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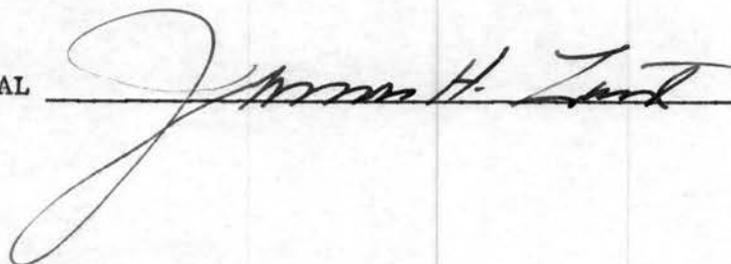
Candidate for Degree of Master of Science

Major Field: Natural Sciences

Scope of Study: The scheduling of time devoted to biology is out of the hands of the classroom teacher. The amount of learning that takes place during that period, however, is the direct responsibility of the teacher. Some of the methods used to improve the accomplishments of each student are discussed. The study is not exhaustive, but many suggestions are given to aid the biology teacher in doing his best for each student.

Findings and Conclusions: Assignments must be made in a positive way so that the student will know what is expected of him. Workbooks may be used to provide for individual initiative and flexibility in the laboratory periods. There should be definite correlation between the laboratory and the class discussions. In the laboratory the students should develop basic techniques. Motivation turns work into enjoyment; yet motivation is the door to accomplishment. There are several methods of motivation: knowledge, humor, enthusiasm, reference to the familiar, school marks, praise, success, social approval, ideals, honors, rivalry, and, as a last resort, compulsion. The teacher is wise who can make use of most of these.

ADVISER'S APPROVAL

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IMPROVING SECONDARY BIOLOGY
TEACHING TECHNIQUES

By

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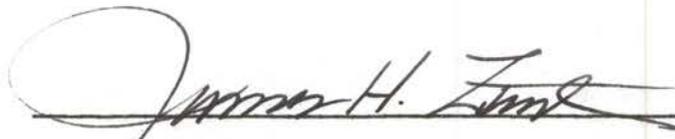
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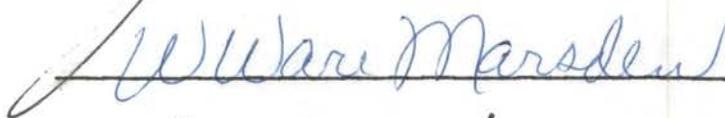
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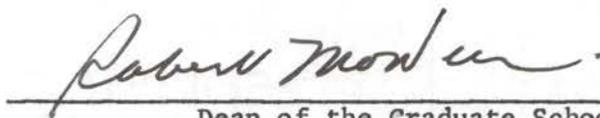
IMPROVING SECONDARY BIOLOGY

TEACHING TECHNIQUES

Report Approved:

A handwritten signature in cursive script, appearing to read "James H. Ford", written over a horizontal line.

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Dean of the Graduate School

PREFACE AND ACKNOWLEDGEMENT

The purpose of this report is to increase my perception of the needs of the individual student. This can be accomplished through a better understanding of the student and those things that influence him. Using this knowledge, I hope to be able to instill in the student a high regard for Biology and science in general.

Indebtedness is acknowledged to Dr. James H. Zant and Dr. W. Ware Marsden for guidance in the writing of this report, to Drs. Imy Holt, Ernest M. Hodnett, and Sylvan R. Wood, who have set the example in showing consideration for the student.

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CHAPTER I

INTRODUCTION

The generally accepted objectives of a high school biology class are: to gain information, to develop methods of reasoning, to learn the application of principles, and to develop critical thinking. This study is made to determine effective methods of accomplishing these objectives. It is apparent to teachers of experience that no learning takes place without motivation.

The maximum can be obtained from each student if there is good will and understanding between the teacher and the students. This can be obtained by: definite assignments; a knowledge, by the student, of what is expected of him; and a knowledge of the relative values of each phase of class work. Another factor having an effect on harmony is the fairness of the teacher.

A teacher must be fair. He cannot be fair unless his students get all he is able to give them. He cannot be fair if his students do not learn because of lack of motivation. He cannot be fair if the student thinks he has an A and receives a C. His students will compete with the best scientists in the world in the next few years. It is the responsibility of the teacher to see that they are ready.

