GENERAL EDUCATION IN THE NATURAL SCIENCES: COMPARISONS OF SELECTED SECTIONS OF A COMMUNITY COLLEGE GENERAL BIOLOGY COURSE

by

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Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of DOCTOR OF EDUCATION

in

Community College Education

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July 16, 1990

Blacksburg, Virginia
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(ABSTRACT)

From the establishment of Harvard in 1636, to the establishment of the first public Junior College in 1901, to the curricular reforms of the 1960's and 1970's, the purpose of higher education and the role of general education have been the subjects for many lively debates. The national debate on issues relating to general education has intensified within the last decade, and community colleges continue to be active participants in these debates.

The purpose of this study was to describe the course contents and classroom environments of selected community college general education general biology courses in sufficient detail as to shed light on the contribution each makes to general education. This study offers descriptions, interpretations, and evaluations of community college general education biology classrooms and laboratories. The intent was to present vivid descriptions of the classroom experience and to offer interpretations of what was being taught and what was being learned.
This study relied on qualitative case study methods and the notions of connoisseurship and disclosure to collect data, analyze data, and present the results. The study examined a real-life situation and presented events in the words and actions of the real-life participants as observed in context in an attempt to determine to what extent general education goals were being taught in general biology classrooms and laboratories.

The principle finding of the study was that general education goals as they are commonly identified in the literature were not a significant part of the biology classrooms at this community college. The study took an additional step and attempted to answer the question, "If the values expressed by general education goals were not being taught, what other values were being taught?"
ACKNOWLEDGEMENTS

The completion of a task such as this requires the help, support, encouragement, and advice of many people. First and foremost, it would have been impossible to complete this project without the support, faith, and patience of my wife, Linda Hirvonen, and our boys, Kyle and Erik.

My committee chairman, Darrel Clowes, deserves many thanks for providing the guidance and encouragement that allowed me to pursue a project that others thought could not be done. He calmed my nerves, eased my anxieties, and pushed me at the appropriate times. The other committee members, Don Creamer, Sam Morgan, Charlie White, Alan Heath, and Marilyn Lichtman also deserve thanks for having confidence enough to let me pursue this project.

Of course, without the instructors and students who allowed me to observe them and talk with them, this study could not have been done. Although I cannot name them, my thanks go out to the administration, faculty, and students of Valley View Community College for allowing me to intrude into their lives.
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GENERAL EDUCATION IN THE NATURAL SCIENCES:
COMPARISONS OF SELECTED SECTIONS OF A COMMUNITY COLLEGE
GENERAL BIOLOGY COURSE
Chapter 1

From the establishment of Harvard in 1636, to the
establishment of the first public Junior College in 1901, to
the curricular reforms of the 1960's and 1970's, the purpose
of higher education has been the subject of many lively
debates. Is the purpose of higher education to prepare our
citizens for the world of work? Is the purpose of higher
education merely the transfer of knowledge? What are the
qualities, kinds of knowledge, and skills common among
educated people? How do community colleges contribute to a
student's development of those qualities, kinds of
knowledge, and skills? Some educators argue that it is
enough to produce individuals with the knowledge and skill
to earn a living, while others argue that the educated
person should be an "improved" person and a "better" person
in ways that go beyond the ability to earn a living (Moore,
1982). Apple (in Shor, 1986) argued that schooling should
result in an "educated citizenry that can raise the ethical
and political questions so necessary to keep democracy a
vital living force [rather than] a quiescent population more
interested in personal gain than the social good" (p. x).
In offering one view of the aims of education, a Carnegie Foundation report, *Missions of the College Curriculum* (1977) submitted that education should be designed to help individuals increase their "intellectual, social, personal, and moral potentials" (p. 152). The report further stated that educated persons have increased capacities for dealing with life and the world today. Each institution of higher education, deliberately or not, offers its view of an educated person through its curriculum. The general education component of the curriculum is each institution's way of providing courses which provide an education "that results in citizens who are well prepared as workers [as well as] citizens...able to interpret the changing world in which they live, vote responsibly and intelligently on the issues, and use leisure time in a way that is valuable to themselves and to society" (Northern Virginia Community College, Unpublished report, 1989). The Carnegie Foundation (1977) suggested that general education should provide learning that:

1. Builds skills for advanced studies and lifelong learning; 2. Distributes time available for learning in such a way as to expose students to the mainstreams of thought and interpretation - humanities, science, social science, and the arts; 3. Integrates learning in ways that cultivates the student's broad
understanding and ability to think about a large and complex subject (p. 165).

The national debate on issues relating to general education has intensified within the last decade, and community colleges continue to be active participants in these debates. The American Association of Community and Junior Colleges (AACJC) has published several position statements relating to general education reform and the Associate Degree and has recently cited general education as an area for curriculum review and reform in a monograph entitled *Building Communities* (AACJC, 1988). In addressing the aims of education, and general education in particular, the AACJC (1988) stated: "...the aim of a community college education must be not only to prepare students for productive careers, but also to take them beyond their narrow interests, broaden their perspectives, and enable them to live lives of dignity and purpose" (pp. 17-18).

The mission of the first community colleges was to provide the first two years of baccalaureate education. Throughout most of their existence community colleges subscribed to the notion that higher education literacy, associated with independent reading, original writing, and general scholarly work, was a worthwhile goal (Richardson, Risk, & Okun, 1983). But as community colleges expanded opportunities, increased diversity, and broadened their mission, their emphasis shifted from transfer to vocational
education and with it has come a deemphasis on traditional college literacy. A declining emphasis on traditional college literacy might also be interpreted as an abandonment of the goals of general education, since, in many ways, the goals of general education reflect the intentions of higher education literacy. A deemphasis on critical literacy in the classroom, termed leveling down by Richardson, et al. (1983), thus points to a deemphasis on general education goals in the community college classroom.

Regardless of an institution's stated intentions or purposes, it is in the classroom where these intentions become reality. If an institution states that the goals of general education are being met by virtue of its distribution requirements, can it be assumed that these goals are in fact being addressed? Although general education requirements are most often met through a sampling of courses in various disciplines, questions concerning the aims of general education persist in the classroom. Teachers, or instructors as they are known in the community college, continue to struggle with what and how much should be taught, while students continue to wonder why is this important.

This study examines the natural science component of general education at the classroom level in an effort to determine the extent to which general education goals are being addressed. Since efforts to directly address general
education goals will occur in the classroom, the place to look for evidence of such efforts is in the classroom. Mission statements and curricular objectives tell us what the institution intends for its students, but it is in the classroom where intentions become reality.

BACKGROUND

This study is grounded in the liberal arts tradition of American higher education from which general education has evolved. The first colleges were church dominated and liberal arts oriented. For example, at Harvard in 1642, 72 percent of the courses required for a bachelor of arts degree were in the humanities, while the remainder were divided almost equally between mathematics (including science) and the social sciences (Carnegie Foundation for the Advancement of Teaching, 1977). But from the beginning of higher education in America, college curricula have been constantly changing and evolving. Sometimes the changes took place slowly, sometimes quickly - but often without an apparent goal in mind (Rudolph, 1977, p. 1).

Changes in the curriculum took place as changes were taking place throughout society. Church domination began to lessen and gradually colleges moved away from strict church control. The curriculum also broadened and included a wider variety of subjects. Early in the nineteenth century electives began to be seen in the curriculum, supported by such prominent educators as Thomas Jefferson and Charles W.
Eliot. The justification in support of electives was that students were mature enough to make decisions regarding what courses to take.

Another change involved the organization of some colleges around specializations - a movement toward the establishment of departments organized around disciplines. When the University of Virginia opened in 1825 the curriculum contained eight areas of specialty: "ancient languages, modern languages, mathematics, natural philosophy, natural history, anatomy and medicine, moral philosophy, and law" (Brubacher & Rudy, 1976, p. 101).

In the early twentieth century, general education arose in response to specialized education and took on considerable significance through the 1930's. General education was originally promoted as a way to bring back the integration of knowledge and as a way to make the liberal arts more practical (Cohen & Brawer, 1987). General education dominated the curriculum as evidenced by a study of fifty-eight public and private junior colleges in 1921-22 that found 75% of the courses offered were in the liberal arts (Koos, 1925).

The focus of attention was on general education again following the publication of the Harvard Committee's 1945 report (the Harvard Red Book) General Education in a Free Society, which reaffirmed a belief in the importance of the liberal arts. According to the Harvard Committee, "The
task of modern democracy is to preserve the ancient ideal of liberal education and to extend it as far as possible to all the members of the community" (p. 53). Today the term liberal education is often used synonymously with general education (Conrad & Wyer, 1980).

But general education in the undergraduate curriculum, including community colleges, has been in a state of decline in recent decades and has been categorized as a disaster area by the Carnegie Foundation (1977). Blackburn and associates (1976) reported a gradual decline in the proportion of general education in the undergraduate course of study during the 1960's. They reported that the number of classes required in each of the disciplinary areas, including the natural sciences, declined during this period. In 1967 43% of the curriculum was in general education and by 1974 it was reduced to 33%.

Central to this study are the notions that (a) general education, despite the controversies that surround it, is still a significant part of the community college curriculum today and (b) natural science courses are a significant component of general education.

ASSUMPTIONS

The major assumptions underlying this study include the following:

1. Community college general education goals are
often not clearly stated nor understood by faculty and students.

2. Community college general education natural science courses should contribute as much as possible to general education.

PROBLEM STATEMENT

The majority of community colleges provide general education through the use of distribution requirements. For example, Levine (1978) reported that "85% of all colleges use prescribed distribution requirements" (p. 12). The distribution model requires that students take a minimum number of courses (or credits) from the humanities, the social sciences, and the natural sciences. The rationale is that each discipline offers a somewhat different view of reality, and students should be exposed to all these "realities." Other schools, such as Miami-Dade Community College, require a core of general education courses of all degree-seeking students. But general education in community colleges is typically a list of courses categorized by departments or divisions and students select courses from the list.

One element of the problem revolves around the decline in natural science course requirements in general education and a decline in student interest in the natural sciences generally. "When students elected courses outside their major division, the courses were more likely to be in the
humanities or social sciences than in the natural sciences" (Blackburn, et al., 1976, p. 35). Brawer and Friedlander (1979) noted that "Student interest in science is low, and recent reports show that a trend away from the sciences is likely to accelerate in that enrollments in high school science courses are decreasing, particularly those in chemistry, physics, and biology" (pp. 10-11). Education Week (September 28, 1988) reported on a study released by the National Assessment of Educational Progress which stated that "only 7% of high school students have the knowledge and skills necessary to perform well in college-level science courses" (p. 1). Cox (1980) concluded that steps should be taken to reverse these trends and that natural science courses with a broader appeal to nonscience majors are needed.

The extent that any particular general education course exposes students to the specific elements of general education as defined by each institution is another aspect of the problem. Under the distribution model, or under any model that allows students to choose from a variety of courses, can an institution know to which general education goals any one student has been exposed? General education requirements are most often met by students enrolling in a random sampling of courses from the many courses available. It is readily apparent that student exposure to the elements of general education is more accidental than planned. And
because the courses most often offered under this plan are introductory courses with multiple purposes, "the purposes of the nonmajor students are likely to be subordinated or completely ignored by the instructor" (Thornton, 1972, p. 203). Clowes (1985) reported that community college courses often have multiple functions. Only 4% of the courses in his sample of 1295 community colleges nationwide, had a discrete general education function.

In examining the science component of general education, Cox (1980) reported that natural science courses exclusively for the nonmajor are not widely offered at community colleges. Many community colleges are unable to offer natural science courses for nonmajors only, resulting in courses that serve a general education function as well as serving as introductory courses for majors. It is important to take note of this since, as Cohen and Brawer (1987) reported, the goals of science courses offered exclusively for nonmajors are significantly different than the goals of courses for science majors. Furthermore, Edwards (1980) discovered that natural science courses which serve dual purposes, even if the majority of students enrolled are nonmajors, are directed toward the science major and do not specifically address general education-related goals. The courses selected for this study had dual purposes; fulfilling a general education requirement and introductory for science majors.
A third element of the problem is that community colleges today, far too often, have difficulty in defining a clear mission and a concomitant inability to develop a clear consensus of the purpose of general education. And even though community college catalogs continue to include a definition of general education and claim that each program includes appropriate general education courses, community colleges have not, in practice, accepted general education as one of their primary purposes. The result has been a lack of focus and cohesion to community college general education programs.

Community college natural science faculty are faced with declining student interest in science, a diverse student body representing various educational goals, and limited institutional resources which require that their courses serve multiple functions. And because many community college students enter underprepared and enroll in college level courses without college level reading, writing, or computation skills, community college faculty may lower expectations with general education goals being set aside in favor of basic skills.

A primary assumption to this study is that efforts should be made in each general education course, including natural science courses, to facilitate student progress in as many areas of general education as possible. Thornton (1972) has argued that "every instructor should become aware
of [general education] goals and be committed to them, so that every course in every department contributes as it can to general education..." (p. 205). It can be argued further that natural science courses can, and should, play a significant role within the general education component of the curriculum. Natural science courses can be designed to facilitate student development of many of the qualities usually associated with a broadly educated person, such as effective communication, critical thinking, and problem solving.

Therefore, the problem for this study was to determine if and in what ways selected community college dual-purpose general education general biology courses contribute to general education.

PURPOSE STATEMENTS

The general purpose of this study was to describe the course contents and classroom environments of selected sections of a community college general education general biology course in sufficient detail as to shed light on the contribution each makes to general education. This study will:

1. Synthesize the related literature concerning the origins and purposes of community college general education.

2. Describe the course contents and classroom environments of selected sections of a community
college dual-purpose general education general biology course as they relate to the purposes of the general education program.

3. Compare the selected community college dual-purpose general education general biology course sections in terms of course content and classroom environments.

RESEARCH QUESTIONS

The primary research question underlying this study was:

1. In what ways do selected sections of a community college dual-purpose general education general biology course contribute to general education?

Within the scope of this question a number of additional questions will be addressed. The first four questions will be addressed through a synthesis of the related literature.

2. What are the origins and purposes of general education?

3. What are the meanings of general education in the community college?

4. What is the significance of natural science to the overall goals of general education?

5. What is the nature of scientific knowledge?

In an effort to provide a framework for the study, the following questions were taken to the observation sites as
"foreshadowed problems" (Smith, 1974). These questions were analyzed and modified during the initial analysis phase.

6. What efforts are being made to address those student outcomes commonly associated with general education, such as the ability to:
   a. communicate effectively?
   b. apply critical thinking skills?
   c. interact effectively with others?
   d. understand and interpret numerical data?

7. What efforts are being made to help students see the interrelatedness among the various disciplines and kinds of knowledge?

8. What efforts are being made to facilitate student development in the areas of:
   a. aesthetic appreciation?
   b. relationships with others?
   c. wise decision making?
   d. an integrated outlook?

LIMITATIONS

Due to the nature of the research methodology employed in this study, a number of limitations are inherent. These limitations will be discussed in more detail in Chapter 3, but briefly, the limitations of this study are:

1. The amount of time and money available for this study limited the number of institutions and classrooms that were observed.
2. The classroom observations generated extensive field notes that, having been transposed into a readable narrative, may be too lengthy for many of those interested in the results.

3. The results will not be generalizable to other institutions in the way that quantitative data are.

4. The results will not reflect classroom environments at other times of the year.

DELIMITATIONS

This study is delimited by its focus on:

1. Selected public community colleges in Virginia.
2. Dual-purpose general education natural science courses.
3. General education goals.
4. Associate degree general education requirements.
5. Time of year observations are made (e.g. Spring semester).

DEFINITIONS

**Classroom environment.** The classroom environment includes the physical setting, patterns of teacher-student interactions, student behaviors in the classroom, and the style of teaching.

**Community College.** According to Cohen and Brawer (1982), "It has seemed most accurate to define the community college as any institution accredited to award the associate
in arts or science as its highest degree" (p. 5). For the purposes of this study a community college is defined as any publicly supported, open admission, post-secondary institution accredited to award the associate in arts or science as its highest degree.

**Competence.** The term is used in this study to designate a demonstrated capability or means of accomplishing that which is specified (Perkins, 1985).

**Distributive model.** "...requirements designed to ensure that each student takes a minimum number of courses or credits in specified academic areas" (Levine, 1978, p. 11).

**Dominant culture.** Those beliefs, values, ways of behaving, which are held, or are perceived as held, by society constitute the dominant culture. "It is a set of meanings and values which... constitutes a sense of reality for most people in the society (Apple, 1979, p. 5).

**Evaluation.** Evaluation implies value judgments concerning the strengths and weaknesses of academic programs and provides descriptive information about them.

**General education** (as a starting point). "A complete person should be skilled in the use of speech, ...factually well informed, capable of creating and appreciating objects of esthetic significance, endowed with a rich and disciplined life in relation to self and others, able to make wise decisions and to judge between right and wrong,
and possessed of an integral outlook." (Phenix, 1964, p. 21). "General education refers to programs of education specifically designed to prepare young people for the responsibilities that they share in common as citizens of a free society and for wholesome and creative participation in a wide range of life activities" (Thornton, 1972, p. 202).

**General education natural science courses.** These are courses deemed acceptable for general education credit by the institution, and which are open to students who are not majoring in a science. These courses have also been termed "mixed-majors" courses and "dual-purpose" courses.

**General learned abilities.** Ratcliff and associates (1989): "Within the term 'general learned abilities', we mean to include such frequently used terms as 'higher order intellectual processes' (Pascarella, 1985), 'academic competencies' (Warren, 1978), 'generic competencies' (Ewens, 1979), 'generic cognitive capabilities' (Woditzsch, 1977), and 'general academic ability' (Conrad, Trisman & Miller, 1977)." (p. 13).

**Goals.** For the purposes of this study, goals are defined as expected student competences.

**Hidden curriculum.** This term includes the covert teaching of values that occurs in schools and classrooms; "the tacit teaching of norms, values, and dispositions" which goes on simply by virtue of students interacting with
teachers, administrators, and other students (Apple, 1979, p. 14).

**Interrelatedness.** This term refers to the extent that courses within a program are designed to complement one another. The extreme case of interrelatedness is the interdisciplinary approach to courses.

**Program.** "A program should have institutional recognition, some form of organization, a set of goals and objectives, and the means to accomplish them" (Case, 1983, p. 103)

**NEED FOR STUDY**

General education in community colleges has been in a state of decline in recent years. In 1977, the Carnegie Foundation described general education as a "disaster area," and for many institutions that label still fits today. Allowing an intensive study of community colleges nationwide, the AACJC, in its *Building Communities Report* (AACJC, 1988) concluded that "...for too many colleges, general education has been allowed to drift," and that "strengthening general education is one of the most urgent obligations community colleges confront" (p. 15).

Many community college programs, particularly in the occupational area, have experienced severe modifications of general education requirements, with natural science courses often being the most greatly affected (Cox, 1980). In addition, the courses that make up the general education
Component of the community college curriculum show little relation to each other. In fact, a fundamental criticism of community college general education programs is their lack of coherence.

Past research studies have focused on analysis of transcripts and surveys of faculty, students and administrators to evaluate the state of general education, but few have examined to what extent general education natural science courses contribute to general education.

The recent emphasis on excellence and accountability, as well as mandated assessment activity, make it imperative that community college curriculum decision makers seriously consider appropriate ways of evaluating their academic programs. Cross and Fideler (1988) reported the results of a 1987 Campus Trends survey which indicated 95% of campus administrators support a type of assessment that will help to improve the quality of instruction. Because of the diverse nature of general education programs, improvements can be made most efficiently when it has been determined which general education skills are emphasized in each course. This study illustrates a method for determining the extent that community college general education natural science courses contribute to general education.

**Organization of the Study**

The study is organized around six chapters. The first chapter contains the introduction, background, assumptions,
problem statement, purpose statements, research questions, limitations, delimitations, definitions, and need for the study. Chapter two includes a review of the literature related to the origins of general education and the current state of general education in community colleges.

Chapter three includes a detailed description of the research methods used in the study. Included in this chapter is a description of the research design, a description of the population, how the data were analyzed, and a chronology of the study.

Chapter four contains descriptions of the general biology classrooms and laboratories observed for this study.

Chapter five includes interpretations and evaluations of the events that were observed during the study period, including the teaching, the classroom culture, and the nature of information presented.

Chapter six includes conclusions based on interpretations and evaluations of the general biology classrooms and laboratories observed for this study. This chapter also includes a discussion of the relevance of this study to other classroom situations and recommendations for additional research.
Chapter 2

Review of Related Literature

INTRODUCTION

The review of the literature was undertaken to provide information related to the primary purposes and research questions of this study. The assumption that the educational aims and purposes of an institution are expressed through its general education program is fundamental to this study. The first section of this review of the literature highlights the major changes that have occurred in the liberal arts in American higher education. The second section provides a brief overview of the emergence of general education. The third section in this review covers the meanings of general education in the community college, including a discussion of the most commonly stated goals of general education. The fourth section covers the natural sciences as a component of general education and its presumed contribution to general education competences. The fifth and final section delves into the notions of classroom culture and the nature of scientific knowledge.

HISTORY OF THE LIBERAL ARTS IN AMERICAN HIGHER EDUCATION

In today's usage, the terms liberal arts and general education are often used synonymously, or at least interchangeably. Although general education programs as implemented today are very different from their liberal arts
predecessors, to understand and fully appreciate general education, a brief overview of the changing focus on the liberal arts in American higher education will prove useful.

Higher education in colonial America was not available to the "common man", but was reserved for the elite of society, which has led some to caricature the early years of higher education in America as the "ivory tower" era (The Carnegie Foundation for the Advancement of Teaching, 1977). Early institutions of higher education in America were designed to educate the future leaders of the country. Education was still used to separate one class of person from another. The liberal arts, themselves rooted in the Greek ideal of an educated man, dominated this era. The seven liberal arts of the medieval university consisted of prerequisite subjects of the quadrivium (arithmetic, geometry, astronomy, music) and the higher order subjects, the trivium (logic, grammar, and rhetoric), and early American colleges clung to this relatively narrow view of useful knowledge. The curriculum of the colonial colleges, as evidenced by the Harvard curriculum of 1642, was fixed and consisted entirely of the humanities (72%), mathematics and science (15%), and what we would today call the social sciences (12%) (The Carnegie Foundation for the Advancement of Teaching, 1977).

Institutions of higher education in America have their educational roots grounded in Christian principles.
Colleges of the 1700's were considered religious societies that emphasized Christian piety as the unifying aim of college education. According to Brubacher and Rudy (1976): "In the early American college, one of the principal instruments for moral supervision and religious indoctrination was compulsory chapel" (p. 44). These early educational institutions were thus concerned about the spiritual and moral development of students as well as their intellectual development. The faculty were required to act "in the place of parents, to care for moral, social, and intellectual needs of students" (Creamer, 1983, p.3). Changes taking place both within and outside American colleges created pressures that lead to changes in the faculty/student relationship (Creamer, 1983).

In the early eighteenth century, in the public's mind, the American college was considered neither a center of independent thought nor an agent of intellectual progress. The American college was a school of preparation for minors, a substitute parent for the young. In 1814, President Dwight of Yale equated American colleges to secondary schools. Eventually, true universities came into existence, schools with graduate and undergraduate programs. In 1861 Yale awarded three doctor of philosophy degrees—the country's first Ph.D.'s. One of the forces behind the growth of American universities was the Enlightenment, a period of rationalism and empiricism starting in early
eighteenth century Europe. Gradually "American thought" was influenced by the Enlightenment which, in turn, led to changes in the development of American colleges and universities.

America grew and became more diverse through the eighteenth century and into the nineteenth century, leading to dramatic changes in the nature of liberal education. The nature and purposes of higher education were hotly debated during this period. More and more of the trustees, administrators, and faculty were not trained clergy. As a result, the curriculum began to shift away from strictly religious teaching and toward more secular teachings. Events in the scientific community, particularly, began to change the importance people placed on Biblical teachings. The rise of science in Europe was to have a profound influence on American higher education, resulting in long-term changes in the college curriculum. As changes were taking place in society, the curriculum changed, becoming broader, including a wider variety of subjects. Early in the nineteenth century, electives began to be seen in the curriculum, supported by such prominent educators as Thomas Jefferson and Eliot of Harvard.

The general education movement that was to take shape in the early twentieth century can be seen as a reaction against the elective movement of the nineteenth century. Thomas Jefferson was one of the more important early
advocates of electives. Part of Jefferson's plan became reality with the opening of the University of Virginia in 1825. Although it would be another forty years before the Morrill Act (1862) would provide federal support for the public sector of higher education, the University of Virginia, under the guidance of Thomas Jefferson, can be considered America's first state university. It differed from other schools of the time in that it (a) aimed to give advanced instruction, (b) it was a "thoroughly public enterprise", and (c) it was decidedly secular and nondenominational (Brubacher & Rudy, 1976, p. 148). Under this plan students were allowed to choose the lectures they wished to attend. If they were pursuing a degree, however, there was a prescribed sequence of courses within the school of specialization leading to a degree. This plan operated under the assumption that students had the maturity to make decisions regarding courses to take. At Virginia a curriculum containing eight specialty fields was established. The eight "professorships" were in the fields of "ancient languages, modern languages, mathematics, natural philosophy, natural history, anatomy and medicine, moral philosophy, and law" (Brubacher & Rudy, 1976, p. 150). This was an attempt to bring a German-style university to America. Harvard, through the efforts of George Ticknor, also moved toward adoption of an elective system. This "movement" spread slowly to other American colleges.
More dramatic changes in the curriculum were implemented at Harvard during the presidency of Charles W. Eliot. In 1841 Harvard instituted a plan that allowed students to substitute subjects such as science, modern languages, and history for required Latin and Greek. Later a free elective system was installed which was intended to make education more meaningful, relevant, and democratic. Eliot advocated a vocational-liberal curriculum, i.e., a curriculum that offered courses both in the sciences as well as literature. "This University recognizes no real antagonism between literature and science, and consents to no such narrow alternatives as mathematics or classics, science or metaphysics" (Brubacher & Rudy, 1976, p. 112). But changes came about slowly. There was continued resistance within the traditional colleges to institute the new scientific programs. A major source of resistance to these reforms came from the clergymen presidents of other colleges who felt this broadening of the curriculum was harmful to the intellectual and moral development of the future leaders.

Another group strongly opposed to a broadened curriculum were the faculty of Yale who expressed their views in a report that came to be known as the Yale Report. The Yale Report advocated a prescribed traditional curriculum and "was probably the most influential publication in the whole history of American higher
education between the Revolution and the Civil War" (Brubacher & Rudy, 1976, p. 104). This report firmly supported the notion that all undergraduate education should follow the liberal tradition. The faculty justified this view by asserting that a common knowledge base is needed by all liberally educated men. Although the Yale Report dominated, calls for curriculum reforms were not totally silenced. There were some who urged American colleges to establish their own, unique identity. In 1837, Ralph Waldo Emerson "made a strong plea for adapting education to the individual, rather than vice versa, and for developing a distinctively American intellectual culture, rather than tamely submitting to a prescribed curriculum derived from other lands and times" (Brubacher & Rudy, 1976, p. 105-106). President Quincy of Harvard, President Wayland of Brown, and President Tappan of Michigan all took up the call for educational reforms.

Colleges and universities in America in the mid to late nineteenth century were struggling with enrollment problems. It was recognized by some that the "classical" education being offered was not of much practical benefit. The number of occupations in which a college education would be beneficial was quite small: "the leading doctor, the minister of the best church, the judge, a few wealthy landowners, perhaps the editor of the weekly country paper, or the master of the local academy" (Rudolph, 1977, pp. 101-
102). Some began to speak of providing a practical education—training for farmers, merchants, and mechanics. The message was: "be practical or perish" (Rudolph, 1977, p. 102).

Still many of the established colleges refused to relinquish control over the curriculum and refused to withdraw from their liberal arts traditions. To accommodate the rising demand for a more practical curriculum, separate schools were established for the sole purpose of teaching nonclassical subjects (Brubacher & Rudy, 1976). Yale and Harvard established the first scientific schools. At Harvard the Lawrence Scientific School was "exclusively concerned with the natural sciences, and giving instruction solely on a non-graduate level" (Brubacher & Rudy, 1976, p. 110). At Yale, schools of applied chemistry and engineering were established which later became the Sheffield Scientific School. "But both the Harvard and Yale 'scientific' courses were for many years considered 'lower' in intellectual quality than the traditional arts course, and their students were looked down on by the regular undergraduates" (Brubacher & Rudy, 1976, p. 110). The scientific schools, in order not to contaminate the B.A. degree offered a separate bachelor of science degree.

These kind of changes led to an emphasis on research, the establishment of graduate schools, and the establishment of departments based on disciplinary specialization, modeled
after the German university. Despite lingering resistance to these reforms, the curriculum was gradually broadened and expanded. One event that provided additional support for an expanded curriculum was the passage of the Morrill Act in 1862. The Morrill Bill was first introduced in 1857 and vetoed by President Buchanan in 1859, the year that Charles Darwin published his book *On the Origin of Species*. However, dissatisfaction was growing in the latter quarter of the nineteenth century regarding traditional liberal arts colleges in America. In 1862 Congress passed the Morrill Act and President Lincoln signed it. Scientific research was on the rise and many Americans were becoming impatient with colleges that were not preparing people for their life's work as farmers, merchants, or mechanics. As late as 1862 there were only six "higher" schools in the whole country dealing with "utilitarian fields" (Brubacher & Rudy, 1976, p. 62).

The Act of 1862 charged each state with using proceeds from the sale of some seventeen million acres of federal lands for the support of colleges to offer programs related to agriculture and the mechanical arts. The land-grant colleges took up the challenge and in the process redefined the American college curriculum. Some states used the money to found new colleges, others turned over the land-grant endowments to existing universities. The Morrill Land-Grant Act of 1862 provided federal aid to establish and assist
"land-grant" colleges - "colleges of which the leading object shall be, without excluding other scientific or classical studies, to teach such branches of learning as are related to agriculture and the mechanic art" (Rudolph, 1977, p. 117). In the original disposition of the land-grant fund, agricultural and mechanical arts colleges were added to ten existing universities; ultimately some of the independent land-grant colleges increased their size and added graduate schools.

The emergence of the land-grant colleges and universities also coincided with commercialism and corporate enterprise. The industrialized society needed technical skill, scientific knowledge, managerial experience, and engineering competence. The land-grant colleges were the most famous product of the industrial movement in education. Land-grant colleges reflected the activities of leaders of scientific agriculture, and as teaching organizations purveyed the abundant and complicated "knowhow" that American industry was acquiring. As research organizations, they emphasized the applied sciences - the "better way-of-doing" - that American culture was geared to accept. The passage of the 1862 Morrill Act was seen as an answer to the practical needs of society, and agricultural education had come to be regarded as a partial answer to the farmer's problems.
The Morrill Act created an atmosphere that would lead the "old colleges" to reexamine the "old course of study" (Rudolph, 1977). Many of the publicly supported universities (established or aided by federal money made possible via the Morrill Act) provided a lower-cost alternative to private colleges. The land-grant act was the culmination of a movement: the Jacksonian philosophy of more education for more people. A major thrust of the land-grant movement was an emphasis and recognition that higher education should be made available to all citizens. Access for a wider range of the population was increasing as programs to teach an ever-increasing number of subjects and occupations were introduced. People with more diverse goals led to more diverse programs, the newer programs attracted greater varieties of people. The land-grant movement helped to bring about a change in philosophy from preserving the past to expanding knowledge and applying knowledge, paving the way for the establishment of the first public junior college in 1901.

In 1892 President William Rainey Harper separated the first two years from the last two years at the University of Chicago. He used the terms Academic College for the first two years and University College for the last two years. Later these titles were changed to "junior college" and "senior college" (Thornton, 1972). The University of Chicago was the first to award the Associate in Arts degree
"to all students who successfully completed the junior college program of studies" (Thornton, 1972, p. 51).

Community colleges, as these public two-year post secondary comprehensive institutions are now known, increased in number rapidly during the early twentieth century. Koos (cited in Cohen & Brawer, 1984) reported twenty in 1909 and one hundred seventy by 1919. By 1922 thirty-seven of the forty-eight states contained junior colleges. These early colleges had small enrollments: in 1922 the total enrollment for all institutions was only around 20,000. By 1930 there were four hundred fifty junior colleges with total enrollment around 70,000 (Cohen & Brawer, 1984).

