AN EXPERIMENT IN TEACHING TECHNIQUE: TRADITIONAL INSTRUCTION COMPARED TO STUDENT INVOLVEMENT IN THE LEARNING PROCESS

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ABSTRACT

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The history of the public high school is discussed including characterization of the slow learner, the culturally disadvantaged and the problem student. Two identical groups of students participated in the experiment; one group actively and physically involved in the educational process; the other less actively and physically involved. The raw score data were statistically analyzed. The mean, median and ninety-five percent confidence interval were similar for both groups. Thus, attempts to physically involve these students will not increase their achievement. The current methods of teaching, curricula and building designs are discussed.

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INTRODUCTION

Background

The first high school in the United States opened in Boston in 1821 with an enrollment of 102 students. It was named the "English Classical School" which was later changed in 1824 to the "English High School" (Alexander *et al.*, 1971). The school was organized for three reasons. One, the existing levels of education were too elementary to fulfill the abilities of the young. Secondly, those who desired advanced education were forced to attend private schools thus separating them from their families. The third reason was to "render the present system of public instruction more nearly perfect." (Alexander *et al.*, 1971).

From its inception in 1821, the public high school has undergone rapid development, growth and change. The period from the 1800's to the 1920's was devoted primarily to establishing functions and purposes of the public high school. By the 1920's the National Education Association had established that secondary education should be universal and should prepare each citizen for effective and significant social living (Alexander *et al.*, 1971).

The 1920's were characterized by a rapid growth of schools and by the expansion of curricula and programs within them. This growth and expansion was precipitated by an exponential increase in the number of students available for enrollment. The theme of this era which continued until World War II was "education for all the children of all the people." During this time, numerous experiments, innovations and reforms occurred in all areas of instruction. Extracurricular activities and well-developed athletic programs blossomed in an effort to provide the broadest range of activities for all youth of all interests (Alexander _et al._, 1971).

Since World War II, the secondary schools have undergone another wave of reform designed to eliminate segregation and its resulting unequal education of white and black students. Thus, after many years of legal segregation, the Supreme Court, in 1954, ruled that separation of students in different schools on the basis of race could never provide equal educational opportunity for each race regardless of the provisions made for schooling (Alexander _et al._, 1971).

Presently, other educational inequalities are receiving much attention. A few examples are:

1. The educational limitations of small schools in rural districts.
2. The financing of schools in poverty areas.
3. The education of migrant children.
4. The design of special programs for the physically disabled, the mentally retarded and the emotionally disturbed.

The federal government has allocated billions of dollars to plan and implement programs designed to eliminate some of these inequalities.

Throughout the many years of educational change, the underlying philosophy of education has been to educate each individual child subject to his own inherent talents and abilities. This philosophy, known as progressive education, is indelibly established in our educational system from the works of the late John Dewey. He maintained that the school should become more of a community center rather than a place in which to learn lessons. The Dewey philosophy has been embraced by practically every large school system in the country. For the teacher it is both a challenge and a stumbling block (Dunn, 1955). It is a challenge in that it sets the goals that all teachers wish to achieve. It is a stumbling block because it is unwieldy and impractical in large schools. Whether it is called progressivism, child-centered education or individualized instruction, the Dewey philosophy continues to dictate the operation of America's high schools.

The majority of high school students in the United States attend comprehensive high schools. Such schools are open to all youths in the community and they offer a broad range of programs including academic, practical, prevocational and vocation curricula (Alexander _et al._, 1971). These high schools usually encompass the grade levels nine through twelve. Often, ninth grade students attend heterogeneous classes in which no attempt is made to separate students of similar learning capacities. This ungraded condition is usually modified in grades ten through twelve. Here, the students are divided into three groups; advanced, average and basic. They attend homogeneous classes with students of similar learning capabilities. The basic group includes slow learners, the culturally disadvantaged and the problem students. These classifications are usually arbitrary and are neither binding nor well delineated.

The Slow Learner

The following characterization of slow learning students is taken, in part, from Johnson (1963). Slow learners comprise approximately fifteen to eighteen percent of the general school population. Since they do not deviate markedly from the mean, few educational provisions have been forthcoming to aid the teacher in their instruction. The most obvious characteristic of the slow learner is his inability to maintain normal academic growth. For example, such students learn to read approximately one year later than most children. They grasp new skills and concepts more slowly than expected. Usually they attain a maximum mental growth of between eleven and thirteen and one-half years. Students in this category will usually receive grades in the lowest quartile. Frequently, they will drop out of school before graduation.

