use in the high school classroom.

Indebtedness is acknowledged to Dr. James H. Zant for his valuable guidance; and to John Akey, Victor Voorhees and my wife for their advice and encouragement.

Indebtedness is also acknowledged to the National Science Foundation for making my stay at Oklahoma State University possible.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Statement of the Problem and Limitations of the Study

Most high school biology teachers, regardless of the approach, are interested in seeing that the students are aware of and appreciate what has been labeled as the scientific method. Many teachers, either through lack of training, time or facilities discuss the problem solving approach with the students but give the student very little problem solving experience.

There are several ways that a teacher can give the student an appreciation for problem solving technique. One way is to have students perform experiments in class and draw their own conclusions. A second method may be to assign individual projects to the students. A third method is the use of the group type of project.

The purpose of this report is to give some general information on the selection, organization and completion of a group project and to give a detailed example of a group project as used by the author.

This report is limited to a discussion of group projects easily handled by high school biology students. The arguments for and against group type activity will

not be discussed in this report.

Clarification of Terms

The term "group project" has been so widely used in education journals that the meaning is obscure. The term "group project" is defined in this paper as a problem solving experience on the part of several students working under the supervision of the biology teacher. These students may be doing the work on regular class time or on their own time after school. The project may involve a week or four years to complete.

CHAPTER II

General Information

Characteristics of a Good Project

There are several characteristics that mark the successful use of projects as a teaching method. (1) The project should be a task that the student willingly assumes. It should not be just another required assignment. (2) The project should be such that the student must utilize the biology he has learned. (3) The problem must be a meaningful one. It may not be an original experiment or discovery but the student must feel that he is contributing to the over-all knowledge of science. It must not be a repeat of a text book experiment in which the student knows the outcome before he starts. (4) It must be a project that presents a real challenge and a sense of accomplishment yet within the ability of the high school biology student. (5) The student must feel that he is free to experiment in his own way. The teacher should be an advisor and very careful not to dictate procedure. (6) There should be some form of recognition for the student upon completion of the work.

Getting Started

There are various ways to stimulate interest in project work. The teacher must be able to recognize genuine interest on the part of the student and to cultivate the interest until such time as the student is actually proceeding with the project.

The teacher may give out a list of suggested projects at the start of the term. In schools that have science fairs it might be worthwhile to have a science fair contestant discuss his project with the class. There are several books devoted to projects for high school students and these can be utilized by the teacher to stimulate interest. A list of these books can be found in the bibliography of this report.

If the school has a science club the club may wish to undertake a group project. This was done at my high school last year when the science club decided to identify and label the plants on the campus. The science club is an excellent place to stimulate interest in group projects.

Often, a simple experiment can grow into a full scale investigation. A question may come up in class that catches the interest of all of the students. If the teacher is alert this can very well lead to a worthwhile group study.

Bringing in a guest speaker can often stimulate a great deal of interest in a particular study and with

proper guidance this can lead to a group project.

An interesting animal in class, a newspaper report or a magazine article can often be the source of generating the interest in starting a group project.

The teacher that is interested in trying group project work will have little trouble in generating interest if he is alert and able to recognize and differentiate genuine interest on the part of the students from interest in getting a grade.

Selecting the Project

The experienced high school teacher is aware that the students have no real concept of what is involved in a scientific study. Often, the student will display a keen interest in projects that he can have little hope of bringing to a successful conclusion. They often select complex topics for which they do not have sufficient training or laboratory facilities. There are several important criteria that should be used in the selection of the group project to be undertaken.

First, is the project something that a group of high school biology students can handle with a reasonable assurance of some success?

Secondly, is the probable outcome in keeping with the objectives of the course? Does it illustrate a biological principle or concept?

Third, what is the cost of the project? Does the

school have the necessary equipment or can the students construct the necessary equipment?

