1978

A Curriculum Unit to Provide Enrichment Activities for Talented Students in Biology

Mary Angela Gibson Morrissey

THE UNIVERSITY OF NORTH FLORIDA

A CURRICULUM UNIT TO PROVIDE ENRICHMENT ACTIVITIES FOR TALENTED STUDENTS IN BIOLOGY

A THESIS SUBMITTED TO THE FACULTY OF THE DIVISION OF EDUCATION IN CANDIDACY FOR THE DEGREE OF MASTER OF EDUCATION

DEPARTMENT OF EDUCATION

BY
MARY ANGELA GIBSON MORRISSEY

JACKSONVILLE, FLORIDA
NOVEMBER 1978

TABLE OF CONTENTS

A FABLE FOR EDUCATORS

Elizabeth Jones

University of Wisconsin

Once upon a time, when the world was very small and standardization was very "big", shoemakers from all over the world assembled to discuss their mutual problems of rising costs and diminishing returns. As they talked, they realized that drastic changes were needed to improve the efficiency of their factories. The most sagacious of these cobblers meditated for several days and then offered his wisdom to the consortium.

"Gentlemen," he began. "We have been proceeding in exactly the wrong direction. For centuries cobblers have struggled to make shoes to fit all shapes and sizes of feet. We have assumed that since no two pairs of feet are alike, it was our job to produce a perfect fit for every foot. Every year there are more feet to fit, and every year there is a demand for new models. We have tried to meet these demands, but we are falling behind.

"I propose, Gentlemen, that henceforth, we will make one shoe model for all feet: one size, one color, one style. Think of the benefits, Fellow Cobblers. Our production costs will drop as a result of decreased specialization; our income will rise because population is booming. Soon all of us will be ranked among the corporate giants!"

The simplicity and logic of his idea stunned the assemblage for a moment; then the shoemakers rushed for the exits, tripping over each other in their haste to set this fantastic plan in motion.

Within days, the first of the standardized shoes were offered in the marketplaces of the world. Within a year, few reminders of the cobblers' past inefficiency were to be found outside of museums. The feet of the world were not overjoyed, but who listens to feet?

Some feet could not fill the shoes. They slid and shuffled along, stopping frequently to attend to their wounds, hoping no one would notice them. They were unable to step forward with confidence lest they fall out of their shoes. These feet became known as underachievers.

Other feet were so cramped by the shoes that their stride was hobbled. No one noticed that they were hurting, and no one cared that their steps grew shorted and shorter. Few of these feet reached their destination--only those who were particularly determined bothered to try. They wanted to do so many things, but the shoes confined them. They were called "gifted" feet.

There were some feet which fitted the shoes perfectly and these feet were contented--until they found that there was no room for growth. These feet were labeled average.

From each of these groups there were some feet who ran away from their shoes. These feet were drop-outs; and the feet who refused to wear any shoes in the first place were labeled nonconformists and they gave up their rights to walk in places where feet without shoes were unacceptable or uncomfortable.

Then one day a fast-talking politician from Toningwash felt a twinge in his bunion and jolt of inspiration. "That's it!" he shouted to his feet. "I have just figured out a way to keep my seat in the senate. I'll build a campaign around shoe restraints. I'll organize reform groups, special interest groups--and committees; we'll need lots of committees. Boy, will this thing snowball! Who could vote against feet?"

Our astute senator outlined his idea to a senate committee, and soon the whole country was talking about his reform bill. The senator was re-elected and his bill became a law. At last feet would be given recognition and assistance.

Action began at once. Underachieving feet were all put into yellow shoes. Gifted feet were all put into red shoes. Average feet were all put into brown shoes. Drop-out feet were allowed to remain in hiding, and non-conforming feet were put into sandales.

The feet were bewildered by all of the fuss. "Doesn't anyone understand that nothing has changed"? wailed an underachiever. "Why can't we have shoes that fit us"?

The sandal-clad feet paused, waiting. There was no answer, so the sandal-clad feet walked slowly toward the commune.[1]

---

[1]Elizabeth Jones, "A Fable For Educators," The Gifted Child Quarterly 21 (Spring, 1977): 109-110.

INTRODUCTION

The foregoing fable casts much doubt on some elements of the instructional process. All children cannot fit in the same shoe size just as all children cannot learn the same things at the same rate, following the same teaching strategies. These individual differences should be taken into consideration.

The situation is not at all helped by attaching labels to the students. Children are not cows that we herd from one grade to another, all needing the same nutritional requirments. They should be compared more to various species of plants. Some may be like the cactus which only needs water once a month, and too much water would kill it. Other plants may need watering every day. Likewise, all students are individuals and have many different needs.

The problem to be examined here concerns the "gifted feet" which were put into the "red shoes". The word "gifted", in referring to students, seems to imply that these students are all geniuses, and, therefore, the term needs some clarification. For the purpose of this paper, the term "gifted" is broadened to also include the "talented" and/or "highly motivated". For the sake of simplicity, the term "talented" will be used throughout the rest of this paper, but with the understanding that the other two terms are included in the meaning.

Through experience in teaching in four different school systems, by talking with other teachers, and by research, it seems as though many educational systems, do not provide enough, if any, enrichment materials for talented students in high school biology. Some schools do, however, allow these students to take some courses a year earlier than they would normally. On the whole, it is assumed that these youngsters are put in with the "brown" shoes, the "yellow" shoes, and the "sandals". They are asked to do the same things as the other students, which usually involve taking notes from a lecture on a chapter, answering questions about the chapter, outlining the chapter, filling out ditto sheers about the chapter, and so on. This is not to suggest that anything is wrong with these tasks for those who need them. They are very good methods to encourage students to study. Repetition can also be very good for learning. However, it cam be noted that talented students may not need all this repetition in order to learn and may view these tasks as "busy work". It could be argued that we are boring them to the point that they may, in fact, be making lower grades doing repetitious work rater than using this time more wisely.

Talented students in science may posess the following characteristics:

1. They are strongly and sincerely motivated toward learning and achieving in science.
2. They are able to work well independently in the laboratory, library, and calssroom.
3. They are curious about phenomena.

4. They are very interested in getting answers to questions suggested by their work and their teachers.
5. They ask many questions.
6. They are stimulated by problem solving approaches to learning.
7. They relate well to their peers and elders.
8. Many have long term goals well established.[2]

Some talented students, in science, may exhibit all of these characteristics, while others exhibit only a few. Talented students will also exhibit these characteristics to varying degrees because each is an individual.

It appears that in our vast concerns for helping the poor learner, we have actually stifled the talented student. The talented student is simply not being motivated, and is not being taken to the height of his potential. Surely, they will survive, for they always have. However, it is our job as educators to encourage the talented student to pursue his interests, and to move ahead as far and as fast as is within his capabilities.

Upon having defined this problem area, the next logical step is considering what steps might alleviate the problem. One possible solution is implementing Mastery Learning Units as enrichment activities for these talented students. Mastery learning is a method in education which is capable of providing successful and rewarding learning experiences to almost all students. James H. Block wrote:

> Mastery learning enables 75 to 90 percent of the students to achieve to the same high level as the top 25

---

[2]Milton Kopelman, Vincent G. Galasso, and Pearl Strom, "A Model Program for the Development of Creativity in Science." The Gifted Child Quarterly 21 (Spring, 1977): 80-83.

> percent learning under typical group-based instructional methods. It also makes student learning more efficient than conventional approaches. Students learn more material in less time. Finally, Mastery Learning produces markedly greater student interest in and attitude toward the subject than usual classroom methods.[3]

It is believed by many educators that there have been few recent ideas which have produced such dramatic effects on student learning than has mastery learning. The assumption of mastery learning, quoted above, is a positive one, whereas, in traditional education, the assumption is thought to be negative. Educators in the past have assumed that many students will fail. This negative assumption by traditional education is most often symbolized by the "normal distribution" or the "bell curve". Block says that because of this negative outlook, "schools continue to provide successful and rewarding experiences for only about one-third of our learners".[4] He says that we should no longer allow two-thirds of our students to go through twelve long years of unrewarding school experiences. Such negative experiences limit an individual's chances for future economic survival and security. Negative experiences in school can affect an individual's psychological well-being. Block says that there is evidence to indicate a strong correlation between a student's history of school learning success and failure and his personality development.

---

[3]James H. Block, ed., Mastery Learning-Theory and Practice (New York: Holt, Rinehart and Winston, Inc., 1971), p.3.

[4]Ibid., p.2.

He continues by saying that the continual humiliation and flustration for many students promote a negative self-concept and possibly contribute to mental helth problems.

It is suggested in this paper that Mastery Learning Units can be successful in encouraging the talented students to excel in their interests and capabilities. The intent of this paper is to show how enrichment activities and centers can be easily implemented in the biology curriculum by the use of Mastery Learning Units. In so doing, only one mastery unit will be included for the purpose of demonstration. It is suggested that teachers write the units that they will be using for their students. This would allow their units to fit their own particular objectives, as well as the needs and interests of their students.

The topic of the unit will be "Entomology", and would take a talented student no more than six weeks to complete as an enrichment activity. The time, of course, to finish the module would depend upon how much in-depth study the student wanted to allocate to the subject.

Entomology is the part of biology which deals with the study of insects. This subject was chosen not only because of the author's own interest, but because very few pages are allocated to these animals in high school biology books. Three-fourths of all known animal species are insects. They are extremely important as they affect us all. Some insects are beneficial while others are harmful.

The apartment dweller may eat honey or wear silk which are obtained from the work of insects. At home we are continually trying to get rid of ants, roaches, and flies. While working in our yards, we are constantly being attacked by mosquitoes and knats. Harmful insects cause more than a billion dollars worth of damage per year in the United States alone. They injure forests, farm crops, flower gardens and lawns, stored foods, and other property. Some cause disease to man as well as other animals. In order to control these pests, we need to learn about their habits, their life cycles, and their physiological characteristics.

Many insects are beneficial. They are essential in cross fertilization of many plants. Others are beneficial because they help control other harmful insects. Some are useful in cleaning up the dung and dead bodies of animals and in reducing the remains of dead plants and trees. Insects are also extremely important in our food chain. By studying insects, it is possible that we may discover new and better ways that insects can serve man.

The implementation of Mastery Learning Units in a course such as biology would be feasible because of the nature of the course itself. Biology is not so much involved with "steps" in learning as is mathmatics. For example, in mathmatics, one presumably has to learn how to add before learning to divide or multiply. However, in biology, one could learn about mammals before learning about microorganisms. Therefore, it would

seem that biology enrichment activities for the talented could easily be included in the standard school curriculum in the form of individual Mastery Learning Units.

DEFINITIONS

1. Entomology: the study of insects.

2. Individualized Instruction: "an instructional system which provides for the planning and implementation of an individualized program of studies. This system can be tailored to each student's learning needs and his characteristics as a learner that can facilitate his acquisition of new skills."[5] Peggy House says that individualization must adequately provide curricular and instructional alternatives so that each student can increase to a maximum, his or her learning and growth.[6]

3. Instructional Packages: modules which contain a variety of materials which relate to a specific concept and are designed to facilitate a change in learning behavior. "Instructional packages develop students' abilities to follow directions, complete tasks, self assess themselves and learn independently."[7]

4. Learning Station: "small areas of tables that house specific related materials and resources related to a given curriculum."[8] The station would ideally include workbooks, books, tapes, films, and other teacher-organized items. (dittos, filmstrips, photographs, slides, etc.)

5. Mastery Learning: a method of learning and teaching which claim to insure that almost all students can succeed in school if teachers will give them all the help they need, enough time to learn, small units to work with, formative evaluation and alternate learning materials.

---

[5]John Bolvin, "Individually Prescribed Instruction," Individualized Instruction and Learning, ed. Madan Mohan and Ronald E. Hull (Chicago: Nelson-Hall Co., 1974, p. 124.

[6]Peggy A. House, "Individualization-What is it Really?", Science Teacher 44(Jan. 1977): 20-21.

[7]Rita Dunn and Kenneth Dunn, Practical Approaches to Individualizing Instruction: Contracts and Other Effective Teaching Strategies (New York: Parker Publishing Co., Inc., 1972), p. 67.

[8]Ibid., p. 69

6. Mini-Unit: self-contained instructional packages which attempt to individualize learning by enabling the student to proceed through the material with little outside help.

7. Talented Students: students who display an extraordinary capability for learning and/or students who may display a high degree of motivation. Talented students show a high degree of independence, curiousity, ability to get along with others, and usually have well established long term goals.

REVIEW OF RELATED LITERATURE

Introduction

In reviewing the literature, it became apparent that there are three main areas that are relevant to the problem of developing enrichment activities for talented students in biology. The assumption can be made that talented students do indeed have special problems that other students may not encounter. However, in this paper the discussion will focus on the problem involving the lack of enrichment activities for these talented students.

After having researched the problem of the lack of enrichment activities for the talented, it is suggested that individualized instruction could be an answer in solving this problem. There are many methods of individualizing instruction which can be used. Some of these methods are discussed briefly in this section.

Of the many possible ways of solving the problem of the lack of enrichment activities for the talented, Mastery Learning Units were selected as possible ways to provide such enrichment activities.

Problems of Talented Students

Now he likes to multiply.
"How do you do long division?"
"How do you find square roots?"
"What's the formula for free falling bodies?"
"How many zeros in a googleples?"
He hates math at school

Does she know he recognizes school buses by their sound?
Some of their windshield wipers go up.
Some of them go down.
And the telephone poles are not all alike
Some have three extensions. Some have seven.
And there's one on Manchester that's huge!!
And that's odd---
Because it's made of wood.
Most that size are steel.

I don't know what Chip's teacher would do
If she knew him like I do.
She's right,
He does need to socialize
But he's making progress here.
Cub scouts---bike riding.
He wants to be just like his friends
Doesn't want to stand out or be odd.

Maybe he prefers to play the game at school
Of learning two plus two.
While at home
He'll roam
Through books
To satisfy his thirst.

Will he ever learn to listen
When he already knows what is being taught?
Will he ever discover a teacher can teach
And schools are for learning-NOT
For using up all of his precious time?[9]

---

[9]The Gifted Child Quarterly 21 (Spring, 1977): p. 112.

The poem quoted above describes some of the problems that talented students may have. They may have problems in socializing with other students. They don't want to be different from the other students, although they know that they are. They may go through the motions of learning that all the other students go through even though they already know what is being taught. Lastly, teachers are wasting their precious time.

Rita and Kenneth Dunn suggests that talented students should not be restrained until peers reach the level of academic ability of the talented student. They say it is the school's responsibility to help each child reach his maximum potential. "If teachers restrict (and we should be encouraging) superior youngsters from advancing more rapidly than the "average" child mean, we are, in fact, stifling talented and intellectual students."[10] They suggest the use of modular units as one means which would allow these students to pursue topics of interest. Oberteuffer says there is a need for a varibility in the biology programs to accomodate for the differences of the students needs, interests, and abilities.[11]

Studies have indicated that talented students are ready and willing to make use of their talents in areas of interest to them. Sig Abeles states, "What has happened and still happens in a number of instances, is that the climate surrounding

---

[10]Dunn, Practical Approaches to Individualizing Instruction, p. 128.

[11]William H. Oberteuffer, "Science Course Structures: Some New Approaches to Learning." in Individualizing Learning Through Modular-Flexible Programming, ed. Gaynor Petrequin (New York: McGraw-Hill, Inc. 1968), p. 118-130.

these youngsters has either been non-supportive or even negatively disposed toward allowing them to pursue their areas of interest."[12] He says that science teachers should determine the attitudes of persons involved in the educational process toward the problems of talented students. If their attitudes are negative, science teachers should try and modify their thinking. If their attitudes are positive, then science teachers should move ahead in providing for the special needs of talented students.

There have been some efforts in alleviating these problems. Some teachers have attempted self-pacing within a course with varing degrees of success. However, this method usually lasts no longer than a year at the most. The concept of modular units have also been tried at the secondary science level. Abeles states, "While these programs have not been developed specifically for gifted youngsters, they can be used to provide materials of interest to them at an earlier time in the science sequence."[13] He goes on to suggest that the enrichment of the science program could be accomplished by adding mini-courses or full courses that would not normally be encountered in the science sequence. He says that, "enrichment activities have demonstrated a degree of usefulness in helping gifted youngsters achieve their potential."[14]

---

[12]Sig Abeles, "Science Education for the Gifted and Talented," The Gifted Child Quarterly 21 (Spring, 1977): 75-80.