For many years, the problems of the slow learner were ignored at the secondary level because few students remained in school long enough to reach high school levels. However, with the advent of social promotions and overcrowding, it became impossible to ignore the needs of these students. Unfortunately, few curricula are designed solely for the instruction of the slow learner. Therefore, these students are usually grouped with the culturally disadvantaged and the problem students and follow curricula designed for average students. The results of such treatment are predictable: the slow learner becomes academically frustrated and eventually indifferent to further education; the teacher suffers the lack of reward for her efforts and eventually loses all enthusiasm for teaching. In such situations neither teacher nor student benefit from the educational experience.

The Culturally Disadvantaged

The following characterization of culturally disadvantaged students is taken in part from Beck and Saxe (1965). The culturally disadvantaged student has been denied social and cultural experiences normally provided to average or advanced students. Such experiences include:

1. A family environment in which reading is encouraged.
2. A childhood amply provided with a variety of toys and play materials of various colors, sizes and shapes and objects which challenge the intellect.
3. A family conversational experience which both answers and encourages questions and which expands the child's vocabulary and ability to express his views.

Generally, these students come from groups whose economic resources are extremely limited. Often, they have a rural background. They are distributed widely among the urban centers of the United States. Racially and ethnically they consist mainly of:

1. Blacks from the rural south, many of whom have migrated recently to northern industrial cities.
2. Whites from the rural south, many of whom have migrated recently to northern industrial cities.
3. Puerto Ricans who have migrated to northern industrial cities.
4. Mexicans with a rural background who have migrated to the big cities of the west and middle west.
5. European immigrants with rural backgrounds.

Together, these racial and ethnic groups comprise approximately fifteen percent of the population of the United States. Since they tend to have large families, their children may provide as much as twenty percent of the school-age population. Furthermore, since these groups tend to concentrate in large cities, as much as thirty percent of the school-age population in such cities as Detroit, New York, Chicago, Philadelphia, Washington and Cleveland may be composed of culturally disadvantaged students.

The culturally disadvantaged student has suffered the ignominious result of benign neglect. Very few curricula are extant which are designed specifically to meet the special requirements of students in this category. Instead, these students are usually grouped with the slow learners and the problem students and are provided with instructional programs designed for average students. With few exceptions, the culturally disadvantaged student in this situation fails to be motivated or intellectually challenged. His disinterest is manifested in very poor achievement. Frequently, he will leave school before graduation.

The Problem Student

The following characterization of problem students is taken, in part, from Washington (1963). The behavior problem student is generally male. He usually comes from a low income family in an overcrowded urban community. A variety of environmental problems such as poverty, large families, lack of one or both parents, drugs, peer pressures, etc., make it difficult for these students to adjust to any school. For these students, failure at school means failure in reading and in achieving the ability for adequate verbal expression. As a result, the school experience and the learning process are additional sources of frustration, conflict and bitterness. The problem student has difficulty in concentrating on any task for long. Though he seeks attention, he rejects instruction. Fearing failure, he has difficulty accepting help or following directions. Because there is little relation between what he learns in school and life as he knows it, the learning process seems quite unreal to the problem student.

Clearly, the traditional school routine, methods and materials do not suit these students. Yet, they are usually grouped with the slow learners and the culturally disadvantaged into basic classes where they are provided with curricula designed for average students. Under the regimen, the behavioral problem student deteriorates rather than improves and his behavior becomes more and more unpredictable and disruptive. Ultimately, he either begins to act out the impulses that flood his awareness or else he retreats from them and the demands of reality. There is little likelihood that the problem student treated in this manner will complete the twelfth grade.

<u>The Basic Group</u>

The slow learners, the culturally disadvantaged and the behavioral problem students collectively comprise the basic group. Such students are educationally uninvolved (Wong and Kilburn, 1971). Their lack of involvement in the educational experience probably results, in part, from the failure of the American educational system to provide comprehensive and specific programs of instruction designed to meet their special needs. Grouping these students of such widely disparate backgrounds and with such dissimilar educational needs, and providing them with an instructional program designed for average students, is irresponsible. Basic students treated in this manner will very rapidly develop a disdain for the educational process.

It must be recognized that basic students can indeed benefit and profit from the educational experience. This will occur, however, only when a comprehensive instructional program is designed and initiated specifically to meet their needs (Johnson, 1963).

Statement of the Problem

Basic students of the three categories described above appear to have a similar academic development. Their academic achievement does not begin to deviate markedly from that of the average student until the sixth, seventh, or eighth grade. At this time, they begin to exhibit restlessness in class, many begin to show severe behavioral problems and their academic development begins to deteriorate. This is manifested in sharply reduced achievement and an inability to maintain an academic competitiveness with average students. It is not surprising to note that it is during this period that the emphasis in academic programs shifts rapidly from a highly physical involvement to more intellectual types of activities.