Planning the Project

The proper planning of a group project is as important to it's successful conclusion as the actual laboratory or field work. After the project has been selected the teacher should call together the students involved and a "Thinking the Problem Through" session should take place. Students should be asked to do the necessary library research so as to become familiar with the topic involved.

It may be desirable to bring in or correspond with an expert in the field. Several meetings of the group should be devoted to learning as much about the topic as possible.

After all of the students have become familiar with the topic it is necessary to organize for the actual experimental or observation work. Such things as meeting dates, transportation, equipment, cost and scheduling all need to be carefully planned. It may be necessary at this time to organize the group into "teams" or to assign individual tasks to be done.

Questions to be answered in planning the project might include the following:

1. Deadline for completion
2. Estimated cost

3. Scheduling time
4. Gathering or constructing equipment.
5. Dividing the work
6. Final disposition of the project.

Careful planning can eliminate excessive costs and time. The students will feel more secure when they realize that the project is well organized. Poor planning could easily result in failure of the project.

Executing the Project

The primary function of the teacher should be that of an advisor. High school students need supervision but if the teacher dominates the work it can very well end up as a teacher project.

In any experimental work or observations the students must learn to strive for accuracy and to make proper notes. If the project work has been divided among individuals or teams it would probably be worthwhile to receive periodic reports and the entire group can discuss these reports. They should be asking: (1) What hypothesis was explored? (2) Why was the particular approach decided upon? (3) Have all avenues of approach been explored? (4) Have any new problems arisen? (5) How does the information contribute to the completion of the group project?

Schedules and deadlines must be closely adhered to. This is especially important for high school students. It tends to keep things moving and gives the students a feeling of progress.

Sources of Aid in Project Work

There are several agencies that are interested in assisting and encouraging students to do project work in science.

The American Society of Metals provides awards for projects under the Science Achievement Award Program. The awards are based upon grade level and geographical regions. Generally, individual projects have the best chance for an award but group projects are considered. The author had the honor of serving as one of the judges for the far western entries several years ago and most of the projects were of very high quality.

The National Science Fair provides awards for projects. Generally, these awards are in the form of scientific equipment.

High school teachers may apply to the National Science Foundation for a research grant. A special fund for high school research has been made available. A maximum of two hundred and seventy dollars is available if the project work qualifies.

Many local industries are more than willing to assist. They are especially willing if they are able to realize some sort of publicity from their help. Washington Union High School, Fremont, California was able to procure a much needed refrigerator in this manner.

If you live in an area that can provide expert technical assistance by all means ask the experts if they will

assist you. Often, the expert is too busy but most of them are more than happy to work with young people. This provides the student with the opportunity to meet a working scientist and to learn, first hand, the meaning of research.

General Suggestions

One of the most serious problems facing the completion of a group project is the time involved. Are you going to use class time, if so, how much? The "Block of Time" concept might be a desirable way of doing it. This involves making the last six weeks of class strictly for project work. It is the authors own opinion that project time should be an extra-cirricular activity. This helps to insure genuine student interest which is the prerequisite for the successful completion of a good group project. This also means that students cannot be required to do the project work. As stated previously, the project should be something that the student wishes to do and not just another assignment.

The teacher, through proper use of publicity, can make certain that the students receive recognition. This will help to maintain interest. Many newspapers, especially in smaller communities, are eager to get school news. Good publicity can often lead to community interest and help in the project.

The results of the project could very well be submitted for publication in some periodical. Serious con-

sideration should be given to this phase. It is just as important that the students learn how to write up a piece of research as it is for them to do the research. If nothing else, the project should be written up and submitted to the school library.

CHAPTER III

A GROUP PROJECT USED BY THE AUTHOR

Selecting the Project

A student brought in an adult Pacific Lamprey and asked me to identify it. He explained to the class that the lamprey had attached itself to him while he was swimming in the local creek. Several other students said that they had seen the lampreys in the creek. Class interest was aroused and so was mine.