[13]Ibid., p. 79.

[14]Ibid.

Individualized Instruction

The term "individualized instruction" has been abused through the years by educators. The authors of "Studies on Individualized Instruction in Biology", define an individualized program as one which has at least four of the following five characteristics.

1. Students are permitted and encouraged to proceed through instructional material at a pace commensurate with their interests and abilities.
2. Heavy emphasis is placed on self-instructional approaches.
3. Students select learning activities which prepare them to master a set of instructional objectives.
4. Students determine the amount of time devoted to studying material and how this time will be allocated.
5. The role of the teacher is that of "advisor" and "facilitator" rather than "information giver".[15]

These authors also agree that there is a need for varibility in the biology programs to accomodate for the differences of the students' needs, interests, and abilities.

We as teachers have always noticed the differences in individual students. We have noticed differences in their mental and physical abilities, their interests, and their talents. On the whole, however, we continue to teach to the group as though all students learn at the same rate and as though all are interested in the same subject matter. Recently, there have been some changes in various school systems.

---

[15]Joel Mintzes et al., "Studies on Individualized Instruction in Biology", School Science and Mathmatics 76 (December, 1976): 675-686.

Individualized instruction differs from traditional instruction in many ways. Jack Edling says that in traditional instruction, "student learning experience are group oriented, teacher paced, and scheduled at a time convenient to the teacher and the school".[16] In contrast, individualized instruction is oriented toward the child.

There are various ways in which individualized instruction can be implemented. Individually diagnosed course of study, independent study, and instructional packages are the three methods of individualizing instruction which will be discussed.

Individually Prescribed Instruction, (IPI), is a program under recent investigation in education. The essential components of the program are as follows:

1. sequentually established curricular objectives in each area stated in behavioral terms;
2. a procedure and process for diagnosis of student achievement in terms of objectives of the curriculum and the proficiency level desired for each student and each objective;
3. the necessary materials for individualizing learning to provide a variety of paths for attainment of mastery of any given objective;
4. a system for individually prescribing the learning tasks the student is ready to undertake;
5. the organization and management practice of the total school environment to facilitate individualization; and
6. strategies for continuous evaluation and feedback of information for teacher decision-making as well as information for continuous evaluation of the curricula for curriculum developers.[17]

---

[16]Jack V. Edling, Individualized Instruotion: A Manual for Administrators, (Oregon: Oregon State University Dept. of Printing) p. 1.

[17]John Bolvin, "Individually Prescribed Instruction." Individualized Instruction and Learning, ed. Madan, Mohan and Ronald E. Hull (Chicago: Nelson-Hall Co., 1974) p. 124.

Another way in which individualized instruction may be implemented is through independent study. Paul Torrance states that, "since much continued learning is likely to be through independent study, such study should be the most powerful instructional tool in helping young people acquire the motivation and skill for continued learning."[18] Gaynor Petrequin says that "through independent study the pupil learns responsibility for he must choose how to use his unscheduled time."[19] One of the greatest advantages of using independent studies in a class is that the student enrolls for the best reason. He is interested in the subject and wants to learn.

Instructional packages are another means of individualizing instruction. Instructional packages are units or modules which contain a variety of materials which relate to a specific concept and are often sequential. By the very nature of the modular unit, they are specialized and individual Dunn says that individualization of learning by instructional packages "provide extensive opportunity for students selection and exploration of materials based on interest, the establishment of either teacher-or student-selected goals, selfpacing and individual leveling."[20] Instructional packages differ from

---

[18]Paul Torrance, "Independent Study as an Instructional Tool", Individualization of Instruction-A Teaching Strategy, ed. Virgil M. Howes (New York: The Macmillian Company, 1970) p. 211-213.

[19]Gaynor Petrequin, ed., Individualizing Learning Through Modular-Flexible Programming (New York: McGraw-Hill, Inc., 1968) p. ix.

[20]Kenneth Dunn and Rita Dunn, Educators' Self-Teaching Guide to Individualizing Instructional Programs (West Nyack, New York: Parker Publishing Company, Inc., 1975) p. 28.

programmed learning because they are less structured and permit options and alternative learning processes. The teacher can be in control of what the student learns only if she designs the package.

Educational research has indicated that some learners from nursery school to graduate school require a great deal more structure than others. Some students may not have the dicipline or self-motivation that is necessary to pursue learning by themselves over an extened period of time. Dunn suggests that an instructional package may be useful to a talented student for the following reasons:

1. An advanced student able to cope with new concepts or skills independently, may work well ahead of his peers through the use of this method. He need not wait to learn until either the teacher can work with him individually or the rest of his peers catch up. He also need not learn on "grade level".

2. An interested student may learn more about a given topic, concept or skill at the moment in time when he wants to, not when the teacher is able to get to the subject.[21]

As stated previously, there have been varying degrees of success in the implementation of individualized programs in the schools. Audrey Grissom reported that Annandale High School began in individualized program for biology in 1971. She says that based on data collected before the new program and comparing it with data collected after the program was implemented,

---

[21] Dunn, Practical Approaches to Individualizing Instruction, p. 30.

there was a 43% increase in the number of A's and B's received by the students at the close of the 1975 school year. Only one student out of 240 failed to receive a passing grade.[22]

There are many factors involved in the success or failure of any educational program. Varibles such as teacher ingenuity, patience, attitude, personality, and perseverence, as well as administrative and community support, all play a part in determining the amount of success of new programs. Jack Edling says the following observations have been made by those persons who have had experience in implementing individualized instructional programs within the school system:

1. Little evidence has been provided to indicate that individualized procedures work more effectively at achieving skills than do traditional group oriented procedures.

2. Although many persons believe that individualized procedures are necessary for achieving objectives related to motivation toward learning, to the learner's self-concept and development as a person, there is little evidence to support these beliefs.

3. Some evidence has been documented which support individualized instruction because there seems to be less disciplinary problems associated with attention, boredom and disinterest.

4. Evidence indicates that some persons have difficulty adapting to individualized procedures which require them to assume additional responsibility for their education. Evidence suggests that individuals with intellectual, emotional, and/or motivational deficiencies are most inclined to experience difficulties.

5. There is evidence to suggest that most students prefer individualized procedures to traditional group oriented procedures.

---

[22]Audrey Grissom, "Another Approach to Biology Teaching", American Biology Teacher 38 (May, 1976): p. 300.

6. Some teachers have difficulty adapting to individualized procedures. Usually, these teachers are those who have a strong commitment to teaching a prescribed content.

7. Many teachers require more planning time and training to implement individualized procedures.

8. Evidence suggests that in order to implement an individualized program, more instructional materials are needed.[23]

The authors of "Studies of Individualized Instruction in Biology" say that many students have difficulty adjusting to this method of teaching and "overall achievement is often depressed because of procrastination or lack of self-discipline on the part of the students."[24] They explain that to many educators it is becoming apparent that individualized programs may be appropriate instructional approaches for some students but inadequate for many others.

---

[23]Jack Edling, Individualized Instruction, pl 100.

[24]Joel Mintzes, et al., School Science and Mathmatics, p. 675-686.

Mastery Learning

History

Although the development of effective mastery strategies has occurred principally during the last few years, the idea itself is much older. Carleton Washburne developed the Winnetka Plann in 1922 and in 1926 Henry Morrison developed a similar program at the University of Chicago's Laboratory School. In both programs, objectives were written that each student was expected to master. Both programs employed the use of learning units, where each unit contained learning materials arranged to teach a specific objective or set of objectives. Both programs required the student to master each unit before going on to the next unit. In both programs, when the student completed the unit, an ungraded, diagnostic-progress test was given which provided feedback on how well the student had learned the material. Using the test results, the student was then given learning correctives so that he could complete his learning unit. Both plans also allowed for the time needed for almost all the students to master the unit.

Although the above methods were popular in the late 1920's, the idea of mastery learning disappeared and did not resurface until the late 1950's with programed instruction. Programed instruction suggests that the learning of any behavior depends upon the learning of a sequence of less-complex component behaviors.[25] "Theoretically, therefore, by breaking a complex

---

[25]B. F. Skinner, "The Science of Learning and the Art of Teaching," Harvard Educational Review 24 (1954): 86-97.

behavior down into a chain of component behaviors and by ensuring student mastery of each link in the chain, it would be possible for any atudent to master even the most complex skills."[26]

Because programed instruction was so popular in the 1960's, two well known programs were developed. One was the Individually Prescribed Instruction (IPI) project at Pittsburg.[27] The other program was Stanford's Computer Assisted Instruction (CAI) project.[28] IPI was designed to teach arithmetic,science, and reading for grades K-6 while CAI was designed to teach only arithmetic and reading. Both programs broke the subject material down into sequential objectives and developed programed learning units for each objective.

Programed instruction was effective for some students. Students who required small learning steps, constant drills and reinforcement, seemed to get the most from the program. However, for a lot of students it was ineffective, and therefore was not a useful model for mastery learning.[29]

In 1963, John Carroll proposed a useful model for mastery learning. His model suggests that if given enough time, almost

---

[26]James H. Block, Mastery Learning (New York: Holt, Rinehart and Winston, 1971), p. 4.

[27]Robert Glaser, "Adapting the Elementary School Curriculum to Individual Performance," in Proceedings of the 1967 Invitational Conference on Testing Problems. (Princeton, New Jersey: Educational Testing Service)

[28]P. Suppes, "The Uses of Computers in Education", Scientific America, 215 (1966), 206-221.

[29]Block, Mastery Learning, p. 5.

all students can learn what they are supposed to learn in school.[30] The amount of time necessary for a student to learn a task under optimal conditions is a reflection of the student's aptitude. He says that there are five varibles which may be adjusted in order that each individual child may master a given subject. These varibles are: aptitude for particular kinds of learning, quality of instruction, ability to understand instruction, time allowed for learning, and perseverence.[31] Carroll says that it is not important to measure or predict perseverence, but it is important to enhance it.[32] He explains that if instructions were arranged so that students experienced success more often than failure, then students would persevere. Success creates interest in learning where none had existed.[33]

In 1968, Benjamin Bloom created a working model for mastery learning from Carroll's conceptual model. Bloom contends that the school systems in the past presume many students will fail. He says that 90% of students could master a subject

---

[30]John B. Carroll, "A Model of School Learning," Teachers College Record, 64 (1963), 723-733.

[31]Benjamin S. Bloom "Learning for Mastery", Individualized Instruction and Learning, ed. by Madan Mohan, and Ronald C. Hull (Chicago: Nelson-Hall Co., 1974), p. 5-32.

[32]John B. Carroll, "Problems of Measurement Related to the Concept of Learning for Mastery," Mastery Learning, ed. by James H. Block (New York: Holt, Rinehart and Winston, Inc., 1971), p. 44.

[33]Ibid., p. 45

if they were not expected to work at a certain rate and in a particular way.[34] Bloom says that:

> ...if students are normally distributed with respect to aptitude for some subject and all students are given exactly the same instruction (in terms of amount and quality of instruction and learning time allowed), then achievement measured at the subject's completion will be normall distributed."[35]

On the other hand, he explains:

> If students are normally distributed with respect to aptitude, but the kind and quality of instruction and learning time allowed are made appropriate to the characteristics and needs of each learner, the majority of students will achieve mastery."[36]

In Bloom's model, mastery was defined in terms of objectives which the student was to exhibit at the completion of the subject. The specific subject was broken into smaller learning units with the unit objectives specified for mastery of that mini-unit. If the student mastered each mini-unit then it is assumed the student mastered the subject. Typical group-based methods were used to teach each unit. The instructor gave the students feedback to insure that the student was making progress. The feedback procedures were in the form of short diagnostic tests which were taken at the end of the unit. These tests covered all of that particular unit's objectives and therefore showed what each student had and had not mastered. Correctives were then suggested to help the student in the needed areas.

---

[34]Benjamin S. Bloom, "Learning for Mastery", Individualized Instruction and Learning, p. 5-32.

[35]Bloom, "Learning for Mastery", Mastery Learning, ed. James H. Block, (New York: Holt, Rinehart and Winston, 1971) p. 50.

[36]Ibid., p. 50.

Bloom's model of Mastery Learning was more successful than earlier methods because feedback instruments were improved upon. This improvement is partially due to Peter Airasian who developed the formative evaluation.[37] Formative evaluation allows the teacher and the student to identify learning weaknesses early enough so that they may be corrected before the grading evaluation. Another reason for the success of Bloom's model over previous models was due to his use of a greater variety of instructional correctives.[38] Small-group study sessions, tutoring, reteaching, and various learning materials were used as correctives. Block explained:

> The purpose of these correctives is to provide each learner with the clearest and most appropriate instructional cues, the requisite amounts of active involvement in and practive of learning and the amounts and types of reinforcements his learning requires.[39]

Criticisms

Many concepts of mastery learning have been criticized by some. Patrick Groff, a professor of education at San Diego State University, believes that some of the proposals of mastery learning are not acceptable for many reasons.[40] First of all, mastery learning has not presented any concrete evidence to prove that all students have the same aptitude for learning every subject. It does not consider the past

---

[37]Peter W. Airasian, "The Role Of Evaluation in Mastery Learning", Mastery Learning, ed. James H. Block, (New York: Holt, Rinehart and Winston, 1971) p. 77-88.

[38]Block, Mastery Learning, p. 8.

[39]Ibid., p. 71.

[40]Patrick Groff, "Some Criticisms of Mastery Learning", Today's Education, (November-December, 1974) p. 88-91.

grades of students, their measured intelligence, and their attitudes toward the subject, teacher, and school.

He criticizes the assumption that teachers have the extra time necessary in mastery learning to give the students all the time they need to learn. Fault is also found with the idea that writing learning units with alternate learning materials and prescriptive tests is an easy task.

> Commercial publishing companies have had their least success in producing these kinds of diagnostic units for use with students.[41]

Groff questions the idea that all subjects can be made simple enough so that all students can master them. He finds if difficult to believe that a simple set of rules will overcome low school achievement.

Summary and Conclusions of Review of the Literature

From the foregoing discussions, we can summarize the following:

1. Talented students do have special problems different from those of other students.
2. There is a need for biology programs to keep motivation high for talented students.
3. Enrichment activities can be useful in helping gifted students achieve their potentials.
4. Talented students are highly motivated, capable of working independently, are trustworthy, and are aboe to follow directions.
5. Instructional packages may be useful to advanced students who posses the qualities listed above.

---

[41] Ibid., p. 90.

Mastery learning is only one technique of many which could be implemented to solve the problem of the lack of enrichment activities for the talented in biology. Some of these methods have briefly been discussed thus far. It is not the author's intent to explore each of these programs in detail. However, since mastery learning is a technique, it can be used in various methods of teaching such as independent studies and individual learning packages. The unit written for the purpose of this paper is in fact an individual learning package, and if used as suggested for enrichment purposes, it would also be considered an independent study.

PROCEDURES

Some of the procedures used in developing the curriculum were based on past experiences in teaching. The plan for developing Mastery Learning Units was adapted from the work of Jacobson [42], Block [43], Bloom [44], Carroll [45], and Airasian [46]. It involves the following six steps:

1. Decide on the content
2. Develop objectives for the content
3. Develop evaluation measures for the content
4. Teach
5. Identify learning difficulties
6. Reteach and retest when needed

Content

The first step in writing a mastery learning unit is deciding on the subject that is needed. Entomology was chosen for the sample unit because it is a high-interest area and because many high school biology books do not cover the subject extensively. After choosing the subject, it became necessary

---

[42] D. A. Jacobson "Mastery Teaching Reference Sheet" (Spring, 1978) University of North Florida, Jacksonville, Florida.

[43] Block, Mastery Learning

[44] Bloom, "Learning for Mastery", p. 47-51.

[45] Carroll, "Problems of Measurement Related to the Concept of Learning for Mastery", p.29-35.

[46] Airasian, The Role of Evaluation in Mastery Learning", p. 77-88.