It is a part of the central dogma of modern education that children who are actively and physically involved in the educational process will achieve greater success and pleasure in school (Johnson, 1963). School systems throughout the United States are adopting curricula and designing new construction to implement this dogma. Although these new programs appear to be successful for average and advanced students, I am not convinced they are successful for basic students. Therefore, the purpose of this paper is to report the results of a test designed to measure the achievement of two identical groups of basic students: one group actively and physically involved in the educational process; the other less actively and physically involved.

METHODS AND MATERIALS

Two classes of basic students at the tenth grade level were chosen for the experiment. The school files of each of these students were carefully examined to assure homogeneity. All fit the pattern characteristic of basic students. Experimental and control groups were designated at random by drawing numbers from a hat. Each group was challenged with a different specially designed six week curriculum in botany (Appendix I). In both the experimental and the control groups, the program was divided into six identical sections of one week duration.

1. Classification
2. Seeds
3. Roots, Stems and Leaves
4. Plant Processes
5. Flowers and Reproduction
6. Review

The curriculum designed for the experimental group required the active and physical participation of the students (Appendix I). The curriculum designed for the control group was developed along more traditional lines and did not include active and physical participation.

The experimental group consisted of twenty students and the control group of thirteen students. Both groups started the six week curriculum at the beginning of the second semester on 31 Jan. 1972. With the exception of a few school-wide assemblies which occurred during class time, the curricula were followed precisely. Lost time was recovered during the review week. A single examination was administered at the conclusion of the experiment on 10 March 1972, with make-up examinations given during the following week. No test papers were returned to the students until all had taken the examination. The test consisted of forty objective questions and a drawing to be labelled (Appendix II). The raw scores were recorded and statistically analyzed.

RESULTS

The raw scores of all students in the experimental and control groups are shown in Table 1 of Appendix III. The range in grades for the experimental group was between nine and fifty. For the control group, the grades ranged between twenty-three and forty-one. Figure I of Appendix III shows the frequency distribution of raw scores among students in the experimental and control groups. It is clearly seen that the frequency distribution of raw scores among students in the experimental group is bimodal in nature. Seven students scored between twenty-one and thirty, while the same number of students scored between thirty-one and forty. Among the students in the control group, nine students scored between thirty-one and forty producing a distinctly unimodal frequency distribution.

Table 2 of Appendix III provides a summary of the results of the statistical analyses performed on the raw score data of the experimental and control groups. There was considerably more variation among the twenty students comprising the experimental group than there was among the thirteen students comprising the control group. The range, standard deviation, standard error and length of the ninety-five percent confidence interval were all larger in the experimental group than they were in the control group. Nevertheless, the mean, median and ninety-five percent confidence interval of the experimental group are not significantly different from those of the control group. Of particular importance is the observation that the ninety-five percent confidence interval of the control group (28.90-35.41) falls completely within the ninety-five percent confidence interval of the experimental group (27.88-37.12).

DISCUSSION AND CONCLUSIONS

Every attempt was made to assure that the experimental group and the control group were identical. Prior to the experiment, the school files of all basic students enrolled in the tenth grade were rigorously examined. From this examination a preliminary list of students who were to take part in the experiment was constructed. At this time interviews were held with the school guidance counsellor and with the school psychologist. Any student considered unsuitable for the experiment was removed from the preliminary list. A final list of candidates who were suitable for the experiment was constructed at this time. It included only those students who were, in the opinion of the guidance counsellor, the psychologist and myself, slow learners, culturally disadvantaged and/or behavioral problems. Such criteria as classroom behavior, academic achievement, absentee record, reading ability, verbal expression and family background were considered. The final list of candidates comprised a homogeneous group of basic students whose schedules allowed their inclusion in the experiment. From this list the experimental group and the control group were randomly chosen. Due to scheduling priorities the number of students in the experimental group (twenty) was larger than the number of students in the control group (thirteen). The students were never told that they were participating in an experiment.

The curricula designed for the experimental and control groups were distinctly different (Appendix I). The experimental group was challenged with a course of study that required active physical participation. This group performed several expreiments involving the classification of different objects such as cards and cut-outs of different colors and shapes. Students in this group were required to weigh and dissect seeds. They observed and dissected living plants in order to learn anatomy and performed paper chromatographic separations of chlorophyll. In addition, members of the experimental group performed dissections of several different kinds of flowers to observe reproductive morphology.

The control, on the other hand, was challenged with a course of study that required considerably less active physical participation. They learned the concept of classification by lecture, discussion and with the aid of an overhead projector. Only passive participation was required. Students in this group studied seeds by means of blackboard drawings. They studied plant anatomy by using models and by listening to explanations from the instructor. They were shown a demonstration of the paper chromatographic separation of chlorophyll rather than perform the experiment themselves. All other concepts and information in the curriculum was provided to them by means of lectures. In no case did students in the control group become physically involved in the curriculum.