Starting with World War I the curricular emphasis in the junior college began to shift. Many junior colleges began to promote their uniqueness by demonstrating: "provision of opportunity for training for social leadership, improvement of instruction over that available in the universities, and increased attention to the individual needs and interests of students" (Palinchak, 1973, p. 30). Following the Smith-Hughes Act of 1917, the emphasis was beginning to shift toward occupational-technical programs. The emphasis in higher education was being placed on training and community colleges were particularly vulnerable to outside pressures to provide trained workers. As the emphasis on training increased, the
emphasis on liberal education decreased. The prevailing viewpoint was that workers being trained for one particular job had no need for humanities or the natural sciences or the social sciences (Cohen & Brawer, 1987).

**THE EMERGENCE OF GENERAL EDUCATION**

General education arose in the early decades of the twentieth century in response to the elective system and the specialized education that arose in the late nineteenth century. General education was originally promoted as a way to bring back the integration of knowledge and as a way to make the liberal arts more practical (Cohen & Brawer, 1987). General education developed during the 1920's and 1930's around two philosophical ideas: humanism, with emphasis on the classical tradition, and pragmatism, with emphasis on practical utility (Cohen & Brawer, 1987). General education dominated the curriculum through the 1930's as evidenced by a study of fifty-eight public and private junior colleges in 1921-22 that reported 75% of the courses offered were in the liberal arts (Koos, 1925, cited in Cohen & Brawer, 1984).

The focus of attention was on general education again following the publication of the Harvard Committee's 1945 report *General Education in a Free Society* (the Harvard Red Book), which reaffirmed a belief in the importance of the liberal arts. According to the Harvard Committee: "The task of modern democracy is to preserve the ancient ideal of liberal education and to extend it as far as possible to all
the members of the community" (p. 53). The Harvard Red Book declared that the general education curriculum was a needed remedy to "class divisiveness and as a common bonding device for high school students destined for different futures" (Harvard Committee, 1945, p. 79).

While some were debating what should be taught in colleges, others were debating who should have access to higher education. The government addressed the question of who should have access to higher education in a report released in 1947 by the President's Commission on Higher Education (The Truman Commission). The report suggested that "as many as forty-nine percent of the population could profit from two years of education beyond high school" (Vaughan, 1983, p. 6). The report went on to suggest that a system of locally controlled "community colleges" would allow a larger number of Americans access to higher education (Vaughan, 1983). The emphasis on access as a primary social goal further accelerated community college growth and ultimately led to the expansion of the community college as a "center for learning for the entire community" (Kennedy, 1952, p. 25).

The Truman Commission in its report offered its view of the purposes and aims of higher education. The report (cited in Kennedy, 1952) stated: "The crucial task of higher education today...is to provide a unified general education for American youth...General education should give
to the student the values, attitudes, knowledge, and skills that will equip him to live rightly and well in a free society" (p. 24). The commission went on to list eleven goals of general education.

The reform movement that began with the publication of these reports affected the curricular patterns of a large number of American colleges. McGrath (1976) suggested that as many as one-half of all American colleges had initiated reform measures in general education by the late 1950's.

As a result of world and national events, the reforms that were begun during the 1940's and 1950's were gradually and quietly eroded during the 1960's and 1970's (Gaff, 1983). It has been thoroughly documented that general education in community colleges has been in a state of decline in recent years. Part of the reason may be misunderstandings related to its liberal arts origins. When higher education was composed entirely of the liberal arts, education was meant for the leisure class, the slave-owning class. As society has changed, so too has education. The curriculum throughout higher education has continued to change as society's demands change. Community colleges, because of their close ties to the communities they serve, continue to be more vulnerable to community pressures than do four-year colleges and universities. The community college curriculum readily changes in response to pressures from outside the institution. Rudolph (1977) described the
relation between society and the curriculum as a two-way street, each influencing the other.

GENERAL EDUCATION IN THE COMMUNITY COLLEGE

Community colleges were established at the turn of the twentieth century as connecting institutions to the four-year colleges (Cohen & Brawer, 1984; Brint & Karabel, 1989). There were three basic functions of the two-year college during the first decades of this century: remedial education, vocational education, and university transfer education. The comprehensive community college of today offers programs in collegiate/transfer education, career education, remedial (some may call it developmental) education, student services, and community services, but there continues to be much discussion and disagreement over the priority that should be given to each. The emphasis given to each has changed dramatically over the years, as evidenced by the statistic that by 1980 the proportion of students in programs specifically designed to provide career education had risen to 70%, while transfer rates continued to decline (Baron, 1982).

From their beginning, community colleges have been in a state of steady evolution. They have expanded opportunities, increased in diversity, and broadened their mission. And as their emphasis has shifted from transfer to vocational education, their emphasis on general education has declined. Of the three major components of the
curriculum: general education, the major, and electives, the general education share has declined while the electives share has increased. A curriculum study by Blackburn and associates (1976) indicated that "the proportion of a student's undergraduate program in general education is about 22% less today than it was in 1967, a drop of about twelve credit hours in four-year colleges and five credit hours in two-year colleges" (p. 33). In addition, general education requirements diminished between 1967 and 1974 from 43% to 33.5% of the average undergraduate program at four-year colleges, and from 58.7% to 53.8% at two-year colleges (Blackburn, et al., 1976).

Indications are, then, that institutions of all types have lost, and are losing, control over which courses students take for graduation, therefore losing control over defining what it means to be an educated person. In 1977, the Carnegie Foundation for the Advancement of Teaching described general education as an "idea in distress" (p. 164), and for many institutions that label still fits today. Following an intensive study of community colleges nationwide, the American Association of Community and Junior Colleges (AACJC), in its Building Communities Report (1988) concluded that "...for too many colleges, general education has been allowed to drift," and that "strengthening general education is one of the most urgent obligations community colleges confront" (p. 16).
The majority of community colleges provide general education through the use of distribution requirements. Levine (1978) reported that 85% of all colleges use prescribed distribution requirements. The distribution model requires that students take a specified number of courses or credits from each of these areas: (a) the humanities, (b) the social sciences, and (c) the natural sciences. The rationale is that each discipline offers a somewhat different view of reality and that students should be exposed to all these "realities."

Under the distribution model, or any model that allows students to choose from a variety of courses, it may be difficult to know to which general education goals any one individual has been exposed. Because students often enroll in a random sampling of courses from the many courses available, student exposure to specific goals is more accidental than planned. And because the courses most often offered under this plan are introductory courses with multiple purposes, "the purposes of the nonmajor students are likely to be subordinated or completely ignored by the instructor" (Thornton, 1972, p. 203).

The result has been that general education "programs" in community colleges don't actually exist, since a program should have "institutional recognition, some form or organization, a set of goals and objectives, and the means to accomplish them" (Case, 1983, p. 103). Others have
criticized the unstructured nature of community college general education programs. O'Banion & Shaw (1982) observed that, general education has become "too general" and is often defined as "what it is not" (p. 60). As such, community colleges have been unsuccessful in designing appropriate and innovative programs. While numerous programs have been attempted, little agreement on outcomes has been reached.

Responding to these concerns, several higher education institutions took a much closer look at the general education component. Harvard and Princeton Universities conducted major studies on general education, and Harvard returned to a core curriculum to ensure that all students will have a basic foundation in the liberal arts. Miami Dade Community College in 1981 put into effect a general education program which had been in the planning stages since 1971. This program was designed "to reflect the multiple educational missions of community college education" (Lukenbill & McCabe, 1978, p. v), and was required of all degree-seeking students.

The curriculum represents a philosophical expression of what a college stands for—what a faculty believes is important in terms of an educated person. In higher education today, the ideal of an educated person can be seen in the general education component of the curriculum, with its roots in the Greek ideal of educating people for
participation in political organizations and in the liberal education philosophy of the first colleges in this country. By increasing the percentage of courses that are at the discretion of the student, the institution is saying that it does not know what an educated person is.

Although there is no single, specific definition of general education, in a generic sense general education is whatever a faculty believes ought to be common among all of its graduates, regardless of a student's major or career. General education has been defined as narrowly as the trivium and quadrivium and as broadly as that education that "integrates and unifies all knowledge" (Cohen & Brawer, 1984, p. 316). Hutchins (cited by Dell, 1979) stated that the purpose of general education is to teach students to think independently. The Carnegie Foundation for the Advancement of Teaching (1977) stated that in addition to integrating learning in such a way that students are able to deal with large and complex subjects, general education should provide learning that:

(1) Builds skills for advanced studies and lifelong learning; and (2) Distributes time available for learning in such a way as to expose students to the mainstreams of thought and interpretation—humanities, science, social science, and the arts (p. 165).

The Carnegie Foundation report (1977) also stated that general education provides the educated person with those
qualities that allow him or her to be an informed, productive citizen. Furthermore, it is through general education that an institution of higher education describes the important qualities of an educated person. The qualities associated with an educated person are important qualities for holders of baccalaureate degrees as well as associate degrees, and general education provides the basis for the establishment of these qualities. Thornton (1972) wrote: "If the definition and the ideal of general education are valid, they are valid for all students" (p. 204).

The curriculum is a statement made by an institution of what it thinks is important (Cohen & Brawer, 1984), and the general education component of the curriculum provides the opportunity for an institution to define what it means to be an educated person. Dean Rosovsky of Harvard in his annual report for 1975-76, outlined what he considered to be necessary attributes of an educated person for the last third of the twentieth century:

a. An educated person must be able to think and write clearly and effectively.

b. An educated person should have achieved depth in some field of knowledge. Cumulative learning is an effective way to develop a student's powers of reasoning and analysis, and for undergraduates this is the main role of concentrations.
c. An educated person should have a critical appreciation of the ways in which we gain and apply knowledge and understanding of the universe, of society, and of ourselves. Specifically, he or she should have an informed acquaintance with the aesthetic and intellectual experience of literature and the arts; with history as a mode of understanding present problems and the processes of human affairs; with the concepts and analytic techniques of modern social science; and with the mathematical and experimental methods of the physical and biological sciences.

d. An educated person is expected to have some understanding of, and experience in thinking about, moral and ethical problems. It may well be that the most significant quality in educated persons is the informed judgement which enable them to make discriminating moral choices.

e. Finally, an educated America, in the last third of this century, cannot be provincial in the sense of being ignorant of other cultures and other times. It is no longer possible to conduct our lives without reference to the wider world within which we live. A crucial difference between the educated and the uneducated is the extent to which
one's life experience is viewed in wider contexts (Harvard Committee, 1979, pp. 7-8).

Some definitions of general education are written in terms of what general education will do for society, rather than in terms of what general education will do for the individual student. The Harvard Committee of 1945, for example said that with respect to adult education,

*General education is the sole means by which communities can protect themselves from the ill effects of over-rapid change. For its concern is with what is the same throughout all changes and with the very process of change itself and the techniques of taking account of it* (p. 266).

Reform movements in general education seem to occur in cycles. Current attention on general education reforms seems to stem from the assessment movement that is sweeping the country. Citizens and politicians are calling for more accountability in higher education, and students are calling for improvements in the quality of their undergraduate education. Cross & Fideler (1988), citing the results of several studies, reported that two-thirds of the states have assessment initiatives and that 79% of campus administrators "expect that some form of assessment will be introduced at their college in the next few years" (p. 275).

The American Association of Community and Junior Colleges (AACJC) has published several reports addressing
general education within the Associate Degree. In the 1988 Report of the Commission on the Future of Community Colleges, "...the aim of a community college education must be not only to prepare students for productive careers, but also to take them beyond their narrow interests, broaden their perspectives, and enable them to live lives of dignity and purpose" (AACJC, 1988, p. 17-18). This report went on the state that "...an effective general education program is one that provides students a more integrated view of knowledge and a more authentic view of life" (p. 18).

Starting in 1984, the Virginia Community College System (VCCS) began investigating the general education component of the curriculum. In 1984 a special committee was appointed to review the Associate in Applied Science Degree including the general education component. In February 1989, the VCCS instituted a system-wide review of general education. Jeff Hockaday, then Chancellor of the VCCS, issued a call for a state-wide review of general education:

A task force is being organized within the VCCS to study the general education components in both our transfer degrees and in the AAS degrees. Our overall goals will be to reaffirm appropriate principles of general education, to create new principles as necessary, and to recommend any needed alterations in the composition of our degrees with respect to general education (VCCS, 1990, p. 3).
In its final report issued February 1990, the Task Force proposed a definition of general education, including eight essential elements of general education:

General education is that portion of the collegiate experience which addresses the knowledge, skills, attitudes, and values characteristic of educated persons. It is unbounded by disciplines and honors the connections among bodies of knowledge. The following eight elements embody the essence of general education:

1. Communication;
2. Learning Skills;
3. Critical Thinking;
4. Interpersonal Skills and Human Relations;
5. Computational and Computer Skills;
6. Understanding Culture and Society;
7. Understanding Science and Technology; and
8. Wellness (p. 8).

The report included descriptive statements to illustrate in more detail the meaning of each element.

Despite the many attempts to define general education, there appears to be no clear consensus for a broad definition. It was more than forty years ago that B. Lamar Johnson studied general education in the community colleges in California, and we seem no closer to a consensus today than in 1952. Johnson (1952) offered the following set of goals as important outcomes of general education: (a)
democratic citizenship, (b) a satisfactory vocational adjustment, (c) cultural heritage, (d) problem solving, (e) communication, (f) moral values, (g) basic mathematical skills, and (h) biological and physical environment.

Twenty years later, Thornton (1972) offered this definition of general education:

General education refers to programs of education specifically designed to prepare young people for the responsibilities that they share in common as citizens of a free society and for wholesome and creative participation in a wide range of life activities (p. 202).

Perkins (1985) listed thirteen general education "competences" (or desired student outcomes), and after surveying community college faculty found that five of the competences were deemed important by a majority of faculty surveyed. These five were (a) communication skills, (b) critical thinking, (c) vocational adjustment, (d) human relations skills, and (e) mathematics skill. Knowledge of science was number six on the list.

Cross and Fideler (1988), after an extensive search of the literature, developed a list of forty-eight generally accepted goals of higher education, which can also be interpreted as goals for general education. Included in this list were, in abbreviated form, (a) develop ability to think, (b) develop good reading, writing, and speaking
skills, (c) acquire knowledge and skills for job, (d) understand numerical data, and (e) capacity to respect others. Also included in this list were such goals as to understand science theory and application and to tolerate intellectual ambiguity.

In many other lists of goals for general education one can find communication skills, critical thinking skills, and mathematical skills near the top, and other goals such as developing social awareness, historical consciousness, and knowledge of science and technology somewhere on the list. But general education goes beyond a list of skills that can be learned by virtue of selecting courses from a college catalog. The essence of general education is the broader goal of students as thinkers and communicators. As Warren Self, head of Radford University's English Department has said, "A student who has learned to read, reason, write, think, and come to a conclusion has, in my book, acquired the marks of an educated person. And the educator who has encouraged this type of learning is a success" (quoted in Radford magazine, July 1989, p. 36).

Others, sounding a similar theme, have suggested that general education (or the liberal arts), along with "the dialogic method of knowledge acquisition" (Aronowitz & Giroux, 1985, p. 158), can be useful tools for returning more meaningful and useful knowledge to the college curriculum. Recent trends toward careerism and away from
the liberal arts have led to what some have termed the
disempowerment of students, students who have lost the
ability to see beyond their narrow fields of specialization.
Students, to become empowered, need to "acquire mastery of
language as well as the capacity to think conceptually and
critically" (Aronowitz & Giroux, 1985, p. 158). Aronowitz
and Giroux (1985), while arguing against the relevance of
specialized technical training to a changing workplace,
described the liberal arts, or general education, as a
"broad conceptually-oriented curriculum [which teaches the]
processes of abstraction, the social and historical context
of scientific and technological innovation, and preparation
in the logical processes underlying all calculations" (p.
189).

For the purposes of this study, the following
definition was compiled from the various definitions found
in the literature, and expresses the meaning general
education has for this author:

General education is an institutionally recognized
program of study designed to help students develop
those qualities and skills characteristic of an
educated person. General education should promote the
development of independent critical and conceptual
thinking skills and those skills necessary for the
effective communication of their thoughts. General
education should provide students with an integrated
view of knowledge and prepare them for their role as productive and responsible citizens in a democratic society.

CONTRIBUTION OF NATURAL SCIENCE TO GENERAL EDUCATION

The National Assessment of Educational Progress issued a report in September 1988 that indicated high school students are being poorly prepared in the sciences. The report stated that only 7% of high school graduates have achieved the necessary skills to progress into college science courses. The gains that were noted in test scores resulted from students' increased knowledge about science, not from any improvement in their ability to use scientific reasoning. Brawer and Friedlander (1979) reported that enrollments in high school science courses are decreasing.

Several studies have shown that student interest in science is decreasing at the college level. Cox (1980) reported that the number of classes required in the natural sciences declined and, since high school science enrollments are also declining, the trend away from the sciences is likely to continue. Studies by both Blackburn et al. (1976) and Brawer and Friedlander (1979) indicated that students in higher education demonstrate little interest in taking courses in the natural sciences. Blackburn and his associates reported, "When students elected courses outside their major division, the courses were more likely to be in the humanities or social sciences than in the natural
sciences" (p. 35). Brawer and Friedlander suggested that one reason for low enrollment levels in the natural sciences in two-year colleges is the lack of courses for the students who are not majoring in science.

Community colleges, because of their diverse missions and because the open-door policy creates an extremely diverse student body, are faced with an enormous challenge. Community colleges offer courses for students who will be transferring to four-year institutions as well as students who will go directly into the job market. In addition, there is a great deal of diversity in the academic preparation of these students. The diverse nature of the community college mission and student body pose many problems for the biology/natural science curriculum. Who should the curriculum serve? Should separate science courses be offered for the science major and nonmajor?

Most general biology courses offered at the community college are offered as part of the distribution (breadth) requirement for general education. At many community colleges this means offering a course in which both majors and nonmajors will be enrolled. The significance of this is two-fold: (a) faculty have different goals for majors than for nonmajors (Cohen & Brawer, 1987), and (b) introductory courses that enroll both majors and nonmajors are designed for the one out of eight who will take a second biology course (Edwards, 1979).
According to Cox (1980), based on a survey of community college natural science instructors, the three primary goals for natural science courses designed for science majors were:

1. Apply principles learned in course to solve qualitative and/or quantitative problems
2. Understand the principles, concepts, and terminology of the discipline
3. Develop the ability to think critically.

The goals of courses designed for general education (nonmajors) were:

1. Understand/appreciate interrelationships of science and technology with society
2. Relate knowledge acquired in class to real world systems and problems
3. Gain qualities of mind useful in further education.

Whitaker (1968), in a study of twenty-five small community colleges, reported that the majority of community colleges in her survey were not providing suitable courses in the biological sciences to serve as electives in a general education program. It follows then that the majority of general biology courses offered at community colleges across the country will enroll both majors and nonmajors, will be designed for the science major, and will not incorporate goals specific to general education.
One of the on-going conflicts in the teaching of an introductory biology course is the question, "What and how much should be taught?" As more and more discoveries are made and as we generate more information about the natural world around us, the amount of factual material is growing rapidly, almost out of control. The way many biology courses are currently being taught, students are expected to memorize numerous terms each class period. Teachers and instructors feel compelled, based on a perceived future need, to cover as much material as possible. The result is that students are expected to memorize facts but are not expected to engage in activities that might be termed higher-order thinking. Students who are made to memorize and reproduce facts are practicing an activity that has little in common with meaningful uses of scientific knowledge.

The problem for instructors of introductory natural science courses is to offer a course that will benefit both the students who will be taking additional science courses and those who will never take another science course. At the introductory level, all students can benefit from a well-structured course that is made relevant to current issues. According to Adams and Baker (1986), many now believe "that effective science education should be interdisciplinary, showing the dynamic interaction among science, technology, and ethics" (p. 254).
Many authors, such as Adams and Baker (1986), agree that two things need to be accomplished in community college science courses: (a) To impart an understanding of basic scientific principles and of the scientific method, and (b) to impart a sense that there is a relationship among scientific knowledge, other kinds of knowledge, and the larger society. As advances continue to be made in science and technology, it is becoming more and more important that all citizens have knowledge of fundamental scientific principles and to be able to apply them to their individual life circumstances.

Johnson (1987) described four issues that he confronted and ways that he dealt with them when designing a general biology course for majors and nonmajors:

1. Rearrange traditional material. The bulk of the course is devoted to general principles, with detailed consideration of the anatomy and physiology of animals and plants delayed to the end of the course.

2. Limit paradigms. To make room for teaching new developments while at the same time preserving a detailed treatment of basic principles, we limit ourselves to examining only those principles that are absolutely essential...Choosing the proper material to present in depth is the essence of a
successful mixed-majors introductory biology course.

3. Stress current material. In the necessary trade-off between classical material and recent developments, we have leaned far toward the new: we incorporate detailed discussion of the mechanisms leading to cancer and AIDS, progress in genetic engineering, and other topics of current interest.

4. Pedagogy. As students are exposed to more and more modern information, they find it progressively harder to see the structure of the course. Almost all of what they are learning is new to them, and they have no perspective to tell them what is most important, what less so (pp. 21-22).

Many educators agree that change is needed across the curriculum and some have tested new approaches that emphasize depth, not breadth, with significant success. Yet many teachers resist. Many don't see the point of all the "extra stuff" between the facts or engaging students in intellectual struggle. Many instructors are afraid of even engaging students in conversation. I've heard faculty say it over and over again: "If I do that, I'll lose control." Although discipline may not be a major concern of community
college instructors, many still feel it is important they maintain control over all classroom activities.

CLASSROOM CULTURE AND THE NATURE OF SCIENTIFIC KNOWLEDGE

Perhaps the one word that describes community colleges better than any other is diversity. Community colleges enroll students who differ in social class, academic backgrounds and abilities, age, gender, race, career goals, and motivations. Community colleges offer a wide variety of courses and programs, from terminal vocational programs to purely transfer programs. Community college faculty are equally diverse, representing the various program areas and disciplines. And finally, community colleges are influenced by and reflect the communities in which they exist. The result of such diversity is that a generic description of a community college does not exist. Each individual brings to the community college a unique background and cultural heritage that creates a conflict inside the institution and between the institution and the outside community. As important as it is to understand this conflict, very little has been written on the subject of the culture of community colleges. Exceptions to this are Weis (1985) and London (1978).

Kempner (1988) spoke of the work of Weis and London: "The studies by London and Weis both offer valuable insights into the culture of a community college, but, because each college was quite unique, the findings are limited to other
similar institutions" (p. 2). The essential worth of these studies is the in-depth nature of their investigations into community college cultures. Kempner (1989):

To understand the significance and meaning of formal education in society, researchers should be aware of the inherent cultural conflict over its function and then employ investigative approaches capable of discerning the effects of this conflict (p. 2).

The core of that statement is directed to the function or purpose of education. "What is the function or purpose of education?" is also a question at the heart of this study.

Education in the broad sense includes events experienced outside the formal school setting. Cremin (1977) offered a definition of education which, on the one hand, broadened education to include events outside schools but, on the other, limited it in its notion of intentionality. According to Cremin (1977), education is the "deliberate, systematic, and sustained effort to transmit, evoke, or acquire knowledge, attitudes, values, skills, or sensibilities, as well as any outcomes of that effort" (p. 134). This definition accommodates a wide range of institutions and individuals that educate, such as churches, museums, parents, and libraries. Schooling, on the other hand, as defined by Aronowitz & Giroux (1985) is limited to those activities that take place "within institutions that are directly or indirectly linked to the
State through public funding or state certification requirements" (p. 131). Education or schooling, as applied to this study, refer to those experiences that occur in a formal school setting, such as elementary schools, secondary schools, community colleges, or four-year colleges and universities.

What is the purpose of education? What is the role of schooling? What are educators trying to do? Is the purpose of schooling knowledge production? Is it preparation for work? Is it for the transmission of values? Apple (1979) described schools as "institutions of cultural preservation and distribution" (p. 3). But Apple (1979) also asked the questions: "Whose culture? What social group's knowledge? In whose interest is certain knowledge being taught in cultural institutions like schools?" (p. 16).

Aronowitz and Giroux (1985), Apple (1979), Shor (1986), Willis (1981) and others have discussed at length the relation between culture (or cultural capital) and schools. (Although most of these authors were addressing these issues in the public school context, the essence of their arguments apply to community colleges as well.) Aronowitz and Giroux (1985) described cultural capital as "the different sets of linguistic and cultural competencies that individuals inherit by way of the class-located boundaries of their family" (p. 80). Kempner (1989), in describing organizational culture, used the phrase "webs of
significance" and defined them as the "norms, values, beliefs, symbols, and myths the members bring to the organization to help form its character" (p. 3). Certain forms of cultural capital are more valued by society than others, the most valued being the dominant cultural capital. Schools are important agents for the preservation, legitimation, and distribution of the dominant cultural capital. Aronowitz and Giroux (1985) summed it up this way:

[Schools] tend to legitimize certain forms of knowledge, ways of relating to the world that capitalize on the type of familiarity and skills that only certain students have received from their family backgrounds and class relations. Students whose families have only a tenuous connection to the dominant cultural capital are at a decided disadvantage (pp. 80-81).

Schools give legitimacy to certain kinds of knowledge, "legitimate knowledge--knowledge that we all must have" (Apple, 1979, p. 64). Schools control the legitimation of knowledge, thus exercising power through cultural control of the students. Through the curriculum, schools select, organize, and distribute certain bits of knowledge from all the variety of knowledge that is available. Schools determine what is "real" knowledge by presenting a "false consensus" of what is real knowledge or what knowledge is worth knowing (Apple, 1979).
Schools preserve and distribute the cultural capital and knowledge of the dominant culture. Apple equated control of knowledge preservation and distribution to "economic and political potency" (p. 16) or power. Power may be seen in the form of political power—either in the big picture of national and international politics, or in the day-to-day politics of interacting with other people—or in the form of economic power. Apple argued that to control the distribution of knowledge is to control who gets the power. The result is that schools become the inadvertent agents for the preservation of an existing set of social inequalities. Again, Apple (1979) described the role of schools:

[S]chools exist through their relations to other more powerful institutions, institutions that are combined in such a way as to generate structural inequalities of power and access to resources...Through their curricular, pedagogical, and evaluative activities in day-to-day life in classrooms, schools play a significant role in preserving if not generating these inequalities (p. 64).

Not all of what schools do is done overtly. Students learn a great deal from things that may not be part of the formal, overt curriculum. Apple referred to these more subtle aspects of education as the hidden curriculum: 
"...the norms and values that are implicitly, but
effectively, taught in schools and that are not usually talked about in teachers' statements of ends or goals" (p. 84). The unequal distribution of social power is one example. Anyon (1988) argued that the very structure of the hierarchy of schools and the way decisions are made, creates the impression for students that unequal power distribution is legitimate and proper. She pointed out that teachers generally have authority over students and administrators have authority over teachers. She also pointed out that decisions are not made democratically but by a minority and handed down to the majority, and students are rewarded for "acquiescence to the inequities of power" (p. 178).

This pattern of reward, of prolonged exposure and acquiescence to decisions from above, may create a prima facie legitimacy to hierarchy and unequal power when encountered in other institutions... One may come to assume, without verification, that hierarchical organization is necessary for "efficient" economic production (Anyon, 1988, pp. 178-179).

The notions of power and control, as presented by Apple and Anyon, are depicted as negative forces used for domination. Aronowitz and Giroux (1985) summed up this view:

Social control becomes synonymous with the exercise of domination in schools, while school knowledge and culture are reduced to serving the interests of
privileged groups. The question of how power works in schools is almost by intellectual default limited to recording how it reproduces relations of domination and subordinancy through various school practices (p. 154). Aronowitz and Giroux went on to offer an alternative, positive view, of social control and power. The essence of this view requires the empowerment of teachers and students. "Social control has to be seen as not just an instance of domination but also as a form of emancipatory practice" (p. 155). This view posits that the aim of education (schooling) is to prepare students to become active, participating adults with the skills and knowledge "which allow them to take part in adding to the general social good... and gain the basis for making judgments about undesirable social directions" (Aronowitz & Giroux, 1985, p. 156, quoting D. White, 1983). Aronowitz and Giroux (1985) described the empowered teacher, the teacher as transformative intellectual, as someone who "takes seriously the need to give students an active voice in the learning experiences" (p. 37).

Shor (1986) and Shor & Freire (1987) also addressed the issue of student participation in the educational process. Shor (1986), using the words of John Dewey, spoke against the "talking teacher" (p. 120). Dewey (cited in Shor, 1986) went so far as to describe non-participation as a form of slavery, "insofar as a slave is someone who has to carry out
the intentions of a superior authority" (p. 121). Shor, in his dialogue with Paulo Freire (1987), argued that students are passive in the classroom, do not participate in the process and, "formal education fails to motivate students" (p. 4).

Knowledge is handed to them like a corpse of information—a dead 'body of knowledge'—not a living connection to their reality. Hour after deadly hour and year after dull year, learning is just a chore imposed on students by the droning voice of the official syllabus (Shor & Freire, 1987, p. 4).

What is described as a lack of student motivation and student mediocrity by some, Shor defined as a "performance strike" (Shor & Freire, 1987, Shor 1986). That is, students have refused to participate under the current conditions. "The truth is that students are not stupefied or mediocre. They are refusing to perform under these oppressive conditions..." (Shor, 1986, p. 83).

Teachers acting as authority figures who dispense dominant forms of knowledge and students who refuse to participate in the process, have led to what might be termed a form of commensalism between teacher and student. Boyer (1983) and Sizer (1984) noted a truce of sorts exists between high school teachers and students, and which is also an appropriate description of community college classrooms:
(Boyer) there is a kind of unwritten, unspoken contract between the teachers and the students: Keep off my back and I'll keep off yours... (Sizer) The agreement between teacher and students to exhibit a facade of orderly purposefulness is a Conspiracy for the Least, the least hassle for anyone (cited in Shor, 1986, p. 81).

Many teachers are withdrawing from active involvement in the teaching/learning process, and are turning to a reliance on prepackaged curricular materials and textbooks. Too heavy a reliance on materials prepared by outside agencies leads to the disempowerment and deskilling of teachers (Aronowitz & Giroux, 1985). In addition, many teachers have adopted the rationalistic, productivity model of education whereby they reduce the subject matter into concise objectives that are intended to make it easier for students to digest the material (Wirth, 1983). Apple (1979) argued against the dictum that requires of those building instructional systems, for instance, to formulate specific learning objectives, clearly stating whatever the learner is expected to be able to do, know, and feel as an outcome of his learning experiences (p. 110-111).

Some prepackaged materials are organized into modules with precise steps to be taken by the teacher, and some even go so far as to provide the exact words for teachers to use.
An example from a kindergarten kit illustrates: "Task 1. Show the child a yellow cube and ask, What is the color of this cube?...Task 4. Say, Put your finger on the orange cube" (Wirth, 1983, p. 127). Teachers who use such materials become specialized technicians and high-level clerks implementing the orders of others (Aronowitz & Giroux, 1985).

The separation of curriculum design from execution can also be seen in the use of the textbook. Just as prepackaged materials can lead to a disempowerment and deskilling of teachers, so too can the use, or misuse, of textbooks. Many teachers assume that textbooks contain a synthesis of knowledge from their discipline and all the related information their students will need. Textbooks contain consensus knowledge and contain "little, if any, debate concerning different positions on a particular object of knowledge" (Aronowitz & Giroux, 1985, p. 150).

That brings me to the final discussion: What is the nature of scientific knowledge and how is it presented in the classroom? Science, or the scientific approach to discovery, is associated with positivism and objectivism and rationalism. Positivism posits there is a single, knowable, measurable reality capable of being separated into independent variables and examined using a value-free method of inquiry. In the natural and physical sciences that means that natural phenomena can be identified, taken apart,
measured and objectively described. Schrodinger (cited in Keller, 1985) identified two fundamental tenets of science: "...nature is (1) objectifiable and (2) knowable" (p. 141). Objectifiable as used here means both "objective, i.e., independent of our cognizance, and objectlike, hence having a well-defined position in space and time" (Keller, 1985, p. 141). Objectifiable implies that (1) the goal of scientists must be to distance themselves from that which they observe, and (2) reality is composed of discrete objects. The concept of knowability implies a one-to-one correspondence between theory and reality, i.e., theories are capable of providing a complete representation of reality. The goal of science then is to collect data, use the data to describe and explain natural phenomena, and ultimately develop theories as explanations of reality.

Science as described here is assumed to be an objective activity, and scientists are viewed as being "severed from the outside world of other objects and simultaneously from their own subjectivity" (Keller, 1985, p. 70). This is the view of science that is presented in schools: Science is objective and "subject to empirical verification with no outside influences, either personal or political" (Apple, 1979, p. 89). This view of science as objective is an illusion, according to Keller (1985), and "may mirror a rather deep fear of intellectual, moral, and political conflict," according to Apple (1979, p. 89). The truth is
that science and the direction of scientific research was and is influenced by economic, political, and ethical forces, both from inside and outside the scientific community (Keller, 1985).