To break the subject into smaller parts so the student can handle the material more easily. "Entomology" can be broken down effectively into six sections:

1. Insects and Their Importance
2. Exterior Anatomy of a Grasshopper
3. Internal Anatomy and Physiology of the Grasshopper
4. Metamorphosis
5. The Social Insects
6. Some Insect Orders

Certainly, each one of these sections could be a unit in itself. However, it was assumed that a talented high school student could best be served by having a less detailed overview of the subject. If more information was desired by the student, supplementary reference materials are suggested.

Objectives

Several objectives were written for each of the six sections in the unit. Some of the objectives were taken from various high school and college textbooks, while others were written by the author alone. There are many books available concerning the correct ways to write behavior objectives. Behavior objectives were written in observable terms containing the condition which the student will be measured and the criteria for the student's success.

The author tried to write some of the objectives in each of the following levels:[47]

---

[47] Benjamin S. Bloom, (ed). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. (New York: David McCay Company, 1956.)

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

It is highly desirable to write objectives above the knowledge level. The knowledge level is the lowest level of learning, involving only memorization and recall. Information received at the knowledge level is most easily forgotten. Levels above the knowledge level involves a more complex thought process. Objectives should be sequenced from the least to the most complex so the student can master the easier objectives before attempting the harder ones.

Develop Evaluation Measures for the Content

According to Mastery Learning principles, evaluation measures were developed for each section of the unit. There should be at least one test item for each objective and the test items should fit the objectives. The first type of evaluation used in the unit was a pretest. Each student must take the pre-test. There is no grade assigned to this test. It is used only to assess the student's abilities in relation to the instructional objectives. If the student demonstrates on the pretest that he has met the instructional objectives, he need not continue through the unit.

The second type of evaluation used in the mastery learning unit is the formative evaluation. Peter Airasian defines the formative as an evaluation which:

> ...seeks to identify learning weaknesses prior to the completion of insturction on a course segment--a unit, a chapter, or a lesson. The aim is to foster learning mastery by providing data which can direct subsequent or corrective teaching and learning.[48]

Formative evaluations are administered frequently and no grade is assigned. If a student does not show mastery of the objectives on the first formative of each section, he is given alternate activities to help with his learning difficulties. Afterwards, he is given an alternate formative evaluation. The alternate formative evaluation serves the same purpose as the formative evaluation. If the student masters the objectives tested on the formative, he may then move on to the next section.

The third type of evaluation used in the sample unit is the summative evaluation. It is different from the formative in that its primary purpose is to assign a grade according to the student's achievement of the course aims.[49] There is only one summative evaluation for the unit "Entomology", and it is taken at the unit's completion.

Teach

Each section is composed of a relatively short section that the student is expected to read. After having read the section, there is list of activities the student could choose from to

---

[48]Airasian, "The Role of Evaluation in Mastery Learning," p. 79.

[49]Ibid., p. 78.

achieve the objectives for that particular section. Various methods of teaching are used to consider indivudual learning differences. The methods include films, slides, lectures, group activities, selected references, independent study, laboratory work, teacher conferences, and tutorial help. Whatever teaching procedures are effective should be used.

Identify Learning Difficulties

The student goes through a section of the unit selecting activities which will help him achieve the objectives for that section. When he feels comfortable with the material in a section, he takes a formative evaluation on that section. The formative may be self-administered and self-corrected or if so directed in the unit, may be given and graded by the teacher or selected tutors. In any case, the student or the teacher may identify learning difficulties according to the results of the formative evaluation. If there are no difficulties, the student proceeds to the next section. If there are learning difficulties, the student is directed to alternate activities and to alternate fromatives until he has achieved the objectives and is ready to move to the next section. The student has to master each section before moving on to the next. The hypothesis in mastery learning is that if the student masters each section on the ungraded formatives, he would then be able to master the entire unit on the graded summative.

Reteach and Retest When Needed

If the student does not achieve the objectives on the first formative, reteaching of the material is desired in the form of

suggested alternate activities. After choosing from these activities, the student takes the alternate formative evaluation which has been discussed previously.

Setting up the Program

The ideal setting could be easily set up in most classrooms. There should be many mastery units covering a wide range of biology subjects, from which the student can choose according to his or her own interests. Some teachers may wish to have these units at the teacher's desk where she may keep a record of who has each specific unit. A small work area could be set up in the back of the room. There should be a small library composed of related literature on the various subjects at the student's disposal. The student should be responsible for checking out the learning materials or lab equipment needed for the unit. Some students may wish to do extensive study in the library.

Because of the emphasis being put on school and teacher accountability, these talented students will have to continue to do well in the regular curriculum. However, at any point, when the talented student feels comfortable with the material being taught to the whole class, the talented student may choose to work and study a mastery learning unit. By implementing this program, the talented student will be given the opportunity to go over and beyond the regular curriculum. Enrichment activities should also tend to develop interests in specific biological areas not covered in the regular curriculum.

Learning Station

The learning station for the unit "Entomology" consists of a small nine drawer file cabinet, consisting of specimens of twelve orders and fifty-three families of insects. These were collected, mounted, and identified by the author. Identification of the families were made by using various insect classification books from the library. Only twelve orders are represented because it was felt by the author that this was all a beginning Entomology student that was talented could handle.

ENTOMOLOGY
Mastery Learning Unit

TABLE OF CONTENTS

I. PROSPECTUS

A mini-unit is a self-contained insturctional package. It is an attempt to individualize learning by enabling the student to proceed independently through the material. This mini-unit is based upon the method of Mastery Learning, which enables 75 to 90 per-cent of the students to achieve the minimal success level. In this class, the minimal success level is a grade of a "c".

The study of insects is called Entomology, and consequently, scientists who study insects are called Entomologists. The major instructional purpose of this mini course is for the student to acquire a better understanding and appreciation for insects. E. S. Ross stated," With a casual flick of the hand or a stomp of the food we crush an amazing piece of biological engineering that has evolved millions of years." As the student progresses through this course he will be actively involved in learning about insects.

Many students might ask, "Why should I study bugs?" Insects play a very important roll in our lives, both directly and indirectly. Three-forths of all known animal species are insects. They have been extremely successful in colonizing almost all habital enviroments. Economically they play a very important roll. Some are beneficial while others are detrimental. Because of the world food crisis, we need to find more efficient means of controlling insect pests.

Because insects are "free" and easily found, they can easily be studied in the laboratory. They are inexpensive to maintain. Many of the processes that occur in higher

organisms, can also be observed in insects. Very few persons would object to dissecting an insect, as some do with higher animals.

V, J. Tipton wrote, "In past years the fascination for the study of insects may have been inspired by their exquisite beauty and their bizarre form, their diligent labors and their casual flight, the bustle of their urban centers and their idyllic life style, their perfumed elegance and their unsavory habits, their miraculous ability to change form and their wondrous consistency through time." However, he goes on to say, that entomologists are more concerned with "the frail unadorned mosquito, responsible for transmitting 200 million cases of malaria per year; the homely louse, which turned armies from their objectives and changed the course of history; the diminutive Mediterranean fruit fly, which threatens the citurs industry; and the common European corn borer, the destroyer of tons of corn each year."

As you proceed through this unit, you will learn many things about insects. You will study why they are important to us and ways in which we can control them. You will study how they are put together, and what makes them "tick". You will study how they grow and change forms, and how the social insects live. Finally you will study some of the specific insect orders and learn how to identify some insects.

Basic Assumptions

The entire approach in this experience is based upon the following assumptions:

1. The student is seeking educational experiences which will enhance his knowledge of Entomology.
2. The student is willing to work hard.
3. The student is willing to assume responsibility for his/her learning.
4. The student is willing to try new learning techniques.
5. The student wants to succeed.

Prerequisites

Although a general knowledge of Zoology would be helpful, it is not a necessity in order to complete this unit. Biology as a course, is not somuch involved with steps in learning as in, for example, Math. Biology is made up of many small subjects which conceivably could be taken entirely separately.

It would be helpful for the student to have succeeded in the unit concerning nomenclature and classification. How well you remember these concepts will be determined by a pre-test found in Section III. If you miss the questions dealing with these concepts, review materials will be suggested for you and/or your teacher will review them with you.

It is also useful if the student has had previous laboratory experience, and has previously studied other Arthopods. These entry behaviors are not required, but would help the student proceed through this unit at a more rapid pace.

Procedure

Within this Entomology module, there are six areas the student will study. Each area is listed as an objective in Section II while discussions and activities are found under Enabling Activities in Section IV. For example, everything in Enabling Activity #1 is designed to facilitate Objective #1. The format for each Enabling Activity includes an overview which presents organizational and/or instructional material; an enumeration of classroom activities including the presentation of alternative for facilitating the objectives; questions and or problems for consideration; a brief reference listing; and a formative evaluation. The procedure that you will use in working through the unit is as follows:

1. A through explanation of the procedures will be presented during the first session of this mini-course. DON'T PANIC! It's not as complicated as it may seem at the moment.

2. Read "Prospectus" and "Basic Assumptions" if you have not already done so. (also Prerequisites)

3. Read each of the specific performance objectives in Section II that you are to master during this mini-course.

4. Read and complete Section III, the Preassessment and Pre-test.

5. Each enabling activity includes an overview which presents organizational and/or instructional material; a list of classroom activities including alternatives for achieving the objectives and a list of resources to be consulted. There is a formative evaluation at the end of each activity that you must complete satisfactorily before moving on the next activity. No grade is given

for the formative evaluation. They are only to let the student know whether or not he has achieved the objective. The teacher then can prescribe alternatives if he-she has not achieved the objectives.

6. On the final day of this mini-course, you will, be given a summative evaluation over the objectives of the course. The student will receive a grade on the summative.

7. The following are areas covered in the Enabling Activities.

   a. Enabling Activity--Introduction
      "Insects and Their Importance"

   b. Enabling Activity #1
      "External Anatomy of the Grasshopper"

   c. Enabling Activity #2
      "Internal Anatomy and Physiology of the Grasshopper"

   d. Enabling Activity #3
      "Metamorphysis"

   e. Enabling Activity #4
      "The Social Insects"

   f. Enabling Activity #5
      "Eight Orders of Insects"

OBJECTIVES

Int.a: The student will be able to discuss, either orally or on a written exam, the role that insects play in our lives including five ways that they are helpful and five ways that they are harmful to man.

Int.b: The student will be able to discuss on an oral or written test, at least four methods of controlling harmful insects, selecting one which he feels is the best method and justifing his answer.

1a: The student will be able to identify the external anatomy of a grasshopper either on a written exam or orally, and either from a diagram on paper or from a "flagged specimen".

1b: The student will be able on a written or oral exam, to compare and contrast the wings of an insect and the wings of a bird.

2a: The student will be able to show his understanding of the digestive system of the grasshopper by tracing a piece of grass from the mouth through the digestive tract.

2b: The student will be able to discuss the respiration of a grasshopper on a written or an oral exam.

2c: The student will be able to identify the parts of the grasshopper's internal anatomy on a True-False written or oral exam.

3a: The student will be able to compare and contrast complete and incomplete metamorphosis, including examples of each, and harmones involved on an oral or written exam.

4a: On a written or oral exam, the student will be able to discuss the social insects, including the types, the divisions of labor, and how they communicate with each other, and if in fact they are or are not intelligent supporting your answer.

5a: When given a key, the student will be able to "key out" unknown insects on a written test or orally. These will not necessarily be from the 3 orders we studied.

5b: When given several unknown species of animals, the student will beable to identify those that belong to the class Insecta.

5c: When given the name of an insect, the student will be able to identify the appropriate order to which it belongs either on a written or oral exam from the 8 orders we studied.

5d: When given specimens of insects of the 8 orders studied the student will be able to identify the order or and thecommon name of the insect.

5e: The student will compile his/her own insect collection, including examples from each of the 8 orders and any others he may wish to include. They should be mounted neatly and in correct order. This is due at the final summative evaluation and may be done in groups of two.

25 insects=C
50 insects=B
75 insects=A

This grade will count 1/3 of your summative grade.

III.
Instructions for the Pretest

Each student must take a pre-test. There is no grade assigned to this test. It is used only to assess students' abilities in relation to instructional objectives. If the student demonstrates an ability on the pretest to meet the instructional objectives, then he need not continue with the activities. He may instead work on some enrichment activity or help in tutoring students who are going through the unit.

Answer each question the best that you can. Do not be concerned if you do not know any or all of the answers. You are not expected to.

Pre-Test

1. Arthopods are: a. crabs b. spiders c. insects d.millipedes e. all of the above.
2. List four reasons why we should study insects.
3. Give an example of a beneficial insect and why it is beneficial.
4. List three methods of controlling insects.
5. Define exoskeleton.
6. List 3 characteristics of an insect that separate it from other animals.
7. Name the three sections of the thorax.
8. Name the five parts of the insect leg.
9. What is the tympanum?
10. List three requirments for good laboratory drawings.

11. Briefly discuss the following systems related to the insect;
    a. Locomotion
    b. Respiration
    c. Digestion
    d. Excretion
    e. Circulation
    f. Sensory
    g. Reproduction

12. What are two social insects, and why are they called such?

13. Compare Complete and Incomplete Metamorphisis and name some insects that have each.

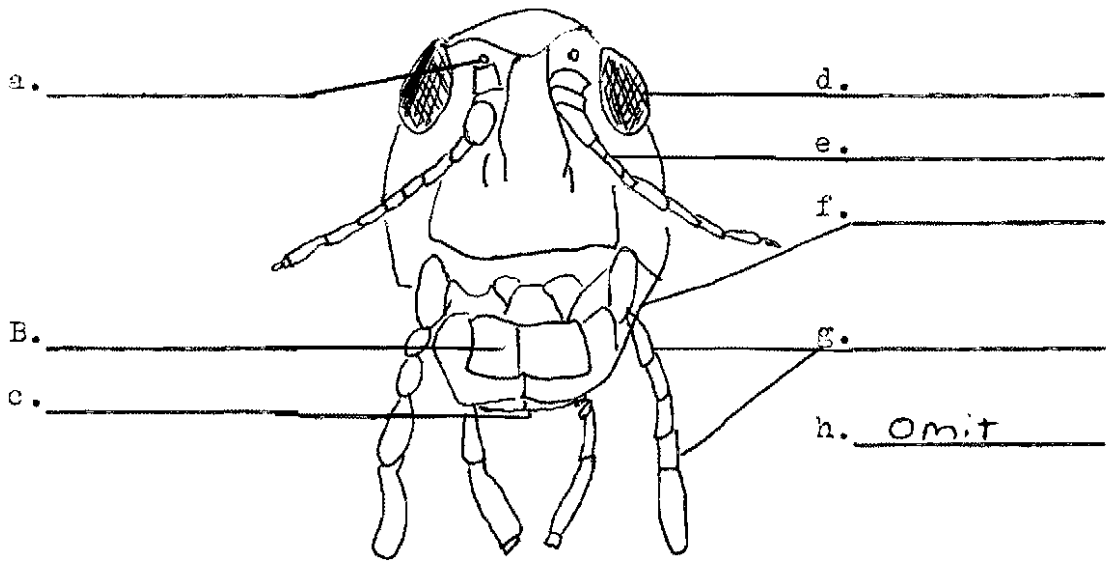
14. Match the following insects to their correct order.

Coleoptera ____	a. true bugs
Diptera ____	b. Bees, wasps, ants
Hemiptera ____	c. Grasshoppers, roaches
Hymenoptera ____	d. Butterflies, moths
Isoptera ____	e. Beetles
Lepidoptera ____	f. Dragonflies
Odonata ____	g. Flies, mosquitoes
Orthroptera ____	h. Termites

15. Construct a simple key using the following six items. Paper, pencil, leaf, rock, insect, book.

16. List the 7 categories that animals are classified starting with the largest and ending with the smallest.

17. Identify the following parts;



Feedback and Activities

Your teacher will review your answers to the pre-test and from this information will determine your learning sequence. The questions of the pre-test deal with the materials presented in this module, and you should not be concerned if you did not know the answers. If this were the case, you should participate in all the enabling activities of the module. If you were able to deal with any of the questions, the teacher will direct you to(1) in-debth studies of enrichment activities (2)tutor other students, or (3) move ahead to another module.

Activities will be provided at the end of each enabling activity. Additional activities will be prescribed when needed. Meet with your teacher so he can facilitate and record your progress.

If you missed question 15 and 16 on the pretest, you need some help on keys and classification. Special lecture sessions will be held for this purpose. The following activities will also be of some help to you.