Throughout the six week duration of the curriculum the number of students in both groups remained relatively constant. Two students, one from each group, withdrew prior to completion of the unit. Another student withdrew from the experimental group, but because she was consistently absent, she never took the examination and was not included in the final data. Absenteeism was quite high in both groups and several students in each group missed material and/or experiments which might have improved their performance on the examination. In the experimental group, the two lowest scores (nine and seventeen) were made by students whose absences were significant during the program. One of these students was absent for as long as two consecutive weeks.

The same examination was administered to both the experimental and the control groups. In both cases the administration of the examination was uniform with students in both groups, as well as those who took make-up examinations, being given fifty minutes to complete it. The test was designed to obtain factual information only; it was purely objective and required the student to recall only facts learned during the program. In other words it did not require him to apply his knowledge to new problems. Make-up examinations were administered to all students who were absent from the scheduled examination. Leakage of information concerning examination content was minimized for these students since no examinations or grades were returned until all make-ups had been completed.

The results of this experiment clearly show that basic students who were more physically involved in a six week curriculum in botany did not achieve higher scores than basic students who received a more traditional and less physically active course of study. I suspect that the same results would be obtained if the experiment were repeated in other disciplines (e.g. mathematics, social sciences etc.). If this is indeed a generalized phenomenon, then all attempts to involve basic students in a more physically active curriculum will not increase their achievement. Nevertheless, school systems throughout the country are adopting this method of instruction for all students and even the design and construction of new school buildings is being influenced by this approach. For example, in Anne Arundel County, Maryland, large and open-spaced school buildings are now being designed and constructed so that the entire building can be compartmentalized into different discipline areas with children free to move from one station to another in order to perform an experiment or solve a problem.

The available evidence appears to support the contention that average and advanced students achieve greater success under this educational regimen, that is, when they are physically and actively involved in the learning process (Johnson, 1973), but there is certainly no evidence that the same kind of program will benefit the basic student. Indeed, the results of the experiment reported in this paper suggest that the efficacy of a physical and active curriculum is restricted to average or advanced students only. The basic student does not benefit from the most widely used methods of instruction and school construction.

Clearly, more consideration must be given to the circumstances under which basic students learn more effectively and pleasantly. Until specialized curricula are designed to meet the specific needs of basic students, they will continue to be the educationally uninvolved, attending class with little enthusiasm or interest and achieving far below their capabilities.

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Appendix I

Curriculum for the experimental group.

DAY	CURRICULUM	CONCEPT
1	Introduce unit to class. Give students outline to follow and discuss topics to be covered. Explain projects and assignments and give examples such as: a. Plants in Medicine, b. Poisonous Plants in Florida, c. Herbs and Spices, etc. Have students formulate ideas in class.	
2	Unit 2 in _Biology iis_. Read in class and discuss questions orally. Develop concept with class.	there are different kinds of living things
3	_Using Exploring Life Science_, give students list of terms to define. a. angiosperm, b. gymnosperm, c. monocotyledon, d. dicotyledon, e. characteristics of six families of flowers. Discuss terms with class.	there are several different groups with different characters
4	Library Day. Assist students in finding materials for projects. Notify librarian in advance.	exploring requires systematic research
5	Unit 2 in _Biology iis_. Answer questions orally. Review terms followed by short quiz.	Living things can be arranged into related groups
6	Give students 10 bean seeds and 10 corn seeds. Have students measure and record length of each seed. Graph results. Discuss variations in class.	there is variation among species
7	Have students weigh several seeds and prepare them for germination. Discuss terms a. seed b. germination and define them. Using _Exploring_	seeds are dormant but still living

DAY	CURRICULUM	CONCEPT
	Life Science, have students draw and label parts of seed.	
8	Have students reweigh seeds and record weight. Students will cut open seed and compare with drawings they made. Discuss requirements for germination.	all parts of a plant begin in the seed
9	Library Day. Students should have materials give assistance where needed	
10	Have students plant several seeds for observation during next weeks. Give short quiz on terms. Discuss how water and soil types are important in plant growth	soil and water provide basis for growth
11	Have class make list of roots used as food products. Using filmstrips, discuss function of roots. Look up terms a. osmosis b. diffusion and discuss. Students observe root hairs under microscope.	roots are important for plants to sustain life
12	Demonstrate osmosis with thistle tube apparatus. Students predict what will happen. Use perfume to explain diffusion. Have class make list of food products from stems.	all living things use water for life
13	Using celery stalk, show conducting vessels. Define terms a. xylem, b. phloem. Using Exploring Life Science, students will point out differences in stem types. Supplement with film strip on stems.	water and food must be conducted to all parts of living things
14	Library Day. Help students organize paragraphs and thoughts. Aid in obtaining outside materials.	organized thoughts are important for research