Some of the things to be considered by the biology teacher are: the advisability of using supplemental aids such as workbooks, notebooks, and audio-visual material. Teachers may benefit from the accumulated years of experience of many authors in learning ways to improve student achievement by teacher techniques. Biology, the study of living things, should find eager disciples among the high school students.

CHAPTER II

MOTIVATION

Motivation has been defined as getting someone to want to do what you want him to do. It may be as simple as the pat on the back that will cause a student to do three times as much work as he has been doing. Motivation, too, may be a complex problem of finding background, ideas, ideals, interests, and all sorts of things to decide just what will serve to motivate a particular student.

"Why motivate? Am I not the king, and this classroom my Monaco? They had better do as I say."

To begin with, the young do not like to work. They would rather be playing football, or sitting in the movies eating chocolate. But, they must learn to work, because they will assuredly have to work all the rest of their lives; and to teach them that work is unnecessary or avoidable is to deform their characters.¹

The young do not like authority. They must be taught to respect the principles of authority. Can this be pounded into their heads? No. There must be a motivation factor. The young hate concentration. We must teach them to concentrate - again by motivation. Give him a job to do in which his interest is high, stand back and watch him. His power

¹Gilbert Highet, The Art of Teaching (New York, 1950), p. 67.

of concentration grows. If he is really intent, he may miss sleep and food in order to finish the job. From this job he may find other areas of interest which will be motivation for another period of study.

Many resistances on the part of the students point to the need of motivation. These situations must be met. They cannot be remedied by bull-headedness. Motivation is vital to any learning situation. Risk says, "No learner does something without some motive back of it."² A stick of candy may be inducement enough to get a child to pull a dead dog from under a house, while to another child, the candy would be no incentive whatsoever.

The teacher must know the child's background, environment, interests, and attitudes in order to know what to do to build motives where none exist. To build a fort is a motive. To construct the same structure in the form of a fence is a very difficult task.

Motives must be built from things that interest the student. It must be kept in mind that an interested person is open to suggestion. If you build on this interest, and get the student in the habit of accepting you, you are in the position to plant a little knowledge. Perhaps this has some bearing on the activities observed by Dr. Roger J. Williams, president of the American Chemical Society. He indicates that,

²Roger J. Williams, "Forty Ways to be Dumb," Journal of Chemical Education, XXXIV (1957), p. 261.

at times, some of the best students make a terrible showing and weak students come up with the right answer. In the business world, many "top" students make a mediocre success, while those who had to struggle through school become outstanding individuals. It may be that we have developed a pattern into which "successful" students must fit. If the individual does not exhibit these characteristics, he is discarded. Then we say, "If one fits this pattern, he is a great student." What could this individual have accomplished had he been inspired rather than discarded by his teachers. And how many resign to failure because of the label with which they are branded.³

Spontaneous attention is derived from interests, habits, and appreciation. The job of the teacher is to capitalize on this spontaneous interest in order to have a basis for suggesting something worthwhile to do. This must be correlated with interesting activities until motivation can be established. The relation between these two aspects are illustrated in Table I.

It is of value to the teacher to know how to build motives where none exists. Methods of building these motives are pointed out by Risk in Table II.

The value of the work is little motivation in itself. The teacher needs to find other forms of motivation. If no particular value can be found for doing a job, and the student cannot see personal benefit, then there can be little argument

³Thomas M. Risk, Principles and Practices of Teaching in the Secondary Schools (New York, 1947) p. 17.