Activities for Pre-Test Question #15and#16

1. Leskowitz, Irving. Basic Facts to Improve your Grades in Biology.
2. Johnson, Willis, et al. Laboratory Manual for Biology. Work through and study unit 25, p.159.
3. Biological Sciences Curriculum Study, Patterns and Processes. Read and work pages 16 and 17.

4. Storer, Tracy. Elements of Zoology. p.218-229.

5. Durst, Harold. High School Biology. p. 139-146.

6. Consult your instructor for further work and assessment.

7. Attend the scheduled seminar during Enabling Activity Introduction.

IV. ENABLING ACTIVITIES

Introductory Enabling Activity: INSECTS AND THEIR IMPORTANCE.

The study of insects is called entomology, and consequently, scientists who study insects are called entomologists. The class Insecta includes almost one million species, which is far greater than all other forms of life put together. Insects comprise about three-fourths of the Animal Kingdom. They are the most common land animals, and the only invertebrates that are able to fly. Of all the major habitats on earth, the oceans are almost completely lacking of insects. Their food requirements are so varied that they are able to survive in tremendous numbers without interfering with each other. There are sap feeders, leaf feeders, flesheeaters, blood suckers, nector and pollen gatherers, wood eaters, and even cannibalistic insects. They reproduce in extraordinary numbers. A well known English biologist, Thomas Huxley, arrived at the following calculation:

> "I will assume that an Aphis weighs one-thousandth of a grain, which is certainly vastly under the mark. A quintillion of Aphides will, on this estimate, weigh a quatrillion of grains; consequently, the tenth brood alone, if all its members survive the perils to which they are exposed, contain more substance than 500,000,000 stout men---to say at the least, more than the whole population of china!"(Otto, James. p.423)

All persons are affected by insects. The apartment dweller may eat honey, wear silk, chase ants and roaches,

and swat flies. The primitive tribesman is plagued by fleas, flies, and lice. Insects affect us economically, socially, and medically.

Many insects are beneficial. They are essential in cross-fertilization of the blossoms of apples, cherries, blackberries, clover, and various other crops. Hive bees produce tons of honey annually which serves as human food. The beeswax is used in polishes, church candles, and to wax thread. The silkworm gives us raw silk. The larvae spins a cocoon of silk from its salivary secretions. Each cocoon yields approximately 1,000 ft. of fiber and about 25,000 cocoons are unwound to spin one pound of sild thread. Certain dyes are obtained from the dried bodies of some tropical cactus scale insects.

Various insects are beneficial to us because they help control other insects that are harmful. For example, the larvae of ladybird beetles feed on the scale insects that damage citrus and other trees. These insects that eat other insects are called predacious insects. Certain parasitic insects are also helpful. They lay their eggs in the eggs or on the young of plant feeding insects and their larvae destroy the plant feeding insects. Predaceous and parasitic insects are often released in fields or orchids to biologically control harmful species.

Certain insects, such as the scavenger beetle and flies, are useful in cleaning up the dung and dead bodies of animals. Eggs are laid in animal carcasses, where the larvae

soon reduce the carcass to bone. Many insects such as ants, termites, and beetles also serve in reducing the remains of dead plants and trees. Insects are extremely important in our food chain.

Harmful insects cause more than a billion dollars worth of damage per year in the United States alone. They injure forests, farm crops, flower gardens and lawns, stored foods, and other property. Some affect the health and comfort of man as well as wild and domestic animals. Each of our important crops such as corn, wheat, cotton, and tobacco have a hundred or more pests. To name a few of these pests are the chinch bug, cotton boll weevil and Colorado potato beetle.

Our food is eaten or ruined by ants, weevils, cockroaches, and are dirtied by house flies; grain weevils and moths damage stored cereal; moths and carpet beetles ruin clothing, carpets, and furs; silverfish damage books; termites destroy homes and fenses; mosquitoes, bedbugs, gnats, and stable flies bite man and his animals; and many insects act as intermediate hosts for various diseases of man, other animals and plants. One of the most well known diseases, Human malaria, is caused when an infected mosquito (Anopheles) bites man and injects the plasmodium into his body.

Several methods are used in controlling harmful insects;

1. Chemical sprays and poisons: These are called insecticides.
2. Quarantine; This involves keeping insects from enter- certain areas.

3. Natural enemies: These include birds, other insects, and bacteria, or any animal that feeds naturally upon an insect.
4. Enviromental changes: Drain breeding places; rotate crops; eliminate certain plants that insect pests feed upon.
5. Radiation: Sterilize male insects by radiation and allow them to mate with the females in nature. The females will lay sterile eggs.

Activities for Introductory Enabling Activity

Course Structure and Orientation
Read Introduction
Film: The Winner- the Insects 29 min.
Lecture on Nomenclature and Classification
Activity #1
Relfect upon how insects affect your life directly. How do they affect a farmer? a cattleman? Summit the three different lists, and include comments and/or any conclusions.
Activity #2
Suppose we could "get rid" of all the insects of the world. Why or why not would this be a good idea?
Activity #3
Discuss Biological control of insects. What do you think the advantages and disadvantages of using this method?

Questions for Consideration

1. Why are termites considered both harmful and helpful to man?
2. Why should we study insects?

Selected References for Introductory Enabling Activity

Durst, High School Biology p. 127-128.
Otto, Modern Biology Ch. 31 and 32.
Storer, Elements of Zoology Ch. 23.
Curtis, Biology p. 283.

Formative Evaluation for Introductory Enabling Activity

Using the above activities, references, and any source of your choice (including teachers, students, parents, etc.) discuss why we should bother to study insects. This should be written and should be no longer than three pages.

Vocabulary-you should be familiar with these words from this activity.

Entomology
Entomologist
Insecta
species
invertebrate
Beneficial insects
predaceous insects
parasitic insects
biological control
intermediate host

Alternate Activities

Conference with teacher
Look up definitions to the vocabulary words, and drill yourself on them. Have another student drill you on the words.
Ask for tutorial help
Briefly outline the reading to Introductory Enabling Activity.

Alternate Formative Evaluation

1. Write a story on what would happen if all insects were suddenly killed. This should be no longer than two pages, and should be turned in when reporting for the second part of this evaluation below.

2. Orally, report to the teacher and be able to discuss;
   a. Harmful and useful insects
   b. Ways in which harmful insects are controlled.

Enabling Activity #1: Anatomy of a Grasshopper

The phylum Arthropoda is one of the most important of all groups of animals. All arthropodes have an exoskeleton composed of chiten, segmented bodies and segmented appendages. Insects compose only one class of Arthropods. Other classes contained in this phylum, Arthropoda, are class Arachnoidea (spiders, mites, ticks,), class Crustacea (crayfish, crabs, srimp etc.), class Chilopoda (centipedes), and class Diplopoda (millipedes). Although many persons call anytiny crawling or flying animal a "bug", they are not correct in doing so. As shown above, spiders, centipedes and millipedes are not insects. If the following characteristics can be identified on an animal, it is probably an insect.

1. Three distinct body regions: Head, Thorax, and Abdomen.
2. The thorax has 3 pairs of legs and two pairs of wings.
3. The head has one pair of antennae and one pair of compound eyes, which is composed of hundreds of individual units.

Now that you know how to identify an insect, we are going to look at some specific parts of the grasshopper.

Head: Carefully remove and identify the following: the the labrum, the upper lip, is a large, lobed flap; two heavy tooth jaws, the mandibles; a pair of maxillae each with a 5-jointed maxillary palp; the labium, the lower lip, and a pair of 3-jointed labial palps;a tongue-like hypopharynx located

between and under the mandibles. The grasshopper's mouthparts are adapted for chewing whereas some insects' mouthparts are adapted to sucking and biting.

Thorax

The thorax is composed of three segments; the prothorax, mesothorax, and metathorax. The head and the first pair of walking legs are attached to the prothorax. The first pair of wings, the anterior wings, and the second pair of walking legs are attached to the mesothorax. The metathorax bears the second pair of wings, the posterior wings, and jumping legs. Identify the segments of the large hind leg as follows: The coxa joins the leg to the thorax; the trochanter joins the coxa and appears as a triangular plate; the large femur, where the large muscles for jumping are contained; the spiny slender tibia; and the tarsus composed of 3 joints and 2 claws.

Abdomen

The abdomen lacks appendages, is usually rounded, and is distindtly segmented. The first abdominal segment bears a large, oval, membraneous tympanum which is the organ for hearing. Many of the abdominal segments have pairs of tiny openings called spiracles. These openings lead to the air tubes or tracheae which form a complex network inside the animal. By action of the wings and movement of the abdomen, air is pumped in and out of the tracheae. Diffusion of carbon dioxide into the tracheae and oxygen into the

tissues is how respiration occurs. There are two pairs of pointed plates forming the ovipositor in the female. The end of the abdomen is rounded in the male and serves as a copulatory organ. The sting is a modified ovipositor and therefore is present only in females.

GENERAL LABORATORY PROCEDURE

Every science course must include laboratory work. By direct observation, the pupil is able to verify what he has read in books and heard in class.

To accomplish a laboratory exercise successfully, the pupil should:

1. Before starting a drawing, examine the specimens carefully, identify and understand the specific parts named.
2. Where dissections are required, follow directions carefully.
3. Make required drawings accurately and neatly, and label each structure as directed.
   a) All labels must be in drawing pencil and each label should be in a straight line.
   b) Manuscript or capital letters may be employed, but their use should be consistent.
   c) A "straight-edge" should be used.
4. The pupil should follow these helpful hints for good drawings
   a) Label line should not be crossed.
   b) Words or labels should not be abbreviated.
   c) Words or labels should not be hyphenated.
   d) Labels should not be run into the drawing.
   e) The heading and identification should be made first; the drawing should not be made first and then the heading and identification crowded into a small space.
   f) The height of the letters in the labels should not be varied.
   g) The drawing should not be started until the pupil knows what he is doing.
   h) The labels should be checked for spelling errors.
5. All printing, labels, and identification should be parallel to the top and bottom edges of the drawing paper.
6. The use of colored pencils to shade in different areas is highly desirable; this will aid in the identification of those areas of structures.
7. A little advance thought as to the layout of the drawing will pay big dividends.
8. A pupil should not hesitate to ask for assistance in performing an experiment, but he should not expect the teacher to do all the work for him.
9. The sink and desk should always be cleaned after it has been used. Refuse should be wrapped in paper towels and placed in the wastebasket.

Activities for Enabling Activity #1

Sumit formative evaluation for introductory enabling activity.
Module Reading: Enabling Activity #1
Orientation: Handout: General Laboratory Procedure
Directions for Group Activity

Individually or
Group activity - 2 or 3 persons

After reading through the enabling activity, the group should follow the general lab proce dures and make a neat drawing of the grasshopper, labeling all the underlined parts. Each person should make a drawing and also answer the following questions. The selected references below may help you with your drawing. The microscope is useful and desired in looking at some of the grasshopper's anatomy.

1. Observe the grasshopper as he moves. (if you habe a live grasshopper) What patterns of locomotion do you observe?

2. Count the appendages. How many are there?
How many wings? antennae?

3. How are young grasshopper different from the adults?

4. Do you see any evidence that the grasshopper has a respiratory system?

5. From your observation of the behavior of the grasshopper what kind of enviroment would it be best fitted?

6. What outward evidence is there of sexual differences in the grasshopper?

Questions to think about

1. What would you consider to be an advantage of an exoskeleton? a disadvantage?
2. The exoskeleton covers the body of an arthropod like a suit of armor and does not grow. How then does the insect grow larger?

Selected References for Enabling Activity #1

Otto, James, Modern Biology - Ch. 31
Storer & Usinger, Elements of Zoology Ch. 23
Berrill, Biology in Action p.424
Biological Sciences Curriculum Study, Biological Science an Inquiry into Life p. 334-346
Fingerman, Animal Diversity p. 137-138

Formative Evaluation: for Enabling Activity #1

This will be a lab evaluation where parts of the grasshopper will be "flagged" and you will be required to identify the parts on paper.

Alternate Activities

Teacher lecture on grasshopper Anatomy
Student tutor in areas where you need help
Using any of the suggested material, make a poster drawing for the class, or a bulletin board display, displaying the parts of a grasshopper
Word puzzle- on the following page
Have another student quiz you on the anatomy of the grasshopper
From the list of vocabulary words, write the ones you are having trouble with. Define them, study them, and have either another student or your parents quiz you.

Alternate Formative

An oral evaluation given by the instructor with the use of a specimen. The student will be required to identify orally, parts of the grasshopper.

Vocabulary words used in this Activity

exoskeleton
chiten
segmented
head
thorax
abdomen
antennae
compound eyes
simple eyes
labrum
mandibles
maxillae
maxillary palp
labial palps
hypopharynx
prothorax
mesothorax
metathorax
anterior wings
posterior wings
trochanter
coxa
femur
tibia
tarsus
tympanum
spiracles
ovipositor
copulatory organ

Word Puzzle

N	A	C	N	C	N	I	C	F	M		M	E	X	A	M	O	P
A	R	T	H	R	O	P	O	D	A	U	E	S	A	R	E	A	R
L	A	B	A	I	A	X	D	E	N	A	S	E	F	E	T	S	O
M	L	B	F	N	N	D	A	A	D	R	O	R	T	N	A	P	T
T	A	B	E	S	B	E	P	N	I	T	Q	G	H	O	T	I	H
I	H	C	M	E	L	M	C	D	B	H	T	T	T	U	H	R	O
B	Z	O	U	C	Y	E	H	I	L	A	B	I	U	M	O	A	R
I	K	I	R	T	I	W	O	B	E	O	R	B	O	V	R	C	A
L	A	B	J	A	B	J	M	C	O	I	D	I	R	P	A	L	X
A	Y	X	L	A	X	L	A	B	R	U	M	A	P	T	X	E	N

Circle the words that correctly answer the following definitions. Words may go across, down, or diagonally up or down.

1. The part of theinsect that has 3 pr. of legs.
2. The phylum that insects belong.
3. The class that insects belong .
4. The upper lip
5. Heavy jaws
6. Lower lip
7. First pair of legs are attached to the_____.
8. The posterior wings and jumping legs are attached to ___.
9. Joins leg to thorax
10. Largest part of leg.
11. The long spiny slender part of the leg.
12. Hearing apparatus
13. Respiration apparatus

Enabling activity #2: Internal Anatomy and Physiology of the Grasshopper

Locomotion:

The grasshopper's appendages for locomotion are located on the thorax and include 3 pair of legs and 2 pairs of wings. Large muscles are found in the femur and are adapted for jumping. The success that insects have had can be attributed to their power of flight. Wings gave insects a tremendous advantage over other land invertebrates by giving them the means to avoid predators. The frequency of wingbeat of a midge has been reported to be as high as 1046 beats per second. Hummingbirds have only a mere 90 wingbeats per second. Birds's wings are thick and made up of muscle and bone. Insect wings, however, are thin, usually transparent, and although it moves also by muscle , contain no muscle in the wing itself.

Respiration

Spiracles are openings which lead to the tracheae or air tubes. When the wings or abdomen move, air is pumped in and out of the tracheae. By diffusion oxygen is exchanged for carbon dioxide.

Digestion

After grass has been bitten off by the mandibles the esophagus carries food to a crop, where it can be stored for a time. Salivary glands secrete fluid into the mouth which moisten the food and allow the insect to swallow more effectively. From the crop the food passes to the gizzard,

where food is ground up. The food then passes to the stomach. The gastric caeca produces enzymes which aid digestion in the stomach where digestion is completed. Digested food is absorbed through the stomach wall into the blood stream.

Excretion

Material left in the stomach passes into the intestine which is made up of the colon and rectum and terminates at the anus. Cellular wastes are picked up by the blood stream and collected by yellowish hairlike structures called Malpighian tubules. Wastes are then passed to the intestine and out the anus.

Circulatory

Insects have an open circulatory system which means the blood is not confined in a continuous system of vessels. Usually there is a heart(except in smaller insects), which have a number of open-ended arteries. The blood flows from these arteries into the body cavity, then slowly drifts back to the heart. The heart is located dorsal to the digestive tract.