Often these other forces result in conflict within the scientific community. The "scientific community" is governed by norms and values, and is bound by a common language (Apple, 1979; Keller, 1985). The convention is that the scientific community consists of those who are able to speak a common language (Ziman, 1968). Interpretation of data requires a common language, where common language not only means knowing names and syntax, but also means knowing what constitutes legitimate questions and meaningful answers. Keller (1985) pointed out that to be admitted into the scientific community one needs to learn the common language, including the right questions and reasonable answers. To challenge the consensus, then, one must first demonstrate an understanding and acceptance of it as it is (Ziman, 1968). Conflict often arises when new paradigms are introduced that challenge the status quo or the "right questions and reasonable answers."

But just as often the resulting conflicts and the affects they have on scientific discoveries are not presented in the science classroom. Ziman (1968) justified this approach by saying the aim of scientific education is to prepare students for research. "Scientific education is
for research...The student must acquire a thorough understanding of the consensus of his day, whether to practice it or to change it" (Ziman, 1968, p. 69). Apple (1979) argued that the way scientific knowledge is presented to school children, and to college students, presents a false image of the scientific community and leads students to believe that conflict does not exist in scientific research and does not play a role in the direction of scientific research:

By the fact that scientific consensus is continually exhibited, students are not permitted to see that without disagreement and controversy science would not progress or would progress at a much slower pace. Not only does controversy stimulate discovery by drawing the attention of scientists to critical problems, but it serves to clarify conflicting intellectual positions (Apple, 1979, p. 89).

All of the issues that have been presented in this section are interrelated. Culture, power, control, and conflict are all intertwined. The cultural capital of individuals often conflicts with the dominant cultural capital. Schools give legitimacy to the knowledge of the dominant culture while at the same time exerting control over conflicting cultures. Control is equated with order which is viewed as being positive, while conflict is seen as negative (Apple, 1979). By presenting scientific knowledge
as consensus knowledge and not demonstrating that conflict is a natural and necessary part of the process, students may come to believe that conflict is not natural or necessary in other areas of society.

Ira Shor expressed his frustration as a teacher spending "many hours in front of silent students who stare back...unmoved" (Shor & Freire, 1987, p. 9). In advocating what he called the "liberatory classroom," Shor summarized the current state of education in the classroom, and is worth quoting at length:

Education is much more controllable if the teacher follows the standard curriculum and if the students act as if only the teacher's words count. If teachers or students exercised the power to remake knowledge in the classroom, then they would be asserting their power to remake society. The structure of official knowledge is also the structure of social authority. That is why the syllabus, the reading list, and the didactic lecture predominate as the educational forms for containing teachers and students inside the official consensus. The lecture-based, passive curriculum is not simply poor pedagogical practice. It is the teaching model most compatible with promoting the dominant authority in society and with disempowering students (Shor & Freire, 1987, p. 10).
Chapter 3

Methods

INTRODUCTION

The method of inquiry chosen for this study was a qualitative case study, a form of naturalistic inquiry using, in this case, participant observation as the primary method of data collection. This study has also drawn from the notions of connoisseurship and disclosure espoused by Eisner (1976). A case study, according to Yin (1984, p. 23) "investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." The qualitative case study approach was deemed appropriate since the desired end product was a "holistic, intensive description and interpretation" (Merriam, 1988, p. 4) of selected classroom environments. Each course section fit Yin's criteria of a "case:" a real-life situation, unspecified teaching methods, and multiple sources of data. Patton (1980) confirmed that the case study design is appropriate when the aim of the study is to capture "unique diversities and contrasts" that develop in response to "local needs and circumstances" (p. 66). The desired end product of this study was a description, interpretation, and evaluation of community college general education biology classrooms and laboratories for the
purpose of developing a deeper understanding of the ways they contribute to general education.

Even though the movement toward qualitative methods and naturalistic research designs have been gaining increased acceptance in recent years, there still seems to be an element of distrust and misunderstanding surrounding their use. There are those who would still argue that quantitative methods are "better" than qualitative methods, and some might even argue that qualitative methods should not be considered true research. This researcher would argue that neither method is "better" than the other and, in fact, the use of both methods can provide us with the most accurate description of the phenomenon being studied. In many respects it is appropriate to think of quantitative and qualitative methods as simply opposite ends of a continuum.

Quantitative methods are associated with the scientific approach to research, and the scientific approach is associated with positivism and objectivism. Positivism posits that there is a single, knowable, measurable reality capable of being separated into independent variables and examined using a value-free method of inquiry. In the natural and physical sciences that means that natural phenomena can be identified, taken apart, measured and objectively described. The ideal of quantitative research is found in the classical scientific paradigm. Schrodinger (1967, cited in Keller, 1985) identified two fundamental
tenets of science: "...nature is (1) objectifiable and (2) knowable" (p. 141). Objectifiable as used here means both "objective, i.e., independent of our cognizance, and objectlike, hence having a well-defined position in space and time" (Keller, 1985, p. 141). Objectifiable implies that (1) the goal of scientists must be to distance themselves from that which they observe, and (2) reality is composed of discrete objects. The concept of knowability implies a one-to-one correspondence between theory and reality, i.e., theories are capable of providing a complete representation of reality. The goal of science then is to collect data, use the data to describe and explain natural phenomena, and ultimately develop theories as explanations of reality.

Qualitative methods, at the opposite end of the continuum, are associated with naturalism and "interpretivism" (Howe, 1988) and assume "that there are multiple realities—that the world is not an objective thing out there but a function of personal interaction and perception (Merriam, 1988, p. 17). Qualitative methods strive to find meaning and understanding in that which is observed in their natural settings. The qualitative researcher does not look at a phenomenon as an object apart from the participants, but rather as a collection of objects interacting and interconnected, creating a whole. The qualitative researcher strives to understand the complex
nature of the whole and tries to understand the whole from the perspective of the participants. Qualitative research is subjective only in the sense that intuition, judgement, and interpretation are an acknowledged part of data analysis.

It seems fair to say that "reality" is extremely complex. In fact, past experience indicates that it may not be possible to completely explain every natural phenomenon in quantitative, empirical terms. The situation is even more complicated when we are dealing with human beings interacting with one another, such as in an educational setting. The qualitative position posits that "there are multiple constructed realities that can be studied only holistically; the inquirer and the 'object' of inquiry interact to influence one another; and inquiry is value bound..." (Guba, 1985, p. 85). Many researchers have come to believe in the worth and value of qualitative, naturalistic methods of inquiry in all areas of research, but particularly in the social and education sciences. It is perfectly legitimate to think of reality being influenced by the perceptions of the observer.

Both quantitative and qualitative methods have strengths and weaknesses, but neither is necessarily "better" than the other; some researchers argue that the best method is to combine qualitative with quantitative. One argument is that by combining techniques the overall
credibility of the results is enhanced. Howe (1988), in making an argument in favor of the compatibility of quantitative and qualitative data, quoted Jackson (1968, pp. vii-viii):

> Classroom life, in my judgment, is too complex an affair to be viewed or talked about from any single perspective. Accordingly, as we try to grasp the meaning of what school is like for students and teachers we must not hesitate to use all the ways of knowing at our disposal. This means we must read, and look and listen, and count things, and talk to people, and even muse introspectively over the memories of our own childhood (pp. 11-12).

**PROCEDURES FOR THIS STUDY**

**Data Collection**

It was decided early on to select one community college and observe several sections of one course; therefore, a community college within commuting distance was identified and access gained. The study being reported here was conducted at a suburban community college in western Virginia and will be identified by the pseudonym Valley View Community College (VVCC). Three sections of general biology (BIO 102), a natural science course acceptable for general education credit and which enrolled both science majors and nonmajors, were selected for observation. Each section
consisted of a lecture and a lab, and each section was taught by a full time faculty member.

Data gathering began with descriptive information concerning the institution, most of which was found in the college catalog and various reports put out by the college's Office of Institutional Research. This information included school mission and philosophy, school location, number of students, number of faculty, types of programs offered, and educational background of instructors observed for this study.

Once access to the classrooms and laboratories was gained, a complete description of the physical setting was made. The description of the physical setting included the size and shape of the room, number of windows, color of walls, location of blackboard(s), arrangement of desks, and location of instructor's desk or podium. Photographs of the lecture classrooms and laboratories, as well as the exterior of the science building and campus, were taken as permanent record.

The technique of naturalistic inquiry is one of direct observation of an ongoing naturalistic situation, in this case the "real world" of education: the classroom. For this study, community college general biology classrooms and laboratories were observed. Data collection consisted primarily of participant observations of the "real-life" situation of selected community college general biology
lecture classrooms and laboratories during which extensive field notes were made that provided a detailed description of the situation. Classroom observations took place over a period of several weeks during which I sat unobtrusively in the back of the classrooms "noting everything that seems to be happening as well as making descriptions of people [and the setting]" (Loomer, 1982, p. 73). From my vantage point in the classroom I was able to observe both the instructor and the students. My presence was not announced in two of the classrooms, but in a third case, the instructor simply pointed me out to the class and announced that I would be sitting in on lectures and labs for a few weeks. But in none of the cases was any particular overt notice taken of my presence. Of course, after I had been part of the class for a few weeks, I began to have informal conversations with some students before or after class or during labs and field trips.

Lecture classroom observations began on Monday, February 26, 1990 with I.A.'s class. During the observation period I visited I.A.'s lecture classroom thirteen times and I attended the lab class seven times for a total of approximately thirty-three hours of observation. I began observing I.B.'s lecture classroom on Wednesday, February 28. I visited his classroom ten times and the lab five times for a total of approximately twenty-five hours of observation. Classroom visitations in I.C.'s class were
begun on Tuesday, February 27. I visited his lecture classroom seven times, each class meeting lasted for one and one-half hours, and the lab four times for a total of approximately twenty-two hours of observation. During the course of the observation period, I observed approximately thirty-three hours of lecture and forty-seven hours of laboratory.

During these visits I took extensive field notes of classroom activities, including physical descriptions of the classrooms and laboratories. I took note of instructor behaviors, student behaviors, lecture content, questions asked and answers given. Starting on March 12, 1990, I began making audio tape recordings of lectures while continuing to observe and record classroom activities. In addition to the data gathered through direct participant observation, the following were also used for collecting data: examination of syllabi and tests, interviews with instructors, interviews with students, and questionnaires completed by students and instructors. Copies of selected field notes, syllabi and tests, transcriptions of interviews and comments, and questionnaires can be found in the Appendices.

Observations of laboratory classes were conducted in much the same way. When the class was held inside, I sat near the back and took notes of classroom activities. When the class went on a field trip I accompanied them and took
notes. Audio tape recordings were not made of any laboratory session due to the more informal nature of laboratory activities.

Additional data were collected through a series of informal discussions with each instructor that took place throughout the course of the observation period, as well as in-depth interviews at the end of the study. The in-depth interviews were conducted one-on-one with each instructor, were tape recorded, and lasted slightly over one hour each. During these interviews, instructors were questioned about their educational backgrounds, their goals for the course, their perceptions of their relationships with students, and their knowledge of general education goals. Excerpts from interview transcripts can be found in Appendices A (I.A.), B (I.B.), and C (I.C.).

Focus group interviews, which provided additional insights into the classroom behavior of students and instructors, were held with small groups of students from each class. Each interview session took place in one of the classrooms or laboratories, was tape recorded, and lasted for approximately one hour. These interviews provided valuable data regarding student motivations, student perceptions of the course and instructor, and student expectations for the course and education.

Seven students from I.A.'s class were interviewed on Thursday April 26, 1990 in one of the laboratory rooms. The
interview lasted for nearly one hour. Excerpts from these interview transcripts can be found in Appendix A. Ten students from I.B.'s class were interviewed for approximately one hour later the same day and excerpts from these interview transcripts are located in Appendix B. Five students from I.C.'s class were interviewed for forty minutes on Tuesday April 24, 1990. Excerpts from these interview transcripts are located in Appendix C.

Demographic data concerning students enrolled in the courses being observed were gathered using a Student Characteristics Questionnaire (Appendix D). Information gathered from this questionnaire included students' age, gender, ethnic background, high school attended/completed, enrollment status, employment status, reason for taking course, and primary educational goals.

Supplementary data were provided by a Student Classroom Activities Questionnaire (Appendix E) completed by students and an Instructor Questionnaire (Appendix F) completed by faculty. The questionnaires were designed to elicit information regarding both faculty and student perceptions of course structure, content and goals, as well as goals, intentions, and expectations each has for the course. For the most part, this information was used to confirm or refute data gathered through observations and interviews.

Additional data related to course structure and course goals was obtained through an examination of textbooks,
course syllabi, and tests. Course syllabi and examples of quizzes and tests can be found in Appendices G, H, and I. The syllabi provided initial data concerning course objectives, planned activities, reading assignments, writing assignments, attendance requirements, and grading policy. Examination of tests yielded useful information which provided for a more complete description and interpretation of course contents and classroom activities. The use of multiple data sources was intended to enhance the credibility, dependability, and trustworthiness of the study's results.

Data Analysis

The method of data analysis used for this study was derived from the notion of connoisseurship, an element of a naturalistic research method proposed by Elliot Eisner (1976), and was begun immediately upon entering the classroom using the foreshadowed problems as a focus. Connoisseurship is a form of expertise "which appreciates the complexities, the nuances, the interweaving patterns that evolve from the totality of an educational setting" (Loomer, 1982, p. 57). The connoisseur as observer brings with him/her specialized experience and theoretical knowledge. In education, a connoisseur has an appreciation for and awareness of the educational setting where appreciation leads to understanding and awareness provides the basis for a judgment of some kind (Loomer, 1982).
Educational connoisseurship first describes the phenomenon as vividly as possible and then goes beyond description to interpretation and evaluation. Connoisseurship/disclosure involves three steps: (a) description, (b) interpretation, and (c) evaluation. Description is a recreation of the classroom and answers the question "What is going on here?" Interpretation is made by examining the meaning and explanation of events. Evaluation involves value judgments concerning how well it was done.

The purpose of this study was to determine to what extent efforts were being made in selected community college general biology classrooms to improve student general education competencies. Because this methodology is one of discovery rather than verification, there were no hypotheses to guide the study. However, a number of questions called "foreshadowed problems" by Smith (1974), were used to provide a focus for the observations and to aid in the analysis of data. The primary value and role of the foreshadowed problems are that they "selectively guide one's perception and thought while one is in the field" (Smith, 1974, p. 188). The following questions, which began as broad questions and became more focused, represent questions brought to the classrooms observed for this study and questions which were added as the study progressed:
1. What is the intent of the instructor regarding general education?

2. What detectable effort is being made to affect student progress in specific general education areas other than an understanding of biological facts and principles, such as:
   (a) critical thinking abilities,
   (b) effective communication skills,
   (c) social interaction skills,
   (d) numerical interpretation skills, and

3. What detectable effort is being made to affect student understanding of the interrelatedness among biology, other disciplines, and other kinds of knowledge?

4. In the opinions of the instructor, how much effect does s/he (or the course) have on student competence in general education areas?

5. To what extent do students perceive that general biology contributes to their competence in writing, critical thinking, and knowledge of science?

6. What evidence is there that higher learning is taking place?

7. Are biological facts presented as consensus knowledge and objective truth?
8. What role does subjectivity play in biological discovery?

9. What role does ethical behavior play in biological research?

10. How is power and control manifested in the classroom?

At the beginning of this study the focus was on general education goals in a broad sense and the extent that student development of general education goals was being enhanced in a general biology classroom. Case study researchers, such as Merriam (1988), suggest that data be analyzed as it is collected. Without on-going analysis of data as they are collected, the data are likely to be "unfocused, repetitious, and overwhelming in the sheer volume of material that needs to be processed" (Merriam, 1988, p. 124). The following steps were taken to analyze the data during observation:

1. The "foreshadowed problems" were assessed after entering the classrooms to determine which were relevant and which should be reformulated.

2. Comments or interpretive asides were made during the data collection phase. These comments allowed me to think critically about what I saw and to be more than a recording machine.

3. After each observation session I tape recorded memos regarding what I had learned. I also used
this technique to comment on discussions I'd had with instructors and to make general comments on what I had observed (see Appendices A, B, and C.) As data were collected and analyzed, the focus of the study was redefined. It quickly became apparent that general education goals, as they are commonly identified, were not a significant part of the biology curriculum. After examining the literature in more depth, I began to focus on such things as (a) the level of cognitive development attempted, (b) the nature of scientific knowledge, (c) instructor role and relationship to students, (d) student involvement in the learning process, and (e) the issues of power and control in the classroom.

This methodology involved the taking of extensive field notes which needed to be organized for further analysis. Since, as Merriam (1988) pointed out, data analysis is the process of making sense out of one's data, the data needed to be reduced and organized according to categories. Tentative categories, which first emerged during a pilot study conducted in January and February, 1990, were used as a starting point for organizing the data at VVCC. During the early stages of classroom observations at VVCC, these tentative categories were more clearly defined and new categories were developed. Examination of field notes and interpretive asides made during the observations, led to the discovery of patterns that suggested the most common and
persistent themes. Data gathered during the latter stages of classroom observations were used to confirm or refute the adequacy of each category. Tape recorded interviews with faculty and students were transcribed and analyzed along with the field notes. In this way the data were reduced and organized into five categories: content, students, interaction, pedagogy, and control. Colored markers were used to color code all notes and transcribed data for organization into categories. Examples of field notes, interview transcripts, and transcripts of tape-recorded comments can be found in Appendices A, B, and C.

Two of the categories emerged quite early in the observation phase; these were CONTENT and PEDAGOGY. Of major concern for both students and instructors was the content of the course. Each of the instructors indicated to me they constantly wrestled with the questions of what and how much material should be covered in a general biology course. Other data that were placed in this category were (a) the nature of scientific knowledge, (b) purpose of course, (c) biology's relation to society, and (d) the importance of reading and writing to success in the course.

Pedagogy emerged as a category early in the observation phase because that is largely what was being observed. Data included in this category were (a) lecture style of instructor, (b) use of questions during lecture, (c) use of review, and (d) class discussions.
Another category that emerged from the data I've simply titled STUDENTS. The category emerged in part because of the emphasis each instructor seemed to place on student motivation and abilities as contributing factors to the success or failure of the course. Data included in this category were (a) student motivation, (b) student's educational goals, (c) student ability, and (d) student responsibility.

A fourth category which emerged from the data was related to the relationships that existed between the instructor and students. This category, INTERACTION, included such data as the amount and kind (e.g., formal or informal) of (a) student/instructor interaction and (b) student/student interaction.

The fifth and last category to emerge was the issue of CONTROL in the classroom; not discipline but control. In the classrooms observed for this study, discipline was not a major problem, but control seemed to be an underlying force within each of the other categories. Instructors controlled course content, the level of interaction, and the style of presentation. Students, in their own way, also controlled classroom activities by virtue of their academic abilities, motivation, and willingness to participate in the process. Control was not always observable but had to be inferred from the observable data. That is, control was a subliminal force that created a link among the other categories.
LIMITATIONS

Merriam (1988) discussed at length the issues of validity, reliability, and ethics as they apply to qualitative research. It has been suggested that the terms validity and reliability as conventionally defined in quantitative research, should not be applied to qualitative research, although most agree the criteria for rigor should still apply (Lincoln, 1985).

Generally, traditional trustworthiness criteria include internal validity, external validity, reliability, and objectivity. Analogous criteria for naturalistic studies are credibility, transferability, dependability, and confirmability (Lincoln, 1985, p. 151).

It is important that those who read the results of qualitative research have confidence in the explanations offered. As Merriam (1988, p. 164) said: "The applied nature of educational inquiry...makes it imperative that researchers and others be able to trust the results of research--to feel confident that the study is valid and reliable." Qualitative researchers should not ignore methods and procedures that might enhance the credibility and trustworthiness of their results. While explanations may reasonably vary within the community of observers and interpreters, that should not be taken to suggest that all
interpretations are equally valid (Allison, 1971; Phillips, 1987).

It is also important to discuss the issue of external validity: to what extent are the results of qualitative research generalizable to other situations? "One selects a case study approach because one wishes to understand the particular in depth, not because one wants to know what is generally true of the many" (Merriam, 1988, p. 173).

When explanation, propositional knowledge, and law are the aims of an inquiry, the case study will often be at a disadvantage. When the aims are understanding, extension of experience, and increase in conviction in that which is known, the disadvantage disappears (Stake, 1978, p. 6).

Generalizations from qualitative case study research need to be viewed differently than in quantitative studies. Merriam (1988) argued further that the notion of generalization needs to be redefined to reflect the assumptions underlying qualitative inquiry.

One way to reconceptualize generalizability is to think in terms of the reader or user of the study. "Reader or user generalizability involves leaving the extent to which a study's findings apply to other situations up to the people in those situations" (Merriam, 1988, p. 177). "It is the reader who has to ask, what is there in this study that I
can apply to my own situation, and what clearly does not apply" (Walker, 1980, p. 34).

**SUMMARY**

The method of inquiry chosen for this study was a form of naturalistic inquiry, the qualitative case study, which utilized participant observation as the primary data collection technique. This method, a holistic, discovery model, was well suited to the research questions being asked.

The method also drew from the notions of connoisseurship and disclosure. This approach allows that the observer as connoisseur has the experience and background to "appreciate nuances, complexities, forms and patterns in the work not always perceived by others" (Loomer, 1982, p. 82). The disclosure aspect involved description, interpretation, and evaluation.

The desired end product of this study was a description of course contents and classroom environments of community college general education biology courses as they appeared to the connoisseur and, to some extent, as they appeared to the students. The methodology chosen for this study resulted in holistic descriptions of the selected classrooms including interpretations of events as they were related to the research questions.
CHRONOLOGY OF STUDY

The proposal for this study was presented to committee and approved in January 1990. Before this particular study was begun, a pilot study was conducted at a nearby community college. The pilot study was conducted to establish a framework for the study and clarify the research questions to be used. Observations for the pilot study were begun on January 26 and continued through February 14. The study being reported here was conducted at a suburban community college in western Virginia which will be identified by the pseudonym Valley View Community College (VVCC).

Initial inquiries were made on February 20, 1990 when I met and talked with three of the five VVCC faculty members who teach general biology. We discussed the purpose of the study, how much time I would be spending at VVCC, which classes I wanted to observe, and other matters related to the study. I returned on Friday February 23 to finalize the visitation schedule and speak with Dr. H., Chairman, Division of Science and Mathematics. But before final plans could be made, I was asked to again speak with the biology instructors and clarify the purpose of the study. After speaking to four of the biology faculty who teach general biology, I was able to get permission to observe the classrooms and laboratories of two. On Monday I was able to get permission to observe the classrooms and laboratories of a third faculty member. The three faculty members will be
identified as Instructor A (I.A.), Instructor B (I.B.), and Instructor C (I.C.).

Actual observations began on Monday February 26, 1990 and continued through Thursday April 26, 1990. On Mondays and Wednesdays I observed I.A.'s lecture class at 9:00am and I.B.'s lecture class at 11:00am. On Tuesdays I observed I.C.'s lecture class at 11:00am. All three laboratory classes were observed on Thursdays, I.A. at 8:00am, I.B. at 11:00am, and I.C. at 2:00pm.

During observations of the lecture classroom, I sat unobtrusively at the back of the room in a location that allowed me to observe both instructor and students. In lab I would sit in the back of the room when the instructor talked, but I would sometimes walk around and observe during the exercise portion. When the class went on fieldtrips I would go along. No one seemed to question my presence although I.B. pointed me out to the class and said that I would be sitting in on lectures and laboratories to observe. Nothing was said in the other classes regarding my presence until toward the end when I asked students to complete a questionnaire and to be interviewed.

Interviews with students were conducted on Tuesday April 24 and Thursday April 26, 1990. Interviews were conducted using the focus group technique. The size of the groups ranged from five to twelve. Faculty interviews were conducted as in-depth interviews and took place on Tuesday
May 1 and Wednesday May 2, 1990. Each interview lasted for approximately one hour and ten minutes and was tape recorded.
Chapter 4

Descriptions

INTRODUCTION

This study used participant observation in selected community college general biology classrooms as the principle data collection technique. Data were also gathered from tape recorded interviews with faculty, focus group sessions with students, examination of syllabi and exams, and questionnaires completed by faculty and students. Three dual-purpose general biology courses, lecture and laboratory, were observed over a nine week period between February 26 and May 2, 1990. In the spirit of grounded theory, there were no hypotheses to guide the study, but a number of research questions, termed foreshadowed problems by Smith (1974), were used to provide a focus for the observations and to aid in the analysis of the data. At the beginning of this study the focus was on general education goals in a broad sense and the extent that student competence in general education was being enhanced in a general biology classroom.

This methodology involved the taking of extensive field notes which needed to be organized for further analysis. Following the advice of Merriam (1988), the research questions (foreshadowed problems) were analyzed from the start of data collection. As data from all sources were collected and analyzed, the focus of the study was
redefined. The data were analyzed both during and after the observation phase. Analysis of data led to the identification of categories, or recurrent themes, which were used to refocus the observations and interviews and were used to organize the data for reporting purposes.

Upon entering the classrooms selected for this study, it quickly became apparent that deliberate efforts were not being made to address the broad goals of general education beyond the narrow focus of biological facts, principles, and concepts. That is, general education goals, as they are commonly identified, were not a significant part of the biology curriculum. Several themes or topics which emerged from the data were organized under five main categories: (a) content, (b) students, (c) interaction, (d) pedagogy, and (e) control.

Chapters 4 & 5 present descriptions and interpretations, respectively, of course content and classroom activities using the categories that emerged from the data as chapter organizers. Chapter 4 begins with general descriptions of the college, its programs, and general biology instructors, then presents descriptions of the courses loosely organized around the five categories. Chapter 5 goes beyond the descriptions and offers interpretations of course content and classroom activities; that is, what were the inadvertent results of the way the courses were being conducted.
DESCRIPTION OF VVCC AND ITS PROGRAMS

Valley View Community College (VVCC), established in 1966, is located in a picturesque valley of western Virginia. The campus and buildings were well maintained, neat, and clean. The campus grounds were carefully landscaped and well groomed, providing students and visitors with an aesthetically pleasing environment. The views of the mountains and city were breathtaking and since this study was conducted, in part, during the early days of spring, the flowering dogwoods and redbud just added to the overall beauty of the campus.

VVCC, with a service region population of approximately 250,000 (VVCC Office of Institutional Research), is one of twenty-three colleges within the Virginia Community College System (VCCS). VVCC is one of the largest colleges in the VCCS with an unduplicated headcount of over fourteen thousand for the 1987-88 academic year. The campus consists of several buildings on a seventy acre site at the outskirts of a city of less than 100,000. VVCC could be most accurately described as a suburban, middle class community college. According to a report put out by the Office of Institutional Research (January 1990), VVCC had a Fall 1989 headcount enrollment of over seven thousand of which 90% were white, 59% female, and 78% part-time. Although the average age for all students enrolled at VVCC was twenty-nine, the average age of full-time students was twenty-two
and the average age of general biology students who responded to a questionnaire was twenty-three.

Valley View Community College, while remaining in many ways self-governing, operates within the policies and regulations of the State Board for Community Colleges and contributes as it can to the mission and goals of the VCCS. A principal goal of the VCCS has been to provide accessible, quality educational opportunities to all citizens of Virginia. An excerpt from the recently revised (1986) VCCS mission statement, including goal statements, illustrates the thrust of the Virginia Community College System:

The Virginia Community College System functions within the educational community to assure that all individuals in the diverse regions of the Commonwealth of Virginia are given a continuing opportunity for the development and extension of their skills and knowledge through quality programs and services that are financially and geographically accessible.

Occupational-technical education, transfer education, developmental studies, continuing education, and community services are the primary avenues through which the mission is fulfilled (VCCS Policy Manual).

According to VVCC's 1990-91 General Catalog:

Valley View Community College is dedicated to the belief that all people should have an equal opportunity to develop and expand their skills and knowledge for
the betterment of themselves and their community. The College strives to provide quality programs that are affordable and accessible to area residents. A wide range of educational opportunities and a complement of student support services are provided to serve the diverse and dynamic needs of the region, including the employment needs of the region, business, industry, professions and government (p. 9).

To accomplish these goals VVCC offers sixty-three academic programs comprising the following general areas: (a) University Parallel/College Transfer, (b) Technical-occupational Education, (c) General Education, (d) Continuing Adult Education, (e) Cooperative Education, (f) Developmental Education, (g) Regional and Community Service, and (h) Special Training Programs. It is plainly evident that VVCC ascribes to the dictum that "community colleges should be all things to all people."

This study examined General Biology, a course that is a component of two program areas, University Parallel/College Transfer and General Education. The 1990-91 college catalog provides a description and definition of each:

UNIVERSITY PARALLEL/COLLEGE TRANSFER includes programs designed to prepare students for transfer to baccalaureate degree programs at four-year colleges and universities. Associate degrees in arts and sciences are offered.
GENERAL EDUCATION includes courses that encompass the broad foundations of higher education, including the humanities, social sciences, natural sciences, and mathematics. The two purposes of general education courses are to provide knowledge and academic skills for individual enrichment and responsible citizenship, and to provide a foundation for further and more specialized study.

GENERAL BIOLOGY I-II (BIO 101-102) explore fundamental characteristics of living matter from the molecular level to the ecological community with emphasis on general biological principles. Introduces the diversity of living organisms, their structure, function, and evolution.

As a component of both university/college transfer and general education, it would appear that General Biology is intended to (a) "explore fundamental characteristics of living matter from the molecular level to the ecological community," (b) "prepare students for transfer to baccalaureate degree programs," and (c) "provide knowledge and academic skills for individual enrichment and a foundation for further and more specialized study." Of these three, the contribution that biology makes to "c" may not be as clear-cut as its contribution to "a" and "b". It is quite logical to assume that biological principles are being covered and that the course meets standards for
transfer, but it is not as obvious to what extent and in what ways General Biology contributes to general education beyond the transfer of scientific knowledge.

INSTRUCTOR PROFILES

Of the five instructors teaching Biology 102 during Spring semester, 1990, three were observed. The other two instructors were reluctant to have me visit and observe their classrooms. These brief profiles are presented here to provide the reader with background information on the instructors, and help the reader better understand the actions of each instructor. All three instructors were approximately the same age (between thirty-seven and forty-five) but their educational and work backgrounds were quite varied. The instructors will be identified as Instructor A (I.A.), Instructor B (I.B.), and Instructor C (I.C.).

Instructor A, a female, has been a member of the faculty of VVCC since the fall of 1988 and is the only one of the three observed for this study with a doctorate. Before coming to VVCC her teaching experience was limited to teaching labs during her graduate work and one year at another community college. She received a B.S. from a small liberal arts college, majoring in biology and minoring in chemistry. At that point she did not intend to go on and become a teacher. In the sixteen years between receiving her baccalaureate and doctoral degrees, she worked as a laboratory research technician and earned a medical
technology degree. She received a Ph.D. in 1987 from a southeastern university medical school, where she specialized in microbiology and immunology.

Instructor B, a male, was the only one of the three who attended a community college. He went directly from high school to a community college and two years later earned an Associate Degree. Two years after that he earned a Baccalaureate Degree from a midwestern university and one year later earned a Masters Degree from the same university. His bachelors degree was in science education with a major in botany and a minor in zoology, and his masters was in plant ecology. So five years after graduating from high school he had earned his masters and he was teaching at VVCC. He has been at VVCC since then, a total of twenty-two years. He credits the community college for allowing him the opportunity to pursue a college degree and thus the opportunity to pursue a career as a biology instructor.

Instructor C also holds a masters degree, and his specialty is the reproductive physiology of fish. Although he has only been at VVCC since the fall of 1988 (he and I.A. were hired at the same time), he taught at another college within the VCCS from 1972 until 1988. He did not attend a community college and was familiar only with junior colleges until he started teaching in one. He spent one year teaching biology at a junior high school in Alabama before starting to work on his masters. He never intended to stay
teaching in public schools, saying his intention was to teach at the college level. In addition, he spent nearly twenty years working during the summers on the Blue Ridge Parkway, first as an interpreter and then as a ranger.

**PHYSICAL DESCRIPTIONS OF CLASSROOMS AND LABORATORIES**

Both the lecture and laboratory classes were held in the three-story science building which also contained the physics, chemistry, and geography classrooms. In the main lobby of the building were glass display cases that contained a variety of exhibits. On the walls throughout the building were a variety of photographs and posters providing evidence that one was indeed in a science building. The hallways were well maintained, the floors were well polished and the walls were clean, many appearing to be freshly painted.