I gave the class a general description of the life history and habits of the animal and we discussed the damage caused by a different species in the Great Lakes Region. The discussion raised many questions in the class. How many lampreys are in the creek? Will they ruin the Steelhead fishing? Will the larvae burrow into the sand as well as the mud? How long does it take the larval form to develop into an adult and many other questions.

When I approached the class with the idea of trying to answer some of the questions with some research on their own time I was able to get seventeen volunteers. Later eight volunteers from the chemistry class joined our group. The project had been selected and the lamprey crew was ready to go.

Planning the Project

I held several planning sessions with the students both after school and a few evenings in my home. After several planning sessions the students decided that before anything could really be accomplished it would be necessary for us to read the available literature on the Pacific Lamprey.

The group was divided into five "teams" and each team was assigned a library to canvas for material. I happen to teach in an area surrounded by several fine colleges and Universities so good library facilities were no problem. In many rural areas the city library and the high school library would probably have to suffice.

Before the teams started on their library research the school librarian gave them a lesson on the proper use of the card catalog, the biological abstracts and other reference sources essential to their research.

One team was assigned to Stanford University, another to the University of California and still others to San Jose State College, the University of Santa Clara and San Mateo City College. We were able to secure the permission of each of these schools for our students to use their library facilities.

Each team was to find as many references on the Pacific Lamprey as they could and to properly cite the references on an index card. The library research took nearly two months. We met periodically to compare notes and to write

up the results of our library effort. We were able to write a fairly comprehensive life history of the Pacific Lamprey from what we had been able to learn from the library work.

We held two more planning sessions to debate our next step. The students decided that our problem could be defined as, "The Life History of the Pacific Lamprey in Alameda Creek, Alameda County, California." It was decided that we should try to answer the following questions:

1. Why are the lampreys found in Alameda Creek?
2. What is the estimated lamprey population in Alameda Creek?
3. Where do the adults spawn?
4. Where do the larvae burrow?
5. What do the larvae feed upon?
6. How long does it take for the eggs to hatch?
7. What is the critical temperature for egg hatch?
8. How long does it take the larvae to develop into the adult?
9. Are the lampreys a menace to the trout and Steelhead in Alameda Creek?

The group again was split into teams and each team was assigned a question to work on. Reporting schedules were decided upon and each team elected a captain who was to be responsible for turning in a report on the teams progress. We decided to meet once per month to hear reports. We hoped to have the first five questions answered by the end of the school year.

Executing the Project

Team #1, decided that they would have to do an ecological survey of the creek. They secured some topographical maps of the county and from these they made overlay sketch maps of the creek. The mechanical drawing teacher assisted them in the map making.

The chemistry teacher was able to show them how to use a modified Winkler method for determining the amount of dissolved oxygen in the water. They also learned to use indicators to determine pH. The group made several water tests at selected stations on the creek.

The team also checked records and made graphs from material furnished by the local water department. They were able to determine rate of flow, average water temperature, average depth and other useful information.

By writing to the California Department of Fish and Game the students were able to secure a list of California streams that had populations of the Pacific Lamprey. They noticed that all of these streams were coastal and were considered to be good trout and steelhead streams.

It took team #1 several months to complete their survey of the creek. The team was assigned to question number six when their survey was completed. Next fall this same group will try to determine the embryology of the lamprey.

Team #2, had the very difficult task of estimating the lamprey population in the creek. Several ideas were tried. The students first decided to have observers

Stationed at two small spillways and actually count the lampreys as they made their way over the spillway during the spring migration from San Francisco Bay. It was pointed out during our meetings that an accurate count would be difficult to get using this method. We would have no idea of how many lampreys were going over the spillways during school hours or at night. From the literature we had learned that they prefer to move in the shade and so it was felt that most of the upstream migration may be at night.

The observation was further hampered by scheduling around paper routes, weekend trips and other problems. Several counts were made but the students generally agreed that the results were not very valid.