Sensory

The tympanum are sensory organs which function in hearing. Antennae are sensory organs for touch and smell. The grasshopper have both simple and compound eyes. The simple eyes are located right above thebase of the antennae. The compound eyes are large and are composed of hundreds of lenses. The sense organs receive stimuli and are then relayed to other parts of the body by nerves. The Brain is an enlarged ganglion composed of Optic lobes

Reproduction:

Sexes are separate in insects. Males have testes which produce sperm. Females contain ovaries, which produce eggs. The male deposits sperm in the seminal receptacle of the female where they are stored until eggs are ready for fertilization. With the ovipositor, the female digs a hole in the ground (in some cases) and deposits her fertiliged eggs. The eggs of the grasshopper are laid in the fall and do not hatch until spring.

Questions to think about

1. What could there be about the insects anatomy which limits its size? Consider the circulatory systems, the tracheal system, the excretory system and the exoskeleton for possible answers.

2. To do its work, one end of a muscle is often attached to something solid. To what are grasshopper's muscles attached?

3. How do you think the cells within a grasshopper's body obtain theoxygen they must have?

4. What do you think makes the wings move?

Activities for Enabling Activity #2

Sumit formative evaluation #1
Module Reading: Enabling Activity #2
Lecture/Seminar: Taxonomies and keys
Independent Study
Conference

Activity #1

Continue to disect your grasshopper if you wish. Find as many of the parts as you can for this enabling activity. Draw and lable parts as directed in the lab direction sheet. You may use other sourses to help with your drawing. The selected references will help you with this. The drawing should be turned in to the teacher. Refer to the following page for your drawing.

Activity #2

Using the references suggested make a bulletin board showing the Internal Anatomy of the Grasshopper.

Activity #3

Make a drawing of the internal anatomy from the enabling activity or any other suggested sources. Quiz yourself on the parts, or have another student quiz you. Have the teacher check your drawing.

Questions for Consideration

1. How does an insect internal anatomy and physiology compare to man's?
2. How do you suppose, the grasshopper and other small animals survive with an open circulatory system? Could Man?

Selected References

Storer, Elements of Zoology ch. 23.
Fingerman, Animal Diversity p. 146-152
Vogel, A Functional Bestiary p. 47-49
Otto, Modern Biology p. 428-430.
Korn, Investigation into Biology p. 270-274.
Wiley, Beast, Brains, and Behavior p. 42-50, p. 21-28.
Fitzpatrick, Modern Life Science p. 523-525
Curtis, Biology p. 284-285, p. 570-588.

Formative Evaluation

When you feel you know the material in this section, report to the teacher for a short written evaluation. You have to get 15 out of the 20 questions to go on to the next section.

Group Activity #2 (con't)

Examine a dissected specimen of the grasshopper and draw and label the following:

1. Mouth-opens between mandibles
2. Mandibles-lateral jaws
3. Esophagus-short tube leading from the mouth to the foregut.
4. Foregut or Crop- first enlarged area of the digestive tract.
5. Midgut or Stomach-enlarged area of the digestive tract following the crop. This is where digestion takes place.
6. Caeca- pouches which extend from the stomach; secretes digestive juices.
7. Hindgut- leads to anus
8. Spiracles-small valved openings found laterally in the thin membranes between the thoracic and abdominal segments.
9. Tracheae-tubes entering the body from the spiracles through which air penetrates into the body.
10. Heart- dorsally located in a sinus
11. Aorta-only blood vessel;runs toward head on Dorsal side.
12. Ovaries-found lying above the posterior portion of the gut.
13. Testes- narrow tubes in which sperm develope.
14. Ventral Nerve Cord-runs along ventral side of the grasshopper.

Alternate Activities

Teacher lecture
Have another student Quiz you on your weak points
Make up your own test on Enabling Activity #2 and see how well you do.

Alternate Formative

You have the choice of either an oral evaluation given by the teacher or a written evaluation which the teacher will give to you when you think you are ready.

Enabling Activity #3: Metamorphosis

Metamorphosis is defined as a marked change in structure of an animal during its growth. Most insects undergo these changes in their development. Some insects such as grasshoppers, true bugs, and termites under go incomplete metamorphosis which consists of three stages: The egg, the nymph, and the adult. The nymph resembles the adult except for smaller size, absense of wings, and lack of development of the reproductive organs.

Complete metamorphosis occurs in butterflies, moths, flies, and beetles. This type consists of four stages: the egg, larva, pupa, and adult. The larvae are wormlike and segmented. Depending on the kind of insect, these larvae are called caterpillar, grub, or maggot. Insects are most destructive in this stage. After a period, the larva enters a pupa or resting stage. Actually they are not resting at all, because all the tissues of the larva are transformed to those of the adult. Maggots turn into adult flies, grubs to beetles, and caterpillars to butterflies or moths. Two hormones are involved in transforming immature forms to adults. These are juvenile hormone and growth hormone.

Activities for Enabling Activity #3

Sumit formative evaluation#2
Read: Enabling Activity #3
Film Strip: Butterfly 8 min.
Film: The Hidden World of Insects
Independent Study
Conference

Activity #1

Make a Bulletin Board Display of Complete and Incomplete Metamorphisis.

Activity #2

Make observations of eggs, larvae, cocoons, and adult forms of insects provided by the instructor. You may also bring your own forms to observe. Write down your observations and turn in.

Activity #3

Go to the library or use the selected references, and find information as to what makes an insect go through metamorphisis. Turn report in to the teacher.

Selected References for Enabling Activity #3

Storer, Elements of Zoology p. 336-337
Otto, Modern Biology p. 424-526
Fitzpatrick, Modern Life Science p. 213-217
Curtis, Biology p. 285-287

Vocabulary

Metamorphosis
Incomplete Metamorphosis
Nymph
Complete Metamorphosis
Larva
Pupa
Grub
Maggot
Caterpillar
Juvenile Hormone
Growth Harmone

Formative Evaluation For Enabling Activity #3

This will be a short evaluation (written). When you are ready, repost to the teacher.

Alternate Activities for Enabling Activity #3

Teacher conference help
Student Tutor
Make a list of new interesting words, to be added to your vocabulary, and define, that you learned during this topic
Make up a quiz on the information and test yourself.
Photograph insects in different phases of metamorphosis using pictures or slides.
If you were an insect, and you could choose between having complete or incomplete metamorphosis, which would you choose and why?

Alternate Formative

You have the choice between an oral or written evaluation. Report to your teacher when you are ready.

Enabling Activity #4: The Social Insects

Insect social behavior and human social behavior have many similarities. Bees, ants, wasps, and termites exhibit a high degree of social behavior. Individuals carry on special tasks and seem to work closely together for the good of the group. Some have jobs of collecting food, some are fighters, and others are baby-sitters. Some species wage war and make slaves, and others construct complicated housing projects. Pastoral ants shelter aphids. From them they obtain honeydew as food. Harvester ants gather and store seeds in summer so they can survive the winter. The fungus ants actually grow their own pure crop of certain fungi in underground gardens.

The honey bee is a social insect of the order Hymenoptera. There are three types of individuals of a bee hive; the workers, the drones, and the queen bee. The workers are the most numerous inhabitants of the hive. They are underveloped females with the ovipositor modified into a sting. Upon discovering a food supply, the worker fills her stomach with nectar, returns to the hive, and either deposits the gathered nectar or feeds young bees. She then executes a "dance" that informs other bees as to the direction and the distance of the source. Experiments have shown that the location of the food source is indicated in relation to the sun's position. The nature of the food is communicated by the odor on her body or in the nectar brought. The other bees touch her continually with their antennae during the dance. Nectar held in the stomach is broken down by salivary enzymes to dextrose.

The worker regurgitates this fluid into a cell of the comb, where other young bees,"housebees", work it in their mouths and cause further chemical change. Excess water is evaporated by fanning their wings and they seal the cell with wax.

The male bees,or drones,are larger than the workers but smaller than the queen. Their body is thick and broad and their wings are very powerful. They develop from unfertilized eggs. They have to be fed by the worders because their tongues are not long enough to obtain nector. They serve no functionexcept to mate with the queen. As autumn approaches and honey runs low, the workers will no longer support the drones. The workers will either sting or starve the drones to death.

The queen is thelargest bee of thehive. She develops from the special treatment of a fertilized egg. A wax cell for which the egg is to grow is enlarged by the workers. When the larva hatches, they are fed with extra portions of a high protein food they secrete called "royal jelly". This substance causes the queen larva to develop differently and to become larger. After five days, the larva spins a cocoon, change to a pupa, and is then sealed in a large waxen chamber by the workers. After the mature queen emerges from her cell, she kills theother queen larva in the colony. If she finds another adult queen, they fight until one is killed. She only uses her sting against another queen. Sometimes the workers prevent her from killing the other queen in which case she leaves the

hive, taking several thousand bees with her to find a new hove. This is how overcrowding is prevented.

About seven days after emerging as an adult, the young queen mates with a drone high in the air. The drone's copulatorn organs are then torn away and remain in the queen's genital bursa until removed by workers after her return to the hive. The sperm will serve for all the fertilized eggs she will ever lay. In a few days, she begins to lay her eggs. She can control the fertilization of her eggs. Unfertilized eggs produce drones or males, while fertilized eggs produce females. A queen may lay as many as one million eggs a year and often live from five to ten years.

Activities for Enabling Activity #4

Sumit Formative Evaluation #3
Module Reading: Enabling Activity #4
Required Film: "Story of the Bees"
Independent Study
Conference

Activity #1

Watch and take notes on the film "Story of the Bees". Record specific behavioral acts that must have been either inherited or learned. Be sure to record the sequence of jobs through which young workers pass. Be aware of any special adaptions of the queen, workers, and drones. Also note any behavior which might have survival value for the colony. Sumit a summary statement to the teacher.

Activity #2

From a survival stand point, what advantages result from society life? Are there any advantages in having a queen whose only function is to lay eggs: Is she actually a queen? Who rules the society? Who determines what types of individuals and how many of each will make up the society? Is this thoughtful behavior and has it survival value? Sumit your conclusions to the teacher and be prepared to discuss these questions.

Activity #3

Make alist of organisms that you feel instinctive behavior could be investigated properly. Select one and design an experimental approach for studying this organism. Sumit to teacher.

Activity #4

From suggested references or library sources (or any sources you may have), do a study on the social lives of the termites, wasps, and ants. Sumit to teacher.

Activity #5

Answer the following questions on the film, "The Story of the Bees".

1. How many behavioral activities which must have been either inherited or learned did you record? What were they?
2. As shown in the film, what wequence of jobs do young workers pass through consecutively after emerging from the cells?
3. Devise an experiment by which you could check whether this behavior is inherited or learned.

4. How do the following animals "know when and how to perform their tasks?
   a. The larva spins a cocoon just prior to prpation.
   b. Emerging from its cell, the young bee eats the "cap" off the cell.
   c. After emerging, the young bee cleans out the cell from which it emerged.
   d. Young workers go through a sequence of jobs.
   e. Workers recognize an intruder.
   f. Old workers prepare up to 12 "great cells" in which to raise new queens.
   g. A newly emerged queen stings the remaining "royal cells".

5. What adaptions has natural selection favored the
   a. drones?
   b. workers?
   c. queen?

6. Is their any survival value in the following aspects of a bee society and, if so, what might it be?
   a. the caste system of queen, drones, and workers.
   b. The care of the young.
   c. Bee communication as evidenced by the "nectar dance."
   d. The construction of up to 12 "great cells" for rearing new queens as opposed to constructing only 1.
   e. The swarming that occurs just prior to the emergence of a new queen.

7. Can bees learn?

Problems for Consideration

1. Are the social insects intelligent?
2. What are some instinctive behaviors in other animals?
3. How is the bee's body adapted for locating flowers?

Vocabulary

social behavior
hymenoptera
workers
drones
queen
dextrose
royal jelly
copulatory
genital bursa
inherited behavior
learned behavior

Selected References for Enabling Activity #4

Berrill, Biology in Action p. 421-423
Fingerman, Animal Diversity p. 152-154
Otto, Modern Biology p. 435-438
Fitzpatrick, Modern Life Science Ch. 23 p. 521-523
p. 236-244
Curtis, Helena. Biology p. 289-290, p. 584-586, p. 650-656

FormativeEvaluation for Enabling Activity #4

When you are ready the teacher will give you a written evaluation for this activity.

Alternatives for Enabling Activity #4

Teacher lecture
Teacher conference
Student tutor
Films: Social Insects: The Honey bee
Secrets of the Bee World
Secrets of the Ant and Insect World
The voice of the Insects
World of Insects
If you did not already do so, answer questions under Group Activity #5 in this section.

Alternate Formative for Enabling Activity #4
Choose one.

1Orally, with your instructor describe the jobs and social levels of a bee hive. Be prepared to answer any questions she may have concerning the hive and/or behavior of the bees.

2.Prepare a debate with the teacher taking which ever side "pro" or "con", and debate whether or not a bee is intelligent.

Enabling Activity #5: Some Insect Orders

Because there are so many insects, we will not be able to study them all. However, we will look at eight of the more common orders and learn to recognize the characteristics that are used in their classification. These characteristics include types of wings and mouthparts and types of metamorphosis. Insects can easily be found in your home, at school, in fields, ponds or trees, under stones or hiding on plants with almost perfect camouflage.

1. Lepidoptera- This order includes the butterflies and moths. The word lepidoptera means "scale winged", and was named this for their brillant colors which are due to microscopic scales on their wings. Butterflies and moths can easily be distinguished by the following comparisons:

BUTTERFLY	MOTH
Flies during day	Generally flies in the dark
Pupa in chysalis	Pupa in cocoon
Wings vertical when at rest	Wings held horizontally
Antennae knobbed	Antennae feathery
Abdomen slender	Abdomen stout

Most lepidoptera deposit their eggs on or near the material which is to be the food for the young. Usually eggs are deposited in the spring and develope into caterpillars the following summer. Metamorphosis in the butterfly has already been discussed. The butterfly pupa rests in a hardened case called a

chrysalis. The moth larva usually spins a strong case of silk called a cocoon. This order usually spends the winter in the pupa stage. In the spring the insect emerges, totally changed, as the adult butterfly or moth.

2. Hymenoptera- The social insects, bees, ants, and wasps, are included in this order. The name means "membrane-winged", and therefore the order is characterized by two pairs of wings of this type. They have complete metamorphosis and biting or sucking mouthparts, and a definite constriction between the thorax and abdomen. The characteristics of the social insects have been discussed previously.

3. Isoptera means "same winged", and generally this order which include termites have two pair of similar wings. Termites are harmful in that they destroy buildings, but also perform an important function of returning minerals to the soil. Termites cannot digest the cellulose found in cell walls of plants. A protozoan, trichonympha, lives in the termite's digestive tract and produces an enzyme that is capable of breaking down cellulose. The termite provides the protozoan with a place to live and food. And the protozoan provides the termite with digested cellulose, withoutwhich, the termite could not live.

4. Odonata - The wings of this order of insects are membranous and do not overlap. They are held at right angles to the body when at rest. This order includes the dragonflies and damselflies and are beneficial beneficial because they are predators as larvae, and as adults, they feed on other insects.

5. Coleoptera- Hard forewings which fit closely over the body and resemble a shell are characteristic of this order. The word "coleoptera" means "sheath-winged." Some species of this order, such as the potato beetle and the boll weevil, are very distructive. Others, such as the lady bugs, are beneficial insects.

6. Hemiptera- The name means "half-winged" because the edges of their wings overlap and only half of the wing is thickened. These are the true bugs and include pests as chinch bug, bed bug, and stink bug. Others include water striders, water bugs, and water boatmen.

7. Diptera- This order, meaning "two-winged", have only two wings. The other pair is reduced. They have complete metamorphosis. This order indludes the mosquitoes, some of which transmit malaria, the tsetse fly, responsible for transmitting sleeping sickness, and the common housefly, which infects people with typhoid and dysentery. The stable fly and horsefly bites man and cattle. Flies multiply at atremendous

rate. If reproduction were unchecked and all off spring survived, one fly laying 200 eggs would result in 2,020,202,020,200 flies in only twelve weeks time.

8. Orthoptera- This order includes the grasshoppers, the crickets, the katydids, the locusts, and cockroaches. The name means "straight winged" because the wings are held straight along the body when not in flight.