The lecture classrooms were well suited to the purpose for which they were intended; that is, the lecture method of instruction, where students sit in rows or columns facing the instructor. The three lecture classes observed were conducted in two rooms located on the third floor of the science building. They were at opposite ends of the hall and, thus, were mirror images of each other. The rooms were rectangular, almost square, with painted cinder-block walls. There was a chalkboard in the front of the room and a projection screen attached to the wall over the board. One room had a chalkboard on one of the side walls as well as
United States and world maps on the other walls, while the other room had chalkboards on both side walls and a contour map of the world on the back wall. The rooms were at the corners of the building and had narrow rectangular windows at either end of the back wall and another window on the outside side wall.

The desks, or writing armchairs, were arranged in columns facing the front chalkboard. There were six columns with six chairs per column, for a total capacity of thirty-six in one room, while the other room had a capacity of forty. Each room also contained an overhead projector, a desk at the front of the room, and a podium, although not all instructors chose to use it. A clock was located on the back wall of each room.

The laboratories were again very typical, although the two rooms used by the general biology classes were setup somewhat differently. Laboratory A was the larger of the two, long and narrow. The room was approximately fifty feet long by twenty-five feet wide. The room contained ten square, black-topped, lab tables with four stations per table. Eight tables were used by the students, and the other two contained a variety of models and specimens. There was a sink in the center of each table, and each table contained air and gas jets. There were three large windows along the outside wall. A counter, cabinets, and shelves lined the inside wall, and there were microscope cabinets
and what looked like herbarium cabinets on the other walls. There were two chalkboards, one on the front wall and one on the outside wall, above which was a projection screen.

Lab B, adjacent to Lab A, was somewhat smaller. The lab tables were not table height but were counter height. There were three such tables with room for eight at each. There was a single chalkboard on the front wall and a counter with cabinets and shelves along the inside wall. Again the outside wall contained windows, and florist charts of flowers were on each wall.

COURSE ORGANIZATION AND STRUCTURE

Biology 102 at VVCC was delivered using the classical university model of science courses which employs a combination of lecture and laboratory. Students registering for a lecture section were required to register for a specific lab section. The result was that each lecture-lab combination could be treated as a separate course, since one instructor was responsible for each and the same students were present in each. This distinction is made because of the variety of ways that general biology courses are offered. Probably the most common is to have a single, large lecture section divided into several, smaller laboratory sections. At some schools the laboratory sections are conducted by someone other than the lecture instructor, often by a part-time faculty member, whereas at
VVCC both lecture and labs were conducted by full-time faculty.

Instructor A scheduled five lecture exams during the semester accounting for 75% of possible points. The remaining 25% was derived from two lab exams. She graded on a ten-point (percentage) scale, 90-100 an A, etc. Her exams were objective in nature, combinations of multiple choice, matching, true/false, and short answer. According to her syllabus,

Students are expected to take exams on the day they are scheduled. If they are not taken by the next class period, make-up exams are given during final exam week. This is done so that fellow students may get their exams returned promptly.

Instructor B scheduled tests and quizzes in the following order: (a) Miniquiz I worth 25 points, (b) Test I worth 100 points, (c) Miniquiz II worth 25 points, (d) Midterm Exam worth 200 points, (e) Miniquiz III worth 25 points, (f) Test II worth 100 points, (g) Miniquiz IV worth 25 points, and (h) Final Exam worth 200 points. In addition he scheduled three lab tests. His tests and miniquizzes were objective, combinations of short answer, true/false, and multiple choice. He also graded on a ten-point (percentage) scale and, like I.A., made it clear that tests were to be taken when scheduled. His syllabus included this admonition:
ALL TESTS SHOULD BE TAKEN AT THE SCHEDULED TIME. IF YOU MISS A TEST, IT WILL BE TAKEN AT THE END OF THE SEMESTER. ALL MAKE-UPS WILL BE TAKEN THEN...There will be NO MAKE-UP on the mini-quizzes.

Instructor C scheduled five one-hour exams plus a final exam in lecture, thirteen to fifteen quizzes and three exams in lab. 75% of the final grade for the course was determined from the lecture tests and 25% from the lab quizzes and exams. His tests were objective, again a combination of multiple choice, matching, fill-in-the-blank, true/false, short answer, and an occasional discussion question. Instructor C was also concerned about students missing tests and had a firm policy regarding the missing of tests, quizzes, and other assignments:

If tests, quizzes, examinations, or other graded exercises, either scheduled or with a turn-in deadline, are missed without prior notification or reasons given are not important and/or responsible and verifiable to the satisfaction of the instructor, a grade of 0 may be assigned for that material or a penalized late grade given. Any make-up activities that are allowed must be arranged and completed within one week after the original date. No make-up work will be done during the final exam week.
Introduction

The first issue that became readily apparent from early conversations with the faculty was concern each had over content. It seemed everyone was wrestling with the problem of what and how much information should be presented in a general biology course. Since there is such a vast amount of information that could be presented, each instructor was asking him/herself, "Which should be included in this course?" The biology faculty collectively devised a general outline of topics to be covered, which included a list of twenty-three chapters from the textbook (Appendix A). The general syllabus, however, did not include a time-line, or any suggestions as to how much time to spend on any chapter or group of chapters.

The five faculty members who taught general biology met regularly and discussed changes that needed to be made in the syllabus for next year. Among the three instructors observed and interviewed for this study there appeared to be two rather distinct "schools of thought," or preferences regarding where emphasis should be placed. I.B. was strongly committed to natural history and ecology. It was his belief that the study of their natural surroundings would have relevance to students and generate student interest in biology. I.B. felt that field trips were excellent means whereby student interest in biology could be
stimulated. I.A. and I.C., on the other hand, were convinced that scientific research was going in the direction of molecular and chemical biology; therefore, it was necessary to help students stay abreast of recent developments in these areas.

Despite the differences concerning which specific topics should be covered in a general biology course, each instructor had the freedom to organize his/her own course without regard to what the others were doing, except that each was expected to cover the topics included in the general syllabus. Each instructor was free to cover each topic in as much depth as s/he saw fit. Each used the same textbook, Biology by Neil Campbell (1987), and the same lab manuals. Biology, an impressive book of over one thousand pages, contained fifty chapters organized around eight themes: (a) The chemistry of life, (b) The cell, (c) The gene, (d) Evolution, (e) The history of life, (f) Plants, (g) Animals, and (h) Ecology.

There were twenty-three chapters scheduled to be covered during Spring semester, 1990. The semester started with a survey of the animal kingdom followed by the physiology of animal systems and embryology. The next general topic was ecology, which included the various biomes and population dynamics, and was followed by evolution, speciation, and behavior. Considering that twenty-three chapters were covered during a fifteen week semester, it can
be assumed that these instructors were more concerned with breadth than depth.

I.A. Course Content

I.A. distributed a syllabus to students that included a list of topics to be covered and the corresponding chapter in the textbook. This was a copy of the general syllabus prepared for the instructors and, therefore, did not include dates; just a list of topics and chapter numbers. When I entered the classroom I.A. was lecturing on chapter 40, the sixth chapter in the list. That is, half-way through the semester she was one quarter of the way through the number of chapters scheduled to be covered.

I.A. spent most of her class time covering basic biological facts, terms, and concepts. I.A. indicated in our in-depth interview that one of her goals was to help students learn the terminology of biology so they would be able to understand what they read in the newspaper:

One of my major goals is to give them some concept of the topic as far as terminology, because if you read *Newsweek* or the newspaper, there are a lot of science articles that without a basic background in terminology, [e.g.,] What are chromosomes? What is DNA? What is photosynthesis? CO₂?

I.A. was also concerned about and aware of the problems associated with the amount of material that is expected to be covered in one semester or in one year. She was aware
that to cover all the material on the syllabus was a nearly impossible task, but she made an effort. Although she indicated they cover approximately 2/3's of the book, Spring semester she covered twenty-three chapters. If twenty-three chapters were covered Fall semester, that would mean that 92% of the chapters in the book were covered. So, even though she felt it would be better if she could cover the topics in more depth, she nevertheless covered all the topics that were on the syllabus.

[I.A.] To get a topic interesting enough you have to go into some depth...I do try to cover major topics, because I'm trying to [follow] the syllabus...The syllabus I gave you, it's a joke. There's no way they can cover all those topics.

I.B. Course Content

The syllabus that I.B. distributed to his class listed fourteen topics and twenty chapters from the textbook. When I entered his classroom he was lecturing on the tropical rain forest biome. According to the syllabus, then, he had covered eleven chapters during the first eight weeks and would be covering nine chapters during the second eight weeks.

I.B. did not actually cover the chapters so much as he covered the topics. I.B. used the textbook as a reference for students and used lecture notes that had been prepared from other sources as his primary information source. The
result was that the textbook did not play a major role in determining content for this course. I.B. knew what topics he was going to cover and in what order, and referred students to those chapters in the book that corresponded to his topics.

I.B. indicated that what he was trying to do, or what he thought was important, was that students should come away from this course with a sense of how biology fits into their lives. He wanted students to be able to make a connection between biology and their day-to-day lives. I.B. was trying to make this connection through ecology and the environment. He spent considerably more time than the other two instructors observed for this study on the environment and ecology. I.B. had these things to say about what topics he covered and why:

...You're not going to teach them all of the biology there is to know anyway in one year, so you need to make it something that they can take from there, something that's a good foundation course in a sense for students going on in biology, but at the same time it needs to be workable and useful for the nonmajors, something that's going to help them be better citizens, to make better decisions...I don't hit animal physiology and animal systems like I'm sure [the other instructors do]. On the other hand I'm going to hit ecology more...And I think that's a hook, that's
excitement ...The thing I think is important in
general biology is natural history, I really do. And
that is because of people using it to go out and enjoy
nature, family vacations, trips, and whatever.
But despite his intentions to help students become
better citizens and to be able to make informed decisions,
I.B. covered all the topics on the syllabus, and did it in a
manner that required little independent thought on the part
of the students. I.B. relied heavily on the presentation of
terms and the memorization of those terms by students.

I.C. Course Content

The syllabus that I.C. distributed to his class was
very complete and detailed. The syllabus listed the date,
the lecture subject, the corresponding textbook chapter
number, and page numbers. I.C. included twenty-two chapters
on his syllabus, covering the same topics as the other two
instructors. When I first entered his classroom he was
lecturing on chapter forty, the seventh chapter on his
syllabus. I.C. was not in a hurry to complete all the
topics on the syllabus, since by the last week before final
exams he had covered only thirteen of the twenty-two
chapters scheduled. Apparently this happened Fall semester
also, and one student explained how he was able to cover all
the topics:

Last semester he gave us a take home test on the
chapters we didn't get to cover... So we'll probably get the ecology in there.

I.C. indicated he has struggled over the years with what to cover and in what depth to cover it. His primary concern was that general biology be suitable for transfer students and that the most current topics in research biology be covered. I.C. was concerned that the course offer information that would be helpful to biology majors who would be transferring. He was concerned that if his course did not reflect current trends in research biology that the science majors would be behind when they transferred. I.C. felt that research biology was going in the direction of molecular biology and biochemistry and that general biology should reflect that and offer more topics, or spend more time on, the molecular and chemical aspects of biology. So part of I.C.'s motivation for not making a point of getting to the ecology topics was that, in his opinion, ecology and natural history are out-dated and "behind the times." I.C. summed up his course's relation to the same course at a four-year institution this way:

There's got to be some sort of common ground [referring to the four-year colleges and universities] in terms of what we do for the students, what they're going to get out of it, what they're exposed to... I just feel some kind of professional bond or ethical bond to at least do as much or better... Therefore, a student comes out
of this college as good or better than the one coming out of [a four year school].

I.C. relied heavily on the textbook, saying that the textbook publishers have surveyed biology faculty and therefore know which topics are most important and how much time should be spent on each one. I.C. also relied heavily on the textbook in that he lectured from the textbook and expected students to read the textbook.

The end result was that I.C. took more time covering the first thirteen chapters and then rushed through, or didn't cover, the last nine chapters. But regardless of the topics covered, I.C. leaned heavily on the presentation of terms or factual information that he expected students to memorize.

Summary

Biology 102 at VVCC was guided by a syllabus that was developed and accepted by the biology faculty. Each instructor had the freedom to progress through the designated topics and textbook chapters at his/her own pace. Although each instructor observed for this study progressed through the material differently and emphasized different topics, they all had one thing in common: Each instructor emphasized memorization of biology terms, definitions, and other "facts." General education goals as they are commonly identified were not a significant part of the course content of BIO 102 at VVCC (see Table 1).
Table 1

Instructor Effort Related to General Education Goals

<table>
<thead>
<tr>
<th>Goals</th>
<th>I.A.</th>
<th>I.B.</th>
<th>I.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lecture</td>
<td>Lab.</td>
<td>Lecture</td>
</tr>
<tr>
<td>Independent thinking</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Critical thinking</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Problem solving</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Understanding of science</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Written communication</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Oral communication</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Social interaction</td>
<td>L</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Understanding of other cultures</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Aesthetic appreciation</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Integrated view of knowledge</td>
<td>L</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>Decision-making</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note. Ratings were assigned by author based on classroom observations using the following scale:

H=High   M=Medium   L=Low
STUDENTS

The community college student population is as diverse as community colleges themselves. Students not only vary according to gender, age, and ethnic background, but also according to academic ability and background. The students in the courses observed for this study, however, were quite similar in age and race. The average age of those who returned a student characteristics questionnaire was twenty-three, although most were between eighteen and twenty-two years old. The range in I.A.'s class was 18 to 42, with the average age being 21.4. In I.B.'s class the range was 19 to 22 with the average being 19.8. The range in I.C.'s class was 18 to 41 with the average (of those returning the questionnaire) being 27.7. The racial mix in the classes observed for this study was also quite homogeneous. Of the approximately sixty-five to seventy students enrolled in the three sections, there were five blacks, one oriental, one "middle east/indian," and the remainder white.

The students in the three sections of general biology observed for this study were similar in other respects as well. Of those responding to the survey, 82% indicated they worked at least part time, 72% were enrolled full time, 82% were taking the course for transfer credit, 64% indicated they intend to earn an Associate Degree, and 85% indicated they intend to earn a Bachelor's Degree. A primary goal for 94% of those responding to the questionnaire was to get a
good grade and to get credit, while only 50% of those responding listed "gaining general thinking skills" as a primary objective. Most of the students were not intending to major in a science; only 12% indicated they were currently science majors.

All of the instructors were concerned about the range of abilities and motivations of the students enrolled in general biology. The faculty were aware that there were students in the course who had never had biology and some who had, some who were familiar with basic concepts and terms and some who weren't, some who had strong academic backgrounds and some who didn't. From conversations with the faculty it was clear they were aware that many students come to the community college not fully prepared for college-level work. The general faculty perception of students was that students come to class not wanting to think but wanting and expecting to be told what to learn. I.A. said, "Students want to be told what's going to be on the test, no more/no less." I.C. had this to say: "They want it verbatim, with very little alteration, if any, to appear right on the test again."

INTERACTION

Introduction

The amount and kind of student/instructor interaction observed during the course of this study varied from lecture to lab, but was quite similar across courses. As might be
expected, the amount of interaction was less and more formal in the lecture classrooms than in the laboratory classroom. In the lecture classroom, interaction was limited to questions and answers between students and instructors. The laboratory classes, depending on the exercise, involved more frequent and more informal kinds of interaction between instructor and student.

I.A./Student Interaction

The majority of interaction between I.A. and students during lecture was in the form of questions and answers, although the purpose of I.A.'s questions was not always clear. It appeared that most of the time she did not expect an answer and I assumed the questions to be rhetorical in nature. Another explanation, however, is that she did expect an answer but simply didn't allow enough time for a response from the students. Questions that did require a response generally required students to recall information from a previous class or from their reading. Occasionally students would ask questions which were usually aimed at clarification of a term or structure rather than probing for deeper understanding. The number of questions was quite low, averaging no more than five per class meeting. The following excerpt from my field notes describes the kinds of question-answer exchanges that occurred between I.A. and students.
March 7, Wednesday. I.A. is lecturing on the endocrine system and is explaining adrenalin. A student responds to a question about adrenalin and mentions fight or flight. I.A. says, "If you run across a bear in the woods you can fight or, if you're like me, you'll run like Hell, basically." Students respond with laughter.

I.A. goes on to ask a question about another hormone, aldosterone. "What was the target organ of aldosterone?" There is no response from the class. "What system were we talking about before the endocrine?" No response. "What does renal stand for?" A student responds, "Kidney." I.A. follows up with, "Right, so aldosterone has its effect on the kidney." Students rarely asked questions in class. Questions, when they were asked, were usually from only two or three students. One student explained the lack of questions this way:

I think a lot of it as you write it down you read it, you say I understand that, but if you take time to read it and say do I really understand this, is this what she's trying to say, by the time you sit there and comprehend it, she's onto something else so you don't realize you don't understand what she's saying until you go back and read your notes...[When somebody does ask a question] she would answer but it's more of a
rush. She's sorta afraid she's not going to get through everything she needs to get through.

When students did ask questions, I.A. often seemed hesitant about answering. I don't question her knowledge in biology, but her hesitancy to follow through when answering questions gave the impression that she was unsure of the answer, or unsure of what she wanted to say. According to one student, "She knows what she's talking about, it's just hard for her to explain it." It often appeared as if she were searching for a particular fact rather than getting at the question being posed. She had a tendency to rush through answers and move quickly back to her notes. In the following excerpt, I.A. mentioned that some organisms can live at great depths in the ocean, to which a student responded by asking a question:

March 26, Monday. They have actually found organisms living at these great depths. They look like something out of a science fiction movie, I mean there are blind worms...

Student: Aren't there some that produce their own light?

Most, this is what I know, there were some organisms, most of their, the ultimate source of energy we said was the sun. But down deep in the ocean floor we have vents, what they call vents, where hot gases from underneath the ocean come up,
all right. There are some bacteria that have 
ad适应了那个区域，它们可以用那个，它们叫作地热能，geo-meaning ground, 
ergy. And they're able to use that as a source 
of energy.

I.A. went on to talk more about certain bacteria and then 
went back into talking about these long worms that live on 
the ocean floor, but never really answered the question.

The relationship between I.A. and students in 
laboratory class was much more informal. After the first 
field trip I took with this class, I made the following 
note:

Going on field trip like this is an excellent way to 
help students make the connections between classroom 
information and real world applications. It is also an 
excellent way for instructors and students to interact 
more informally and to get better acquainted.

There was more talking among students and much more 
interaction between I.A. and students during lab. One of 
the students explained the difference between lecture and 
lab this way:

Lab is a lot more relaxed. You can be yourself and 
take it easy. When you're in class you just go in and 
take your notes and try to do the best you can on 
tests. You're expected to pay more attention in class
cause you have to take those notes. Lab is something you actually do.

**I.B./Student Interaction**

Interaction between I.B. and students was extremely limited in the lecture classroom. Again, the principal mechanism for instructor/student interaction was question/answer. Occasionally I.B. would ask a question, but seldom did students ask a question. During the classes observed for this study, instructor questions averaged between four and five per class session. Questions asked by I.B. were usually the type that required the recall of specific information. Sometimes the questions were rhetorical and were used to move into another topic or simply as part of the explanation. For example, "How long does it take? Well, it takes a long time, maybe five hundred years or so." And another time, "How many layers do you usually find? Well, not many." Another time, while explaining aerobic respiration at the sewage treatment plant, he used a series of questions and answers: "Think about it, what do we need for aerobic respiration? Oxygen. What are the by-products of aerobic respiration? CO₂ and H₂O. If we didn't bubble O₂ here what would happen to the amount of dissolved O₂? It would go down, wouldn't it?"

Questions from students were extremely rare in this class. I observed many lectures where there were no
questions asked by students. One student explained the overall lack of student participation this way:

I think he's gotten into a routine, too. Nobody says anything. I think he's gotten to where he's had class after class and lectured and nobody has spoken up and he's gotten into a routine where he just lectures straight on through giving the material.

The atmosphere was much more relaxed and informal in the laboratory classes, although part of the reason could have been that field trips were a major part of the laboratory experience during the course of the observation period. Two of the labs attended were field trips, one to a stream and one to a deciduous forest. I.B. seemed to really enjoy these trips. I later learned that he firmly believes that field trips help to stimulate student interest in biology and in nature. On the stream field trip the students went into the stream and collected small fish, insects, worms, salamanders, and frogs. After they had been collecting for an hour or so, he gathered the students all together and identified the specimens for the students. The students really seemed to enjoy the experience and it was an excellent opportunity for I.B. to be more informal and to relate to students on a more personal level. One student talked about the difference between lecture and lab:

In class you're taking notes and he's lecturing. In lab he's going around talking to each individual,
you're more active, more relaxed, more informal... You can walk in and out of lab. You can leave after ten minutes if you want to.

I.C./Student Interaction

Again, interaction between I.C. and students in the lecture classroom was limited to questions and answers. The class was relatively small, sometimes as few as eleven students present, and the students were generally quiet by nature. I.C. would ask questions occasionally, often rhetorical.

Student questions were very rare. When a student would ask a question, however, I.C. always made an effort to answer it. For example, a student asked, "Which would last longer, saltwater fish in freshwater or freshwater fish in saltwater." I.C. said that he would bet on saltwater fish in freshwater. And even if he wasn't sure of the answer, which wasn't often, he would offer to find the answer. One student asked, "Can you give me an example of prostaglandins acting on nervous system?" I.C. responded, "I can't think of one example right off hand but I'll look; try to find an example for you." Students, when asked about the lack of questions on their part, had this to say:

...there just isn't enough time. I feel like that we're already so far behind the other classes I don't want to change the subject. Let's get on with this instead of getting in a long discussion...
Like today, I would've liked to ask a couple of questions on the eye, but if you look on the schedule there's so much stuff crammed in there, I feel that we're going to miss out on something else that's going to be tested if I ask a question...

We're trying to take up too much stuff to try and have a discussion.

It's hard for me [to ask questions], but that's just my personality...I don't like to interrupt...I have a hard time stopping him though...It's hard to get his attention.

Overall, then, there were very few questions asked by students and questions asked by I.C. were often rhetorical.

There was more interaction between I.C. and the students in the laboratory class, and the class was again more informal. Once a lab exercise had been introduced and students were "released" to work on the exercise, I.C. would walk around the room and talk with the students informally and answer their questions. In the lab, I.C. appeared to take on the role of facilitator or mentor, even though he still spent most of his time telling the students what they should do next. He was kept busy going from group to group, but it seemed quite clear that he enjoyed it. One day as he was moving around the room from group to group, he looked over at me, smiled, and said, "This is where it's at."
Introduction

Borrowing a term from Richardson, Fisk, & Okun (1983), each section of Biology 102 observed at VVCC can best be described as an information-transfer course. Each course was designed for the transfer of specific information from instructor to student and each class was instructor-dominated. On average 90% to 95% of lecture was the instructor presenting terms and students listening or taking notes. Instructors would occasionally ask questions, often rhetorical in nature, and occasionally students would ask questions. Question-answer sessions, however, were always quite brief, consuming the remaining five to ten percent of lecture time. Whole class discussions rarely, if ever occurred. At no time during the length of this study were whole class discussions lasting longer than from thirty to sixty seconds observed.

I.A. Lecture Activities

In I.A.'s classroom lecture consumed from 75% to 80% of class time (Table 2). I.A. would arrive for class at 9:00, sometimes a few minutes before. She would get the overhead projector ready and arrange her papers on the desk before class began. Each class began with I.A. taking roll by going down the list of students without calling out their names. Apparently I.A. was familiar enough with the students that it was not necessary to call roll. It was
Table 2

Estimated Percentages of Class Time Spent on Each Activity.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Lecture</th>
<th>Lab.</th>
<th>Lecture</th>
<th>Lab.</th>
<th>Lecture</th>
<th>Lab.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor lecture</td>
<td>75</td>
<td>Var.</td>
<td>85</td>
<td>Var.</td>
<td>80</td>
<td>Var.</td>
</tr>
<tr>
<td>Instructor questions</td>
<td>7</td>
<td>&quot;</td>
<td>2</td>
<td>&quot;</td>
<td>4</td>
<td>&quot;</td>
</tr>
<tr>
<td>Student questions</td>
<td>1</td>
<td>&quot;</td>
<td>0</td>
<td>&quot;</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>Dialogue</td>
<td>2</td>
<td>&quot;</td>
<td>0</td>
<td>&quot;</td>
<td>0</td>
<td>&quot;</td>
</tr>
<tr>
<td>Housekeeping: e.g., roll</td>
<td>15</td>
<td>&quot;</td>
<td>10</td>
<td>&quot;</td>
<td>15</td>
<td>&quot;</td>
</tr>
<tr>
<td>&amp; announcements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note. Estimates were made by author based on classroom observations.
quite common for students to walk into class during the
time roll was being taken and often two or three students
would arrive as late as ten minutes into the class.
Sometimes she would use a few minutes to make announcements
concerning school activities ("Classes are cancelled Monday
and Tuesday") or to remind the class what to expect in the
coming laboratory ("In lab tomorrow bring red manual"), or
reminding them of upcoming assignments ("Remember there will
be a test next Monday").

I.A. often started lecture with questions as a way to
review information presented in the previous lecture. The
following exchange between I.A. and students is typical of
the kind of questions and answers during review.

I.A.: Does anyone remember what system we're on?
Class: Endocrine.
I.A.: What is this system composed of?
Class: Glands.
I.A.: What do these glands produce?
Class: Hormones.
I.A.: Where would you look if you were looking for
hormones?

These reviews would last from one to five minutes. Usually
during these reviews I.A. would not write on the board, use
the overhead projector, or use her notes. Students did not
take notes or refer to their notes during the reviews.
Excerpts from my field notes describe this activity:
March 14, Wednesday. I.A. recaps what was covered Monday. While reviewing, I.A. does not write on board, students not taking notes. Students are not double checking or following along in Monday's notes. Even though no one was writing along, when I.A. wrote sensory nerve on board, students' heads immediately went down and they started writing. This may be new material but there was no clear transition from review to this. The writing on board must be the signal that this is new material.

March 26, Monday. I.A. starts class with an announcement that classes are cancelled next Monday and Tuesday in order for students to see their advisors and to arrange schedules for next fall. I.A. starts reviewing previous material by asking the class, "What are abiotic factors?" She gets out the overhead projector and puts up a transparency of biomes and reviews the ones that have been covered up to this point. During this review students are listening, or looking at I.A., but none are taking notes. Now it appears I.A. is going on to new material. When she writes on the board the students start writing. I've noticed that two students have their eyes closed, but when I.A. wrote on the board, even the students with their eyes closed began writing.
When I.A. went into lecture mode she would walk back and forth in front of the board with her notes in her hand. I.A. had a way of lecturing that made the information seem detached from the real world. It was often difficult to make the connection from one bit of information to another. The following excerpts from her lectures illustrate the nature of her presentations:

March 26, Monday. ...So you're going to get in this photic zone at the top, all right, you're going to get what they call phytoplankton. Plankton's the stuff that floats along the top. And this is going to be basically algae...and blue-green algae. And remember blue-green algae is a procaryotic-type of cell, so it's not the same as algae, has a different cell structure. All right, then this is going to be a source of food...for what is called the zooplankton.

Source...of...food...for...zooplankton [writing on board].

All right. Now, lakes and ponds are affected by the temperature, all right, you're going to have a lot of nutrients at the top, all right, are going to be absorbed by these photic organisms, these algae and blue-green algae, all right. They're going to use these nutrients at the top of the lake, all right. But there's going to be a point at which they'll start dying, so you'll end up with a lot of dead material at
the bottom of the lake, all right. Now, one way that this could all sort of turnover is called eutrophication, all right, we get a turnover of the entire lake during the year. At the beginning the water in the spring, all right, is going to be...warmer at the top and less dense, all right, you go through summer and get to fall, all right, now, when the water starts to get colder in the fall, the water at the top gets more dense, all right, and the water at the bottom gets warmer.

March 28, Wednesday. How can we add to a population? What ways are there that we can add to a population, number wise? [Writes on board] Populations...can...be...added...to...or...taken...from. How can we add to a population?... A student answers, reproduction. Reproduction, all right, so we can add [writes on board]...by...reproduction. All right, and there's a term used with reproduction, birth...or...natality, n-a-t-a-l-i-t-y. Can we add by any other way? How else do we add to a population in a particular area? Yeah, now, we can add individuals from other areas, so we can have immigration. [Writes on board] Add...individuals...from...other...areas. How can we subtract? What's the opposite? Death, some die, death, or what we call...mortality. Can we get rid of people? Can we go
the opposite way? So what's the, immigration is coming in, what's the word for going out? [Student answers migration] Well, migration but [another student chimes in emigration] emigration, with an "e", emigration. Emigration, again, you get an exodus...of...
individuals. And basically, they're going to go where there's resources.

I.A.'s lecture style is an excellent example of the process of "bitting" as described by Richardson, et al. (1983), in which course content is presented in small bits of information intended to be memorized and recalled. I say an excellent example because I.A. wrote much of what she said word-for-word on the board. During an interview with a group of students in this class, one student remarked: "And everything she says she writes. I don't think she ever turns around and talks to us. She writes everything. I mean, every single thing that woman says she writes."

As she lectured she would write sentences, often complete sentences, on the board. The following excerpts illustrate the detail of what is written on the board:

February 28, Wednesday. Nephrons control the composition of blood by 3 processes.

1). Filtration--Blood pressure forces fluid from capillaries (the glomerus [misspelled]) into the lumen of the renal tubule. \( \text{H}_2\text{O} \) & small molecules
come through but not cells or protein.
Non-selective.

2). Secretion—as the filtrate passes through the renal tubule, it is joined by substances that surround the tubule—interstitial fluid.
Selective
Active transport
Diffusion.

Regulation of the kidney. Cells in the brain, circulatory system & kidney that monitor salt & H₂O balance.

Hormones control this—a hormone is released from the pituitary gland called ADH or antidiuretic hormone.

March 5, Monday. Diabetics do not produce enough insulin.

Insulin is produced by B [Beta] cells in the pancreas.
Glucagon is " " a (alpha) cells " " .
Insulin lowers blood sugar levels by allowing the uptake of glucose by body cells, including the liver.
Glucagon increases blood sugar levels—it stimulates the conversion of glycogen to glucose.

These are only portions of the material that were written on the board during any given class period, but they serve to illustrate the nature of the notes used. She would write in complete sentences and students would copy them
down. While I.A. lectured she carried her hand-written notes with her. I.A. would walk away from the board as she explained in more detail what she had written on the board, and then would go right back to the board to continue the lecture. As one student explained, "She told me she didn't know how to get it across to the students unless she wrote it on the board."

Since she wrote while she talked, she spent a great deal of time with her back to the class. As one student commented, "I don't think she ever turns around and talks to us." I.A. would occasionally make a mistake, such as in numbering or in spelling (February 28), but no one in the class mentioned them, although, as I found out later, the students were aware of them. Certainly mistakes will occur, but these examples demonstrate reluctance on the part of the students to point out mistakes and might point to a reluctance on their part to ask questions when they don't understand something.

And as I indicated earlier, eye contact was also kept to a minimum during the lectures. I.A. would look at the board, look out the window, or look to the side, but rarely would she look directly at the students. She would occasionally glance around the room but the majority of the time she would look at the board. The majority of eye contact made, when it was made, was with one particular student, or possibly group of students, who sat in the front
on I.A.'s right. And students were aware of that. During my interview with students from this class, I mentioned that I.A. rarely looked around the class, and one student looked at another and said, "Yeah, she looks at you all the time." Once I started taking note of the amount of eye contact, it became immediately apparent that I.A. either looked away from the students or looked at a particular area of the classroom, avoiding eye contact. This habit seemed to maintain a separation between the students and the instructor and kept the students' attention focused on the board. The pattern would change, however, when I.A. stopped writing and got away from the "prepared" lecture. Occasionally I.A. would go into more depth on a particular topic or relate a specific story illustrative of a topic, during which she would turn and face the class, talking directly to them.

Students would respond to these lectures by taking notes when I.A. wrote on the board. One of the most interesting things was to see how the class would one moment seem inattentive and almost in a daze and the next, almost in unison, be writing. It appeared as if the students were responding to a stimulus (e.g., the ringing bell) when I.A. either wrote on the board or changed the tone of voice or emphasized a word or phrase. Because I.A. wrote so much on the board, some students were not able to determine what was
the most important information and tried to write everything down, waiting for later to think about it.

You try and write down every word she says because you know that if you sit there and think about something long enough you're going to miss something. You're trying to write everything down so that you don't miss it [but] you don't listen to her and how she's explaining it. When you read over your notes you're going, now wait a minute, what does this have to do with this and what is this? You're sitting there trying to write as fast as you can not listening to what she has to say.

She writes everything down so I don't know what's important. I wish she'd highlight things that are more important.