TABLE I

MAINTAINING SPONTANEOUS ATTENTION BY THE USE OF
MATERIALS OR ACTIVITIES

1. Appeal to the instinctive drives
 - (a) Curiosity
 - (b) Activities
 - (c) Expressional activities
such as drawing and art
 - (d) Desire to handle, manipulate, construct.
 - (e) New things involving many
relationships
2. Appeal to present attitudes and interests
3. Appeal to interests of pupils in such
things as they like to do, all of which
should lead to, or be related to, the
objectives of learning

TABLE II

BUILDING MOTIVES

1. Appeal to values related to objectives
and creating felt needs
 - (a) Future vocational values
 - (b) Future social values
 - (c) Personal satisfaction
 - (d) Intrinsic value of product
produced
2. Appeal to pupils to fulfill present ideals
3. Appeal to the desire for social approval
 - (a) Of social groups
 - (b) Of the class or school
 - (c) Of individuals
4. Appeal to other values in the form of
school awards
 - (a) Privileges
 - (b) Honors
 - (c) Material awards
 - (d) Good grades
5. Appeal to rivalry
6. Compulsion
 - (a) Use of penalties
 - (b) Fear

given for attempting the activity. Ideals can be used for motivation, but experiences may break down ideals. The job of the teacher is to strengthen good ideals and to build new ones.⁵

One type of motivation is the appeal for group approval. This may be an appeal to pride, school spirit, "esprit de corps", the maintaining of standards, etc. This type appeal may be made directly to the student, as: "Do you want us to make a good showing?" In addition to the group approval, students are motivated through the desire for the approval of individuals. If the teacher is well liked, the desire for his approval provides a great amount of motivation. The praise of a student's work is an effective way to stimulate him. Results of experiments show that students motivated through approval do much better work than those not motivated, and those motivated by punishment. One author says, "A pat on the back is only a few vertebrae removed from a kick in the pants, but the results are miles apart."

Another type of motivation is working for a reward not related to learning. These are less desirable types of rewards, but they compare with those of everyday life. Examples are: school privileges, honors, and material rewards. This type of motivation may be effective at times when others fail.

⁵Ibid., p. 506.

The proper use of school marks and test scores has proved a powerful stimulus to good work. Symonds found that test motivation was twice as effective as attempted teacher motivation or practice repetition in securing desired outcomes. Charting group and individual progress has been found to be an effective motivating device.

Rivalry is another source of motivation. There should be a good chance of success if this type of motivation is to be effective.

From the themes of three hundred thirty-seven high school pupils, Robbins made a list of the relative value of motivation forces. They are:⁶

TABLE III

SOURCES OF MOTIVES OF HIGH SCHOOL PUPILS

RANK		PER CENT
1.	The gaining of knowledge	62.4
2.	Preparation for living	58.9
3.	Grades, honors, or passing	57.3
4.	Family influence	53.0
5.	Competition, pride, ambition	44.6
6.	Interest, liking for study	38.4
7.	Extra-curricular activities	37.6
8.	Preparation for vocation	36.7
9.	Fear of failure	34.2
10.	College entrance	18.8

The table itself suggests what motivating factors would be most effective with high school students. It is apparent that such things as saying, "When you get to college, you will have to ***." will not serve to motivate more than 20% of the students.

⁶Ibid., p. 509.

It might be wise to determine what factors in the life of the teacher can be used to influence his students. Emotion plays a large part in influencing human actions. If a teacher is enthusiastic in his approach, the pupils will be in a frame of mind to act favorably on suggestions. Richard M. Sutton says, "Successful teaching requires experience, enthusiasm, knowledge of the subject, constant hard work, and a deep affection for young people."⁷ The students will follow the example set by the teacher whether it be good or bad. The student should find promptness, neatness, industry, accuracy, self-control, and poise.⁸

Students may excuse weakness in personal habits, but never insincerity. Sincerity suggests honesty, courage, loyalty, and impartiality. These qualities the students like.

At times the teacher must take positive leadership in showing the pupils what is to be done and how to do it. Nothing is so disheartening to students as not knowing what they should do. They generally do what is required of them.

Another quality of the teacher should be a clear, distinct, well-modulated voice. Sentences should be said so that the complete class hears the whole sentence. A good voice carries conviction and suggests authority.

⁷Richard M. Sutton, "College Teachers Look at High School Science Teachers" Science Teacher, XXXIII (1956), p. 184.

⁸Thomas F. Risk, p. 510.