Activities for Enabling Activity #5

Sumit formative evaluation for Enabling Activity #4
Module reading: Enabling Activity #5
Film Strip: Hymenoptera 4 min.
Lecture: Collecting, Displaying, and Keying insects.
Film: Insect Mounting and Preserving 14 min.
Slides with Sound: Entomology- Introducing Insects
Independent Study

Activity #1

Observe and study the specimens of pinned insects of each of the 8 orders discussed in this enabling activity. Use the microscope to look at wings and moughparts of each. Write down on paper any you have difficulty in recognising. You should be familiar with the common names and the order name. Quiz yourself, or if possible have another student quiz you.

Activity #2

You will be given some insects and the key. Try and key out the unknown insects. Consult the instructor is you have difficulties.

Activity #3

Report on an insect related disease.

Activity #4

Go on a field trip where you should catch insects for your collection. (required for part of summative).

Selected References for Enabling Activity #5

Otto, Modern Biology Ch. 32
Morholt, A Sourcebook for the Biological Sciences p. 510-513, p. 557-569.

Vocabulary

Lepidoptera
chrysalis
Cocoon
Hymenoptera
Isoptera
Diptera
Trichonympha
cellulose
Odonata
Coleoptera
Hemiptera
Orthoptera

Formative Evaluation for Enabling Activity #5

When you are ready, ask the teacher for your formative which will be written. Good Luck!

Alternate Activities

Filmstrips (8) "Orders of Insects"
Using the available slides, specimens have a student or the teacher quiz you on your knowledge of insects and their orders.
With a tutor, or another student, practice keying out some insects.
Consult with teacher with any specific problems.

Alternate Formative Evaluation for Enabling Activity #5

Report to the teacher for your evaluation. She will give you an insect and you will be required to key it out. You will also be required to identify some insects and their order. Good Luck!

APPENDIX

References

Berrill, N. J. Biology in Action. Dodd, Mead and Company. New York, New York: 1966

Biological Sciences Curriculum Study. Biological Science, An Inquiry into Life. New York: Harcourt Brace Jovanovich, Inc., 1973

Biological Sciences Curriculum Study. Patterns and Processes. New York, N. Y.: Holt, Rinehart, and Winston, Inc., 1966.

Biological Sciences Curriculum Study Committe on Innovation in Laboratory Instruction. A Laboratory Block-Animal Behavior. Boulder Colorado: D. C. Heath and Company, 1968.

Burnett, R. Will. Zoology. New York: Golden Press, 1958.

Curtis, Helena. Biology. New York, New York: Worth Publishers, Inc, 1968.

Durst, Harold et al. (or, and others.) High School Biology. Chicago, Illinois: Rand McNally and Company, 1968.

Fingerman, Milton. Animal Diversity. New York: Holt, Rinehart and Winston, 1976.

Fitzpatrick, Fredrick L. and Hole, John W. Modern Life Science. New York, N. Y.: Holt Rinehart, and Winston, Inc., 1970.

Johnson, Willis H, et al. (or, and others). Laboratory Manual for Biology. New York, N. Y.: Holt, Rinehart, and Winston, Inc., 1966.

Korn, Robert W. and Korn, Ellen J. Investigations into Biology. New York: John Wiley and Sons, Inc., 1965.

Larson, Peggy Pickering, and Larson, Mervin W. Lives of Social Insects. New York: Thomas Crowell Company, 1968.

Leskowitz, Irving. Basic Facts to Improve Your Grades in Biology. New York, N. Y.: Collier Books, 1963.

Michener, C. D. and M. H. Michener. American Social Insects. New York: D. Van Nostrand Company, Inc., 1951.

Morholt, Evelyn, et al. (or, and others). A Sourcebook for the Biological Sciences. New York, N. Y.: Harcourt, Brace and World, Inc., 1966.

Otto, Hames H. and Towle, Albert. Modern Biology. New York: Holt, Rinehart and Winston, Inc, 1963.

Scott, J. P. Animal Behavior. Chicago, Illinois: University of Chicago Press, 1958.

Storer, Tracy I. and Usinger, Robert L. Elements of Zoology. New York: McGraw-Hill Book Company, Inc, 1961.

Vogel, Steven and Wainwright, Stephen A. A Functional Bestiary. Reading, Massachusetts: Addison Wesley Publishing Company, 1969.

von Frisch, K. Bees, Their Vision, Chemical Senses and Language. Ithaca, New York: Cornell University Press, 1956

Wiley, James (Editor). Beast, Brains, and Behavior. New York, N. Y.; Scholastic Book Services, 1963.

Filmstrips

Hymenoptera, 4 min., color , Holt.
Orders of Insects,(eight filmstrips), EBF.

Films

Butterfly, 8 min. Color.
How Living organisms Communicate by Scent. 30 min.,color
Nova.
Insect Mounting and Preserving, 14 min , Dowling.
Secrets of the Ant and Insect World, 15 min. Disney.
Secrets of the Bee World, 13 min., color, Walt Disney.
Social Insects: The Honeybee, 24 min. B & W and Color
EBF.
Story of the Bees
The Hidden World of Insects, Channel 4, Feb7, 1973.
The voice of theInsect, 27 min. Carousel.
The Winner- the Insects, 29 min., color, The world we live
in Series. 1968.
World of Insects 22 min., California Chemical

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

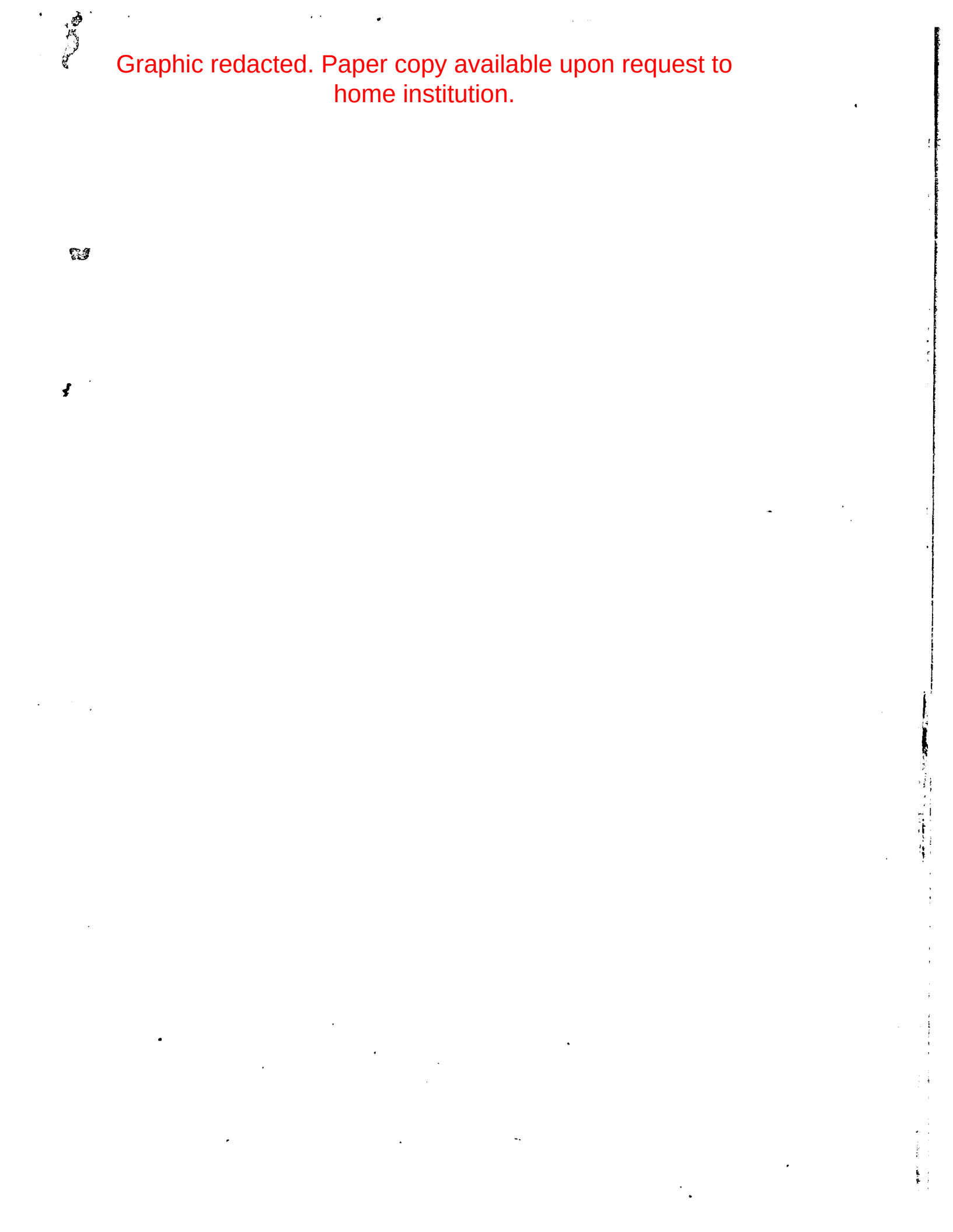
Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.


Graphic redacted. Paper copy available upon request to
home institution.

Graphic redacted. Paper copy available upon request to home institution.

Graphic redacted. Paper copy available upon request to home institution.

TEACHER SECTION

Teacher Rational

This mini-unit or module is an attempt to provide mastery learning for students. It is also an attempt to individualize instruction in that students are able to make choices in how they will learn the material and to a degree, how much time they will use in learning the material.

Many of the activities in this unit include the method of peer teaching. The rationale for using peer teaching is that when students teach a skill to someone else, they have really mastered a concept or skill. Blackburn andPowell cite other reasons for using peer teaching as follows:

1. Can provide insights about "learning how to learn"
2. Provides more persons who are so often needed in an individualized personalized program.
3. Allows young persons to practice adult roles.
4. Many times, it improves the self-concept of the tutor and the student being helped.
5. Makes the person being tutored feel he is important and someone cares.
6. Research confirms that most tutor sexperience success.

Another method often used in the module is group activities. Students are able to learn from each other. They learn to cooperate. Group activity promotes student interaction and the understanding of others. Group activity develops creativity and provides opportunities for developing interests, beliefs, and attitudes. It provides opportunities for making decisions and assuming responsibility.

Management Plan

In order to be successful in any program, the teacher must be experienced in classroom management. Classroom management is the way in which a teacher performs planning and record-keeping functions in an efficient manner. It should permit maximum student self-direction with minimum interruption to the student and/or to the program itself. Management of student progress in this program involves:

1. What activities the student will do
2. When the student will do the activities
3. Where the student will do the activities
4. And how records will be kept to indicate the progress of the student and how these records will be used for assessment of grades.

The first four steps, have been taken care of in the student section. However, one suggestion is that the teacher write on the board each day the activities and the time schedule. The student should pick the activities which he plans to do, sign the sheet and turn it in at the end of class. This record can serve as roll and save time.

The teacher needs some method of checking off formative evaluations. The student has to successfully complete one formative before going on to the next. This sheet would allow the teacher at a glance, to see if the student had successfully completed the necessary formatives. The paper on the following page is an example of such a sheet.

Scheduling

The following is an example of a schedule which could be used for this mini-course. This could be altered in any way the teacher felt necessary. The example shown is for a 3 week unit with 50 minute classes. Students should be instructed to; 1. have read enabling activity before class
2. fill out their tracking sheet as soon as they get into class, and sign it. This will be how the roll is taken.
3. get started as soon as bell rings.
4. stick to time schedule.

Day 1

20 min.	Introduction to course by teacher Note: Students should start their insect collection right away.
20 min.	Students take pretest
10 min.	Students grade each other pre-test

Day 2 — Introductory Enabling Activity

5 min.	Orientation: group work & group sheet.
17 min.	Group Activity #1 Independent study Conference
29 min.	Film: "The Winner- the Insects" Independent Study Lecture on Nomenclature and Classification

Day 3 — Introductory Enabling Activity

5 min.	Orientation: Formative Evaluations.
15 min.	Group Activity no. 2. Independent Study Conference.
15 min.	Group Activity #3 Independent Study Conference
15 min.	Time alloted for Formative Evaluation # Introductory. Independent Study Conference

Day 4 — Enabling Activity #1

	Materials Needed: Grasshoppers, Dissecting pan, Dissecting kit, and Microscope.
10 min.	Orientation: General lab procedure. Directions for group activity #1.

35 min. Group Activity- Drawings of grasshopper should include all designated parts. Questions should also be completed.

5 min. Clean up for next class. Put your grasshopper in a bag with your name on it. The teacher will come around and check your drawings and questions.

Day 5 — Enabling Activity #2

Materials: Dissecting pans, Grasshoppers, Dissecting kits, Microscope.

5 min. **Orientation**
Time alloted for Formativd Evaluation #1. Several stations will be set up in a designated area. At your convenience , and when you are ready, go th the stations and take the evaluations. Give the paper to your teacher, and then continue with your activities.

25 min. Group Activity #1
Conference
Independent Study

15 min. Continue with Group Act #1
Lecture/Seminar- Taxonomy and Keys

5 min. Clean up lab; put grasshoppers in the bag and dispose in the garbage can. The teacher will check your work.

Day 6 — Enabling Activity #2 (cont')

Materials: Bulletin board Material: Construction paper, colored paper, thumb tacs, paste, sissors.

5 min. Orientation

40 min. Group Activity #2 or #3
Independent Study
Conference

5 min. Clean up
Turn in assignments

Day 7 — Enabling Activity #3

20 min. Scheduled Formative for Enabling Activity #2
Independent study
Conference

30 min. Group Activity #1, #2, or #3.
Film, "Hidden World of Insects"
Film strip "butterfly"
Independent Study
Conference

Day 8 Enabling Activity #4

10 min. Scheduled time for formative no.3.
Independent Study
Conference
30 min. Film "Story of the Bees": This is Group Activity #1 and should be read before watching film. Do as directed.
10 min. Sumit a summary statement to teacher.

Day 9 Enabling Activity #4 (con't)

25 min. Group Activity #2 or #3
Independent Study
Conference
25 min. Group Activity #4 or #5
Independent Study
Conference

Day 10 Enabling Activity #4 (con't)

10 min. Group #2 Report
10 min. Group #3 Report
15 min. Group #4 Report
15 min. Group #5 Report

Day 11 Enabling Activity #5

10 min. Alloted time for Formative Evaluation #4.
40 min. Slides with sound
Group Activity #1
Independent Study

Day 12 Enabling Activity #5 (con't)

25 min. Teacher Lecture on how to use a key, and individual help on using keys.
Independent Study
25 min. Group activity #2
Independent Study
Conference

Day 13 Enabling Activity #5 (cOn't)

5 min. Orientation and Instructions
45 min. Group Activity #3 or #4.

Day 14

Formativetime alloted for Enabling Activity #5
Catch up day - Independent Study
Study for Summative
Conferences

Day 15 SUMMATIVE EVALUATION!!

Group assignments

Participants	A	B	C	D	E	F	G	H	I	J
1.	1	4	2	3	3	5	1	3	1	3
2.	2	5	4	3	1	4	1	3	5	2
3.	3	1	3	4	2	3	1	4	1	5
4.	5	2	5	1	4	2	1	1	2	1
5.	4	3	1	2	5	1	1	5	3	4
6.	5	1	3	4	2	5	2	2	1	4
7.	4	2	5	3	1	5	2	3	2	4
8.	3	2	2	1	4	4	2	5	1	1
9.	2	4	1	5	3	3	2	2	5	1
10.	1	5	4	2	5	2	2	1	4	3
11.	1	3	5	4	2	1	3	5	3	4
12.	2	1	4	5	3	2	3	4	2	5
13.	3	4	1	2	5	3	3	2	1	1
14.	4	5	2	3	1	4	3	1	4	2
15.	5	2	3	1	2	5	3	5	5	1
16.	5	4	3	2	1	5	4	4	1	3
17.	4	3	1	2	5	4	4	3	4	5
18.	1	5	3	5	1	1	3	4	1	2
19.	2	3	1	4	2	5	3	4	3	1
20.	4	4	3	3	5	2	1	4	2	4
21.	3	4	1	2	4	3	5	2	3	5
22.	1	2	4	3	5	2	1	3	2	4
23.	3	2	5	4	1	3	2	4	3	1
24.	4	3	5	3	2	4	1	2	4	3
25.	3	2	4	1	5	4	2	4	3	5
26.	5	5	3	5	2	5	1	3	3	2
27.	1	2	4	3	2	4	5	2	3	1
28.	4	5	3	1	2	4	2	3	3	1
29.	3	2	4	1	5	3	5	4	4	2
30.	4	5	1	3	2	1	3	2	4	3
31.	3	4	2	5	1	3	2	5	3	4
32.	1	3	2	4	1	1	2	4	3	5
33.	5	4	3	2	1	3	2	1	4	5
34.	3	4	2	5	1	3	1	2	2	2
35.	4	1	5	3	4	2	5	3	2	3
36.	3	4	3	4	2	5	1	3	2	2
37.	2	2	3	3	4	1	5	2	4	2
38.	1	3	1	4	1	5	1	2	1	3
39.	4	2	3	1	5	3	4	2	3	5
40.	3	3	4	1	2	5	4	2	4	5

FORMATIVE EVALUATION TRACKING SHEET

S= Satisfactory
U= Unsatisfactory

Name	Formative 1	2	3	4	5	6	Summative	Comments

Conferences

Conferences are offered in most of the activities. They could be used in a variety of ways. The student may have organizational problems, in which case the teacher could explain in more detail how the unit is set up and what is expected of the student. If the teacher is using mini-units often enough, the students usually will not have this problem after a short period of time. However, new students do arrive at various times during the year, where organizational conferences will be necessary.