The team next constructed a sein and resorted to seining selected sections of the creek. It was necessary to obtain the permission of the Department of Fish and Game first. This method proved reasonably effective but flood conditions interfered with the spring seining and team #2 was forced to postpone the work until next fall.

Team #3, was given the task of trying to determine the spawning sites of the adult lampreys. From our library research we were able to learn that the lamprey prefers slow moving water, gravel bottom and shade for spawning.

The team was able to utilize the maps furnished by team #1 to pinpoint some of the most promising spawning sites. They selected four sites for observation. During the spring migration these four sites were periodically observed. The observer had to turn in observations on

cloud cover, temperature, water turbidity and other data that the students felt might by pertinent.

Only one spawning was observed but the student was able to make a rather detailed account of the nest building and egg laying of the lamprey. Some eggs were secured but they died before a study could be started.

The team, with the aid of a screen, measured the gravel size used in the nest making. The group is planning on observing the other sites suitable for spawning next year in the hope of trying to determine numbers that spawn and securing eggs for the embryology study.

Team #4, was assigned the task of locating the burrowing sites of the larval forms. From the library research the students had learned that the larvae burrow into the soft mud or sand and remain there from three to five years.

This group started by meeting on Saturday mornings with shovels and systematically digging into the mud. They took a section of the creek each Saturday. They proceeded with this technique for three months without success. Fortunately, one of the group accidently ran across one of the larval forms near the percolation pits and soon team #4 was proudly displaying many larval specimens.

We were able to use some of the larvae in class and succeeded in keeping several of them in an aquarium for several months. One student wrote a paper on their burrowing technique as observed in the aquarium. Unfortunately, the biology classroom was also used for night school purposes and

someone had thrown cigarette butts into the aquarium with the result that the lamprey died.

Team #4, will attempt to do a population count of the larvae, raise more of them in the aquarium and attempt to locate other burrowing sites.

One member of the group has undertaken the task of trying to work out the morphological changes that take place as the larva develops. This will be done by dissecting larvae of varying size and age.

Team #5, undertook the task of trying to determine the feeding habits of the larvae. From the literature research they were able to determine that the larval forms feed on microscopic organic material in the water or mud. The students reasoned, during one of our report sessions, that the shoreline would have more organic material than the middle of the stream beaause of currents. By using strings to mark off areas the group began a systematic count of larval numbers thus enabling them to construct a distribution map to prove or disprove their theory. Flood conditions hampered their work but they plan to continue next fall.

One student, quite seriously, plans on raising the larval forms in a tank of clear water and washed sand in order to test the idea that the larval form does not feed at all.

The Future of the Project

Upon my return to the school next fall the lamprey

crew will organize again in an effort to answer the rest of the questions posed by the group. I understand that other students are anxious to join the crew. There should be plenty of work for all concerned and the project looks as though it will last for several years.

Other projects that fit into the over-all effort include:

1. Isolation of the eggs and the determination of critical hatching temperature.
2. A study of the larval form to determine how long it takes to develop into the adult.
3. What effect, if any, does the lamprey have on the game fish population?
4. The attempt to predict, by stream analysis just when the adult lamprey will move from San Francisco Bay into the creek.
5. The final writing of the complete report.

The California Department of Fish and Game, region III has shown an interest in our findings. This has given the students some incentive for completing the work.

What started as a question in class has taken on the proportions of a full scale research project. Every interested student has the opportunity to do what he can do best and at the same time to learn something about research technique. This is one way to put a little more "bios" into the high school biology course. Too often high school biology is strictly a lecture, textbook course.

This particular group project demanded much of my time. I found that it was worth the time and effort however. For one thing I was interested in learning more about the lamprey myself. Most important, was the fact that my students feel that my interest in biology does not end

with the close of the school day. It is a refreshing experience to be able to work with the students out of doors and the field work can aid your regular classroom lesson immeasurably.

From my own experience with this group project I feel that I can recommend it as a good technique for teaching respect for the scientific method.