On the other hand, a teacher can be as dry as the Sahara and still have his classes filled with students who want to sit under a man of great knowledge. Dean Jackson, of Central State College, tells of an instructor who knows all the aspects of Russian history, yet he buries his head in the book and mumbles all his lectures. In spite of this, he motivated his students by his knowledge of the subject. What could the instructor do if he worked at doing a good job? Hight believes, "Nine thousand times more pupils have learned a difficult subject well because they felt the teacher's vitality and energy proved its value, than because they chose the subject for its own sake."⁹

Motivation may be achieved by connecting the things with which the student is familiar with the new facts he is to learn. If there is no correlation or connection point, there is little reason for learning a particular fact.

Some educators go so far as to say that a good laugh is worth a thirty minute nap. The army realizes the value of having the audience on the instructor's side, so most classes are started and interspersed with a few jokes. One teacher considers the day wasted if she and the students do not laugh together. When people laugh together, they cease to be young and old, master and pupils, workers and drivers, jailer and prisoners. They are as old friends enjoying mutual fellowship.¹⁰

⁹Hight, p. 56.

¹⁰Ibid., p. 61.

Give fifty men four hours to cross a hill and walk down the valley beyond to the nearest town. If they try it separately, many will come in late, and nearly all will be tired. If they march in groups, they will be far less tired and come in sooner. If they do it in two teams competing with each other, or as a hiking party, singing songs in rhythm, they will scarcely be tired at all, they will keep together, and they will enjoy the experience. In just the same way, if you can get a class of thirty youngsters to feel they are all pulling together, and if you can give them some reason to enjoy it, they will do nine times better work than thirty individuals working under compulsion. And one of the best appeals to both gregariousness and the play instinct is a good joke.¹¹

A student will respond to a situation, not in view of the goals established for him, but according to his perception of the situation. A teacher explained to one boy that he was dissecting a frog by the most difficult method. The student took exception to the teacher's offer to help. It was easy for him to defend his method with such an attitude. Later the teacher helped another boy in the same manner. This boy had a different perception of the situation, accepted the help of the teacher and improved his method. Unless one has a knowledge of the student, it is difficult to know his perception, and what it will take to motivate him. Dan told the teacher that he thought teaching so many students must be quite difficult. Mr. Arnold found it easy to help an individual who understood his own problems.

Miss Jones noticed Ralph cheating on a test. She talked with him after class, and discovered that his parents were always bickering and nagging each other. He felt they had no interest in him except when they wanted something done. This

¹¹Ibid., p. 63.

did not change Miss Jones' idea that cheating was wrong, but it did show that with this other concern, the subject she was teaching was of little or no interest to Ralph. Her attitude toward Ralph changed, and she felt it was her duty to make her class more interesting to Ralph.

Joe was a student who felt it his duty to exercise the boys every now and then. He could find no basis for getting along with other students. Upon talking with Joe, she sensed the fact that he thought the other boys had it in for him. As long as he perceived this situation as he did, he acted upon this perception. To alter this situation, Miss Jones had all the students work on a problem that required cooperation. Joe contributed something - so did the other boys. They saw Joe as being able to do other things besides fighting, and Joe found that they had interests similar to his. As Joe's feelings changed, his behavior changed also. They had not changed suddenly, but the little changes meant a lot.

Eiserer and Corey summarize their findings with these four points:

Whatever boys and girls learn in school results from the way they perceive themselves and the demands of the situations in which they find themselves.

To the degree that these perceptions correspond more and more closely with reality - physical and social - behavior becomes more appropriate.

Changes in perception lead to changes in behavior.

A major responsibility of the high school teacher is to help boys and girls extend these perceptions, differentiate

cause and effect relationships among them, and generalize more effectively from the behavior that is based upon them.¹²

If the teacher can keep the pupils' attention centered upon the learning activities of the group, there is a good possibility that he can keep disciplinary situations reduced to a minimum. Pupils who are busy and interested in their classwork usually have little time to devote to mischief. In fact, they are seldom interested in such activities if the regular classwork is of a nature to hold their interest and attention.¹³

The middle class teachers must realize what factors will motivate a person from the lower socio-economic group. If they are to become interested in school at all, the vocabulary, maps, charts, and books must necessarily be such that they can advance from the familiar to the unfamiliar. Presented the unfamiliar and no correlation with the familiar, the student will turn to entertaining himself in various familiar ways.