Each lecture class period ended the same way. I.A. would be lecturing and, starting anywhere from three minutes to five minutes before the scheduled end of the class, some students would start putting their notebooks away, some would zip and unzip their book bags, and the noise and commotion would gradually increase until I.A. would either stop talking or say that class was over.

The general pattern was consistent throughout the observation period: I.A. would lecture directly from notes while writing phrases, often complete sentences, on the board. Students would listen during reviews and write
whenever I.A. wrote on the board. The level of questioning by I.A required recall of specific information that had been presented previously or could be found in the textbook. Questions from students, which were rarely asked, originated from two or three students and were usually directed at clarification of specific bits of information. Questions from students that strayed from specific information were rarely answered directly.

I.A. Laboratory Activities

I.A.'s lab met on Thursdays at 8:00am. The same students that were in the lecture class were in the lab. Field trips were a major part of labs during this part of the semester. Three of the six labs I attended were field trips and another was an outdoor exercise. The laboratory sessions were generally more relaxed and informal than the lecture, although most anytime I.A. talked in front of the class it took on the appearance of a lecture. But I.A. appeared to be more relaxed in lab and would allow the students more freedom in terms of talking amongst themselves than she did in lecture.

The first lab I attended was a field trip to the sewage treatment plant. This particular sewage treatment plant is very progressive and offered several examples of processes that allowed students to see a variety of biological principles in action. For example, the water used to cool engines that operate the pumps is used to heat storage tanks
where anaerobic bacteria decompose the sludge to elemental form. Temperature needs to be approximately ninety-five degrees for most efficient decomposition, but instead of using a separate energy source to heat the tanks, the heat from the pump engines is used. In addition, methane from the decomposition of organic matter is used to run the engines. The end products of organic decomposition is used as fertilizer. These are excellent examples of energy conservation and conservation in action.

The tour of the sewage treatment plant was conducted by the plant manager so I.A. did not have to lecture, and for the most part did not point out special items of interest. I.A. did have the opportunity to talk with students more informally and students, too, were able to interact among themselves in a more relaxed atmosphere. This particular field trip gave students the opportunity to see a real-world application of biological principles and, thus, the opportunity to put meaning behind the words.

We stayed at school for the next lab session. Because the lab was scheduled to start at 8:00 in the morning and students would tend to arrive late, I.A. would often start by reviewing previous labs. The review consisted of going over questions from the end of an exercise in the lab book. I.A. would read the questions and students were supposed to respond. But just as in lecture, only two or three actually responded. It also appeared that when I.A. asked a
question, it didn't matter if the student's response was correct, because once a response was made (correctly or incorrectly) I.A. would go ahead and give the correct answer. Some students would write the answers in the book as they were given.

I.A.'s approach was somewhat different in lab than in lecture. I.A. made more eye contact in lab and would actually ask questions of students directly by name, something I had not seen done in lecture. I.A. would also walk around more in lab and would walk right up to students and maintain eye contact. The rules of conduct that seemed to apply in lecture did not seem to be as important in lab.

I.B. Lecture Activities

This section of Biology 102 conducted by I.B. was also of the information transfer variety. Since he had a lecture in the same room at 10:00am (the section I attended met at 11:00am), he would very often be present for five minutes before class and talk informally with students, usually on a topic related to the course. At 11:00 he would take roll without calling names and make announcements about lab, tests, or other school activities. Announcements usually consumed from five to ten minutes, and then he would go directly into lecture.

Once he started to lecture there was seldom any interruption. Between 95% and 100% of the lecture time was spent with the instructor talking and the students listening
and taking notes. Lecture consumed from 80% to 90% of class
time and consisted almost entirely of the presentation of
biological terms and principles (Table 2). While lecturing
he walked back and forth with hands typically held behind
his back or with a hand in a pocket of his white lab coat,
which he always wore. The main lecture terms had already
been written on the board for the preceding class so he
didn't have to write while he lectured. He seemed to use
the terms on the board as an outline and would lecture from
the outline. He had a notebook containing lecture notes on
the front desk but he seldom referred to them. The
following illustrate the brief nature of the notes written
on board:

Wednesday, April 4.

Between Pops
symbiosis
1). mutualism
mycorrhizae
Yucca
2). Commensalism
epiphytes
3). Parasites
2 hosts
social
4). Predation
Kaibab Plateau
1906-1939
816 mt. lions
863 bobcats
7388 coyotes
30 wolves
4000
100000
Within pops
1). Density
   total count
   random sample

This example illustrates the brevity of notes written on the board. As he lectured he would refer to each of the terms or phrases and then expound on it.

His style of lecture was relaxed and informal. He had a habit of repeating phrases but, because it was done so often, I assumed it wasn't always to emphasize important points. The following excerpts from my field notes illustrate the kinds of phrases he repeated:

March 7, Wednesday. I.B.'s lecture is on oceans. He repeats several phrases. It is the least productive. It is the least productive...It is the least hospitable. It is the least hospitable...Many of them will move with light intensity. Many of them will move with light intensity...Many of these animals are
sifters, as they feed on plankton. Many of these animals are sifters, as they feed on plankton...It is low in nutrient content. It is low in nutrient content.

Monday, April 23. Today's lecture is on speciation. He continues the pattern of repeating phrases. My perception is that the repeated phrases are not necessarily more important than other phrases but rather this is indicative of his lecture style. This could also apply to humans. This could also apply to humans...We talked about the classification of organisms. Classification of organisms... Their offspring would be fertile. Their offspring would be fertile...All three of these represent groups. All three of those terms represent groups.

The pattern of repeating phrases continued throughout his lectures. And again it was not always clear whether, or when, the repetitions were meant to be emphasis or whether they were simply part of I.B.'s lecture style. However, when students were asked if they could tell when I.B. said something that was important for them to know, one student responded, "Sure. He says it twice. If he says it twice you better write it down."

Even though he did not refer to his notes as he lectured it was clear that he had been through these lectures before. There was something about the way that he
spoke that sounded somewhat mechanical. Of course he had
gone through the same lecture the hour before, but it was
more than that. When I asked some of his students about
this one responded, "Oh yeah, I feel like he's been doing it
for years." Another responded,

[His lectures are] almost exactly like my sister's
notes. She took the class in 1983. I've got her
notebook and [her] notes are almost exactly like mine,
almost exactly the same...She wrote the same things I
wrote down.

When he would get away from his "prepared" lecture his
tone of voice and speech pattern would change. Students
seemed to be able to detect these changes because they would
write less when he moved out of lecture mode. His lecture
mode speech pattern was similar to the tone someone takes
when reading; not quite monotone but deliberate. Although
the tone of voice cannot be illustrated here, the following
quote from one of his lectures will illustrate the general
pattern of his lectures:

March 13, Wednesday. [He was discussing the difference
between lakes and ponds.] Another one is the depth of
them. Depth of them. Ponds typically have light all
the way to the bottom. Ponds typically have light all
the way to the bottom. And often times you have rooted
vegetation on the bottom. Often times there is rooted
vegetation on the bottom. Lakes do not have that.
Lakes, there's usually an area where there is no light, that is called the profundal zone. Perhaps another one, and maybe even the most critical here, is thermal stratification. Thermal stratification. Lakes, typically, are stratified from top to bottom. Ever go in a lake, dive in, and hit that zone of cold water? Thermal stratification, thermal stratification. So lakes, then, lakes are usually larger, thermal stratification, and also the wave-swept shoreline. He often used questions to call attention to the next bit of information he would be presenting. Another quote from one of his lectures illustrates:

March 21, Wednesday. [He was discussing succession and the different kinds of animals that appear as plants change.] As we get into the grasses and weeds, what are we going to find there? Well, we're going to find soil, and find worms in the ground. Since we have seed we're going to find birds that feed on those seeds. We're going to find mice, things that feed on the grass. And if we find mice we're going to find things that feed on mice, probably snakes and hawks. So we find that as the plants change, that really dictates what animals can live there. And then we get into the shrubs. What are we going to find in the shrubs? Well, we'll probably find that there'll be rabbits and the predators on the rabbits...
In the previous example, I.B. asked a question and went directly into an answer without waiting for a response. Occasionally, I.B. would ask a question and not wait for a response even though a student would try to respond. When talking about parasitism he asked the question, "If it kills the host, what do you think will happen to it?" A student made an attempt to answer but I.B. apparently didn't see him because I.B. went right on with the lecture. Students have noticed, too. When I mentioned to them that very few questions seemed to get asked by students in class, one spoke up and said, "People have spoken up, he just hasn't noticed."

Student response during lectures was to listen and take notes. When I.B. mentioned one of the terms on the board students would seem to write more. As the lecture moved away from specific reference to the term the amount of writing would slow down. When another term was mentioned writing would pick up again.

I.B. looked directly at the students, making eye contact, approximately forty percent of the time. The majority of the time he appeared to be looking over their heads, out the window, or at the board.

The pattern of this lecture class was consistent throughout the study. I.B. would most often start lecture without reviewing previous material. Once the lecture started there were few distractions. Students would rarely
ask questions and questions asked by I.B. were either
rhetorical or required that students recall specific bits of
information from previous lectures.

I.B. Laboratory Activities

The first of I.B.'s labs I attended started with a
National Geographic video on sharks. I.B. had indicated to
me earlier that he believed videos to be excellent tools for
bringing biology to life for the students. This particular
video was "scientifically" based but was clearly intended to
elicit sympathy for the plight of sharks and to reduce fear
of sharks. After the video I.B. introduced the lab exercise
for the day, which was bones and the skeleton.

I.B., using his lecture mode, described the various
skeletons students were to examine and which bones they were
to know. He distributed diagrams of the human skeleton and
skull and identified the specific bones they were to learn.
The assignment was to learn the bones, thirty-seven in all,
and to fill in the chart in the lab books. Students then
worked on their own or in small groups to locate the various
bones, asking questions of I.B. when they needed to.
Students were not required to remain in lab for any
particular length of time. Some left quickly while others
remained in lab for nearly an hour.

On two occasions I accompanied the class on field
trips. One field trip was to a deciduous forest. I.B. led
the class along a trail, stopped to identify trees, shrubs,
and other plants, and generally discussed the ecology of the forest biome. As we walked I.B. talked and students listened, some asking questions occasionally about specific plants. At the end of the walk I.B. went over questions in the lab book. He also told the class at the end of the walk that his main goal was for them to gain an appreciation of nature—so that no matter what they did in the future they would have a better understanding of their natural surroundings.

The other field trip was to a stream several miles north of the city. I rode with I.B. in a van while the students drove their own cars. It was a warm, sunny day and the stream and surroundings were quite lovely. Once we arrived at the stream, I.B. gave the students instructions and some equipment and sent them on their own to collect specimens from in and along the stream.

The students really enjoyed looking for frogs, salamanders, bugs, small fish, and crayfish. After about an hour of collecting, the students gathered around I.B. who then proceeded to identify each of various animals students found. I.B. did the identifying while students watched.

I.C. Lecture Activities

This section of BIO 102 met on Tuesdays and Thursdays at 11:00am in room 305 of the science building, the same room used by I.A.. I.C. would often arrive five minutes late for class, and I later learned that he was teaching a
course at an off campus location just prior to this class. I.C. would come into the room carrying a book and sometimes papers that he would return to the class. I.C. would take roll without calling names and would sometimes make comments, slightly under his breath so I had difficulty picking up what he said, about who was present or absent. He used a table-top lectern on which he placed his textbook. Approximately 80% of class time consisted of I.C. talking and students listening (Table 2). I.C. did not lecture from notes but lectured from his open book. Of the three instructors observed for this study, I.C. was the only one who relied on the book and required and expected that students read the book. I.C. would use the headings in the book as an outline and would lecture without notes, referring students to particular pages and diagrams in the book. I described the general pattern of his lectures in my field notes:

March 8, Thursday. Still lecturing by going through book page by page, selecting topics and expanding on them. He refers to figures and tables as well as specific paragraphs in book, but he doesn't read. His lecture style is conversational, interspersed with questions, many of which he doesn't wait for an answer. If it's something he thinks they should know he'll probe until he gets a response.
The following excerpts from his lectures provide illustrations of the general pattern of his lectures and the way in which he would refer to the textbook:

March 13, Tuesday. [Discussion of pancreas and insulin.] As they tell you, the beta cells here synthesize and secrete the insulin, so they want to put that in. Actually insulin does what when it affects the target cells? What does it really do? [Four second wait time, no response] It helps those cells, it facilitates, if you will, the absorption of sugar into the cell. It doesn't take it up for them, or anything like that, nothing that drastic. It simply aids in the absorption of the glucose, and therefore it lowers blood glucose levels...It also has a kind of counter effect on the liver to maybe help release a little glycogen, there's not much sense in trying to speed up absorption if you don't have a good level to start with...Now, the alpha cells that you see down there go with the glucagon and glucagon tends to work just the opposite of this. It stimulates the tie-up of glucose, you know it says, gee, we oughta keep this in storage for the time being. So it is a kind of opposite or antagonistic thing. So the management of glucose is kind of delegated to the pancreas.

The illustration over on 896 is a very good one. They show you what insulin actually looks like. I
think...it was...in sixty-three that Sanger won the Nobel Prize for figuring that out. This kind of shows you where we are in the stages of identifying molecules and what not. The sequence of all these amino acids, I think there are 151 or something...

March 27, Tuesday. We talk about the activation of the egg. And if we want to compare this to something, maybe...the humans, but look at the time line over here for the sea urchin. They have long worked with sea urchins in inducing fertilization...They put the time scale here on a logarithmic function. Does that mean anything to us? Why would they do that? [No response]...Basically that's why they do that, to kind of get it on an even time scale... [Goes on and reads through the time line in book.]

I later found out that the reason for not using overheads in this class was that he did not have access to them. This was the first year he had used this particular textbook and there weren't enough copies of transparencies for all instructors. He told me it had taken him until now to make contact with the textbook representative and to get approval for additional copies of transparencies. He uses overheads for his other courses and normally would be using them for this course.
Some of the students, when questioned about I.C.'s lecture style and use of the book as he lectured, seemed to, if not enjoy it, at least appreciate it and recognized there were positive aspects to this style:

I like it. 'Cause if you miss one day of lecture, all you have to do is find the place where he stopped and go back and read from the time before you missed and 'till you came back again and you're caught up.

He did not use the board on a regular basis as he lectured. He would use the board occasionally to emphasize certain terms or to illustrate a structure. On Tuesday, March 27 the following terms were written on the board:

- Development
- cell division
- cleavage
- differentiation
- specialization
- germ layers
- morphogenesis
- organogenesis.

Also during this lecture he drew a picture to illustrate the early development of a fertilized egg and labelled the following parts: blastocoel, blastopore, neurula, mesenchyme, and mesoderm. But the usual method was for I.C. to lecture from the book while students took notes or underlined in the book.
I.C. would sometimes start lecture with questions to review previous material or to get the class thinking about the topic, for example:

I.C. What two systems are control systems in the body? What are they? What are we in?
Stu. Endocrine.
I.C. What system controls muscles?
Stu. Muscles.
I.C. What would you say about local regulators the prostaglandins, about where they're found, etc.
Stu. No response.

Responses from students, when they were made, came primarily from two male students who sat in the back row. One or the other of these two students would respond, not always correctly, but they kept trying.

At other times I.C. would ask questions that tended to be rhetorical. It appeared that he did not expect a response. The following excerpts from lectures represent typical ways that I.C. used questions during his lectures:

March 20, Tuesday. [The beginning stages of a lecture on sexual reproduction.] If I were going to try to outline the process, do a flow chart of sexual reproduction, what would you say? What processes, what stages would you want to include here? [A student responds that it takes two individuals.] All right, let's take that and say that we're going to have
gametes produced [writes on board]...gametes, with this business of fertilization, going to produce a what?

[Student responds zygote.] All right, a zygote [writing on board]. And the zygote, I guess we're going to have to say that, make a big step in development here into some sort of adult. And then we're going to say well, gee, that adult has the ability to produce, via meiosis, gametes again. So what we're doing is, we're saying that the sexual reproduction [cycle] always should have a time and place for fertilization, we should always have a time and a place for meiosis, and your results should be the gamete which is a haploid structure and, of course the zygote is a diploid structure, and that's the way we kind of go through the life cycle...

March 27, Tuesday. [Continuation of lecture on sexual reproduction.] They're actually using Amphioxus. Let me correct myself there. Amphioxus is what? Anyone remember Amphioxus? Where did we run across Amphioxus? Was it a vertebrate or an invertebrate? [Probing, no response]... Little lancet or ___? One of the invertebrate chordates. So this is a fairly simple lower form of development, although it is at the chordate level...You see they've begun to color things. What do we mean by those colors? Do you recall? What
is always blue? What's going to form the ectoderm or outer layer, nervous system, skin, that kind of thing, of the developing embryo? What's going to be the ___? Remember we had blue, yellow, and pink or red? All right, the yellow usually forms the gut. And again the term they're using now is the gastrulation process. Gastrulation as you see there...Well, what you see there then is the formation of what we call the primitive gut, the archenteron.

I.C. lectured from the textbook and often used the phrase, "They say" or "They talk about" when referring to the book. For example, "Look at this sequence they describe in this figure." "They talk about the various areas used for storage." The following excerpt from one of his lectures illustrates the general pattern:

March 13, Tuesday. Let's move over to the thyroid gland, a little bit, this is over on page ninety-four. We have a couple of the thyroid hormones, T-3 and T-4 just to show that there are some variations. They also want to show that, gee, iodine is important here. The reason you consume iodine is largely for the production of these hormones... There is another hormone, and that's calcitonin. Calcitonin is dealing with something else entirely, does not deal with metabolism so much. But it, as it says there, lowers blood
calcium levels, it inhibits calcium from being combined into bone.

As he lectured, I.C. would look at students and make eye contact most of the time. However, 90% of the time he would be looking at only one half of the room. The class seemed to be separated into two halves. The side that he seemed to be lecturing to were students who responded more and asked more questions. The students on that side of the room would often meet together between lecture and lab to study for the lab quizzes. The students in the other half of the room did not participate as much and included two male students who either slept or read other books.

Student response during lecture was, in most cases, to listen with their textbooks and notebooks open on their desks. Most students would follow along in the book and underline, highlight, and write notes in the textbook as I.C. lectured. On some occasions students would take notes in their notebooks. The students in this class were quite subdued and did not actively participate during class. Very few questions were asked and few attempted to answer questions posed by I.C. There were three male students who attended lecture regularly but who did not listen or take notes. These three would often read other textbooks, do math homework, read paperbacks, or as in the case of one student, take short naps. Although they did not listen to lectures, they nevertheless attended class regularly. One
of these students indicated to me that he attended because he knew it would help him if his final percentage was on the borderline between two grades.

Lectures conducted by I.C. were informative but not stimulating, and the material was presented in a concise, well-organized manner. I.C. was open to questions from students and always responded in a cordial tone and made an effort to answer each question. Questions, however were quite rare, averaging less than two per lecture. I.C. would ask questions during his lectures, often rhetorical. Questions that were not rhetorical were the type that required recall of specific information from the textbook.

I.C. Laboratory Activities

Four sessions of this lab section, which met on Thursday afternoons at 2:00, were observed for this study. Three of the labs were conducted in the lab and the fourth was a fieldtrip to a deciduous forest. The class also went on a fieldtrip to the sewage treatment plant, but I did not accompany them. The other labs not attended did not involve actual lab exercises but were days when tests were being given.

This lab was different from the other two in that I.C. gave a quiz each week. Again the general atmosphere in the lab was more informal than in lecture, and I.C. was able to move around and talk individually with students. Although there was an informal atmosphere to the lab, some students
commented that attending lab and paying attention in lab was more important than attending lecture:

Our lab seems more like lecture than some other classes. They're not worrying about a quiz every week, they're just kind of doing the lab.

If you don't pay attention [in lab] you won't know what in the world is going on...If I had to miss one or the other I'd rather miss lecture. You don't miss lab. I'd get by better missing lecture. You really have something to go by [in lecture], you have the book and he follows the book pretty closely.

The labs that were held inside were all conducted in the same way. The first order of business was the taking of a quiz. After the quiz, I.C. would either introduce the lab exercise or spend some time lecturing if the exercise covered material that hadn't been covered in lecture. Once the lab had been introduced, students were "released" to work on the exercise, sometimes in groups. I.C. would then walk around the room and talk with the students informally and answer their questions. In the lab, I.C. appeared to take on the role of facilitator or mentor, even though he still spent most of his time telling the students what they should do next. He was kept busy going from group to group, but it seemed quite clear that he enjoyed it. It was rather stimulating and encouraging to watch students during
labs. Most of them seemed to become involved in the exercises and appeared to be enjoying the experience.

The one field trip I went on was to a deciduous forest, a trail on the Blue Ridge Parkway. Since I.C. had spent twenty summers working on the Parkway, some of those years as an interpreter, he was very knowledgeable about the plants and animals of the region. The class walked along the trail behind I.C., who would stop at various places and identify plants or otherwise describe a particular point of interest. Students, although many seemed to be interested, did not take notes and did not carry lab books or field guides with them.

Summary

The three sections of BIO 102 observed for this study had certain characteristics in common. In all three examples, the classroom was instructor-dominated. In the lecture classroom, lecture consumed from 75% to 85% of class time, and that included time for roll-taking, announcements, and other "housekeeping" chores. Once the lecture was actually underway, nearly 95% of the time was composed of the instructor "lecturing": presenting a condensed, synthesized version of the most important facts and bits of information needed by the students. All three instructors used questions during their lectures, but the majority of questions appeared to be rhetorical, since students either weren't able or given enough time to answer.
In all three cases the students responded to lectures by writing down what they determined were the most important pieces of information. I.A.'s students wrote down whatever I.A. wrote on the board. I.B.'s students wrote down terms from the board and other information that was emphasized by being said twice by I.B. I.C.'s students responded by underlining and highlighting information in the book that was called to their attention. And in all three cases, questions from students were quite rare and, when asked, were often intended to get clarification of a term.

The primary difference among the three, other than their personal styles, was the emphasis placed on the book. The three could be placed on a continuum, from great reliance to little reliance. I.C. seemed to rely greatly on the textbook, lecturing from the textbook instead of from notes. I.B. seemed not to emphasize the textbook whatsoever. His lecture notes were derived from other sources and, in fact, many students indicated they never or rarely read the textbook. In the middle between these two extremes was I.A. Her lecture notes were derived from the textbook and she used transparencies provided by the textbook publisher. Because her notes were so complete, however, many of her students still indicated they only rarely read the textbook.
Introduction

The issue of control in the classroom was one of the more difficult characteristics to observe and document, but was also one that appeared to be a concern of each instructor and a motivator behind many of their actions. Decisions that were made regarding content, faculty perceptions of students, level of interaction between instructor and students, and pedagogical methods all appeared to be related to and to a large degree determined by a perceived need on the part of instructors to be, or appear to be, in control of the entire classroom environment.

Control in the classroom was manifested primarily through a reliance on lecture. As long as the instructor was lecturing, control was maintained. The more involvement on the part of the students, the less control was in the hands of the instructor. The three classrooms observed for this study provided evidence that lecture, indeed, was used as a weapon and as a means for preserving the classroom power structure.

I.A. Classroom Control

I.A. maintained control, quite effectively, by writing on the board as she spoke. Whenever she wrote on the board, students wrote in their notebooks. I.A. always lectured while carrying her hand-written notes with her. She relied
heavily on her notes, never straying far from her prepared outline, which provided her with considerable control over the direction of the lecture. It was obvious as early as the second lecture class I observed that she was maintaining control through her use of the lecture. I made the following comment in my field notes on February 28, 1990:

The instructor certainly has control over the class. There is very little chance for students to ask questions. The approach is "this is the information that you need to know, now you learn it."

As suggested in this comment, control was also maintained by her tendency to shy away from student questions, her quick response to student questions, and her tendency to move as quickly as possible back to her lecture notes. When a student asked a question, it often appeared she did not know how to respond to the question and she often looked uncomfortable when questions were asked. She didn't openly discourage questions, but her manner of responding to questions certainly had the effect of discouraging questions. One of the students put it this way:

She gets real frustrated though if you don't understand it. She wants you to understand so bad and she gets real frustrated...She starts walking real fast back and forth... She wants to jam it in to you...
[When I go to her office she gets really frustrated] and you're just, like, by the time you get out of there you just feel really rotten and so stupid, you don't really care and you don't want to feel this way.

One particular incident during lecture on February 28, 1990 illustrated the importance I.A. placed on her talking as a means of exerting power over the students. The lecture topic on that day was the human kidney. I.A. was describing the function of the kidneys and how they sorted out the various substances in the blood. One of the students asked I.A. a question about dialysis and "Why hadn't [scientists] come up with an artificial kidney, yet?" I.A. started talking about dialysis machines getting smaller and smaller and getting more portable, and that in a sense are artificial kidneys. I.A. then made a reference to the difficulty in doing experiments on humans. At this point a couple of students appeared to be getting interested, because they started talking amongst themselves, and then another group of students began chattering amongst themselves. I.A., instead of trying to bring everyone into the discussion and keeping their interest up, cut them off and went back into her lecture. It was the most interest I'd seen from students to that point, and it was disappointing not to see their interest encouraged. It appeared to be an excellent opportunity to discuss kidney
function as well as the issue of ethics in human experimentation.

Another example of I.A.'s reliance on lecture to maintain her sense of control in the classroom occurred during lab on March 29, 1990. This particular lab was described as a discussion period. I.A. divided the class into six groups and each group selected a topic from a list that was put on the board. The topics were: (a) World Food Reserves, (b) Overpopulation, (c) Ozone Layer, (d) Pollution, (e) Deforestation, and (f) Global Warming. I.A. then put some "facts" related to each of the topics on the board to give the groups a starting point for the discussion.

I.A. started with the Ozone Layer group by asking the group a question but received very little response. She then went ahead and talked about the dangers of getting a tan, but said we look healthier with a tan. "I can't wear shorts, my legs are so white or pale."

She then went on to the Global Warming group and began by asking questions such as, "What affect could global warming have on the polar ice caps?" This was typical of the kinds of questions asked, questions that could be answered with short answer responses and which did not stimulate discussion.

The result was that control remained in the hands of the instructor, and there was very little interaction either
between the instructor and students, or among students. The relationship between instructor and students in this class never seemed to progress beyond the authority/subordinate stage. During these "discussions," I.A. did 90% of the talking and failed to draw students into any open discussions.

Once I.A. had at least gone around to each of the groups and it was obvious that students were not going to become actively involved in discussions, I.A. "gave up" and sent them home. Although this class was billed as a discussion session, very little discussion actually took place. I.A. did the talking and the students either listened or ignored the entire process.

I.B. Classroom Control

Control in I.B.'s classroom was also manifested by his use of lecture. If and when he felt he was losing control he would talk more and present more facts. This behavior, using the lecture as a tool for maintaining control, was deliberate. During our interview, I.B. had this to say:

[When I see students doing other homework or reading other books during my lecture] I'll tend to speed up or give more notes or really emphasize [something] and make a comment that you're really gonna need to know this...So again I feel I use the lecture as a weapon in a sense of keeping their attention.
Classroom discussions were virtually nonexistent in I.B.'s lecture classroom. Again, this was deliberate on his part. I.B. preferred not to have classroom discussions for fear of losing control over the class.

I don't think I necessarily [prefer discussions] in the classroom. And part of the reason is control of the class. I've been in classes [that have] just rambled, and there doesn't seem to be any direction and you've been to class and you've come out and said what in the world was that about and what was important in there. I resented that type of thing and I still do.

I.B. went on the explain that when he lectures he would prefer not to have students interrupt him. When he lectures he often has a specific line of reasoning or logic sequence that he wants to follow and he doesn't want to be thrown off track. He explained:

It's like in photosynthesis, I start building, putting blocks together and someone raises their hand and they'll ask a question that applies way up here...I want to take them through this thing, lead them through it and when they reach this point up here, I like to be able to look at them and see some faces light up, "Oh, yeah!" And I don't like for somebody to take me out of that path.

Two events occurred during the observation period that led to overt expressions of I.B.'s feeling that part of his
responsibility is to maintain control in the classroom. And control in this case means student acquiescence to institutional authority. On March 7, 1990, I.B. was ready to start his lecture on ocean biomes, but some students in the class were apparently not ready, as they continued to talk. At this point I.B. issued the class a warning and distributed to the class a written policy regarding student disruption of class. The policy read, in part:

Students enrolled in this course are expected to attend each class meeting. A student will be irregularly attending class if one or more of the following occur:

4) The student's behavior impedes instructional processes.

** 5) Disruptive talking in lectures or labs.

** First time will be a warning—SECOND TIME WILL BE OUT OF CLASS!!

I.B. gave the entire class a warning, meaning that the next time a student was "disruptive" in class s/he would be asked to leave. The class settled down and was noticeably subdued for the rest of that day. When asked about this incident, students were divided on the appropriateness of I.B.'s actions. The following discussion took place among students during our focus group session:

#1. I thought it was the most idiotic thing I'd ever read in my entire life. He generalized it and gave it to the entire class. If he wanted to use it as a
warning letter give it to the person causing the problem, not the entire class.

#2. The whole class was talking.
#1. No, the whole class was not talking.
#2. Well, the majority of the class was talking.
#1. The majority may have been. But when you discipline people you can't discipline everybody...Why make the people who aren't doing it feel guilty?
#3. I agree. I don't think we need letters to tell us to be quiet in class. That was what you got in first grade when the teacher asked you to put your finger to your mouth and walk down the hall saying "Shhhhh." I mean, we're in college.

#4. Someone has to be the authority in the classroom. Now when we go to college, [students] should conduct themselves like they should.

Another incident occurred where I.B. overtly presented himself as the authority/father figure to the class. On Friday and Monday, March 16th and 19th, I.B. was out of town. He cancelled the Monday lecture but told the class the Friday class was not cancelled, and that he wanted them to watch a film. It turned out that not very many (approximately seven out of twenty-two) were present for the film. At the beginning of class on Wednesday, March 21, I.B. scolded the class about their lack of responsibility. He asked them, "What should I do when someone asks me for a
recommendation? Tell them you're not dependable?" This "lecture" went on for about five minutes and afterward the class was extremely subdued. Again he scolded the entire class, even the ones who were present on Friday. It must have been difficult for students to get enthused about participating in class after that.

I.C. Classroom Control

Of the three instructors observed for this study, I.C. seemed to be the least overtly concerned about classroom control, although there was no indication that there were any discipline problems in his classroom. There were three students enrolled in this section of BIO 102 who regularly read other books or did other homework while sitting in class. I.C. was aware of this but did not do anything to change or alter these students' behavior.

I.C.'s style was not overpowering, although there was no question about who was in charge. I.C. provided an excellent example of someone holding power by virtue of the information and knowledge he controls. The students seemed to view I.C. as the authority but were not intimidated by him:

He's the authority but he's not overpowering. Some teachers like to be put up on a throne and their word is law. You can talk to [I.C.]. He's very cooperative. Sometimes he'll change his answer [on a test] if you show him what you were thinking.
In some ways I.C. seemed more formal than the other two instructors. For example, I.C. always wore a tie (except on field trips). Apparently he had been kidded about wearing a tie when he first started teaching at VVCC, because during our interview, in response to a question about his relationship with his students, he had this to say:

You may know this, no other biology faculty wear a tie. I caught a lot of grief for that last year but I haven't taken it off yet...I don't think the tie makes a difference. I don't see any problems with that. Maybe the students perceive it as a threat or somebody's dominating over them, or too much authority, I don't know...I've never viewed myself any more than here to teach a person, to help a person, to be a mentor to their development, and that's my philosophy, period.

Chapter 5 goes beyond the description of these classrooms and looks for meanings behind what was done and what was not done in the classrooms observed for this study. Keeping in mind that general biology is offered as part of the general education component of the curriculum and that deliberate efforts were not being made to address the broad goals and values associated with general education, Chapter 5 offers an interpretation of what values were being taught as biological facts were being presented. Why did they conduct their classes in the manner described? What was the
"hidden curriculum" of the general biology courses observed for this study?
Chapter 5
Interpretation and Evaluation

INTRODUCTION

On the surface, Biology 102 as presented at Valley View Community College (VVCC), was concerned with the presentation and dissemination of biological facts, concepts, and principles. In particular, it was concerned with the transfer of biological consensus knowledge. But what is just as interesting and just as important is what was not being taught.

It has been stated several times in this document that general education goals, as they are commonly identified, were not a significant part of the biology curriculum at VVCC (see Table 1). Values represented by such general education goals as independent thought and responsible citizenship were not being overtly taught in general biology, while rote memorization of biological facts was being stressed. If students were not being taught values expressed by general education goals, what values were being taught, perhaps covertly, by virtue of the way the course was taught. In what ways might the topics covered, student motivation and participation, student/instructor interaction, method and style of presentation, and the use of authority in the classroom, affect student learning?