CHAPTER III

Some Ideas for Group Projects

Microorganisms

At the present time the study of bacteria and other microorganisms presents one of the most fertile fields for new research. Recent discoveries in the field of antibiotics gives this area a sense of glamour that appeals to many high school youngsters.

A study of microorganisms does not require elaborate equipment or a special environment. The National Association of Biology Teachers has published some excellent reference material on the subject. [1]

The following partial list of project ideas is taken from the June, 1960 issue of The American Biology Teacher:

1. Isolation of Pure Cultures.
2. Effect of Temperature on Fermentation.
3. Effect of Temperature on Bacterial Growth.
4. Inhibition of Bacterial Growth.

---

[1] The Editors, The American Biology Teacher, Special Issue, Microbiology in Introductory Biology, Vol. 22:6, June, 1960.

5. Microbial Populations in Natural Fermentation.
6. Bacterial Populations in Natural Materials.
7. Plate Count Analysis of Soil.
8. Identification of Fungi.
9. Sanitary Anaylsis of Water.
10. Chromatography of Bacterial Pigments.

Entomology

The study of insects is another rich source of project ideas that does not require very much in the way of special equipment or environment. Many excellent references are available including Boy Scout and 4H material.

The following titles for insect projects may suggest an idea:

1. The Insects on our Campus.
2. Harmful Insects in our Community.
3. Helpful Insects in our Community.
4. The Distribution of Insects in our Community.
5. Insect Control.

Ecology

If your students are the type that like field work, and most students do, the study of Ecology lends itself to some excellent ideas for group projects. Consider the following:

1. The Ecology of our Seashore.
2. The Distribution of Rabbits near our Community.

3. Plant Succession in a Local Lot.
4. Soil Organisms in the Flower Beds of Our School.
5. The Distribution of Fish Life in a Local Stream.

An idea that intrigues the author very much might be considered an easy group project to undertake. Secure a topographical map of your area and place it on the bulletin board. As students bring in plants or animals have the specimens numbered and place a pin in the map to show where the specimen came from. Have the student make out an index card with all of the pertinent data on it and keep a file of these cards. In a short time you will find that you have a pretty good distribution map of the living things in your area and the index file may later prove to be an invaluable reference resource. This is especially true in communities that are growing very rapidly with the consequent reduction in wildlife.

Botany

The study of plant life will suggest several ideas for group project work. For example:

1. The Classification of the Plant Life in our school yard.
2. A Study of the Algae in the Local Pond.
3. Transpiration rates in Various Plants.
4. The Use of Algae as an Oxygen Source for Space Flight.

5. The Control of "Damping Off" in Seed Beds.

Genetics

With the DNA gene theory appearing quite often in most of the periodicals a great many students are becoming quite interested in genetics. The following ideas may prove to be good problem solving group projects:

1. Drosophila Genetics.
2. Heredity in Plants.
3. The Heredity of Blood Groups.
4. Preparation of Chromosome Smears.
5. The Construction of the Watson-Crick DNA model.

There are many excellent reference sources for working with Drosophila genetics. [2]

Bird Study

A group of students may be interested in duck hunting or bird watching. With proper guidance these students might be encouraged to try a group project. There are many possibilities in this field, including:

1. Construction of a Feeding Station and Bird Observation.

---

[2] M. Demerec and B.P. Kaufmann, Drosophila Guide, Carnegie Institution, Washington D.C., 1945.

2. A Study of the Game Birds in Your Area and How They Might Be Protected.
3. The Identification of Birds That Migrate Through the Community.
4. The Feeding Habits of the Common Birds in the City Park.
5. A Bird Census.

Embryology

The field of embryology lends itself to group work by high school students. Consider the following suggestions:

1. The Embryology of the Chick.
2. The Embryology of the Frog.
3. The Effects of Ultraviolet Light on Egg Development.
4. A Study of the Fetal Pig.
5. The Egg Development of a Local Species of Fish.