If the need for using a certain principle is felt, the gathering of the facts that lead to an understanding of the principles is well motivated. Some motivating factors peculiar to the field of science are: field trips to laboratories, hospitals and many other interesting places.

Every teacher knows that in some cases the learning stops with a certain amount of memorizing of facts. It is well established that facts so learned are soon forgotten, having little or no useful residue. On the other hand, if functional understanding of principles is attained, the ability to use them and to apply them is retained remarkably well.¹⁴

¹²Paul Eiserer and Stephen M. Corey, "Adapting the Secondary School Program to the Needs of Youth," National Society for the Study of Education Yearbook, LII, 1953, p. 61.

¹³Gilbert C. Kettlekamp, Teaching Adolescents, (Boston, 1954) p. 294.

¹⁴Science Education in American Schools, 46th Yearbook (1947) p. 185.

CHAPTER III

DAILY WORK

The new biology teacher soon finds that his time is consumed to a great extent by the preparation of specimens for the laboratory period, construction of laboratory guide sheets, and cleaning up after the laboratory period. For this reason, it may be wise for the teacher to consider the use of a workbook that will help lighten the burden. Risk suggests the use of a workbook that parallels a particular text. Other authors point out that the workbook should not require information that is not available to the student. It proves embarrassing for the teacher when an expert in the field of biology cannot answer the questions asked in the workbook. The text should provide supplementary material with working space for the pupil in the form of a workbook. The functions of this workbook are:

1. To supplement classroom learning experiences.
2. To give practice in perfecting abilities.
3. To give practice for skill.
4. To test achievement and self improvement.
5. To diagnose learning difficulties.
6. To provide for individual differences.
7. To stimulate interest in self-improvement.
8. To provide for independent, individual work.¹⁵

¹⁵Risk, p. 603.

The workbook saves time for the teacher who would not have time to prepare supplementary material so expertly. By means of the tests accompanying the workbook, the progress of the pupil can be measured, and he can compare his own accomplishments with the average. A source of motivation is provided by the space in which the student may keep his own scores.

In addition, this type of workbook provides, (1) a review or recapitulation of important points covered in the study of the text, (2) practice exercises to develop ability to organize facts studied, (3) practice exercises to develop reflective thinking, and independent thinking, and (4) supervised or directed study.

Unlike the older types of workbooks, the newer editions contain an abundance of well-selected and effective learning exercises which are more effectively organized than could be done by the average teacher in the time at his disposal.¹⁶

Some of the desirable features of a good workbook are study-helps, visual aids, practice exercises, and tests. A workbook with these features will be a special help to the teacher as a time saver. It will also provide for the teacher an instrument to meet individual differences. By individual study, the student may learn independent thinking from the use of the workbook.

The workbook, because of being misused often, has been banned from some classrooms. The workbook is not a cure-all. It does have its limitations. One of the more common misuses made of the workbook is that of the teacher's assigning a certain exercise and having the pupil copy the answers from the book. This indicates no regard for the meaning of the answers.

¹⁶Ibid., p. 604.

Another complaint is of the teacher who builds his class around the workbook rather than around the needs of the student. Other objections are the requirement for information not available to the students, and the cost of the workbooks.

The real danger, other than misuse, of workbook usage is the possibility of the student's being assigned workbook activities in several different classes on the same day. If this happens, the benefits of the workbook are almost completely lost.

Considering the advantages and disadvantages, it seems wise to continue the use of workbooks. One must, however, insure against over use. While there is always the danger of mechanization, it will be held to a minimum by class discussion and such problems as application of principles, provided by the workbook. It is the responsibility of the teacher to make workbook study a motivating factor.

Another important factor to consider in a discussion of daily work is the daily assignment. The assignment is the stimulus of the learning activity. It is the direction of the learning that is to take place outside the classroom. The assignment should be made with the following purposes in mind:

- (1) To orient and motivate pupils for engaging in the learning activities
- (2) To set up objectives
- (3) To set up definite learning exercises
- (4) To provide direction for study and other learning activities.¹⁷

¹⁷Ibid., p. 397.