Chapter 5 offers interpretations and evaluations of meanings behind the descriptions of course contents and
classroom environments, and addresses the question: What were the students likely to learn as a result? This chapter is organized around the five emergent categories: (a) content, (b) students, (c) interaction, (d) pedagogy, and (e) control.

CONTENT

Introduction

One of the most obvious and most consistent areas of concern for the general biology instructors observed for this study, and in fact for instructors in many disciplines, was how much and what should be taught in an introductory course. One of the instructors at VVCC expressed his concern this way:

[I.C.] My biggest wrestle over the past eighteen years has probably been what do you teach, how much of it do you teach, and can you get a package together that puts this over to the student with minimal stress and, hopefully, some ease.

Neil Campbell, author of *Biology*, in a talk given at VVCC, talked about the problems associated with what he called "topic glut" and offered suggestions for dealing with the problem in an introductory general biology course. I think he is worth quoting at length on this issue:

There's so much biology and so little time, and we make tough decisions every year about the trade-off between breadth and depth. My bias is to avoid topic glut and
to spend more time on fewer topics and develop them in sufficient depth so that students at least take away something about the results of science...I think that we have to discourage, especially in our introductory courses, what I call term mongering; words just for the sake of learning words (Talk at VVCC, May 1, 1990).

The biology instructors observed for this study were concerned about what topics should be taught, how many terms should be presented, and whether to stress depth or breadth. But regardless of which facts were stressed, all three courses and instructors had one thing in common: Virtually all of the biological information presented was presented as uncontested objective truth. While the stated purpose was to present biological facts, each instructor was also offering students the view that science is both objective and without conflict. It can be argued, however, that science is neither totally objective nor without conflict.

Science as Objective Truth

It is generally held that the scientific attitude is logical, rational, and emphatic. The scientist is presumed to observe phenomena impersonally and objectively. The scientific approach to discovery is associated with positivism and objectivism and rationalism. The positivist asserts there is a single, knowable, measurable reality capable of being separated into independent variables and examined using a value-free method of inquiry. In the
natural and physical sciences that means that natural phenomena can be identified, taken apart, measured and objectively described. Schrodinger (cited in Keller, 1985) identified two fundamental tenets of science: "...nature is (a) objectifiable and (b) knowable" (p. 141). Objectifiable as used here means both "objective, i.e., independent of our cognizance, and objectlike, hence having a well-defined position in space and time" (Keller, 1985, p. 141). Objectifiable implies that (a) the goal of scientists must be to distance themselves from that which they observe, and (b) reality is composed of discrete objects. The concept of knowability implies a one-to-one correspondence between theory and reality, i.e., theories are capable of providing a complete representation of reality. The goal of science then is to collect data, use the data to describe and explain natural phenomena, and ultimately develop theories as explanations of reality.

The science as presented in the biology classrooms at VVCC was presented as objective, neutral, and value-free. Students were taught that scientists view the natural world objectively, without making judgments about good or bad, right or wrong, and that they too should observe their world without making judgments. Students were left with the impression that a scientist "keeps his or her nose clean by staying out of politics, by not asking critical questions
about [his or her] superior's decisions or about the impact of [his or her] work" (Shor & Freirer, 1987, p. 13).

During the course of their "work", scientists accept the basic premises on which their work is based and do not question the tacit assumptions that guide their reasoning. Scientists often argue that the nature of their work requires they avoid contemplating the "philosophy" of science lest their objectivity be questioned. "Let the data speak for themselves" is a statement often made. But data rarely do speak for themselves. Data require interpretation and interpretation requires a common language and an acceptance of common presuppositions about what is worth knowing. Conclusion: The accumulation of scientific knowledge is not as objective and not as true a representation of reality as we would like to believe.

Based on conversations with the three instructors observed for this study, and based on their educational and professional backgrounds, I have concluded that each has accepted certain assumptions about the nature of scientific inquiry. Each has accepted the notions that it is possible to (a) empirically discover the "truth" about natural phenomena, (b) discover the one theory that would provide a complete representation and explanation of reality, and (c) be completely objective in doing scientific research. And in spite of examples to the contrary, scientists are still unwilling to question their basic assumptions that (a) a
single objective reality exists and (b) it can be completely represented in theory.

Science as described here is assumed to be an objective activity, and scientists are viewed as being "severed from the outside world of other objects and simultaneously from their own subjectivity" (Keller, 1985, p. 70). This is the view of science that was presented in the biology classrooms observed for this study: Science is objective and "subject to empirical verification with no outside influences, either personal or political" (Apple, 1979, p. 89). This view of science as objective is an illusion, according to Keller (1985), and "may mirror a rather deep fear of intellectual, moral, and political conflict," according to Apple (1979, p. 89). The truth is that science and the direction of scientific research was and is influenced by economic, political, and ethical forces, both from inside and outside the scientific community (Keller, 1985), and it is just as true that this view of science was either omitted from the biology classrooms at VVCC or mentioned only in passing.

Conflict and Consensus

The science that was presented to the students in general biology, BIO 102, at VVCC, was the traditional view of science as consensus knowledge, and any discussions of the conflicts that are inherent in any human enterprise were avoided. According to this view, the goal of science is "a consensus of rational opinion over the widest possible
field" (Ziman, 1968). This view implies a certain amount of communication and collaboration on the part of scientists. The ideal of science, and the way science is viewed by the lay public, is that it is an open, collaborative enterprise. The following well-known analogy illustrates this view:

If you had a thousand peas to shell, you could distribute them to a number of people to get the job done more quickly. But if you had a jig-saw puzzle to put together, it would not be very efficient to distribute the pieces among many people. The most efficient way would be for everyone to work on the puzzle at the same time, each seeing what the other is doing. Science is like the puzzle; efficiency requires open, collaborative research.

But the practice of science is also a human enterprise, and as such is much more territorial and much more political than it appears to those who have not been admitted to the scientific community. It was the apolitical view of science that was presented to students in BIO 102 at VVCC. This view ignores the conflicts that are inherent within the scientific community and allows students to believe that conflict either doesn't exist, or is a negative force if it does, and consensus is normal and positive.

An example from one of the classrooms observed for this study was the way Darwin's theory of evolution was presented. I.C. began his lecture on Darwin and evolution
half-way through class on a Wednesday. He spent thirty minutes covering such "facts" as Darwin's trip around the world on HMS Beagle, his presentation to the Linnaean Society on July 1, 1858, the publication of his book, *On the Origin of Species*, in 1859, the contributions made by Wallace and Malthus, and a recent example of evolution in action—the well-known example of the peppered moth. He must have concluded his lecture on evolution during the next lecture on Friday, because the lecture I attended on the following Monday was on speciation.

During the lecture on Darwin and evolution, only passing references were made to any conflict that might have existed ("Theory set the world in a twit!") or that exist today, both inside and outside the scientific community, regarding the Theory of Evolution. Students were not asked to comment on the social impact of the theory, Darwin's personal struggle over publication of his theory, or even the method Darwin used to construct an argument for his theory.

Textbooks also perpetuate the myth that little conflict exists within the scientific community by presenting the view that progress is made through open, collaborative efforts among colleagues. The presentation of the events surrounding the discovery of the structure of DNA in the textbook required in general biology at VVCC, offers an
excellent example of an "objective" treatment of an immensely intriguing and interesting series of events.

The textbook (Biology, by Neil Campbell) begins its discussion of this important discovery by identifying the scientists "working" on the problem:

Among the scientists working on the problem were Linus Pauling in California and Maurice Wilkins and Rosalind Franklin in London. First to the finish line, however, were two scientists who were relatively unknown at the time--the American James D. Watson and the Englishman Francis Crick (p. 310).

The textbook goes on to explain how "Watson saw an X-ray photograph of DNA, produced by Wilkins' colleague Rosalind Franklin, that clearly showed the basic shape of the DNA to be a helix" (Campbell, p. 310).

The student is left with the impression that Watson, Crick, Wilkins, Franklin, and possibly Pauling were all working together, or at least collaborating, to solve the puzzle. In fact, it is fair to say that there was more competition than collaboration among the scientists mentioned. Franklin was not working with Wilkins at all, although Franklin was working in Wilkins' lab. And she wasn't working with or collaborating with Watson and Crick. Dr. Franklin preferred to work alone, was not interested in speculating on the final outcome of her work (which was X-ray diffraction photography), and did not openly share her
on-going results with Wilkins, Watson, or Crick. Franklin had resigned her position in Wilkins' lab and was about to leave the lab and DNA work when Watson and Crick solved the puzzle. Watson and Crick treated the search for the structure of DNA as a competition or race and were actively trying to beat others, particularly Linus Pauling, to the "finish line." Watson and Crick had gone against commonly accepted scientific practices by "borrowing" unpublished data from Franklin, Wilkins, and others. In the end, of course, Watson and Crick gave proper credit to Wilkins and Franklin for their contributions, but the events leading up to their results are as interesting and instructive as the results themselves. The events surrounding this important discovery offer ample evidence of the political nature of scientific research and the roles that competition, ambition, and professional jealousy play in such a thoroughly human enterprise.

The view of science and scientific research as presented to the students in these general biology classes and as presented in the textbook, offers a false image of the scientific community to students, and leaves students with a false impression of the role conflict plays in these and other human activities. Students are left with the impression that conflict does not exist within the scientific community, and if it does exist, has a negative
impact on scientific progress. In the words of Apple (1979):

By the fact that scientific consensus is continually exhibited, students are not permitted to see that without disagreement and controversy science would not progress or would progress at a much slower pace. Not only does controversy stimulate discovery by drawing the attention of scientists to critical problems, but it serves to clarify conflicting intellectual positions (p. 89).

The scientific community is governed by norms and values, and is bound by a common language (Apple, 1979; Keller, 1985; Ziman, 1968). To challenge the consensus, one must first gain acceptance from the scientific community by demonstrating an understanding of existing consensus knowledge (Ziman, 1968). Ziman acknowledged the difficulty associated with trying to change or even to challenge existing assumptions about the natural world. But, he asked, shouldn't science education at least point out, and possibly emphasize, to students "contradictions inherent in the paradigm" (Ziman, 1968, p. 71)? Ziman answered the question by arguing that students first need to have a thorough grasp of the current consensus before they are able to understand the "nature of the anomalies" (Ziman, 1968, p. 71). Ziman went on to state that
the job of the ordinary science teacher, in the first instance, is to make all plain, and plausible, to encourage the student to entrust himself freely to the basic theory. To express doubts, to utter warnings, at this stage will inhibit the confident use of the new technique, the new language (p. 71).

An argument similar to these was used by the biology faculty at VVCC. A justification for concentrating so much of their efforts on the presentation of terms and facts was that students would not be able to understand and discuss the concepts without first learning the terminology:

[I.A.] But then again you realize they have to be at a certain level to discuss things...I would love to have these people back now after going through the basics, and I guess this is why people like to teach upper division courses.

It is not surprising that the biology instructors at VVCC subscribed to the traditional view of science as consensus knowledge and that the role of science education is to present current consensus knowledge to students. And for students who are going to become professional biologists, there may be reasonable justifications for adhering to and presenting this view of science to students. But what is happening in these cases is that a general biology course that is offered as part of the general education curriculum is being presented as if to biology
majors. The result is that general education goals which are intended to provide for an educated citizenry who are able to think and to make responsible choices, are being ignored in favor of goals that are deemed appropriate for science majors.

Of the thirty-four students who completed and returned a Student Characteristics Questionnaire, only four (twelve percent) indicated they were science majors. Furthermore, each of the instructors seemed to realize that the overwhelming majority of students would not be transferring as biology majors. I.B. said, "I realize that most of them are not going to be biology majors..." I.A. said, "Granted, most of the people I would say, especially in my group, don't end up as science majors, they take [general biology] to fulfill a [general education] requirement, and then to go on."

According to Cox (1980), based on a survey of community college natural science instructors, the three primary goals for natural science courses designed for science majors were:

1. Apply principles learned in course to solve qualitative and/or quantitative problems.

2. Understand the principles, concepts, and terminology of the discipline.

3. Develop the ability to think critically.
The goals of courses designed for general education (nonmajors) were:

1. Understand/appreciate interrelationships of science and technology with society.
2. Relate knowledge acquired in class to real world systems and problems.
3. Gain qualities of mind useful in further education.

All three instructors in this study, when asked to select one goal each from three sets of four goals (see Appendix F), selected goals from two sets that coincided with goals for a course designed for general education (goals #1 and #3 from the general education list). From the third set, two out of three instructors selected a goal that had been identified in the national survey as a goal for science majors (goal #2 from the science majors list).

The overwhelming majority of students enrolled in general biology at the time of this study were non-science majors, the faculty were aware that most of their students were not, and would not likely become, science majors, and all three instructors identified as primary goals for the course, goals which are associated with courses designed for general education. But despite this, all three instructors emphasized, above all else, a goal which is associated with courses designed for science majors: "Understand the principles, concepts, and terminology of the discipline."
The biology instructors at WVCC did not make a deliberate effort to incorporate general education goals into their courses. Their primary concern was to offer a course that was comparable to, one might even say identical to, the same course at a four-year college or university. All three instructors made it clear that a primary concern and intention was to provide students with enough factual information that those who transferred as biology majors would not be left behind at the four-year institution.

[I.A.] I realize it's part of the general education curriculum that they have to take a science, but most of them are taking it for transfer credit...So I think I approach it more from that way, as a transfer course... something that they may build on...So my idea was to get across the basic concepts in biology [since] every biology course anywhere is going to have certain basic concepts.

[I.C.] I just feel some kind of professional bond or ethical bond to at least do as much or better [than a four-year school]...Therefore a student comes out of this college as good or better than the one coming out of [a four-year school]...I feel like the exposure and what you do for them and with them has got to be some way comparable.
The end results were courses that not only didn't facilitate student development and understanding of general education goals, but in many ways may have inhibited their development. The presentation of biological information as objective, uncontested truths served to impress upon students that thinking critically is not productive, or even desirable, and that conflict is not a normal consequence of all human endeavors.

The treatment of scientific knowledge as if it developed without conflict had another effect on the students: students were not given the opportunity to develop and improve their independent thinking skills. Students were not given the opportunity to raise the kinds of questions that would allow them to develop their own critical thinking skills as well as a deeper understanding of the subject matter. An example from the classroom of I.B. illustrates this point.

When I.B. lectured, it was 95% him talking and students listening. During our interview I asked him what his primary goals for his students were; what did he expect or want his students to get out of his course. One of his "big" goals was to make students "aware," so that when they read things in the paper or hear things on the news related to biology they will at least recognize it. He then went on to give an example:
I don't know if I can always tell them the answer...
Abortion: I can tell them some pros and cons. When we
did that lab I pulled these human embryos...and we'd
talk about them. I did make some judgment that using
abortion as birth control is stupid, because there are
too many other methods to use...On the other hand I'm
not going to tell someone who has a particular problem
that they cannot have an abortion. You know that's
something that each one of us needs to decide. But I
want you to see what some of these things look like.
I then asked I.B. if the class spent some time talking about
abortion or any other issues related to it, such as
contraception. He responded:

No, I mean they, most of them, there were some who made
some comments that they agreed with that but they
really had problems with using that as a means of birth
control...

The point is not the subject matter or his opinion or
the students' opinions. The point is that I.B.'s notion of
making his students "aware" of biology was to "tell them the
answer." Here was an excellent opportunity to encourage
independent thinking within the context of biology (the
reproductive process, fertilization, development, etc.) and
all he could do was "tell" them his opinion and listen to
those who might have been willing to respond.
STUDENTS

All three instructors in this study argued that the variety of student abilities made it difficult to do the things they wanted to do in the classroom. Student failure was blamed on students' lack of motivation, lack of academic background, or lack of a sense of responsibility. Anyon (1988) described a similar pattern in public school classrooms (in part citing Jackson, 1968):

Whether by behavioral objectives, criterion referenced measures, or everyday teacher-made tests, representatives of the school define scholastic and behavioral criteria and set standards, and evaluate students to see if they have met these criteria. A mismatch between individual performance and institutional expectation is likely to be defined as deviance or deficiency on the part of the student (p. 179).

Without fail, the biology instructors at VVCC put the blame on the students for their failure to perform.

[I.A.] Because they've got to learn to take responsibility for that action...If you don't study you don't expect to pass the course [just because] you come to class and smile at the teacher. You've got to do a certain amount of work, you've got to perform.
[I.C.] I usually assess real quickly where their ability as students is. You look at 'em and say is this student going to stay through the semester? Does he have enough stick-to-it-ness? Does he have enough motivation?...It's a matter of are they ready enough to do it. Are they going to settle down and take on education as a responsibility or not?

Anyon (1988) argued that blaming the student in effect teaches students that the institution is not responsible for their success or failure, and leads students to conclude that to "blame the victim" is an appropriate response to other problems, such as the homeless or the unemployed.

One of the instructors described the relationship between instructor and students as a tug-of-war; where the instructor is attempting to pull the students up to some higher level and the students are resisting. Resistance may take a variety of forms but the resistance that was observed in the biology classrooms at VVCC was a type of "passive resistance." For the most part students simply refused to participate in classroom activities. Students neither asked questions nor answered questions. Is students' non-participation simply the result of the disempowering socialization of schooling or a more purposeful resistance to the oppressive nature of classroom hierarchy, or both? Shor (Shor & Freire, 1987) offered this explanation:
After years in dull transfer-of-knowledge classes, in boring courses filled with sedating teacher-talk, many have become non-participants, waiting for the teacher to set the rules and start narrating what to memorize (p. 122).

Shor (Shor & Freire, 1987) described a "culture of silence" he found in his classrooms. While on one hand "culture of silence suggests passive tolerance of domination" (p. 123), Shor also suggested "there is an aggressive, negative resistance as well" (Shor & Freire, 1987, p. 123). Shor described four segments of the student body:

A segment of the students is thrown into passive acceptance; another will not play by the rules and not rebel either but will scheme how to "get by;" a third group will sabotage the rules by overt aggression; a fourth group will buy into the system and actively support the status quo (p. 124).

Shor is arguing that one response of students to "passive learning" is active resistance, "an aggressive rejection of silence", and he termed this resistance "the culture of sabotage" (p. 124). Students react in a number of ways to the passive role they have been assigned and to the oppressive nature of the classroom. Student reaction is largely a defensive device, a way to survive, to "get the credit" and move on.
I.A., in describing her experience with the tug-of-war, was willing to blame student abilities and motivations, and felt that the lower-ability students were resisting her efforts to "pull them up."

[I.A.] There's going to be a certain crop that will say that this is too hard, this is not what [the instructor] should be doing. They're trying to pull this way and you're trying to pull this way. And you can actually, about midway through the semester, almost feel it. It's almost like [the students are saying], 'You're going to have to make it easier for me to do this.' And you're saying, 'No, I'm not going to [make it easy for you], I'm going to pull you up to a level that I know you are going to be successful in school.

It sounds as though her intentions were good and honorable, and I'm sure she meant what she said. From my vantage point in her classroom, however, it was clear that her idea of "pulling them up" was to rely even more on "teacher talk," to lay out the factual information and say to them, "O.K., I've done my part, now it's up to you to learn this material." For example, I.A. (in fact all three instructors) did not review or summarize one topic area before going on to the next, and justified that by indicating that reviewing is not appropriate in college. When responding to a question about what specific things she did to "pull" her students up, I.A. had this to say:
Specific things? Just trying to get them out of that pattern of no, we're not going to review for the test the day before so that you know what all the information is...I try to make them get a taste of what college is really like.

In fact, I.A. not only didn't review the material just before a test, she did not review or summarize between topics, and it was often difficult to determine when she had moved from one topic to another.

INTERACTION

Students, by the time they have reached the community college, are well aware of what behaviors are expected of them in the classroom. The socialization process starts in kindergarten and before. Anyon (1988) equates the socialization process with the legitimization of adult work activities. Very early in the school experience, work activities are separated from play activities. One of the attributes of a work activity is that students generally work alone:

Although students work side by side, they generally work, not collectively, but alone [or] in duals, and attempts to collaborate in its acquisition and evaluation are not often encouraged; (Anyon, 1988, p. 180).

In the science classroom, this kind of socialization is contradictory to the intent and ideal of science. Even
though in practice, many scientists will work in private, there still exists within the scientific community the assumption that open collaboration is the ideal. As a result of school socialization, both students and instructors find it difficult to challenge the roles they have been given.

As I observed the general biology classrooms, both lecture and laboratory, I was reminded of a description of a kindergarten classroom offered by Apple (1979) which he used to illustrate the classroom socialization process:

As with most classroom settings, the socialization of the children was an overt priority during the opening weeks of school. The four most important skills that the teacher expected the children to learn during those opening weeks were to share, to listen, to put things away, and to follow the classroom routine...

One morning, a child brought two large stuffed dolls to school and sat them in her assigned seat. During the first period of large group instruction, the teacher referred to them, saying, 'Raggedy Ann and Raggedy Andy are such good helpers! They haven't said a thing all morning' (pp. 52 & 54).

It is difficult not to make a connection between the socialization process described here and the behavior of students that were observed during this study. Students, for the most part, sat quietly in their seats, took notes,
followed directions, and many didn't say a thing all morning. Has the school socialization process suffocated these students' natural curiosity and eagerness to learn?

One thing became particularly clear about the relationships between students and instructors in the classrooms observed for this study: There was a tacit, but definite, understanding between student and instructor concerning what role each was to play and about the expectations each had for the course. Students seemed to be there to listen and they expected to be told what information was important and they expected to be asked to repeat that information for a test.

Each instructor saw his/her role as an "information disseminator." Each was there to tell the students what information was most important for them to learn. The instructor was there to present facts and terms. If nothing else students left this course with a few more words in their vocabularies. Students were there to be lectured to and were able to recognize certain cues that told them when to write, when to be attentive, and when it was all right to mentally wander off. If everyone didn't hold to these truths before entering the classroom they certainly came to believe in them and to be guided by them soon after entering the classroom.

Students and instructors alike came to these community college biology classrooms with certain assumptions or
expectations concerning each others role or responsibility. Both believed that the instructor had the knowledge, and the students were there to receive this knowledge. Each instructor, as information disseminator, determined what knowledge was worth knowing and thus determined what knowledge was "real" knowledge. Each instructor observed for this study, had been presented to students as an information broker, not a facilitator of learning. Students had been "trained" to expect teachers and instructors to know all the answers. Students did not expect to be active participants in the learning process and for the most part, instructors felt more comfortable acting as information disseminators. The result was a kind of "truce," albeit one-sided, whereby the instructor agreed to tell the students what information was worth knowing and the students agreed to answer recall questions on tests.

The classrooms observed for this study illustrated forms of disempowerment, where teachers presented a kind of reality that was detached from the "real world" of the students. Knowledge was presented as being neutral, objective, and the truth. Students were not empowered to think critically about what was being presented.

PEDAGOGY

Introduction

Community colleges have long been known as teaching institutions. Because community college faculty are not
expected to and are not encouraged to do research, it is assumed that community college faculty are able to concentrate more of their efforts on teaching. It is also true that community college science faculty, because they hold advanced degrees in a discipline, have not been trained or received formal instruction in the most effective ways to teach. In fact, one of the instructors observed for this study had this to say about good teaching:

Good teaching is natural, innate, and is tied to the individual's personality. You can't tell me how to teach; education courses are theoretical and don't apply when you get into the classroom.

It appeared to be true in the biology classrooms at VVCC that very little was being done to address the quality of classroom teaching. Not only were the biology faculty interested in offering a course that was similar in content to a four-year college course, they also patterned their teaching methods after college teachers they had admired.

Several national reports and recognized educational experts have, in recent years, been critical of the quality of college teaching. Jeff Hockaday, recent past chancellor of the Virginia Community College System and current president of Pima Community College, in a talk given during the AACJC 1990 National Convention in Seattle said, "Good teaching is the number one reason for community colleges. You forsake that, and there's no reason for us to exist."
Weimer (1990) called for more attention to be paid to the improvement of college teaching by arguing that it only takes a visit to a few college classrooms to realize the need for improvement exists. According to Weimer:

Instructional improvement is for everyone...Teaching is very much like running, writing, swimming, painting, and a host of other activities. With practice and attention to detail, performance improves (p. 25).

The three biology courses observed for this study followed the traditional pattern of information transfer. The standard method of delivery was a stand-up lecture supplemented by the use of overhead transparencies, a textbook, and an occasional video or film. Students' information retention was measured using objective tests. The laboratory experience involved primarily student observation of specimens or objects or environmental areas; that is, students were not required to develop, design, or in any way take part in scientific experiments. Evaluation of their laboratory "knowledge" was accomplished through objective tests or quizzes.

Lecture Style

In each case, the instructor stood in front of the class, although two had the habit of walking back and forth from one side of the room to other, and lectured. One wrote on the board as she talked, one already had terms written on the board when he began, and the third stood behind a
lectern and talked, occasionally writing on the board. Two of the instructors indicated they had selected this lecture style because it was a style that was effective for them when they were students.

But regardless of the lecture style or the reasons for selecting a particular method of presentation, each of these biology instructors presented selected bits of information which had been synthesized and digested. One instructor offered this definition of an excellent teacher:

[I.B.] I think a good teacher, an excellent teacher, is one who can take a lot of material and run it all through a digester or blender or something and come out with a story that's streamlined, that the student can understand.

Another instructor added:

[I.A.] My lectures come from the book. If they can understand the lectures and get decent lecture notes, they can probably pass an exam without having to read the book. However, if they don't understand the lecture material the option is there for them to go back and read that book.

Many of the students indicated that they preferred to receive information in this fashion: a condensed version of the book. Students in I.B.'s class, most either had never read the book or had read the book only rarely, said this:
I can't pick it up from the book...I can't either. If we were to use class time for discussion and I'd have to go home and read the book, I wouldn't be in this class right now, I wouldn't have passed...The book kinda goes the long way around. It gives a lot of detail and [I.C.] brings it out like that.

Students in I.A.'s class said this about her lectures:
I've never picked up my book...Her notes do come from the book. She narrows it down to what she wants you to know... I can trust that her notes are what the test is going to be.

Each instructor essentially offered a condensed version of the textbook for the students. They took a wide view of the information, narrowed it down for the students, and presented the information to them. The description of formal classroom education offered by Shor (Shor & Freire, 1987) fits these classrooms perfectly:

The students are not included in the search, in the activity of rigor. They are told the answers to memorize. Knowledge is handed to them like a corpse of information--a dead 'body of knowledge'--not a living connection to their reality (p. 4).

The method of delivery observed in these classrooms is also illustrative of what was termed "biting" by Richardson, et al, (1983):
We labeled the literacy promoted in the classroom as instrumental "bitting" because it involved the transfer of preselected bits of information without requiring analysis, synthesis, or original expression. For example, note taking had become a mechanical procedure of copying words and brief phrases from the blackboard in order to recognize these bits on multiple choice tests (p. xii).

It has been said by some that too many times information goes from the notebook of the instructor to the notebook of the student without going through the mind of either. From my vantage point in the classrooms observed for this study, that statement appeared to be true more often than not. The students received information but were never called upon to synthesize, interpret, analyze, hypothesize, generalize, or in any detectable way think about the information they were writing in their notebooks. As one student described the process: "You don't have time to think, you just write. I think 99% of this class would tell you that they don't listen to one word he's saying, they just write it down." The instructors, too, appeared to be presenting information to the classes without thinking. The whole process, instructors talking and students writing, appeared to be extremely mechanical.

Shor (Shor & Freire, 1987) offered a delightful
description of a lecture classroom that describes the classrooms observed for this study perfectly:

The teacher lapses into a sonorous voice which bores itself as well as the students, and in a way encourages the students to drift off...The teacher will verbally emphasize those few words in a sentence or paragraph which count. By hitting certain nouns, verbs or adjectives with a pop of extra volume, the teacher sends signals to the students about the few key words to remember or copy down, which will appear later as the short answers in a multiple-choice exam (p. 124).

Richardson, et al. (1983) also talked about critical literacy. They associated critical literacy, at least higher education critical literacy, with high levels of independent thinking. Historically, community colleges have subscribed to the notion that higher education literacy, associated with independent reading, original writing, and other "scholarly" endeavors, was indeed worthwhile (Richardson, et al., 1983). As I observed the biology classrooms at VVCC, it was very difficult for me to identify any kind of learning that might be termed higher learning. The students in BIO 102 were expected to perform at the level of recall, identification, recognition, and definition of facts and terms. The kinds of information presented and the kinds of questions posed to students demanded only that they had memorized terms, definitions,
names of structures and their functions, and other "facts."
"When will students be asked to think?" was a question I
asked myself many times while sitting in the classrooms.
"When will students be asked to analyze and interpret the
information they are being given?"

Regardless of content, the method of delivery can
dramatically alter the meanings behind the facts. If
students are not drawn into the presentation and asked to
question what's being presented, they are learning more than
facts. They are learning that acquiescence to authority is
more important than independent thought. We need to ask
ourselves, "As community college educators, what are we
trying to accomplish? With what skills, knowledge, and
qualities do we want our students to enter society? What,
after all, are the goals of general education?"

CONTROL

Introduction

Power, authority, and control were all present in the
classrooms observed for this study. But what do these terms
mean and how were they manifested in the biology classrooms
at VVCC?

It is generally believed that a person has power if he
is able to get others to do what he wants them to do. Weber
28) defined power as "the probability that one actor within
a social relationship will be in a position to carry out his
own will despite resistance." Power is a generic term and does not carry with it any suggestion of how one is able to get someone else to do what it is one wants them to do. Power may be gained through persuasion, through suggestion, or one of several other methods. Fisher (1984) discussed different forms of power, such as coercive power, reward power, legitimate power, expert power, and referent or charismatic power.

Authority is a legitimate kind of power (Hoy & Miskel, 1982). Legitimate power is based on a group's acceptance of common beliefs and practices. Authority carries with it a willingness by the group to obey the commands given. An example of authority is the relationship between teacher and student. Students generally accept the power of the teacher to make assignments and accept his/her responsibility to "obey" the commands of the teacher. The traditional teacher is in charge throughout, from the planning to the execution. Shor (Shor & Freire, 1987) described the authority of the classroom teacher:

This authority must be fixed so that the programmed curriculum all the way from Lesson A to Lesson Z can be implemented on schedule, by virtue of the teacher's initiative (p. 90).

Freire (Shor & Freire, 1987) went on to caution against teachers going beyond the bounds of authority to authoritarianism. Both argued that it is necessary for the
teacher to have authority and to be the authority to ensure freedom for the students. The teacher must have the authority to maintain discipline, for example. But the use of authority should not suppress the students' freedom of expression. According to Freire (Shor & Freire, 1987):

The question nevertheless is for authority to know that it has its foundation in the freedom of the others, and if the authority denies this freedom and cuts off this relationship, this founding relationship, with freedom, I think it is no longer authority but has become authoritarianism (p. 91).

The instructors observed for this study often used their authority to suppress student participation and expression in the classroom. Suppression was sometimes accomplished by simply sticking to the schedule or adhering to the prepared lecture outline. Sometimes suppression was more overt, such as the warning I.B. gave his class for being "noisy," or the way I.A. cut off a spontaneous class discussion and went back to her prepared lecture. These are examples of an authoritarian use of power in the classroom.

**Power and Control at VVCC**

Each of the four previous categories can be reasonably linked to power and control as underlying motivations for what was occurring in the classrooms. The method of delivery of BIO 102 at VVCC put the power and control in the hands of the instructors. The basic force of the power came
from the knowledge the instructors possessed and which the
students needed to meet their goals. The instructors
observed for this study used this power to control the
events and activities taking place in the classroom. The
unspoken message was, "I have the knowledge (in the form of
factual information) that you need. If you want it, or if
you want to meet your goal of getting credit for this
course, you will sit quietly, listen or take notes, and
answer questions on a test."

Students readily accepted the instructors as the
authority figures and as the ones with the knowledge: "The
teacher knows it...You just write down what he's saying and
learn it later." The instructors determined the content of
classroom lectures and how much time would be spent on
classroom discussion. If an instructor didn't want to take
time answering a particular question or wasn't comfortable
with the question, s/he would move quickly back to the
prepared lecture. As one student put it:

He's got a pre-planned lecture and he has to get that
out of the way and maybe if he has thirty seconds he'll
let you discuss something.

Control was maintained by sticking to a pre-determined
syllabus, a planned lecture, and keeping questions to a
minimum.