DAY	CURRICULUM	CONCEPT
15	Studends examine and note differences in different leaves. List food products from leaves. Using large model, point out structures and discuss functions while students follow on worksheets. Short quiz.	leaves vital for food production
16	Unit 5, Biology iis. Students will examine stomates and guard cells and compare with drawings in Exploring Life Science. Define transpiration and explain how it operates.	plants maintain water balance
17	Using Exploring Life Science, discuss chemistry of photosynthesis. All parts of plant aid in food production. Discuss importance of chlorophyll and read together Unit 5 in Biology iis.	all living things need energy
18	Begin Unit 5 experiment on chlorophyll chromotography. Students work in unison to eliminate problems.	plants need chlorophyll to sustain life
19	Library Day. Assist students in completing their reports.	develop assurance in writing
20	Discuss chromotography and plant pigments. Short quiz of weeks work. Use filmstrips to complete study of photosynthesis.	plant pigments necessary for food production
21	Using large model, have students examine flower and label parts on worksheets. Discuss parts and their functions.	flowers are plant structures for reproduction
22	Discuss methods of pollination with class. Make list of methods and plants that use the various methods. Discuss self vs. cross pollination.	flowers have various methods by which pollen can be transferred

DAY	CURRICULUM	CONCEPT
23	Students will examine different flowers and locate structures. Note differences in length of stamens and anthers and determine if self or cross pollinated.	flowers exhibit wide variety in structures
24	Library Day. Students should have research completed. Make sure all books are returned to library.	outside research necessary to broaden knowledge
25	Using filmstrips, review flower reproduction and have students draw flower cycle. Short quiz on terminology.	reproduction necessary for survival of species
26	Finish up all work in lab. Have students clean up and replace materials in storage.	neatness necessary for good research
27	Students present their work to class. They will discuss what they have done and learned from projects.	gaining knowledge from others is valuable
28	Continue student projects.	
29	Review day. Go over work of past weeks and clear up misunderstandings.	
30	Test.	

Curriculum for the control group.

DAY	CURRICULUM	CONCEPT
1	Introduce unit to class. Give students outline to follow and discuss topics to be covered. Explain projects and assignments and give examples such as: a. Plants in Medicine, b. Poisonous Plants in Florida, c. Herbs and Spices, etc. Have students formulate ideas in class.	
2	Unit 2 in Biology iis. Read in class and discuss questions orally. Develop concept with class.	there are different kinds of living things
3	Using Exploring Life Science, give students list of terms to define. a. angiosperm, b. gymnosperm, c. monocotyledon, d. dicotyledon, e. characteristics of six families of flowers. Discuss terms with class.	there are several different groups with different characters
4	Library Day. Assist students in finding materials for projects. Notify librarian in advance.	exploring requires systematic research
5	Unit 2 in Biology iis. Students will read material and discuss lab orally. Answer questions orally. Review terms followed by short quiz.	living things can be arranged into related groups
6	Students will discuss what differences they might find if given 10 different bean seeds and 10 corn seeds. Discuss variations in class.	there is variation among species
7	Discuss terms a. seed b. germination and define them. Using Exploring Life Science, have students draw and label parts of seed.	seeds are dormant but still living

DAY	CURRICULUM	CONCEPT
8	Have students discuss changes in seed during germination. Discuss requirements for germination to occur. Draw seeds on board in condition before and after germination.	all parts of a plant begin in the seed
9	Library Day. Students should have materials give assistance where needed.	
10	Have students plant several seeds for observation during next weeks. Give short quiz on terms. Discuss how water and soil types are important in plant growth.	soil and water provides basis for growth
11	Have class make list of roots used as food products. Using filmstrips, discuss function of roots. Look up terms a. osmosis b. diffusion. Draw root hairs on board.	roots are important for plants to sustain life
12	Demonstrate osmosis with drawing on board of thistle tube apparatus. Students predict what will happen. Have students discuss diffusion by predicting what would happen if perfume was used. Have class make list of food products from stems.	all living things use water for life
13	Using blackboard, draw celery stalk and show conducting vessels. Define terms a. xylem, b. phloem. Using <u>Exploring Life Science</u>, students will point out differences in stems. Supplement with film strip on stems.	water and food must be conducted to all parts of living things
14	Library Day. Help students organize paragraphs and thoughts. Aid in finding outside materials.	organized thoughts important for research