There are several problems to be considered in making an effective assignment. First, of course, is the fact that assignments must be made in accordance with the objectives of the class, based on the needs of the students. The next thing to be considered is the type of assignment to be made. There are many types: textbook, topic, problem, etc. The most unsatisfactory type of assignment is one in which the teacher designates the pages to be covered or the problem to be considered. The teacher must add a few questions and study helps to bring attention to the important points. Students detest learning unimportant facts.

Risk says of the problem or topic assignment:

It differs from the page or ground-to-be-covered assignment in that the problem to be thought through, or the topic to be developed, is the center of consideration. The pupil is to begin with this and must look for the facts, the cause and effect relationships, the values, the reasons, or whatever else is involved. Here again directions and suggestions are very important, and should be used. References may be suggested, even pages in the textbook, but the pupil is freed from the restriction of ground-to-be-covered, and should be encouraged to broaden his search for information. This type of assignment gets away from the textbook idea, stimulates the pupil to do his own thinking, broadens the pupil's outlook, and should be an excellent means of teaching the use of the library, reference books, and other materials.¹⁸

The recapitulation may be the introduction needed for the next assignment. For instance, "We have just finished a discussion on the first three phyla of the animal kingdom: the Protozoa, Porifera, and the Coelenterata. Tomorrow, we will continue our study of the animal kingdom with phylum

¹⁸Ibid., p. 398.

number four, the Platyhelminthes. This phylum includes the human tapeworm and other flatworms that live as parasites on humans." After this introduction, the assignment will follow naturally. This type of introduction to the assignment will provide the proper motivation. Immediately, questions register in his brain. What is this tapeworm like? Does it kill? How can one know if he has a tapeworm? And the student may actually get his assignment.

CHAPTER IV

LABORATORY WORK

The laboratory in any science subject should be thoroughly and skillfully organized. Otherwise a great deal of waste may result. In the first place, the laboratory period should be perfectly correlated with the class work. If any unit is studied which provides for no laboratory experiments, no experiment should be done. In order to secure the greatest benefit from the activities in the lab, it is absolutely essential that pupils be prepared with an adequate background which is achieved through class discussion and study. Pupils should be thoroughly familiar with the purpose of the experiment and the principles which they are to discover through this activity.¹⁹

By conducting the laboratory on Tuesday and Thursday, the students will have time to prepare in advance for each laboratory period. This will allow the instructor to orient the student the day before the experiment is to be done. By allowing the day after the laboratory for a class, there will be ample time for discussion, critique, and summarization.

According to the Thirty-first Yearbook of the Society for the Study of Education, the laboratory should accomplish the following:

- (1) The development of simple laboratory techniques such as the manipulation of the microscope.
- (2) Proving and establishing for the pupil himself principles which have long since been well established and generally accepted.

¹⁹Arthur G. Hoff, Secondary School Science Teaching (Philadelphia, 1947), p. 173.

- (3) Using the laboratory for object or "thing" teaching.
- (4) Using the laboratory for the purpose of developing better understandings and interpretations of the principles of science.
- (5) To produce training in scientific method.
- (6) As a means of possible training in the experimental solution of the pupil's own problems.
- (7) The use of the laboratory as a workshop for the study of science problems which arise in the science class or in the lives of the pupils.²⁰

The laboratory shall be used as a supplement to the daily classroom instruction. This will be a flexible arrangement in that there will be times when the "laboratory" day will be used to give a lecture-demonstration or to show films that will aid the student in learning more about the topic under discussion. At other times, when the students are not engaged in actual experimentation, the "laboratory" days may be used for supervised workbook activity. This permits the student to engage in independent study in an area provided with several books for reference, and an instructor handy for the more complex problems.

It is wise to remember that the high school student may sit through five or six lectures a day. This would be the equivalent of twenty-five semester hours in college. This would certainly be a laborous task if all the classes were

²⁰Ralph K. Watkins, "Instruction in the Physical Sciences in the Secondary School," Thirty-first Year-book, National Society for the Study of Education, (1932), 279.

lectures. The well conducted, informal laboratory period can be a refreshing departure from the academic program. Surveys indicate that the informal laboratory period is more conducive to learning than the formal method still used by some teachers.²¹

²¹Doris H. Hawse, "Ooh! Worms!," Science Education, XLI (1957), 436.