The student may need extra help on a topic. This is another way in which teacher conferences could be used. The student may have a special problem that the teacher alone needs to deal with. The teacher may direct the student to other activities not in the module. She may offer suggestions as to how to study the material. Some students may have trouble reading the material, and the teacher and the student may desire to usethis time for reading exercises. In other words, the conferences are for whatever purposes the teacher and/or the student desire to use them for. It is a very good method for the student and teacher to get to know one another on a one to one basis. The students should be urged often to take advantage of the sessions.

Answers to the Pretest

It is suggested that the students exchange papers to grade as the teacher calls out the answers. This will give immediate feedback to the student and to the teacher. The student then can proceed immediately through the package if he does not do well on the pre-test. If the student does well on the pretest the teacher should direct the student to alternate activities.

1. E
2. a. because they comprise three-fourths of the animal kingdom.
   b. they cause disease.
   c. we need to learn to control them to keep them from eating our crops because of the world food crises.
   d. they ruin our clothes, our homes, our crops, and hurt our animals and ourselves.
   (these are only a few of many accepted answers.)
3. Honeybee-gives us honey
   silk worm- gives us silk (these are only a few
   Ladybird beetle-eats other insects of the many accepted answers)
4. a. chemical sprays and poisons
   b. Quarantine
   c. Natural enemies (any three)
   d. Environmental Changes
   e. Radiation
5. Exoskeleton- the hard skeleton found on the outside of certain animals.
6. a. has 6 legs
   b. 2pair of wings
   c. 3 body segments
   d. 1 pr. of single and 1 pr. of compound eyes.
7. prothorax
   mesothorax
   metathorax
8. coxa
   trochanter
   femur
   tibia
   tarsus
9. Tympanum- found on the abdomen, a large oval membraneous structure which is an organ for hearing.
10. a. lable lines should not be crossed
    b. lables should not run into drawing or off the page.
    c. the height of the letters in the labels should not be varied.
    (these are only a few of the many accepted answers)

11. a. Locomotion-legs are located on the thorax as well as the wings. Insects are the only invertebrates which can fly.
b. Respiration: Is by spiracles found on the thorax and the abdomen. When wings or the abdomen moves, air is pumped in and out of the tracheae. Oxygen is exchanged for carbon dioxide by diffusion.
c. Digestion- mouth-esophagus, crop,(stores food),gizzard (grinds food), stomach where digestion is completed. Digested food is absorbed through stomach wall
d. Excretion-food left in the stomach passes into the intestine made of the colon and rectum and ends at the anus. Cellular wastes are picked up by the Malpighean tubules.
e. Circulation-Insects have an open circulatory system and consists of a heart and a number of open-ended arteries.
f. Sensory- tympanum - hearing. Antennae-for touch and smell. Compound and simple eyes. The brain is an enlarged ganglion composed of optic lobes.
g. Reproduction; Males have testes- produce sperm. Females have ovaries which produce eggs.

12. Ants, bees, wasps, termites- they live in communities where every member seems to work together for the betterment of the community.

13. Complete Metamorphisis- egg, larva, pupa, adult. ex. flies butterflies, moths, beetles.

14. Incomplete Metamorphisis- egg, nymph, adult. Ex. Grasshopper, true bugs or termites.

14. E
G
I
B
H
D
F
C

15. This is only one example answer:

1a Those that were alive	(go to 2a)
1b Those that were not alive	(go to 3a)
2a. Things that were plants	Leaf
2b Things that are not plants	Insect
3a. Things made of paper	(go to 4a)
3b Things not made of paper	(go to 5a)
4a Those with hard outer covering	Book
4b Those without hard outer covering	Paper
5a Things made of wood	Pencil
5b Things not made of wood	Rock

16. Kingdom
Phylum
Class
Order
Family
Genus
Species

17. a. Simple eyes
b. Labrum
c. Labium
d. Compound eye
e. Antennae
f. Mandible
g. Maxillary Palp

Count 1 1/2 pts for each question part.

Formative Evaluations

Formative evaluations are methods which the teacher uses to check on the students' progress. They should not be used to give grades. The student should feel free to make mistakes without penalty, although he should be encouraged to do his very best. In this way, the teacher can see specific problems the student is having with the material, and direct him as to what he should do to master the material. If the student receives an unsatisfactory grade on an formative, he should proceed through the alternate activities. (or any activities the teacher might prescribe) He should then take the alternate formative evaluation when he feels confident with the material. If he receives a satisfactory grade, he is allowed to go on to the next activity. If he does not, then the teacher should offer him other alternate activities and formative evaluations. Exactly how many times the student can recycle the material is up to the teacher. In some courses, as with, a student often has to master a skill before he can go to the next skill. Without understanding one, he surely cannot understand the other. For example, a student surely cannot learn division before he learn addition and subtraction. Therefore, it would be pointless for the teacher to allow the student to go on to the next activity. She would be sentencing the student to failure. However, in other subjects, it is conceivable that the student may by allowed to go on to the next activity without having successfully passed the formative. This decision has to be made by the teacher.

Formative #2

True and False. Write in the correct word to make it true. 1/2 pt. for correct T or F, and 1/2 point for correct change.

1. F The appendages of a grasshopper are found on his ~~abdomen~~. thorax not
2. F Insect wings are moved by muscle ~~contained~~ in the wing as do birds.
3. T Spiracles are openings for respiration.
4. F The ~~crop~~ grinds the food. gizzard
5. T The oesophagus carries food to the crop. Gastric Caeca
6. F ~~Salivary glands~~ produce enzymes for digestion in the stomach. Anus
7. F The intestine terminates at the ~~rectum~~.
8. T Malpighian tubules collect cellular waste. tympanum
9. F The ~~antennae~~ are used to hear.
10. T The heart is located on the Dorsal side of an insect
11. T The testes produce Sperm. ovaries eggs
12. F Females contain ~~eggs~~ which produce ~~ovaries~~. ovipositor
13. f The female deposits her eggs with a ~~seminal receptical~~.
14. T The grasshopper has a small brain like structure.
15. 3 pt. What does an open circulatory system mean?
16. 3 pt. How does an insect breath?

Alternate Formative for Enabling Activity #2

The student must get 15 out of 20 points for success in this activity.

Matching

1. D Esophagus	a.	smalled valved openings for respiration.
2. L Crop	b.	in the female- produces eggs
3. H Gizzard	c.	tubes entering the body from the spiricles through which air penetrates the body.
4. F Gastric Caeca	d.	these structure pick up cellular waste from the blood stream.
5. A Spiracles	e.	short tube leading from mouth to the crop.
6. C Trachene	f.	pouches which extend from the stomach-secretes enzymes.
7. J Heart	g.	Contain 3 pr. legs and 2 pr. wings.
8. B Ovaries	h.	grinds food
	i.	Where digestion of the grasshopper is completed.
9. M Testes	j.	Located dorsally in a sinus.
	k.	organ for hearing
10. G Thorax	l.	stores food
	m.	found in male- produces sperm
11. J Stomach	n.	for touch and smell
12. D Malpighian Turbules		
13. K Tympanum		
14. N Antennae		

15. 3 pt. Describe a grasshopper circulatory system.

16. 3 pt. Describe therespiratory system of a grasshopper.

Formative for Enabling Activity #3

The student must get 7 out of 10 points for success.

1. 2 pt. What is Metamorphisis?
2. 3 pt. What is Complete Metamorphosis? And give two examples.
3. 3 pt. What is incomplete metamorphosis? Give two Examples.
4. 2 pt. Name 2 Hormones involved in metamorphosis.

Alternate Formative for Enabling Activity #3

Matching

1.	F	Metamorphosis	a. Resting stage
2.	D	Incomplete Metamorphosis	b. Larva of beetles
3.	G	Larva	c. Larva of moths
4.	A	Pupa	d. Nymph
5.	E	Maggots	e. Larva of flies
6.	B	Grubs	f. a change
7.	C	Caterpillars	g. A wormlike form of complete metamorphosis
8.	H	Complete Metamorphosis	h. flies have this type

9. 2 pt. Name 2 hormones involved in Metamorphosis.

Formative Evaluation for Enabling Activity #4

2 pts. each

1. How are queens raised?
2. How do queens control the types of individuals in a colony?
3. Discuss the jobs of the workers.
4. What purpose do the drones serve?
5. How do bees communicate?

Formative Evaluation for Enabling Activity #5

The teacher could have various insects out on some tables and have the student identify the order of each, or she could have them do the exercise below.

Write the name of the order beside the insect. Some orders will be used twice.

1. Termite
2. Mosquito
3. Wasp
4. Butterfly
5. Chinch Bug
6. Cricket
7. Cricket
8. Damselfly
9. Ladybug
10. Stinkbug
11. Stink bug
12. Key outthe unknown insect._____

Alternate Formative for Enabling Activity #5

Either written or orally. Have the bugs out, and have the student identify the following orders.

1. Cockroach
2. Dragonfly
3. Butterfly
4. Stable fly
5. tsetse fly
6. Boll weevil
7. Ant
8. Bed Bug
9. Termite
10. Housefly

Key out unknown_____

Summative Evaluation

This is to be given on the final day allowed for the mastery of the mini-course. The entire class will be given the summative at the same time. Their grade will come from the summative evaluation covering the objectives of the course. They should turn in their insect collections at this time also as part of their summative. A pool of questions for the summative is found on the following pages. The pool of items do not fit the specific objectives listed for this unit. That is to say, all of them do not. The teacher may see fit to change the objectives somewhat if she desires to use a different type of question or questions on the summative. The summative for the particular objectives listed in this unit is found following the pool of items.

Summative Pool of Questions

Introductory Objective

1. Discuss the importance of insects.
2. How do insects affect our lives?
3. What are beneficial insects and give examples.
4. What are harmful insects and give examples.
5. Why should anyone bother to study insects?
6. Compare how insects affect you and your family.
   a farmer?
   a cattleman?
7. What are 4 ways in which we control harmful insects.
8. Of the five ways we control insects, which one do you feel is the best method and justify why you chose it rather than the others.

Objective 1

9. Identify the following parts of the grasshopper specimen.

a._____ f._____

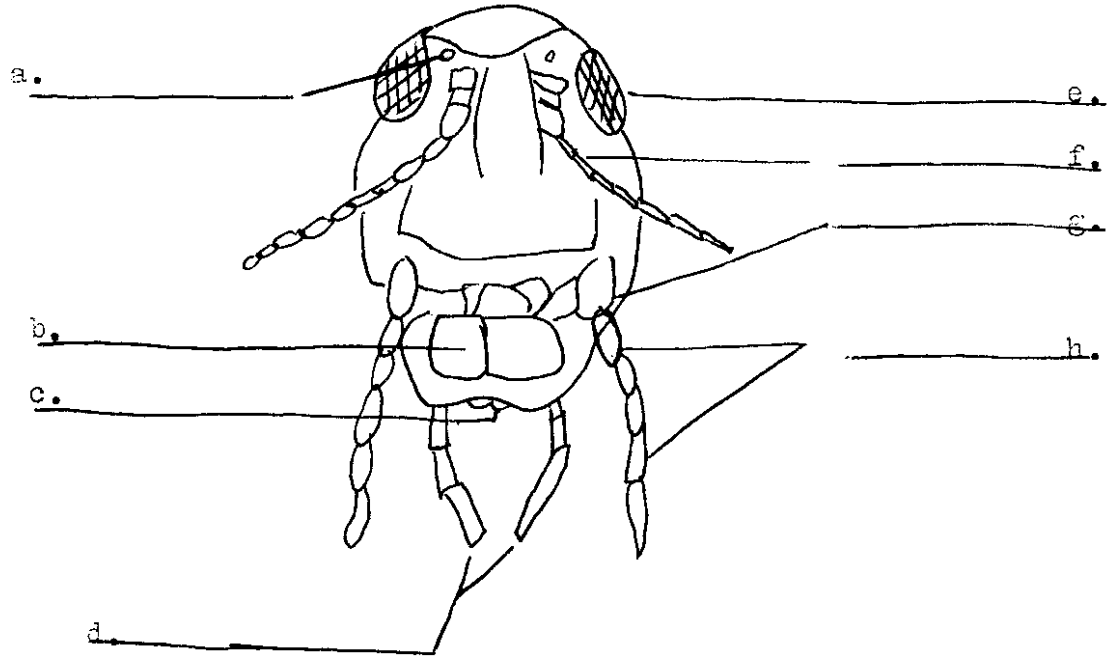
b._____ g._____

c._____ h._____

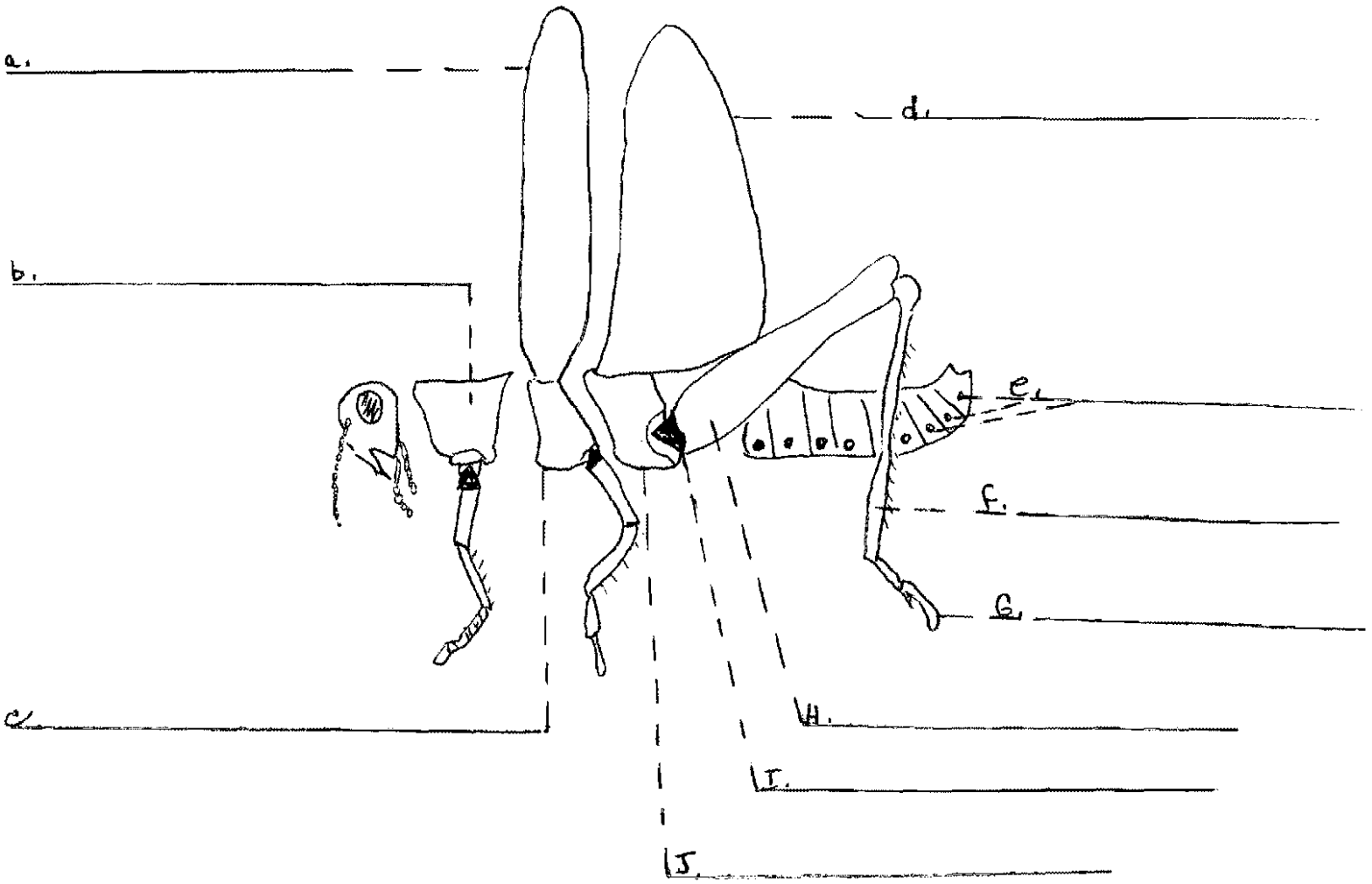
d._____ i._____

e._____ j._____

10. Identify the following parts of the grasshopper.



11. Identify the following:



12. Compare and contrast the wings of an insect with those of a bird.

Objective #2

13. An insect eats a piece of grass. Discuss what happens to it as it goes through the digestive tract of the grasshopper.