DAY	CURRICULUM	CONCEPT
15	Draw different leaves on board and have students point out differences. List food products from leaves. Using large model, point out structures and discuss functions while students follow on worksheets. Short quiz.	leaves vital for food production
16	Read Unit 5, Biology iis. Draw stomates and guard cells on board and compare with drawings in Exploring Life Science. Define transpiration and explain how it operates.	plants maintain water balance
17	Using Exploring Life Science, discuss chemistry of photosynthesis. All parts of plant aid in food production. Discuss importance of chlorophyll and read together Unit 5 in Biology iis.	all living things need energy
18	Demonstrate experiment on chlorophyll chromotography. Students observe and note what happens.	plants need chlorophyll to sustain life
19	Library Day. Assist students in completing their reports.	develop assurance in writing
20	Discuss chromotography and plant pigments. Short quiz of weeks work. Use filmstrips to complete study of photosynthesis.	plants pigments necessary for food production
21	Using large model, have students examine flower and label parts on worksheets. Discuss parts and their functions.	flowers are plant structures for reproduction
22	Discuss methods of pollination with class. Make list of methods and plants that use the various methods. Discuss self vs. cross pollination.	flowers have various methods by which pollen can be transferred

DAY	CURRICULUM	CONCEPT
23	Students will look at different pictures of flowers and locate structures. Note differences in length of stamens and anthers and determine if self or cross pollinated.	flowers exhibit wide variety in structures
24	Library Day. Students should have research completed. Make sure all books are returned to library.	outside research necessary to broaden knowledge
25	Using filmstrips, review flower reproduction and have students draw flower cycle. Short quiz on terminology.	reproduction necessary for survival of species
26	Finish up all work in lab. Have students clean room and replace materials in storage.	neatness necessary for good research
27	Students present their work to class. They will discuss what they have done and learned from projects.	gaining knowledge from others is valuable
28	Continue student projects.	
29	Review day. Go over work of past weeks and clear up misunderstandings.	
30	Test.	

Appendix II

Test--Flowering Plants
Biology B 1
Mrs. Janes

Name ______________

Date ______________

I. Matching. Match the words in Column A with the correct meanings in Column B.

Column A

_____1. Roots

_____2. Osmosis

_____3. Germination

_____4. Chromatography

_____5. Leaves

_____6. Stomates

_____7. Epidermis

_____8. Stems

_____9. Monocotyledon

_____10. Carotene

Column B

A. Spinach and lettuce
B. Outer covering of leaves
C. Orange pigment
D. Celery and rhubarb
E. Openings in leaves
F. Movement through a membrane
G. Green pigment
H. Separation of chemicals
I. Beets and carrots
J. One seed leaf
K. To begin growth
L. Two seed leaves

II. Multiple Choice. Place the letter of the correct answer to the left of the statement.

_____1. The movement of material from an area of greater concentration to an area of lesser concentration is termed (a) osmosis, (b) diffusion, (c) equilibrium, (d) plasmolysis.

_____2. The production of food in plants is called (a) chlorophyll, (b) chromatography, (c) root pressure, (d) photosynthesis.

_____3. The guard cells open and close the (a) stomates, (b) spongy layer, (c) phloem, (d) xylem.

_____4. The correct equation for photosynthesis is (a) $H_2S + CO_2 = 6C_2H_5O_{10} + S_2$, (b) $H_2O + NaCl = NaH_2O + Cl_2$, (c) $CO_2 + H_2O = C_6H_{12}O_6 + O_2$, (d) $O_2 + CO = C_2O_2 + O_2$.

____ 5. The radical of a developing seed will become the (a) stem, (b) leaves, (c) seed leaves, (d) roots.

____ 6. The three requirements for a seed to germinate are (a) oxygen, temperature, soil, (b) water, soil, oxygen, (c) oxygen, temperature, water, (d) soil, temperature, water.

____ 7. The water-conducting vessels in stems are (a) phloem, (b) xylem, (c) vascular bundles, (d) root hairs.

____ 8. Which of the following is <u>not</u> a function of roots? (a) anchor the plant, (b) absorb water, (c) support the plant, (d) store food.

____ 9. The phloem is a vessel that conducts (a) water, (b) food, (c) minerals, (d) vitamins.

____ 10. The reproductive part of a plant is the (a) flower, (b) root, (c) stem, (d) leaves.

____ 11. The incomplete plant in a seed is the (a) seed coat, (b) cotyledon, (c) plumule, (d) embryo.

____ 12. The two end products of photosynthesis are (a) water and carbon dioxide, (b) oxygen and starch, (c) water and oxygen, (d) oxygen and sugar.

____ 13. The escape of water from the leaves is called (a) osmosis, (b) photosynthesis, (c) diffusion, (d) transpiration.