CHAPTER V

ORGANIZATION

In considering the organization of the biology program, one should determine what is being offered at the present time, and the attitude of the students in regard to the emphasis placed on various phases of instruction. Surveys by various individuals reveal possible sources of motivation for the high school students. W. Edgar Martin rates the emphasis placed on various topics by the number of days used to discuss them. His findings are given in the following table:

TABLE IV

THE PRESENT STATUS OF INSTRUCTION IN GENERAL BIOLOGY²²

AREAS EMPHASIZED	TOTAL SCHOOLS REPORTING		RANGE OF TIME IN DAYS		
	number	percent	min.	max.	av.
Genetics, heredity	79	84.0	5	50	17.7
Conservation	77	82.5	5	90	18.6
Health	71	76.5	10	120	36.5
Taxonomy	61	65.5	2	95	28.2
Human biology	37	39.9	10	45	31.0
Plant biology	30	32.4	15	90	37.0
Animal biology	23	24.8	15	90	42.5
Reproduction	22	23.6	3	40	21.5
Psychology	24	25.8	8	45	18.9
Food & Nutrition	17	18.3	3	46	28.6
Disease control	15	16.3	3	40	18.9
Evolution	8	8.5	5	20	13.5

²²W. Edgar Martin, "The Present Status of Instruction in General Biology, American Biology Teacher, XIII (1951) 1953.

The wide variation of time spent with each subject indicates that there is no "standard" to go by. Apparently, the background of the teacher, geographical location, the personality of the community, and many other factors influence the emphasis placed on the many phases of biology. One needs only to scan a number of biology texts to find an equal number of views in regard to the number of pages devoted to each unit. It would seem unfair to catalogue these and come up with the average as the number of pages to be devoted to each heading. Hubert Alyea is of the opinion that the teacher should emphasize the area in which he has the most interest. Students are eager to learn those things that seem to be important. If they are of so much interest to the teacher, they must be important.

One of the general objectives of biology is to gain information. It is left to the discretion of the teacher just what information is to be gained. Plant biology is an important item in the general education of the well rounded, informed individual, but unnecessary emphasis on such things as the life cycle of the wheat rust may destroy the desire to learn for an individual who will probably never walk through a wheat field. Even in biology, everything learned cannot be of a practical nature. Those things that are neither practical nor of such nature that they add to the general education that makes the well balanced individual should be deleted from the course.

Modern trends stress taking advantage of student interests in planning the biology program. Rosenquist has asked the students where their interest lie. The results are given in the following table:

TABLE V
STUDENT SUGGESTIONS AND RATINGS²³

TOPIC	NUMBER OF ANSWERS IN FAVOR OF			RATIO M:L	% CLASS TIME
	More	Same	Less		
Hist of Biol	20	284	64	1:3	5
Phys & Chem					
Principles	90	230	48	2:1	3
Cells, Tissues	98	225	45	2:1	9
Protoplasm	35	288	45	1:1	5
Nutrition	109	112	67	3:2	23
Nervous Sys	68	245	55	1:1	17
Reproduction	130	178	10	18:1	11
Heredity	207	135	26	8:1	9
Evolution	106	176	86	1:1	7
Psychology	138	193	37	4:1	4
Pathology	154	181	33	5:1	5

This table indicates that curriculum workers favoring more emphasis on human biology are likely to find a group of high school students eager to listen. It seems that now, more than ever before, people are interested in learning more about themselves. Other studies indicate that the students are interested in living things. Many of the studies listed frog dissection, along with genetics and human physiology, as an area of great interest to the high school student. If a study were to be made today, the authors would

²³C. E. Rosenquist, "Suggestions and Ratings Upon Different Sections of an Introductory Course in General Biology", American Biology Teacher, XIV (1952), p. 223.

no doubt find a great deal of interest in anatomical models that can be disassembled to show location and relative sizes of the organs in the human body.