General

To attempt to list all of the possible topics that might lend themself to group project work would be an endless task. A few suggestions for exploration have been suggested. The reader should note carefully some of the literature cited in the bibliography for more comprehensive lists of project ideas.

It would be well to bring to the readers attention an article by Charles E. Roth appearing in the American Biology

Teacher, April, 1961.[3] Mr. Roth describes a group type project that worked very well for him.

Nearly any type of investigation can lend itself to group study. If the teacher cannot find an idea for a project that seems to fit your area or your students it is suggested that contact be made with the local department of fish and game. Generally, they are very helpful and usually have some pretty good suggestions.

Remember, however, the best project is the one that the students suggest and that the students desire to do. The teacher may be able to guide the students into a certain area or keep them from undertaking a project that they are not prepared for but to dictate what the project will be would kill much of the interest on the part of the student.

---

[3]Chas. E. Roth, "Field Studies for High School Biology Students," The American Biology Teacher, Vol 23:4, April, 1961 pgs. 213-217.

SUMMARY

The successful high school biology teacher is the teacher that is fully qualified to teach high school biology both from a standpoint of academic background and training in education.

The successful biology teacher does not rely on any one method to teach his course. Too often we hear of textbook and lecture courses in the high school biology class. It is well to remember that biology is the study of living things and the best way to study it is to work with living things. On the other hand there are teachers who have a tendency to overdo group activity.

The group project when supplemented with other teaching techniques can be a valuable tool in the hands of the competant biology teacher. Project work is an excellent way to teach scientific method and to generate a keen interest in biology on the part of the student.

The group project gives the biology teacher the opportunity to meet the students outside of the classroom. This makes him more effective when in the classroom. It also gives the students the feeling that their biology teacher is genuinely interested in his subject.

A SELECTED BIBLIOGRAPHY

Bagby, Grace, Harold Cope, C.S. Hann and Mabel Stoddard. New Discovery Problems in Biology. New York: College Entrance Book Co., 1958

Burnett, Will. Teaching Science in the Secondary School. New York: Rinehart and Co., Inc., 1957

General Biological Supply House. Turtox Service Leaflets. Chicago: General Biological Supply House, 1944-1958

McGill, Bruce. Experiments in High School Biology. New York: Oxford Book Co., 1956

Miller, David and Glenn Blaydes. Methods and Materials for Teaching Biological Science. New York: McGraw-Hill Book Co., Inc., 1938

Morholt, Evelyn, Paul E. Brandwein and Alexander Joseph. Teaching High School Science, A sourcebook for the Biological Sciences. New York: Harcourt Brace and Company, 1958

National Science Teachers Association. If You Want to Do a Science Project. Washington, D.C: National Science Teachers Association, 1955

Robbins, Jack and Alan Wayne. Directed Experiments in Biology. New York: College Entrance Book Co., 1947

Witherspoon, James D. and Rebecca H. Witherspoon. The Living Lab oratory, 200 Experiments for Amateur Biologist. New York: Doubleday and Company, Inc., 1960

VITA

Robert J. Tierney

Candidate for the Degree of

Master of Science

Report: THE GROUP PROJECT IN HIGH SCHOOL BIOLOGY

Major Field: Natural Science

Biographical:

Personal Data: Born in Oakland, California, August 27, 1928, the son of Martin and Helen Tierney.

Education: Attended the Oakland Technical High School, Oakland, California, graduated in 1946. Received the Bachelor of Arts Degree from San Francisco State College, with a major in biology, in January of 1954. Received a Westinghouse Fellowship to the Massachusetts Institute of Technology for the summer of 1956. Received a National Science Foundation grant to Humboldt State College for the summer of 1959. Granted the Master of Arts Degree by San Francisco State College in June, 1959. Attended Tulane University Biology Institute in the summer of 1960.

Professional Experience: Began teaching science in September of 1955. I am at present a member of the National Science Teachers Association, The National Association of Biology Teachers, The California Science Teachers Association, The California Teachers Association.