____ 14. To carry on photosynthesis, plants must have (a) water, (b) sunlight, (c) carbon dioxide, (d) all of these.

____ 15. Extra sugar in a plant may be changed to (a) proteins, (b) starch, (c) enzymes, (d) fats.

____ 16. Plants which produce seeds in closed organs are called (a) angiosperms, (b) gymnosperms, (c) composites, (d) flowers.

____ 17. Photosynthesis occurs primarily in (a) palisade cells and spongy cells, (b) palisade cells and guard cells, (c) spongy cells and guard cells, (d) epidermis and spongy cells.

____ 18. Which of the following is <u>not</u> a function of stems? (a) store food and water, (b) support plant, (c) transport materials, (d) carry on transpiration.

____ 19. The primary function of chlorophyll is to (a) store food and water, (b) capture the sun's energy, (c) increase transpiration, (d) make the plant green.

____ 20. Seeds that are resting or not growing are said to be (a) dead, (b) hibernating, (c) very old, (d) dormant.

III. True and False. Place a T or F to the left of the statement.

____ 1. Egg and pollen cells contain only ½ the total number of chromosomes.

____ 2. Plants whose stamens are taller than the pistil are probably cross fertilized.

____ 3. The chromosomes are located within the nucleus of the cell.

____ 4. Gymnosperms produce their seeds in the open.

____ 5. Dicotyledons have at least three seed leaves.

____ 6. Radial symmetry means being the same in all direction.

____ 7. Perennials are plants that live only one season.

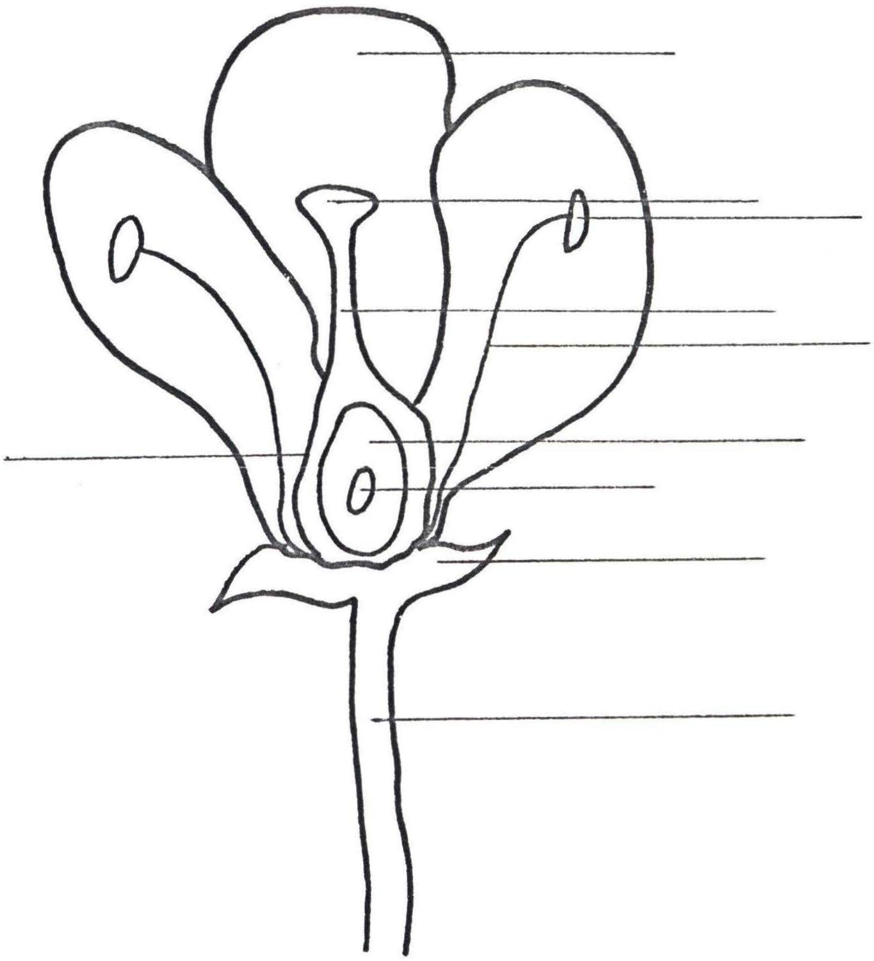
____ 8. The vascular bundles of monocotyledons are arranged randomly.

____ 9. The pistil of a flower produces the pollen cells.

____ 10. The end result of diffusion is to produce an equilibrium.

IV. Drawing. Label the parts of the flower.

Stem
Stigma
Style
Petals
Sepals
Egg
Anther
Filament
Ovary
Ovule



Appendix III

Table 1. The raw scores of all students in the experimental and control groups.