The teacher who is prepared for some frank answers, and a fair estimation of his teaching ability, can discover a great deal about the students, his methods of instruction, and the effectiveness of the whole biology program with questionnaires. Rosenquist left blanks on the questionnaire represented by TABLE V. He asked the students to make additional comments. These remarks, with the number of students commenting, are given below:²⁴

No suggestions	126
Appreciate & satisfied	41
Objective exams not adequate	33
Simplify or shorten course	27
Revise or improve lab	24
Provide a syllabus	20
Give more time to explanation	19
Make course more practical	18
Too much memory work	16
More movies	13
Use a different text	12
Announced exams	10
Teach less or no evolution	9
More subjective tests	7
Course too difficult	7
Distribute a list of important questions to study	6
Criticism of instructor	6
More use of text	5

Of those answering, about half indicated a desire for a syllabus. This should justify the time involved in the preparation of one for their use. A teacher with a generous budget

²⁴Ibid., p. 224.

may be able to purchase some for his class. At Oklahoma State University, the "Bi Sci" class has used the syllabus quite effectively. In this case, they are purchased by the student.

It was pointed out that it would be unfair to judge the value of a subject from the number of pages devoted to it in the book. One reason is that ecology, conservation, and biology for hobbies may be at or near the back of the book indicating less importance in the eyes of the author. Most teachers who follow the book are not able to reach these units because of lack of time. Therefore, though many pages are devoted to the subject, it may not be the most important. Most authors go from the simple to the complex in their books, and leave ecology, evolution, and soil conservation to the last. However, there are many different ways to arrange the sequence. TABLE VI is a general outline of the order followed by three well accepted texts. Each has, of necessity, been modified somewhat.

The order may be varied to suit the needs of the particular school. An instructor who is strong in genetics is likely to prefer to discuss it along with vertebrate biology and its emphasis on man. Some have suggested that the structure and function of plants be discussed in the spring when there are many plants available for study. Others indicate that there are many available from the local florists, and that plants are ideally formed for starting a discussion of living things. For instance, hardly anyone would be embarrassed discussing the

pollen and the ovary of the flower. Then, since they have already discussed male and female gametes, reproduction can be discussed in a natural way with the other systems of the body.

TABLE VI

BRIEF OUTLINE OF
GENERAL BIOLOGY

- I INTRODUCTION
 - A Cells
 - B Scientific reasoning
- II STRUCTURE AND FUNCTION OF COMMON PLANTS
 - A Stems, roots, leaves
 - B Photosynthesis
 - C Respiration
 - D Guttation
 - E Transpiration
 - F Ingestion
 - G Circulation
 - H Growth
- III VERTEBRATES
 - A Nutrition - digestion
 - B Respiration
 - C Circulation
 - D Excretion
 - E Reproduction
 - F Nervous system
 - G Sense organs
 - H Skeleton and muscle
 - I Endocrine system
- IV TAXONOMY OF PLANTS
- V TAXONOMY OF ANIMALS
- VI GENETICS

CHAPTER VI

SUMMARY AND CONCLUSIONS

Through proper motivation, careful assignment of daily work, supervised laboratory experiments, and a good method of evaluation, the student will be able to gain information, develop methods of reasoning, learn the application of principles, and with the aid of mental gymnastics, develop critical thinking.

The teacher must realize that there are many ways to be smart or dumb. Before he labels a student as too dumb to learn, he should try a different approach. The student, himself, may be wise to consider a change rather than to waste an important part of his life. General Electric had some of their top engineers take the Massachusetts Institute of Technology qualifying examination. They all made a poor showing. Both Edison and Einstein would have been dismissed from the classes of many teachers. They both had a great deal of difficulty memorizing facts. About the only consistent trait of great men is that they were collectors. Dr. Gaither, who administers the preliminary examinations at Oklahoma University, states that students who were almost not

admitted because of their lack of apparent ability to succeed may become the top students. Others who show great promise may make very low grades. At the present time, there is no way to predict success. The teacher can, with experience, enthusiasm, and constant hard work, help each student develop to the extent of which he is capable. To do this, assignments must be made in a positive way so that the student will know what is expected of him. Workbooks may be used to provide for individual initiative and flexibility in the laboratory periods. There should be definite correlation between the class discussions and the laboratory exercises.

Motivation dissolves work and leaves the sweet fragrance of enjoyment. Yet motivation is the door to accomplishment. There are several methods of motivation and the teacher should be prepared to use each one to aid in the development of the student.

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