Apple (1979) talked about the "hidden curriculum--that
is, the norms and values that are implicitly, but
effectively, taught in schools and that are not usually talked about in teachers' statements of ends or goals" (p. 84). The power exerted by the instructor over the students is part of that "hidden curriculum." Students are not only made to feel they are subordinates to the authority figure, the instructor, but they are made to feel that this arrangement is normal and necessary for the efficient operation of the classroom and the institution. Students may also learn that those with access to the "legitimate or real knowledge" have a right to determine who else is entitled to it. In the classrooms observed for this study, each instructor exerted his/her power and maintained control by monopolizing the lecture classroom. Each lecture classroom was teacher-dominated; the instructor was the authority and sometimes the authoritarian. Students learned they were subordinate to the instructor. Students were expected to sit quietly, listen, and write down the most important information. To succeed it was necessary to learn and use behaviors the instructor deemed acceptable.

Students were often discouraged, sometimes intentionally and sometimes unintentionally, from making comments, asking questions, or even answering questions. The reason?: If power rests in the knowledge held by the instructor, too much free interaction between instructor and student increases the chance that the instructor's fallibility will show. It seemed apparent in the three
classrooms observed for this study, that some of the reluctance on the part of the instructors to engage students in open discussion evolved from a fear of not knowing the "right" answer. Because instructors present themselves as the "authority" on the subject, there is an inherent fear that the students may find out they don't know all the answers. Instructors are presented as information brokers, not facilitators of learning. Students are trained to expect teachers to know all the answers and do not expect to be participants in the learning process and for the most part, instructors feel more comfortable acting as a vehicle for the transfer of knowledge.

Power, as demonstrated in the classrooms observed for this study, was used as a negative force; the instructors were dominant and the students were subordinate. One outward manifestation of this relationship was the use of the titles Mr. and Dr. by the students. All students, even the older students, addressed the instructors by these formal titles and were not discouraged from doing so by the instructors. The biology instructors at VVCC used their power and authority to control the content of the course, the amount of student/instructor and student/student interaction in the classroom. Their perceived need to use their authority as a negative force was in part justified by their perception of students' motivations and abilities, as well as their desire to maintain "standards" and to offer a
course in the mold of a university course. Any alteration from the standard lecture format was seen as lessening the college-level stature of the course. The instructors in these courses felt a need to be in charge of all aspects of the course, and the responsibility of students was to listen to what was said, read the textbook if what was said was not clear, and perform satisfactorily on objective tests.

The students, too, had power and used it to resist the will of the instructors. The students, in most cases, chose not to participate in classroom activities; choosing instead to be passive and to demand that instructors tell them what to do and to know. Shor (Shor & Freire, 1987) termed what others have called student mediocrity a "performance strike" on the part of students (p. 5). The result was a kind of tug-of-war between students and instructors with instructors pulling and students resisting.

Consequently, both students and instructors were disempowered by their acceptance of traditional roles and methods for learning and teaching. Students and instructors had come to rely on a system, not because everyone had found the system to work, but because they were comfortable with it and the rules of the game were known to them. Shor (Shor & Freire, 1987) offered this explanation of why students and teachers so readily accept the traditional approach to education:
There is a lot of pressure to teach this traditional way, first because it is familiar and already "worked out," even if it doesn't "work" in class. Second, by deviating from the standard syllabus you can get known as a rebel or radical or "flake," and be subjected to anything from petty harassment to firing (p. 7).

Instructors, by virtue of the power and control they maintained over the course and classroom, determined the topics that would be covered and then attempted to keep the class "moving along" at a pace that allowed them to cover as much of the syllabus as possible. Students, too, recognizing the "need" to keep moving in order that the syllabus could be covered, kept their questions to a minimum, unless they saw an advantage to asking questions (e.g., just prior to a test). Again we see a kind of tug-of-war that ended in a stalemate or compromise between two opposing forces.

Evaluation of student knowledge acquisition was accomplished via objective tests, which could also be seen as a mechanism for maintaining control in the classroom. The nature of the tests required that students learn or memorize information as it was presented in class. In addition students realized that only the information presented by the instructor from his/her prepared lecture notes would appear on the test, so why complicate the issue with questions and comments not directly related to the
lecture material. For example, a student in I.C.'s class said this:

You might have a half hour discussion that might not be anything that you'll be tested on. It could be something you're interested in, but yet you're knocking yourself out of what might be important to the teacher, what he's interested in.

The nature of evaluation also placed preeminent importance on the words of the instructor. The instructor held the information that would appear on tests, therefore words spoken by other than the instructor were less important. Students in the classrooms observed for this study seemed to believe that they, or their fellow students, had nothing to contribute to the class. Students took it for granted that the instructors knew "it," that it was the student's responsibility to write down the information and learn it for the test. Students in I.B.'s class had this to say:

I don't think everyone wants discussion. We're there to get our notes and leave...You just write down what he's saying and learn it later...The teacher knows it...

The nature of evaluation has a lot to do with this attitude. Students knew they would be asked to repeat information they heard in class (or read in the textbook) on an objective test. They also knew they would not be
required or expected to analyze, interpret, or come to a conclusion. Control was maintained and power remained in the hands of the instructor. I.B. said it plainly: "But as I go through [planned lectures] I don't like to be yanked out of them." Shor (Shor & Freire, 1987) concluded:

Students know they can ignore the lecture and listen only for periodic emphases, often on the nominative case of spoken sentences, where names, places, and dates are mentioned. This repulsive or just plain silly exercise in class convinces many students to withdraw into silence (p. 124).

But silence is apparently what the instructors observed for this study were striving for. If the class was silent, passively listening, the class must be a success. Overt resistance to passive learning was met with more "teacher talk," or with a parental lecture on student responsibilities.

The general suggestion made by critical theorists such as Apple (1979), Shor & Freire (1987), Aronowitz & Giroux (1985), and others, is for both teachers and students to become empowered, by becoming "intellectuals." Apple (1979) described the teacher as intellectual as someone who is critically aware of how schooling is situated in and related to the larger society. Herb Kohl (cited in Aronowitz & Giroux, 1985) defined an intellectual as "someone who has the courage to question authority and who refuses to act
counter to his or her own experience and judgment" (p. 33). Aronowitz and Giroux went on to describe teachers as transformative intellectuals as those who "take seriously the need to give students an active voice in the learning experiences" (p. 37). Neither the students nor instructors who were observed for this study could be described as being empowered as intellectuals. The instructors were trapped by what they perceived as their responsibility to cover a predetermined amount of material and to offer a course identical to those offered at four-year colleges and universities. As a consequence students were given little opportunity to become active participants in the search for meaning and understanding, little opportunity to develop independent thinking skills, and little opportunity to gain new insights into themselves, their fellow students, and the world community of which they are a part.
Chapter 6
Conclusions and Recommendations

INTRODUCTION

The purpose of this study was to describe the course contents and classroom environments of selected sections of a community college general education general biology course in sufficient detail to shed light on the contribution each makes to general education. The desired end product of this study was a description, interpretation, and evaluation of community college general education biology classrooms and laboratories for the purpose of developing a deeper understanding of the ways they contribute to general education. The intent was to present vivid descriptions of the classroom experience and to offer interpretations of what was being taught and what was being learned.

This study relied on qualitative case study methods and the notions of connoisseurship and disclosure to collect data, analyze data, and present the results. A case study, according to Yin (1984, p. 23), "investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." The study examined a "real-life" situation and presented events in the words and actions of participants in context in an attempt to determine to what extent general education goals were being taught in general biology classrooms and laboratories.
The study took an additional step and asked the question, "If the values expressed by general education goals were not being taught, what other values were being taught?"

CONCLUSIONS

General education goals were not a significant part of the biology curriculum at VVCC (see Table 1). Values represented by such general education goals as independent and critical thought were not common elements in the general biology classrooms observed for this study. The question remains, then, if the values expressed by general education goals were not a constant and consistent theme across the general biology courses at VVCC, what values, ways of thinking, and kinds of knowledge were common to each of the biology classrooms?

As the categories emerged from the data it became clear that a dynamic interrelationship existed: the elements of each category interacted with the elements of all other categories. The categories of content, students, interaction, and pedagogy were not totally discrete but were influenced by and interacted with each of the others. Just as form follows function, the topics selected and the kind of knowledge presented is related to the style of presentation. When terms, definitions, and other facts are the essence of content, the lecture style is appropriate and follows quite naturally. The degree of interaction between instructor and students is also influenced by student
abilities and motivations, as well as course content and style of presentation.

It also became clear that the notion of control was a common thread that connected and tied together the categories of content, students, interaction, and pedagogy. Control was exercised either through the overt use of authority to dominate the classroom or the more subtle use of power through the legitimation of knowledge. Control, and the related phenomena of power and authority were integral elements of the biology classrooms at VVCC.

The selection of which knowledge or information is most worth knowing is a demonstration of control through the use of power. Schools give legitimacy to certain kinds of knowledge, "legitimate knowledge—knowledge that we all must have" (Apple, 1979, p. 64). The legitimation of knowledge operates at all levels within the institution. From the selection of which courses will appear on the schedule, to the selection of which topics will be included in each course, to the presentation of consensus knowledge as "real knowledge," schools and instructors are exercising power through cultural control of the students. Through the curriculum, schools select, organize, and distribute certain bits of knowledge from all the variety of knowledge that is available. Schools, and the instructors who present this knowledge, determine what is "real" knowledge by presenting
a "false consensus" of what is real knowledge or what knowledge is worth knowing (Apple, 1979).

There is a common assumption, a misconception really, that knowledge as presented in schools is neutral or objective. This is particularly true of scientific knowledge. The reasoning is that science, by nature, is objective and thus neutral, and that the role of scientists is to describe, not to interpret. Teachers reinforce this "myth" by asking students to describe what they read or see in the text (or elsewhere), but not to interpret (Shor & Freire, 1987). Scientific knowledge is being presented as value-free. Students learn that science and scientific knowledge are not connected to politics or ideologies.

Students are also learning to accept as proper and necessary the unequal distribution of power and authority. The very structure of the classroom hierarchy gives students the impression that unequal power distribution is legitimate and necessary. Anyon (1988) pointed out students are rewarded for "acquiescence to the inequalities of power" (p. 178). Furthermore, knowledge being offered in this manner, by an authority figure, teaches students to unquestioningly accept what those in positions of authority say as "the truth."

Control in the classroom is not entirely in the hands of the instructors. Students, too, exercise power in a subtle way through their unwillingness to actively
participate in the existing classroom structure, a form of passive resistance. Shor (1986) described student resistance, which some have described as a lack of student motivation and student mediocrity, as a performance strike. "The truth is that students are not stupefied or mediocre. They are refusing to perform under these oppressive conditions...." (Shor, 1986, p. 83).

One result of this struggle for control in the classroom is a compromise of sorts between instructor and students, where the students agree to sit quietly, listen and take notes, and the instructor agrees to tell them what information is most worth knowing; that is, information they will need to memorize for a test.

Control in the classroom is also illustrated by the socialization process of schooling. One of the first things students learn when they enter school is which behavior is acceptable and which is not. School socialization, which begins in preschools and continues right on through college, creates individuals who are willing to accept as proper the subordinate role assigned to students in the classroom. The socialization process trains students to be acquiescent to school authority and to not think critically about the "reality" presented in the classroom. The description by Apple (1979) of socialization in a kindergarten class, in my opinion, represents the classroom behavior expected by teachers at all levels, and
was certainly in evidence in the classrooms observed for this study:

The four most important skills that the teacher expected the children to learn during those opening weeks were to share, to listen, to put things away, and to follow the classroom routine... One morning, a child brought two large stuffed dolls to school and sat them in her assigned seat. During the first period of large group instruction, the teacher referred to them, saying, "Raggedy Ann and Raggedy Andy are such good helpers! They haven't said a thing all morning" (Apple, 1979, pp. 53-54).

The socialization process, as described in this statement, does not stop in kindergarten. Teacher expectations of acquiescent student behavior in the classroom were in evidence even at Valley View Community College. Education becomes an attempt to produce a citizenry willing to accept the values of those in positions of power and authority rather than to think independently and critically concerning the "reality" they represent. In the words of Shor and Freire (1987), this has led to the "dismemberment" of both students and teachers (p. 22).

The socialization process, too great a reliance on textbooks and prepackaged materials, and too great an emphasis on the transfer of knowledge, have all led to the disempowerment of both students and teachers. One of the
lessons to be learned from this study is that students and instructors alike have lost the ability or desire to be active participants in the search for meaning. Instructors do not look critically at the knowledge they have so readily accepted and are so willing to pass on to their students. Instructors need to find ways to bring students into the process, "to give students an active voice in their learning experiences" (Aronowitz & Giroux, 1985, p. 37).

How might this by accomplished? The answer to this question rests in what was the initial focus for this study: general education. General biology (BIO 102) at VVCC, although offered as part of the general education curriculum, provided very few opportunities for students to gain competence in those skills and ways of thinking commonly associated with general education. The definition used as a guide for this study included such qualities as independent thinking, effective communication, and responsible citizenship as fundamental goals of general education. The faculty who were observed for this study were only minimally concerned that general biology contribute to student competence in general education and did not seriously consider general education goals when organizing and preparing material for their courses. Each instructor indicated his/her primary concern was to provide enough biological information that those students who might
transfer and become science majors would not be left behind other students.

Each instructor expressed the concern that there was too much material to be covered in general biology and, yet, each made a valiant effort to cover all the chapters and topics listed in the syllabus. Although each expressed the opinion that it would be better for students if fewer subjects were covered in more depth, in practice each emphasized breadth over depth. The primary reason for this was the importance each placed on the significance of learning terms over the ability to solve problems, think critically, and to express independent thoughts. As long as learning terms is deemed more important than developing the ability to think and express oneself, breadth will win out over depth every time.

Instructors were emphasizing facts but students were learning more than facts as they sat quietly and listened to the instructor's voice. Students learned that acquiescence to authority is the proper mode of behavior, not only in the classroom but in the larger society as well. Students learned that independent, critical thought is not a desirable characteristic. Not only were general education goals not being addressed in the classrooms observed for this study, the lessons being learned were, in fact, inconsistent with the goals of general education. The biology instructors at VVCC were inhibiting student
development of many of those skills and ways of thinking commonly associated with general education goals.

I agree with the 1977 report of the Carnegie Foundation that persons in today's society ought to be equipped to deal with the world today, to have tolerance for the diversity that surrounds them, and to have the ability to make informed rational decisions. In American society the individual has "freedom of choice" on many issues and is called upon to make many decisions. One of the "improvements" derived from education should be the ability to think independently and critically when making these decisions. An individual will be called upon to make choices that affect himself, his family, his coworkers, and others in society that he has never met. An aim of education, then, should be to produce an individual who can think independently and critically concerning situations that confront him.

The ability to think, and to think critically, is not a skill that can be gained exclusively from the reading of books. To paraphrase Weimer (1990), thinking is a lot like running, writing, golfing, or painting; improvement can only come through practice and attention to detail. The kind of thinking being discussed here is not simply the ability to look for mistakes, but the ability to look at the world and ask the necessary questions. Students should be encouraged
to look for alternative ways of doing things and to use their imagination in solving problems.

Even though the instructors observed for this study seemed to understand the importance of communication skills, critical thinking skills, and the ability to relate biological principles to the broader world, they were bound by what they perceived were their most important functions: (a) to present a certain number of facts and (b) to offer a course which is similar to a university course. It is imperative that people in today's society be able to adapt to the many changes confronting them. Change is inevitable. Community college educators, regardless of discipline, have an obligation to provide all students the opportunity to practice skills, such as critical thinking skills, that will enable them to contribute in a positive way to society at large. As long as community college instructors such as the three observed for this study, feel constrained by the need to progress through a specified amount of material and are not given the support and encouragement needed to make necessary changes, they will be reluctant to take time away from prepared lectures to (a) discuss in any detail the broader issues, (b) give students time and encouragement to ask questions and look for answers, and (c) actively promote critical thinking and problem solving as important and worthwhile goals for all students.
Shor and Freire (1987) suggested an alternative to the traditional approach to education, what is termed liberating or liberatory education. According to Freire, liberating education involves "an act of knowing, not a mere transfer-of-knowledge" (Shor & Freire, 1987, p. 13). Liberatory education, instead of offering students an "opaque reality," offers students the opportunity to see the complexities of reality and the conflicts and inequalities inherent in real-world situations. Liberatory education also offers students the view that they have the power and obligation to use their new-found knowledge and understanding to make changes where possible. Shor (Shor & Freire, 1987, p. 14) put it this way:

So liberatory classes illuminate the conditions we're in to help overcome those conditions, offering students a critical distance on society in place of an uncritical immersion in the status quo, to think of changing it."

General education, or the liberal arts, could very well hold the key to bringing about the kind of educational experiences espoused by such critical theorists as Shor, Freire, Aronowitz, Giroux, and Apple. Without making radical changes in the community college curriculum, the educational experience could be made more meaningful by an increased emphasis on the overall goals of general education as expressed by many community colleges. Instead of
thinking of general education goals as a set of discrete skills which students will learn by virtue of taking a variety of courses, think of general education as encompassing broad categories of mind and ways of thinking such as a critical awareness of their world, the ability to do independent thinking and problem solving, and the willingness to accept the responsibilities that come from living in a democratic society. Each member of the college community should be dedicated to those goals (whatever they may be) and willing to actively facilitate student development of those qualities. Each course within the general education curriculum, including the sciences, can and should be thought of as a liberal art. In a talk at VVCC on May 1, 1990, Neil Campbell, author of Biology, had this to say about science as a liberal art:

[We] need to begin thinking about science in general, and biology in particular, as a liberal art...Liberal as in liberate, liberate as in free the mind from provincial ideas and from old ways of thinking...[Biology] trains us to value other organisms, not for their commercial value or for our ability to make something "useful" out of them, but for what they can teach us about life and what they can teach us about our own lives.

The method of teaching and presentation of information is a key element to the changes that need to be made.
Students need to be made active participants in the learning process, not mere passive receivers of information. Teachers, or instructors in this case, need to become leaders in learning. Instructors need to do more than be the middle man between the textbook and the students; to be more than skilled technicians. Aronowitz & Giroux (1985) have argued that "one way to rethink and restructure the nature of teacher work is to view teachers as intellectuals" (p. 30). Intellectuals as in intellect, where intellect "examines, ponders, wonders, theorizes, criticizes, imagines" (Aronowitz & Giroux, 1985, p. 33, citing Richard Hofstadter). Teachers as intellectuals have an obligation to recognize that the myth of value-free education is just that—a myth, and be willing to accept that liberatory education is also not neutral.

Although the sample size for this study was too small to allow broad generalizations to be made, the faculty observed for this study were in many ways typical of community college biology instructors across the country. Community college biology faculty accept as their primary goal the transfer of biological knowledge, and offer their courses as if their students will be transferring to four-year institutions and taking additional biology courses. Community college biology faculty present biological knowledge as consensus knowledge, as objective knowledge, and as if it is detached from day-to-day reality. Biology
instructors make a deliberate attempt to present this information as neutral and value-free, when in fact they are supporting values which are inconsistent with the goals of general education. Biology instructors have come to rely too heavily on textbooks, audio-visual material, and packaged laboratory experiments. The result is that teachers have become disempowered as intellectuals and have become "mere technicians implementing ideologies and interests constructed by people external to the actual experiences of his or her classroom and student interests" (Aronowitz & Giroux, 1985, p. 149).

**RECOMMENDATIONS**

While many researchers have studied general education through an analysis of transcripts, college catalogs, faculty and administrative perceptions, or goal and mission statements, few researchers have undertaken an in-depth, case study approach to understanding how general education is interpreted in the classroom. And there are fewer studies still that have analyzed to what extent an individual course or subject area contributes to the broad goals of general education. In addition, more studies that "seek to understand culture and context" in community colleges are needed (Kempner, 1988, p. 2). Therefore, the following recommendations for further research are made:

1. Case studies of general biology courses at community colleges of different sizes and in
different locations should be conducted and compared to the results of this study.

2. Case studies of general biology courses at four-year liberal arts colleges should be conducted and compared to the results of this study.

3. Case studies of general biology courses at comprehensive research universities should be conducted and compared to the results of this study.

4. Case studies of other courses within the community college general education curriculum should be conducted and compared to the goals of general education.

5. Studies that seek to extend our knowledge of community college culture need to be conducted.
REFERENCES


Kempner, K. (1988, Fall). Faculty culture in the community college: Facilitating or hindering learning? Unpublished manuscript.


Appendices
Appendix A
I.A.--Field Notes, Interview Transcripts, and Comments

Date: Feb 16, 1984  Mon.
Location: [Redacted]
Instructor: [Redacted]
Class: Bio 102
Lecture Topic: Ch 60 Controlling Internal Environment

Fieldnotes

01. Instructor starts by telling class that there were 3/4 of students absent. Not a bad turnout. Students will have to work at end of lecture.

03. Last exam was over circulation system. Talked about some content from circulation system.

05. Student wrote  

07. In order to control substances in blood & tissues keep pH & temperature constant. "(buffer system)

09. Have to control pH & temperature of blood, tissue, body fluids.

11. Student writes: "Buffer systems help keep pH & temperature of blood, tissue, body fluids constant.

13. Question was related to buffer systems. Student asks question, instructor points to text, student reads paragraph and asks question again.

15. It is still cloudy in case that student is upset. He will write short essay. Secretary comes up to board.

21. Questionnaire in front of class. Instructor asks student to rank order of figures. Student reasons if no students stand in front. Talks about student who asked, "What should I do?"

23. Student from student Hein in why coffee is bad for kidneys. Instructor says, "Coffee is bad for you, too much caffeine."
Appendix A (Continued)
Appendix A (Continued)

Fieldnotes

Today in class plant away from lab.

1. **Test:** test - 8/16
  上午 9:00
   101 pH + 3 pH brains
   in ph scale

2. **Field notes:**
   - Passive tests - don't call out names; opponent knows
   - Group test - anyone who didn't feel test will have to repeat
   - Test end of semester - make it easy
   - Final exam will take some questions from this test.
   - Students were positive in school immunity; true test some difficulty
   - No immunity between naturally acquired and
     artificially acquired active immunity - student learned about it
   - Student learned about immunity. Not sure student understood yet.

3. **Discourse field trip to water pollution control plant.**
Appendix A (Continued)

31. "Try to explain in a different way. It's like sugar. Melting sugar. You keep..."
Q 32. "You're doing it the wrong way. The way the lecture works..."
33. "How do I know which to keep? Some mechanism tells me."
Q 34. "Is it compatible with question?"
35. "Students are physically active. Diabetes is off the physically active diabetics?"
Q 36. "Instructor: Let's have it for later when we talk about..."
37. "Student: I'm asking a question..." Artificial kidney...
38. Comments on humane experiment...
39. "Student: What are the..."
40. Instructor: "Summary: lack of detail..."
41. "Students start to read their papers - end?"
42. Comments and Summary: Instructor not comfortable with question. His difficulty addressing question in way that clarifies or explains.
43. "Instructor: Let's have it for later when we talk about..."
44. "Student: What are the..."
45. Instructor: "Summary: lack of detail..."
46. "Instructor: Let's have it for later when we talk about..."
47. "Student: What are the..."
48. Instructor: "Summary: lack of detail..."
49. "Instructor: Let's have it for later when we talk about..."
50. "Student: What are the..."
51. Instructor: "Summary: lack of detail..."
52. "Instructor: Let's have it for later when we talk about..."
53. "Student: What are the..."
54. Instructor: "Summary: lack of detail..."
55. "Instructor: Let's have it for later when we talk about..."
Appendix A (Continued)
Student Interview Transcripts

Do you think she is doing a good job of giving you the information that you need for the test? 

Yes.

Then she will give you essay questions that require you to either write or oral responses or both, answer. Like the one today about the C02 levels and air pollution. She uses all sorts of questions. Multiple choice, fill in the blank, essay, true/false.

Do you have any sense that the questions are more recall type, that they require you to take information from several areas to come up with an answer?

When she's lecturing are you able to detect when she's saying something that's more important than something else? That this is something that you know pretty well will be on the test? She'll say stuff or say this is important.

She'll say that it can be confusing too. She'll go on talking and you're not listening to her. She says that other sentences but she didn't write it on the board and you're left with an incomplete sentence and you're supposed to recall what she was talking about...

And everything she wrote down...she's supposed to write down and take notes because she makes these notes and then she writes everything. I mean every single thing that she says she writes. I don't know if it's important, but you've just there writing.

How do you feel about that?

I like it though. I had somebody else first semester and he was just like the exact opposite. He was pretty much the most difficult. He had maybe 15 pages of notes. He'd say don't study this, this isn't going to be on the test and it was on the test. 75% of the class failed the final exam because he told things were not going to be on the test and they were. So when I came in to her, to me after him, she is a refreshing person. I just love it. Someone I can look up to and her notes are what the test is going to be.

I've never made a C and I made an A in that class and I almost never get those. He being older and can't spell I was like when someone writes it up there she's a bad speller.

Half the time she doesn't even spell it right. She don't count off though and you can have it. I mean, stuff that might not even look close and she'll give it to you. As long as you have the first letter right...cause she understands it. She's fair grading. I think. She'll go out of her way to help you, but it's just hard. It takes...

Does anybody else have any feelings about her writing things on the board word-for-word?

I don't like the English part of it...writing in complete sentences and stuff. I say save that for grammar class...
Appendix A (Continued)
Student Interview Transcripts

I do like the fact that she gives you everything I mean all the stuff that she's saying that's important she at least writes it down so you know...
She writes everything down so I don't know what's important I wish she'd highlight things that were more important...help with the things that were hard to spell and stuff like that and maybe it's up to the student to say that's important and write it down.
One draw back it spoils it...I go to other classes and they're talking and I'm just waiting for them to write it on the board and they've gone on...
But her tests are nothing like that. They're definitely college stuff.

I've noticed that there aren't too many questions being asked in class. Do you have questions that you don't feel comfortable or is it something the instructor is doing that keeps you from asking...

I think a lot of it as you write it down you read it, you say I understand that and if you had time to read it and say do I really understand this is this what she's trying to say, by the time you sit there and comprehend it and she's on to something else. By the time you don't realize you don't understand what she's saying until you go back and read your notes...

It takes some time away from her; she has so many notes each day. She was worse first semester about that though. She had so many notes, pages she was going to cover by a certain day, Room 408, I don't think there was a question she didn't have a question in there. She would answer but it's sort of a long rush. She's sorta afraid she's not going to get through everything she needs to get through that's going to put her behind. I think it's better if you learn less and understand it than learn more...

She keeps us to the last minute and everybody's packing up and you're not hearing the last five minutes...

You have her trained. She never stops herself, the zippers start and get louder and louder and all of sudden she just stops.

Do you recognize when she feels more comfortable with some topics more than others? Are there some things she really understands and some things she doesn't feel comfortable with?
She'll take more time with an idea she likes.

Are you able to understand what she's saying as she says it...there are times when she's saying doesn't make sense to me why she's saying it...

Yeah. She gets frustrated though if you don't understand it. She wants you to understand so bad and she gets real frustrated. She's starting walking real fast back and forth...She wants to jam it in you.

She knows what she's talking about it's just hard for her to explain it. She told me she didn't know how to get it across to the students unless she wrote it on the board. That was the only
Appendix A (Continued)
Student Interview Transcripts

way she knew how to get it across, to make sure they had what she wanted them to have.

Who's responsibility is it to see to it that you learn? How much responsibility do you have and how much does the instructor have?

I think it's 50-50. You can't come to class and expect the teacher to do everything. You have to want to be there and want to learn.

Discussion on evolution...

Difference between lecture and lab:

Lab is a lot more relaxed. You can be yourself and take it easy... When you're in class you just go in and take your notes and try to do the best you can on tests.... You're expected to pay more attention in class cause you have to take those notes. Lab is something you actually do.

Has she ever said anything to you in lecture about behavior in terms of keeping quiet or any discipline things?

If it gets really loud she'll speak up because I've had teachers who won't and that really bugs me... Last semester she was really upset and she would throw you out of class... And I've heard that in her 11:00 class she gets upset.

How much writing have you had to do for this course?
How much reading do you do?

Not much, no reports, no lab reports, occasional essay questions on test... Most don't even read the book except to do the review questions she assigns which they know will be on test.

What would you like her to do differently?

More discussion. Fewer chapters per test.

Have you ever gone to her office to ask questions?

[When I go to her office she gets really frustrated] and you're just like, by the time you get out of there you just feel really rotten and so stupid, you don't really care and you don't want to feel this way.

Lab tests today were too long.

She gave me help. I made a list of the ones I didn't understand so I went to her office and said I don't know this, this, this, and this. And what do I need to know? She helped me.

Due much freedom in there. I don't have the motivation to do the stuff on my own. Just the class leaves. This semester she hasn't gone over the questions at the end of lab like she did last semester. I was shocked that we didn't have to have a lab report for this course. But then, when she says to do something you sort of do it... something is just a little... something is just a little strange...

Is there any value to the field trips?

It gives you a break. You get extra credit if you go
Appendix A (Continued)

Instructor A Interview Transcripts

Can you identify ways that you try to bring them on, bring them into your class? I mean, every professor has a certain style that they bring into the classroom, and I think that's obvious. I'm trying to get people interested in the material, and I think that's important.

Specific things? Just having a lot of repetitions of things, making sure that they hear something many times, so that you know what is the information is. I mean there are different ways that this can be done, and I don't know if I could do it, but I don't have the opportunity to do it. I can't do it. I mean, I can't do it. I mean, I can't do it. I mean, I can't do it.

I mean, my classes are very different from that. I mean, I teach a course that is very different from the way I teach another course. I mean, I teach a course that is very different from the way I teach another course.

Specific things? I mean, I don't do that. I mean, I don't do that. I mean, I don't do that. I mean, I don't do that. I mean, I don't do that. I mean, I don't do that. I mean, I don't do that.

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Appendix A (Continued)
Instructor A Interview Transcripts

Have you ever tried to do anything to compensate for this situation? We find that ones that have a goal in mind are usually the ones that will try to pull them up. This is the constant struggle. There's going to be a certain crop that will say that this is too hard, this is not what I should be doing. They're trying to pull this way and you're trying to pull that way. And you can actually, about midway through the semester, almost feel it. It's almost like you're going to have to make it easier for me to do this, and you're saying no I'm not going to do you. I'm going to pull you up to a level that I know you are going to be successful in school. You can almost feel it. It takes about two months into the semester and you're almost through, you're not there yet. And I had one girl come to me and totally gave me out. "You're just too hard for us, you're expecting too much from me. And I was ________________. And at the end of the semester she came back and thanked me. "I finally understood what you were trying to do. But I thought you were being mean to us. When you look at this year that you've had coming out with this year, I saw people to come from here and say, 'Oh, I got A's and B's and C's and I can do anything.' So you don't have to do everything. A lot of these students, a lot of these students shouldn't be here. They're not going to be in their life where they ought to be in school. It ought to be up a little bit. But you can't compensate for that. So, and pointed it's an open-door policy, and maybe that's good, but you can't let everything go and let your standards down. I can say that I have the answers, but you're not going to get the same type of person to succeed. I had one girl I think she was in the class you were observing got an A last year, she got A's, or how she had the lowest average. What difference was there? I mean that's not her native ability. What's made her change, I can't know...you can have some successes...you're out to do a certain thing, you can't drag down the whole thing...you're not to maintain a certain standard.
Appendix A (Continued)
Instructor A Interview Transcripts
Control & structure & lecture, little lecturing carries note in hand; has overhead or white in beauty when she writes on board, sees computer sentence, talks along as she writes, writes what she says, basically. Quiz a bit of control, doesn't stay very far from her note. When a student asks a question, if the times it appears, she may not know how to respond to the question and, sometimes she feels a little uncomfortable, but even when it looks like it something she probably known to answer to it, she feels difficulty really explains the question or really gets it back to the student in a way that helps that student understand. In general she step away from questions, doesn't really distracts question, but gives quick answers and tries to get right back into the lecture. When students seem to be getting interested in one thing, students start talking amongst themselves, several students start talking one instead of encouraging that, just trying to get more students involved, she will try to get them calmed down and get right back into the lecture again. Abe that happened today, that even an everyday brushed lively a question that had to do with dialysis (talking about texture.)
The question to be asked is how to identify the factor that accounts for about 80% of the variance. Is there a method or data set that can help identify this factor? It's important to understand the underlying factors driving the variance, as this will provide insights into the overall success of the program.
Appendix A (Continued)

Tape Recorded Comments

Note from tape recorder: was present for

General comments: 3-1-90

Sure everybody is wrestling with the same kinds of problems that we've been

talking about. There is so much information that could be presented in biology. What

of all of that do you select? And the fact that the students have such a wide

variation of abilities and backgrounds, some that hadn't had high school biology and some who

hadn't, some who were familiar with basic terms and concepts and some who aren't. How do you accommodate all of these variables? How do you present just the right amount of material? How do you do it in a way that most students can understand, but that is challenging and makes sure that you present the technical information. It seems that everyone here is wrestling with these kinds of issues.