Experimental Group	Control Group
50	41
44	38
44	37
41	36
40	35
39	32
39	32
38	32
34	31
33	31
32	25
30	25
30	23
29	
27	
26	
25	
23	
17	
9	

Table 2. Summary of statistical analyses performed on the raw score data of the experimental and control groups.

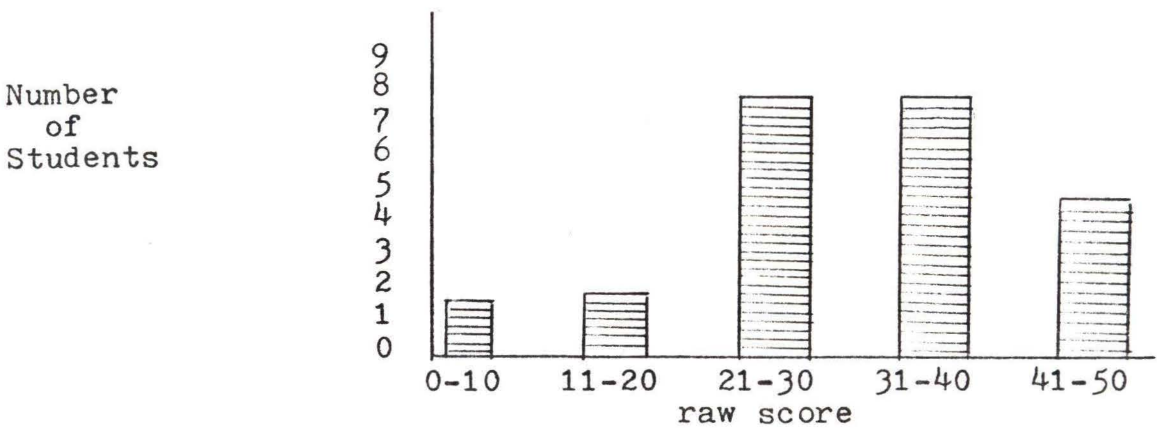
	Experimental Group	Control Group
Mean	32.50	32.15
Range	9-50	23-41
Mode	39.0	32.0
	30.0	
Median	32.5	32.0
Standard Deviation	9.87	5.38
Standard Error	2.21	1.49
95% Confidence Interval	27.88-37.12	28.90-35.41
Length of Interval	9.24	6.51

Figure 1. Histogram showing the frequency distribution of raw scores among students in the experimental and control groups.

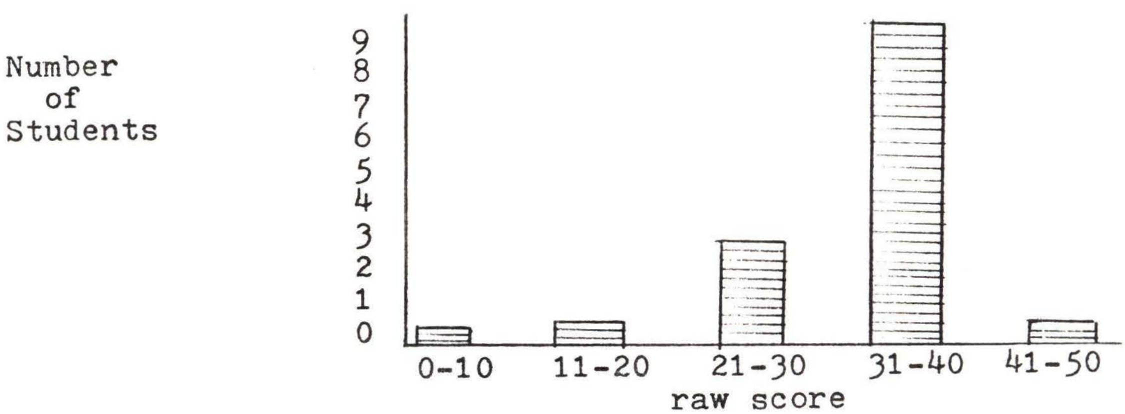
A - experimental group

B - control group

A


Number of Students
9
8
7
6
5
4
3
2
1
0
0-10
11-20
21-30
31-40
41-50
raw score

B


Number of Students
9
8
7
6
5
4
3
2
1
0
0-10
11-20
21-30
31-40
41-50
raw score

VITA

Shelley King Janes was born in Williamsport, Pennsylvania on January 17, 1948. Her secondary education was completed at Williamsport High School, Williamsport, Pennsylvania. In September, she entered Lycoming College, Williamsport, Pennsylvania where she majored in Biology. She received a Bachelor of Arts degree from Lycoming College in June, 1969. She entered the graduate program at Florida Atlantic University in September, 1970. During her graduate studies, she pursued a broad spectrum of courses in the Biological Sciences while continuing her professional career in teaching. She was awarded the degree of Master of Science in Teaching in June, 1976.

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