14. A grass hopper eats a blade of grass. The grass passes from the mouth down a short tube called an _____. This tube takes the food to the _____, where it can be stored for a short time. It is then passed into the _____ where the food is ground up. It then travels to the _____ where digestion is completed. It is here that the _____ _____ produceds enzymes which aid in digestion. Undigested food pass into the _____. Cellular wastes are picked up by the blood stream by structures called _____ _____. Wastes are then passed into the intestine also and pass out of the body by way of the anus.

15. _____ Air is pumped in and out of the trachea of an insect by a. the lungs b. the movement of wings c. diffusion d. movement of the head.

16. _____ Oxygen is exchanged for Co_2 inside the grasshopper's body by a. spiricles b.diffusion c.the air tubes d. the malpighean turbules.

17. _____ Food is stored in the a.crop b.stomach c.gizzard d.gastric caeca.

18. _____ Food is ground up in the a.crop b.stomach c. gizzard d.gastric caeca.

19. _____ Digestion in a grasshopper is completed in the a.esophagus b. crop c. gizzard d. stomach. e.intestine.

20. _____ Structures which pick up cellular waste products are a.colon b.rectum c. Malpighian turbules d. none of these

21. _____ The grasshopper has a heart located a.dorsally b.ventrally c.laterally d.on the stomach side.

22. _____ The sensory organ for hearing is a.Antennae b.tympanum c.spiricles d. optic lobe.

23. _____ The sting of an insect is really a modified a.testes b.seminal receptacle c.ovipositor d. None of the above.

True False- Correct the False answers.

24. _____ The trachea is a short tube leading from the mouth to the crop.

25.__The gizzard stores food.

26._____The crop grinds food,

27._____The testes produce sperm.

28._____The egg produce ovaries.

29._____The eggs are deposited by the ovipositor.

30._____The antannae are for hearing.

31._____The tympanum are for smelling.

32._____The circulatory system is closed.

33._____The malpighian turbules collect cellular wastes.

34._____Digestion is completed in the stomach.

35._____Spiricles are for excretion.(this would be true)

36._____Insects have 2 pr. of legs and 3 pr. of wings.

Matching

37._____	Spiracles	a.	Digestion is completed here
_____	Diffusion	b.	Picks up cellular wastes
_____	Esophagus	c.	Stores food
_____	Stomach	d.	Located Dorsal of the Digestive tract.
_____	Crop	e.	Males desposit sperm here in the female.
_____	Gizzard	f.	Openings for respiration
_____	Gastric Caeca	g.	Structure for hearing
_____	Malpighean turbules	h.	A short tube from mouth
_____	Heart	i.	Structure for laying eggs and sting.
_____	Tympanium	j.	Oxygen is exchanged for CO_2
_____	Antannae	k.	produces enzymes to aid digestion
_____	Ovipositor	l.	Structure for feeling and smelling
_____	Seminal receptacle	m.	Grinds food

Objective #3

50. Compare and contrast the two types of metamorphosis giving two examples of each.

51. What 2 hormones are involved in Metamorphisis?

Objective #4

52. Discuss the classes of the Bee hive, including each's contribution to the community.

53. How do bees communicate with each other?

54. Are bees intelligent? Support your answer.

55. Create an experiment by which you could check whether bee behavior is inherited or learned.

56. Is their any survival value in the construction of up to 12 great cells for rearing new queens as opposed to constructing only 1?

Objective #5

57. Using the key given to you, key the following insects to their correct order.(unknown insects will be provided)

58. Which of the specimens provided are insects?

59. Identify the order:

Ant_____

Bee_____

Grasshopper_____

Termite_____

Moth_____

Beetle_____

Housefly_____

Water strider_____

True Bugs_____

Dragonfly

Summative Evaluation

2 pts each

I. True and False: Correct the False Statements to make them True. You receive 1 point for correct T or F, and 1 point for correctly changing it to be true.

1. _____The trachea is a short tube leading from the mouth to the crop.

2. _____The gizzard stores food.

3. _____The crop grinds food.

4. _____The testes produce sperm.

5. _____The egg produce ovaries.

6. _____The eggs are deposited by the ovipositor.

7. _____The antannae are for hearing.

8. _____The tympanum are for smelling.

9. _____The circulatory system is closed.

10. _____The malpighian turbules collect cellular wastes.

11. _____Digestion is completed in the stomach.

12. _____Insects have 2 pr. of legs and 3 pr. of wings.

II. Matching--2pt. each

13. _____	Termite	a. Lepidoptera
14. _____	Chinch Bug	b. Coleoptera
15. _____	Ant	c. Isoptera
16. _____	Mosquito	d. Odonata
17. _____	Moth	e. Hemiptera
18. _____	Boll Weevil	f. Hymenoptera
19. _____	Cockroach	g. Diptera
20. _____	Damselfly	h. Orthroptera

III. Identification (2pt. each)

Identify the following parts of the grasshopper's anatomy from the specimen provided. Please ask for assistance if you are not sure where the flag is.

21. _____

22. _____

23 _____

24. _____

From the specimens provided, write NO for those that are not insects, and Yes for those that are insects.

25._____

26._____

27._____

28._____

Key out the unknown insect.

29._____

IV. Discussion

30. 2 pts. How does an insect breathe?

31. 5 pts. How do insects affect us including 5 ways they are harmful and five ways they are helpful?

32. 5 pts. Compare and Contrast the wings of a bird and those of an insect.

33. 5 pts. Discuss complete and Incomplete Metamorphosis, giving an example of each, and naming one hormone involved.

34. 5 pts. A grasshopper eats a blade of grass. Trace the bit of grass from the mouth to the body cell.

35. 10 pts. List four methods of controlling insects. Of these select one which you feel is the best method and justify why you chose it and not the other three.

36. 10 pts. Discuss the classes of the bee hive, including their jobs, how they communicate and if they are intelligent. (support your answer)

Suggestions for Improvement

There are several things, as I look over this unit on Entomology, which could be improved upon or changed. I don't care for the names, such as, enabling activity, Formative evaluation, and summative evaluation, for high school students. Some students would be "scared off" right away by such labels. I would use different names if I did another unit, such as, section 1,2,3,etc., progress report and exam,respectively,and of course meaning the same as the above words.

The objectives for the course could be improved. Some probably should be thrown out and others should be added to take their place. As a teacher actually uses the unit with a class, she/he would probably change and revise the unit according to the needs of the class.

It is suggested that a teacher using this unit run a reliability check on the test questions. This method would give the teacher some insight as to how good the tests are, and if they are measuring what they were meant to measure.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This paper describes an effective inexpensive mastery learning approach to teaching biology enrichment courses to talented students. The aim of this strategy was to produce enrichment units that the students could work independently of their classmates at times of their own choosing.

The units are prepared by the teacher using the following techniques stressed in mastery learning:

1. objectives stated in behavior terms.
2. pre-test
3. instruction by various methods chosen by the student
4. formative evaluations
5. alternate instruction
6. alternate formatives
7. summative evaluation

The units should consist of an introduction, a presentation of major objectives to be mastered, suggested activities for achieving the objectives, related literature for further investigation, vocabulary, and study questions. Upon completion of a section within the unit, the student takes a short, written or oral ungraded formative evaluation covering the objectives of that particular section. The tests emphasized both memory and comprehension. Either the teacher, selected tutors, or the students themselves check the formative evaluation. If the formative

showed that the student was having learning difficulties, then learning correctives were suggested. Each student had to demonstrate mastery of the particular unit he was working on before moving to another. Some talented students may be interested in the same unit and therefore, may desire to work on the unit together. Having mastered the material, they may be called upon to tutor others who may need their help on the unit they have already mastered. The teacher should encourage the students to help each other in mastering the units whenever possible.

Although this program was not pilot-tested, the author has the following expectations.

1. Talented students should enjoy picking out subjects of interest.
2. Talented students should be challenged with the idea of accelerating on their own.
3. Talented students will use their time more wisely than in past curriculums.
4. Talented students will master the material of their own choosing.

CONCLUSION

Advantages of Mastery Learning Units

The method of mastery learning can be described as having several strengths. Some of these are listed below:

1. Mastery learning is positive and would seem to help in the positive self-image of students.
2. Time is not wasted working on subjects already mastered.
3. The student can work at his own rate and not have to wait for the rest of the class.
4. Students have to master a unit before going on to another.

Difficulties, Suggestions, and Criticisms

The major difficulty that teachers would encounter would be that of developing thelearning packages. The problem here is primarily one involving lack of time. Teachers have little time during the school year for the purpose of writing mastery learning units, especially if many are desired. Blackburn and Powell suggest the following:

> Working with other teachers to develop and use packages probably results in more efficient use of teacher time and in more creative, practical, packages.[50]

If the administration were kept informed on the activities in developing the packages, they would surely support the implementation of the program.

---

[50]Blackburn and Powell, One at a Time, All at Once, (Palisaides, California: Goodyear Publishing Company, Inc., 1976). p. 101.

It may be possible to purchase mastery units from a publishing company. The school budget could be a problem in this case. Teachers would have to convince the principle that the program is needed and can be successful. However, purchased units are not as desirable as ones made by the classroom teacher for reasons which have already been discussed.

Implementing the packages in the classroom could also cause problems. Students possible have not had any experience with either packages or individualized programs. The teacher may not feel comfortable with the procedures if she has no experience in the area. Blackburn and Powell suggest if the packages are being used for the first time, "introduce them carefully and slowly. Start with one package perhaps even with only a few students."[51]

After having sucessfully used the program with talented students for enrichment purposes, the teacher may desire to use them as enrichment for the whole class. If this were the case, some students may not be able to read well enough to complete the package. This problem could be solved by including many pictures, illustrations, and simple words, in the unit, allowing someone to read to the student, taping parts of the package, having two students working together, one of which can read, or using advanced students or parents as tutors.

---

[51]Ibid., p. 101.

Relevancy is often cited as a problem that mastery learning experts fail to deal with effectively. The experts say that most, if not all, students will master the material. If a student does not feel that a mastery learning unit is relevant to his needs, it is possible, that no amount of positive procedures will help his succeed. Therefore, some students may not succeed due to lack of interest rather than because of difficulties.

Further Research

There are other areas where more research is needed to convince teachers that mastery learning is an effective method of teaching. After having succeeded in providing rewarding enrichment activities for the talented students, teachers may wish to expand the curriculum to include enrichment activities for all students. Depending upon the success of the enrichment program with the whole class, the teacher may wish to expand the program even more to include the use of mastery learning units in the regular curriculum.

BIBLIOGRAPHY

Abeles, Sig. "Science Education for the Gifted and Talented". The Gifted Child Quarterly 21 (Spring, 1977) 75-80.

Airasian, Peter W. "The Role of Evaluation in Mastery Learning". Mastery Learning. ed., James H. Block. New York: Holt, Rinehart, and Winston, 1978. p. 77-88.

Blackburn and Powell. One at a Time, All at Once. Palisades, California: Goodyear Publishing Company, Inc., 1976. p. 101.

Block, James H., ed. Mastery Learning- Theory and Practice New York: Holt, Rinehart, and Winston, Inc., 1971.

Bloom, Benjamin S. "Learning for Mastery". Individualized Instruction and Learning. ed. by Madan Mohan and Ronald C. Hull. Chicago: Nelson-Hall Co., 1974. p. 5-32.

Bloom, Benjamin S. (ed). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. New York: David McCay Company, 1956.

Bloom, Benjamin S. "Learning for Mastery". Individualized Instruction and Learning ed. James H. Block. New York: Holt, Rinehart and Winston, 1971. p. 50.

Bolvin, John. "Individually Prescribed Instruction," Individualized Instruction and Learning. ed. by Madan Mohan and Ronald C. Hull. Chicago: Nelson-Hall Co., 1974.

Carroll, John B. "A Model of School Learning", Teachers College Record 64 (1963). 723-733.

Carroll, John B. "Problems of Measurement Related to the Concept of Learning for Mastery," Mastery Learning ed. by James H. Block. New York: Holt, Rinehart and Winston, Inc. 1971. p. 44.

Dunn, Rita and Dunn, Kenneth. Educators' Self-Teaching Guide TO Individualizing Instructional Programs. West Nyack, New York: Parker Publishing Co., Inc, 1975.

Dunn, Rita and Dunn, Kenneth. Practical Approaches to Individualizing Instruction: Contracts and Other Affective Teaching Strategies. New York: Parker Publishing Co., Inc., 1972.

Edling, Jack V. Individualized Instruction: A Manual for Administrators. Oregon: Oregon State University Department of Printing. p. 1.

Glasser, Robert. "Adapting the Elementary School Curriculum to Individual Performance" in Procedings of the 1967 Invitational Conference on Testing Problems. Princeton, New Jersey: Educational Testing Service.

Grissom, Audrey. "Another Approach to Biology Teaching". American Biology Teacher 38 (May, 1976).

Groff, Patrick. "Some Criticisms of Mastery Learning". Today's Education, (November, December, 1974) 88-91.

House, Peggy A. "Individualization--What is it Really?" Science Teacher 44 (Jan. 1977) 20-21.

Jacobson, D. A. "Mastery Teaching Reference Sheet" Spring 1978. University of North Florida, Jacksonville, Fla.

Jones, Elizabeth. "A Fable for Educators". The Gifted Child Quarterly 21 (Spring, 1977): 109-110.

Kopelman, Milton; Galasso, Vincent G.; and Strom, Pearl. "A Model Program for the Development of Creativity in Science." The Gifted Child Quarterly 21 (Spring, 1977): 80-83.

Mintzes, Joes; Littlefield, David; Shaub, David; Crocket, Richard; Puritan, Robert; and Crocket, Richard. "Studies on Individualized Instruction in Biology." School Science Mathmatics 76 (December, 1976) 675-686.

Oberteuffer, William H. "Science Course Structures: Some New Approaches to Learning." Individualizing Learning Through Modular-Flexible Programming, ed. Gaynor Petrequin. New York: McGraw-Hill, Inc. 1968.

Petrequin, Gaynor ed. Individualizing Learning Through Modular-Flexible Programming. New York: McGraw-Hill, Inc. 1968.

Skinner, B. F. "The Science of Learning and the Art of Teaching". Harvard Educational Review. 24 1954.

Suppes, P. "The Uses of Computers in Education". Scientific America 215 1966. 206-221.

The Gifted Child Quarterly, 21 (Spring, 1977). "Problems of Talented Students."

Torrance, Paul. "Independent Study as an Instructional Tool". Individualization of Instruction-A Teaching Strategy. ed. Virgil M. Howes. New York: The MacMillian Company, 1970. 211-213.