Certainly content is an issue. There's talking about next year, they are more or

less arguing about what topics should be covered. And again, what I can see are the two lenses being drawn. I want to

stay more toward the particular, chemical and physiological stuff. That can be
Appendix A (Continued)
Tape Recorded Comments

...in the laboratory, field trips, and so on. There are the topics that are
dealt with, loosely described as if it
pursues from a science perspective and how
much information to provide, and
have a point when they want to make sense
and keep up with the trends in research,
research, etc. But also [redacted] have a point
when he wants to bring in to battery those
things that have relevance to the student.
And, of course, biology is one of those things,
and nature, natural history, etc., things
that surround them all the time. But so
drudge the physiology of a cell or the
molecular structure of DNA; there are
gots of technical, scientific information,
but students can relate to that. The
question is how do you blend those
two things together? How do you make it
scientifically valid and also keep their
interest and make it relevant to their
careers.
Appendix B
I.B.--Field Notes, Interview Transcripts, and Comments

Fieldnotes

01. lots of talking when he goes ok let's get started on ocean students keep falling if he uses game
Often a warning and distributes goals of the day

02. Can settle down

03. Interesting llevar—can settle into not talking/lcamo-

04. related to method of delivery: lecture emphasis?
Students are quiet

05. and list all ideas for

06. next week

07. Lecture still a problem with diversity; facts

08. student will find new ideas for extra credit or when he makes the issue a week

09. May of them will work with light intensity

10. What do you think about Montana Lab? that demonstrates the

11. may of them are as if they find a problem

12. a low nutrient content

13. How do animals interpret water pressure?

14. Wait—student answers: "They go down in the sand.

15. OK! Many sea creatures aren't they?

16. Related to method of delivery: lecture emphasis?

17. Students list and give reading assignment after discussion or when he makes the issue a week

18. Talk in a group: method to distribute goals of the day

19. Related to method of delivery: lecture emphasis?

20. Many of them are as if they find a problem

21. to low nutrient content

22. Related to method of delivery: lecture emphasis?

23. Students list and give reading assignment after discussion or when he makes the issue a week

24. Talk in a group: method to distribute goals of the day

25. Related to method of delivery: lecture emphasis?

26. Students list and give reading assignment after discussion or when he makes the issue a week

27. Related to method of delivery: lecture emphasis?

28. Students list and give reading assignment after discussion or when he makes the issue a week

29. Related to method of delivery: lecture emphasis?
Appendix B (Continued)

31. What would it take for instructors (college teachers) to change their approach?

33. More time? (Freshmen course, lower student-teacher ratio)

35. Encouragement?

37. Special training?

39. Do college teachers think that current approaches are the best way to "teach," i.e., able to get information to students?

41. What is the top goal of formal education?

43. I see one student taking notes:

45. "Half the people in the world live in coastal areas; N.Y. metropolitan area - 18 million people."

47. Ask instructor: will this question come from film? / Apr. 14

53.

55.

Comments and Summary:

Great Barrier Reef.

Ask student about worth of films.
Appendix B (Continued)

No Monday, 9/6 Wed

Class 3010

Lecture Topic: Rivers & Lakes

Location

Instructor

Fieldnotes: On tape

Time

Day

01

Writing term on board. Answers my question about whether note on board will be included in previous class. Tells class that he will not be here Fri. but will have class. He will not be here Mon., and then will have class on Monday.

03

Talk about assignment he made a week or so ago. About assignment provides examples of things he desired "technically". Tense, self-centered. Seems to be some sort of research among students prior to what specifically they should be doing. How much time to put into work, and what kind of work up is required. From when I'm sitting, from a glance at the board and I can't read good. Handwritten.

In general, people seem to be more alert than the 9:00 Harvard class.

15

Saw a bit distractive today. Lecture strung through repeating to terms written on board, walls, and facts in front of board. Sometimes with one hand in pocket.

21

"If you could have a packed rainbow," "If they're interested."

23

Gave back to Rivers.

Distributed hand-out - Map of VA rivers. Tame River 257M (area of state drained by rivers).

25

Kalamazoo 169'.

New River flows North.
"Other than water-eaten shorelines."  
Indication that student was paying attention. BC said, "Parks have worn-away shorelines." Student circled "Parks." He stopped and said, "What do you mean?" Student told him and he corrected himself.

"The top part of the lake is the uppermost." 
It is typically the warmer part of the lake.

"Run you over — Run over you." 

"What is the importance of this?" Not expecting an answer — this is a signal that he would be talking about importance. Student starts writing. Still talking of how students must pay attention. Will lecture more tomorrow or lab.

Comments and Summary: Glare at board is pretty bad from where I'm sitting today. When he writes, in lecture or board I cannot see it.
Appendix B (Continued)

Student Interview Transcripts

Interviewer: So you are not recommending the role of the instructor in
communicating with you. Is this information and sometimes later with
the professor.

Interviewee: I'm not sure if the professor is supposed to be held by the
instructor and not the professor.

Interviewer: How much do you think people about what he is telling you
and you just have good what for a saying and learn it later.

Interviewee: Is that the way you like it to be? This is the information you
need to know.

Interviewer: We can not be the best approach to say, do you not think of the
information when he tells it?

Interviewee: Sure.

Interviewer: Most of the time people that you prefer the lecture is
remembered and written up later. Sometimes the more classroom
information.

Interviewee: What would you then do if you were still in a biology class and
the instructor never got you to this and said that what is chapter 24, or where would you get the information?

Interviewer: I think you probably wouldn't have read chapter 24.

Interviewee: I have heard people saying that you need to see information
every time and we don't have that you need to do it and you have to use
information.

Interviewer: That sounds good and I don't see why I need further detail.
People are more of a text, they are not going to read.
Appendix B (Continued)
Student Interview Transcripts

...Glenn teaches mostly biology, but he also teaches... music, and he really does a good job for students who... like about the subject. Generally I remember nearly every line he... made until the next day. But when you lecture for a whole... out, how much can you retain of that... I'm not saying you have to take all the notes, but a lot of... things like that about you're... trying to make an important point... you can retain a whole lot better than when you lecture. Look at the board, write it down, memorize it, take a test on it, and forget it two days later.

Q: So we've pretty well agreed that there aren't many, if... any little discussions going on in class, or back and forth questions... getting asked by students.

A: We don't do questions...

Q: And some of you probably think this is a method of teaching... at I'm reading that correction, that come on we expected this when you... came in?

A: We pretty much know what was going to happen because our... friends had already been in this class.

Q: I think he's gotten into a routine, too. Nobody says anything. I think he's gotten to where he's just class after... class and lectured and nobody's spoken up and he's... gotten into a routine where he just lectures straight on through... gives the material...

Q: People have spoken up, he just hasn't noticed...

A: Do you think he has discouraged students from asking... questions... in the way he conducts himself does he discourage... questions?

Q: Do you ever get the feeling... he is a sterner and... stricter than before...

A: Oh yes, I know it at the class before that ...

Q: I'm sure that you only got the feeling as you're sitting there... listening to him, that it was normal...

A: Oh yes, it was here... I feel like he'd been doing it... regularly...

Q: He's almost exactly like my sister's notes. She took the... class in 1983... I've got her notebook and his notes are almost... exactly like mine, almost exactly the same... She wrote the same... things I wrote down...

Q: I would say his tests are the same because he doesn't give... them back. He keeps them, his tests, his quizzes, any kind of... grade he gives he keeps them... I think he is very knowledgeable... he knows the material... he enjoys the material... he enjoys what he's doing...

Q: How does that make you feel? You seem to be resigned to that...

A: That is the way it has to be...
Appendix B (Continued)
Student Interview Transcripts

He's added material, he's going to add material for next year.

Isn't he? I mean, we asked for a couple more specific questions about the actual
content of the course itself. Were there some sections that were not as
important as other sections?

Sure. He says it twice. If he says twice you better write it down...

I've noticed he zeroed out of things here but not all that
information is important.

I don't think so. It sounds so routine all the time. It
sounds like blabla blabla...

He's just making sure you get it down but that doesn't mean

it's important.

The first test we took, I studied more for that than any
test and I didn't recognize some of the questions. I mean, it's
not like the notes. I didn't miss a day, I didn't miss a day of class
and I took a lot of notes... I know that's the same with me
completely.

I think like all you want is for him to tell you what's on
the tests.

Does he ever take time in class to review material before a test?

No, no...

One thing that almost everyone seems to agree on is that there
is so much material in the course that they can afford to take the
five minutes intro instead of the whole question. In some other
sections and I think I have seen that as a reason for not getting
into discussion.

Do any of you ever go to his office and talk to him?

I do. I talk to him sometimes because I was thinking about
wildlife biology and I talk to him quite a bit about that and
jobs and stuff.

I like talking to him...

...and everything but I have a hard time talking to him.

I think he's very helpful. If you miss a lab or something
he's more than willing to let you come into another class or if
you tell him that you... He's more than willing to work around
your schedule. Like I know this girl who's getting married and
she missed several tests and she went in and said I just didn't
have time to study last night and he let her take them later and
stuff. I think he's really good about that. He's very helpful
with students and flexibility.
Appendix B (Continued)

Student Interview Transcripts

"...and I really appreciate your instructor to agree that you, the students, aren't the material.

It's not like it's a fact that it is...if we need help you need to go to the library; it's not your responsibility to come to you...I'm just a substitute, I can't do it. We study it and take a test on it and a week or two later we can't even discuss it.

I feel what they were asking about my body and other stuff...the boys got into the sewage treatment plant and I bat there were about 20 children who didn't even know we had a sewage treatment plant.

One day there was a fire and the beginning of the class and the first thing to do is to do the fire drill. The fire drill is the thing that gave me the relationship between instructor and student.

I thought it was the most idiotic thing I'd ever read in my entire life. He generalized it and gave it to the entire class, if he wanted to use it as a warning letter give it to the person causing the problem not the entire class.

The whole class was talking.

No, the whole class was not talking.

Well, the majority of the class was talking.

The majority may have been. But when you discipline people you can't discipline everybody when...why make the people who aren't doing it feel guilty.

I think I don't think we need letters to tell us to be quiet in class. That was what you got in first grade when the teacher asked you to put your finger to your mouth and walk down the hall saying shhh. I mean, we're in college.

It's your choice to pass or fail this class. If you want to study and want to come and take notes that's up to you the individual. The teacher is not responsible for holding your hand the whole way. "How remember tomorrow you've got to study this. That's not his responsibility it's yours.

What did we say earlier about having someone to hold responsibility to review.

Right. I don't have a problem with him not reviewing. I do homework and study as well. I don't have a problem with that.

How do you think you are when he presents himself as the authority on this?

Because he tries to be the authority in the classroom. How often do you have to go to class and actually push yourself to go to class? And the teacher would have much respect to submit when they're wrong.

One you pretty well assigned to do most things that you do, he assigns you to do most things and he goes and he takes the job of the instructor to come in and bill to you and reading your paperwork.

What is your opinion about probably what it is, the system
Appendix B (Continued)
Instructor B Interview Transcripts

I want to start by asking you some questions about what you're doing in the classroom. What are some important objectives for the course? What do you want your students to get out of your course? How do you get them to stick to it or help them get out what it is you want them to get.

I suppose I have changed since I started teaching. When I started teaching, I was all on wheels around here. For awhile, I had the reputation of being the hardest teacher on campus. And I believe I still have that reputation. But some scientific names, they had to know all the genus and species names. I mean, if they didn't know that they were going to get any credit and they had to have it exactly right. I was really tough on them. I remember when I was teaching here, the first time I met some students, I said, 'Just get through talking about the Hardy-Weinberg.' I never had the Hardy-Weinberg, that was something I had never had. Most of the students had some plant ecology, sampling techniques, taxonomy, things like that. And I don't know if I can put all of that stuff in. So I suppose part of my business of teaching at first was I was scared of some of the material so I was making it tough on the students, but as I began to change, of course a lot of the students at first were older than I was and that was intimidating. The first night I taught a three-hour lecture, I had several pages of notes, but I was through in an hour and twenty minutes. I was going through, and I didn't know how much I could do, and then the next night I taught another three-hour lecture. That was about the same. I guess as I became more confident, probably as I became older, I began to realize that high-level students are not going to be high-precision, and I began to use more the notes. I could do a part of it in class.
Appendix B (Continued)
Instructor B Interview Transcripts

...and I had some success. It became really a challenge for me then to change things and do the course in a different way. Campbell said last night I really like, and that's personalizing the course. I told stories, not to make it all stories, but on the other hand make it personal, and I began to do that more and more. And I do a good bit of it now. It's one of the things that have really come back to me. And so now I am trying to do it, trying to do it in a way that I thought could work, and I've started doing things that are really a metaphor for things I'd like to have students do. And then the students are more engaged and understand these things and they're more interested in the course, and they want to get more out of it. And I have said I think about it, I want to give my students an opportunity at least to think about what's in the textbook and the other things that they need to sort of work their way through and understand to take and apply to their own situation. I think that's what makes the thing that we really look at how I was doing to begin an approach. I also thought about the teaching aspect. I used to have students read the text. And I really rolled this around, 'We've talked about this before.' If the students can read the text and all I'm going to do is rehash what's in the textbook and not add to it than why should I require them to come to class. And so I had a professor who had just got his PhD from Illinois, and he taught pretty much the same way that I teach now, and I really liked his class. I learned more in his class. Everything was organized and students began to get feedback from other students. So I thought about what the type of thing too. They knew what was important, they knew what they had to know. Maybe I've gone that direction too much to the detriment of the textbook, I don't know, but I tell them at the beginning that the textbook is a reference and if they don't understand anything in the textbook they need to ask me about it. And so I will sometimes refer, particularly in the first semester, I do make the second quarter I will refer to some tables and charts in the textbook. So I have perhaps gone too far in that direction, although I find that it works. Students will ask other faculty members class discussion and then they'll take my class and the thing they often make comparisons about is the organization of the class...They like it to be organized more. So I've really done in that direction...
Appendix B (Continued)
Instructor B Interview Transcripts

...and I've said I still have. What do you need--how to be under-
standing? I mean that they need to know all the little details about this, this, this,
and this, and this, and that is because they need to know the biology, all of
the biology, there is to know anyway in a year because if you don't take
something, that's a good foundation course in a sense for students going on in biology, but at the same time it needs to be workable and
courseful for the humanities, something that is going to help them be
better citizens, to make better decisions. I guess I've sort of looked at that too, and ecology and genetic engineering.

...and there's so much stuff coming out it's hard to keep up with it.

...and if that can tickle their fancy, if I can't talk about them and
some of this stuff, it's interesting to see that comes in, and maybe we talk about the greenhouse affect, and they come in, they
read an article, and before they would never have mentioned
that name 
and now after we've talked about it and they understand it
somewhat, they'll start bringing in articles, a magazine, and say did you see this? And I guess maybe that is reaching one of my
big goals that I want is making them aware. They're catching on to things in the news, they're catching on to things that
they read, and about in biology. I don't know if I can always
bring them the answer. Abortion, I can tell them some pros and
cons, and when we did that, I talked about human embryos and
the role of the Catholic Church and we did talk about them, but I did make the judgment that

...and I don't think that is a good part of the lecture technique and the way I teach, I don't know if they, I don't think they feel intimidated by
me, I don't say anything.

...and that is a great way to teach in class because you can ask
students to think about it, you can ask the students to think about
their thoughts and feelings about it, and you can ask them to be
thinking about it and think about the lecture technique and the way I teach. I don't think they feel intimidated by
me, I don't say anything.

...and I don't think I necessarily do in the classroom. And part
of the reason is control of the class. I've been in classes and
I've taught in classes, and I'm sure you have, it's just rambling, and there doesn't seem to be
any direction and you've have to class and you've come out and
Appendix B (Continued)
Instructor B Interview Transcripts

I am not in the world was that I was, and what was expected to happen if I ever became an instructor. I still am not sure that I will ever become an instructor. But in the end, I believe that it is important to keep the class moving forward.

I think it is important to keep the class moving forward. It is like a jigsaw puzzle; you start putting the pieces together and then you start raising the question that applies way up here. Well, if I take time and answer that—these will probably start crumbling, because I want to take them through this thing, lead them through it, and then they reach this point up here, I like to be able to look at the and see some faces light up, "Oh yeah." And I don't like for somebody to take me out of that path and grab me up here and grab the class and the whole trend is broken, and then you come back and try to continue and they've lost their train of thought. And protein synthesis is something like that and respiration, it's the same thing. But this is where we are and we have to keep moving forward.

The thing is, they have any question or any problem with that. I think this is one of the things I told Campbell, I think of some books you use, and I think that's what I mean. I don't get animal physiology and animal systems. I'm sure there are other books out there. On the other hand, I'm going to teach biology and chemistry. And I think, I don't have any problems with that. I think this is one of the things I told Campbell. I think of some books you use, and I think that's what I mean. I don't get animal physiology and animal systems. I'm sure there are other books out there. On the other hand, I'm going to teach biology and chemistry. I think this is one of the things I told Campbell. I think of some books you use, and I think that's what I mean. I don't get animal physiology and animal systems.
Note from tape recording: 3/5/70

Talked with [redacted] briefly after class today, got a copy of his syllabuses and policies. He also gave me a copy of the text book so I can take a look at that.

Talked a little bit about his class again, the amount of material students need to know. He made the comment that when he went to a community college and when he went to a four-year school he felt lost or behind at first. He said he tries to make students learn as much as possible and work as hard as possible and avoid having them saying they're doing things and things like that. Sounds a little different than when we talked last time. I'm not sure how different what he is saying now is from what he was saying before. The impression from today is that he wants to prepare students for transfer. He cause is a combination of a course for majors and for majors; meaning that for majors he needs to stress terms and for students need to know as many terms as possible. He said the students sometimes complain, 'I'm not a business major why do I have to know all this stuff?' Sounds like he's talking to him today that he stresses or at least recognizes that course he has at least help the majors but are going on to four-year college and majors in science or business,
Appendix B (Continued)
Tape Recorded Comments

The material that he is covering now is more the environment and ecology theory. He talked about the marine brains; this material lends itself very well to the application to society. In talking with the sewage treatment plant, he made references to just talk about the biological principals in the large aspect of the process of the things going on at the sewage plant that are related to biological concepts that he had talked about in the class so that student should be familiar with: anaerobic, aerobic, things like that. He talked about the ocean brain, he made a reference at the end of class to brains that had been built along shore and where the standing is evolved away and brains fall in.

I don't want to make too many broad generalizations or come to too many conclusions about what he thinks or what others think or how to approach it until I've had a chance to look further. Certainly he is interested in natural history and wants students to become interested in and involved in their surroundings. But that's not to say that he is not also interested as concerned that they know the biological terms and that they know the things they will need to then take a biology course later. Particularly majors.
Appendix B (Continued)
Tape Recorded Comments

So at least he seems more to the
level of people majors that I can't tell
yet and he might ...

He indicated now that he is
had a reputation for being a very difficult
teacher in at least this section of the
course now perceived to be difficult. So I
don't think his approach is easier than
any other. Apparently he does expect
students to know facts and terms, etc. But
he also wants them to be aware of how
biological concepts help explain what
goes around them in terms of the environment.
Appendix C
I.C.--Field Notes, Interview Transcripts, and Comments

Date: April 3, 1970 (Thurs)  Location: [Redacted]
Class: Bsc 102  Instructor: [Redacted]  I.C.
Lecture Topic: Chap 11 Endocrine System Chemical Coordinated

Fieldnotes

10 students present today (11:06)

Discussing Lab part to today. Today's lab...

...beginning because

Commenting on length of labs. Apparently it is not unusual for labs to last that long. We...

...expect them to stay as long as it take to understand material

Discussed removal of topics in book. Endocrine system placed before reproductive system followed by nervous. All students have books open and note books open except one next to me who is reading a girlfriend.

Inspected stereo in room.

Use boards to lecture today.

Several students readily respond to questions - not always correctly - but they do respond.

One female out with a side hair a tendency to do alternate occasionally.

May have gave 10 min without student response.

There were fewer students in the room.

Question: Refer to graphs with students and...

Question: Do you have an example of... 

Student asks question: Don't know answer:

...very hard but I'll look; try to find an example.
Appendix C (Continued)

Comments on the importance of knowing chemical nature of proteins.

Tells class that it is important for student to know basic chemistry - chemical bonds to

Tells class to try to get students to recall structure of cell membranes

According to his notes -

1. Students look up

2. Still lecturing by going through book page by page, selecting topics and referring specifically on text. He refers to figures and tables as well as specific paragraphs in text - but he doesn't read the text. He tells class to look up something in a particular chapter and refers to an antibiotic. He tells the class they should know how penicillin is made and how it acts.

3. When talking about the book he says: "They talk about... they talk about... look at this sequence they describe in this figure. They talk about..."

4. "The student who is sick..."

5. "I want to be sure that the..."

Comments and Summary:

- Teacher always comes in late to class. Teacher always starts class by asking questions, then goes over homework, then starts class.

- The teacher appears to prefer students who are interested in the subject, particularly interested in those who are able to express interest in a healthy manner, but not those who are not interested in the subject.
Appendix C (Continued)

Fieldnotes

1. Handing back test papers. (lab post)
2. Need plant cell. (lab post)
3. "What are the functions of the body?"
4. "What are they?"
5. "What are we learning?"
6. "What are the functions of the body?"
7. "What are the functions of the plant cell?"
8. "What are the functions of the plant cell?"
9. "What are the functions of the plant cell?"
10. "What are the functions of the plant cell?"
11. "What are the functions of the plant cell?"
12. "What are the functions of the plant cell?"
13. "What are the functions of the plant cell?"
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29. "What are the functions of the plant cell?"
30. "What are the functions of the plant cell?"
31. "What are the functions of the plant cell?"
Appendix C (Continued)

Two students are engaged in a discussion. One student is making a point, while the other appears to be listening intently. The discussion seems to be about a specific topic, possibly related to the course material.

31. Two students are engaged in a discussion. One student is making a point, while the other appears to be listening intently. The discussion seems to be about a specific topic, possibly related to the course material.

32. (继续)

33. (继续)

34. (继续)

35. (继续)

36. (继续)

37. (继续)

38. (继续)

39. (继续)

40. (继续)

41. (继续)

42. (继续)

43. (继续)

44. (继续)

45. (继续)

46. (继续)

47. (继续)

48. (继续)

49. (继续)

50. (继续)

51. (继续)

52. (继续)

53. (继续)

54. (继续)

55. (继续)

Comments and Summary:

By now, I've found that you can become proficient in a new skill by watching someone else do it or by attempting it (whether it's an exercise or a sport). For example, you can learn to swim by watching someone else swim or by taking part once or twice a week. The same holds true for writing skills, thinking skills, communication skills, and problem-solving skills.
Appendix C (Continued)

Student Interview Transcripts

I try to get out of class as much as I can. I get a lot out of class. I try to listen and get a lot out of class. Because I don't have time to read a lot outside of class.

I get a lot more out of it if I read the book before I come to class.

I don't get a whole lot out of it. If I can ask questions...

But that's not really the case. The interaction part of the class. The class when I have you pull out discussion in class. Most of the time in class, it's all from me to you, you to me. I don't really see the interaction that I think of it. I can't see what you're expecting it to be or would you like it to be done some other way.

I do like more discussions. On my own and it's feeling that there discussion might be initiated in that, would it be up to the instructor to force you to answer more questions...

There have been times people have asked, and there just isn't enough time. I feel like that we're already so far behind the other classes I don't want to change the subject, let's get on with this instead of getting in a long discussion...

We're trying to take up too much stuff to try and have a discussion.

Like today I would've liked to ask a couple of questions on the eye. But if you look on the schedule there's so much stuff crammed in there, I feel that we're going to miss out on something else that's going to be tested if I ask a question...

I do think that the professor's been doing an excellent job in something else and that he's expected to back up in that area for a while.

You might ask a half hour discussion at that might not be anything that you'll be tested on, it could be something you're interested in but yet you're knocking yourself out of what might be important to the teacher, what he's trying to get across.

He's said himself that there's too much in that book to get through.

when you're standing in the front of the class and feel a responsibility to cover a certain amount of material, but if I sit back and observe the process in some annual conclusion and I think about all this I'm wondering if you can get the same thing by teaching a book and the point or being here. If it was that new the point of view to go to have a class, it would be where everybody is part of it...

Can you bring up a little more about testing for a...
Appendix C (Continued)
Student Interview Transcripts

I think the labs are fairly informal and that you need to pay attention in lab.

If you don't pay attention you don't know what in the world is going on...if I had to miss one or the other I'd rather miss lecture. You don't miss lab. I'd get by better missing lecture. You really have something to go by [in lecture], you have the book and he follows the book pretty closely.

How do you feel about the fact that he follows the textbook.

I like it. Cause if you miss one day of lecture, you have to do is find the place where he stopped and go back and read from the time before you missed and till you came back again and you're caught up.

Do any of your classmates ask questions in class? Do you feel comfortable to ask questions in class? Do you think there is a proper way to ask questions. Is it easy, hard to ask questions?

He's the authority but he's not overpowering. Some teachers like to be on a throne and there word is law. You can talk to him. He's very cooperative. Sometimes he'll change his answer if you show him what you were thinking about.

How do you view the relationship between student and teacher in this class?

Our lab seems more like lecture than some other classes. They're not worrying about a quiz every week they're just kind of doing the lab.

Too, no brought in so much outside information. Cause this lab book they're not very happy with it. And I think he brought in alot from outside and some of the labs were hard.

If you have the lab before the lecture that's helped me alot. I don't think we've coordinated the lab with the lecture and the lab, they need to be more coordinated together.

Would you describe the atmosphere between lecturer and lab?

There's a lot of things we'd like to discuss such as

AOS and questions we'd like to ask but there's not enough time there's too much stuff you have to cram in.

How do you view the relationship between student and teacher in this class?

He's the authority but he's not overpowering. Some teachers like to be on a throne and there word is law. You can talk to him. He's very cooperative. Sometimes he'll change his answer if you show him what you were thinking about.

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Would you describe the atmosphere between lecturer and lab?

There's a lot of things we'd like to discuss such as

AOS and questions we'd like to ask but there's not enough time there's too much stuff you have to cram in.
Appendix C (Continued)
Student Interview Transcripts

I think it's about finding the truth. Like evolution, you said you were interested in that. He said we're not going to get into it. I mean forget it. But he said when we first started that he wasn't trying to convert anybody, he was telling us what was known. I'm not saying that evolution is fact. I think that if you want to know what fact is, you've got to learn the two sides of fact.

Do you think that science presents one interpretation of truth?

I can't believe against evolution but I can't believe against religion.

So you would like to have less objectivity in the presentation of scientific knowledge? Would you like to have more flexibility in the presentation of knowledge? Would you like a kind of other things brought into the discussion of scientific knowledge?

I think you should maybe not cover so much material. I think he crams too much into each test.

We even asked him about that...

When you want an interview, you need one. We have to talk to your teacher...

We're supposed to meet at 1:15, but I don't think he knows that.

You can tell him what he expects of you so you can get the

I asked him about the letter that goes with it. He just

I couldn't find anything out of the book and put it in my

I can't find any writing for this course.

He'll sometimes have two or three on a test...the last test we had five.
Appendix C (Continued)
Instructor C Interview Transcripts

Well, yeah, I think we're going to have to do this sort of
material and expand it. And I don't think we're going
to get to that material and expand it. I think this is going
to be a new chapter to us. It's maybe a little bit less
spread out. I think certainly some of that, given the recollection
here, and that sort of thing now, we need to know a little more about
it. It's a new area. There's a lot of things in there, you just
need to boil it down a bit more, give a little more direction
with it. And probably the same thing in a lot of these areas.
I think he did a good job in some areas, of condensing things.
Like for instance, the sodium potassium pump with the nerves,
and trying to get the idea of some equal electricity flow. But I
think he didn't do a good job and doesn't waste a lot of time
detailing it and I think they still got a pretty good picture
of it. So we have to do a little bit of that. So we're going to do
that. Yeah, and I feel like I think any instructor learns in the
regard that you're kind of between a rock and a hard place.
If you use a shorter text, and I've used the short Curtis for a
long time. Through several editions, it's still given the top
and what you have to allow for testing and the the thing that and the
other, there's no way, even in a short text that you can
cover it the way you'd like to. The only thing that I see as
my as a teacher, or as a middle aged here, in a squad, is to
roll it down or in some way lead the student into it enough and
operates enough enthusiasm. If it's enough enthusiasm, they don't
mind reading the rest of it. I don't know that we always
accomplish that. I think a lot of students in the halls and in
places like that, and all they're doing is cramming in the
cellular at the end of each chapter, that's all I see. I'm doing
of course. I know I'm doing it, but they're already read and they've just been
putting it. I think most of them are just cramming the things
summary of the chapter content.
Appendix C (Continued)
Instructor C Interview Transcripts

No, I don’t know. I am different in some respects. You may know this, no other biology faculty wear a tie. I caught a lot of grief for that last year but I haven’t taken it off yet. That’s just something I came with and I’m used to doing it and I just never have changed. Now in the summer I don’t wear one. I don’t think the tie makes a difference. I don’t see any problems with that. Maybe the students perceive it as a threat or somebody dominating over them, or too much authority. I don’t know. I don’t. My colleagues may see it as a threat. But to me it’s not what you wear. It’s not how long your hair is, or if your skin is what you eat. It’s the way you deal with in an academic setting. That’s where it is and that’s the only place it should be. So, they may have a little trouble getting around that or say trouble getting around that, as far as I’m concerned, no. I see myself, obviously you got to test, you got to give grades, make decisions, that sort of thing, I’m not sure we would have more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period. It’s the thing that grinds me about that too much is you’re required to religiously to maintain 10 office hours which I cut every now and then, but as far as I’m concerned, I don’t need more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period. It’s the thing that grinds me about that too much is you’re required to religiously to maintain 10 office hours which I cut every now and then, but as far as I’m concerned, I don’t need more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period. It’s the thing that grinds me about that too much is you’re required to religiously to maintain 10 office hours which I cut every now and then, but as far as I’m concerned, I don’t need more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period. It’s the thing that grinds me about that too much is you’re required to religiously to maintain 10 office hours which I cut every now and then, but as far as I’m concerned, I don’t need more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period. It’s the thing that grinds me about that too much is you’re required to religiously to maintain 10 office hours which I cut every now and then, but as far as I’m concerned, I don’t need more than here to help a person, to help a person, to be a mentor to their development, and that’s my philosophy, period.
Appendix C (Continued)
Instructor C Interview Transcripts

...
Appendix C (Continued)
Tape Recorded Comments

...So when I'm recording them, I'm...
STUDENT CHARACTERISTICS QUESTIONNAIRE

I am conducting a study of general education natural science courses at selected public community colleges in Virginia. The information from this questionnaire will be used to develop a demographic description of the classrooms involved in this study.

These questionnaires are anonymous. Only the overall general results will be reported.

1. Course __________________________ 2. Term __________________________
3. Age _____ 4. M _____ F _____ 5. Ethnic Background ______________
6. Name and location of last high school attended __________________________

7. Did you graduate? ______ Yes ______ No Year ______________
8. If you answered yes to #7, what was your G.P.A.? ______
9. If you answered no to #7, have you received a G.E.D.? ______ Yes ______ No Year ______________
10. Parents’ education. Circle the highest grade completed.
    Mother: 6 7 8 9 10 11 12 13 14 College graduate
    Father: 6 7 8 9 10 11 12 13 14 College graduate
11. Number of credit hours for which you are currently registered ______________
12. Are you working now? ______ Yes ______ No
13. If you are working, what is your job? __________________________
14. If you are working, how many hours a week do you work? ______________
15. What is your primary goal in attending this college?
    ______ Improvement of existing job skills.
    ______ Preparation for job to be obtained.
    ______ University transfer credit.
    ______ Personal interest.
    ______ Other
16. Why are you taking this course?
    ______ Required for my major.
    ______ Recommended to me.
    ______ Required for a degree
    ______ Just like the subject
    ______ Other reason - Specify __________________________
17. In what range does your current VNCC overall GPA fall?
   ___ Below 2.0   ___ 2.0 to 3.0   ___ Above 3.0   ___ Don't know

18. How are you being supported while attending college?
   ___ Self-supporting   ___ Family support
   ___ Grants or loans   ___ Other

19. In what program are you currently enrolled? ________________

20. Do you intend to earn an Assoc. Degree? ___ Yes ___ No

21. Do you intend to earn a Bachelor's Degree? ___ Yes ___ No
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Appendix E

STUDENT CLASSROOM ACTIVITIES QUESTIONNAIRE

I am conducting a research project as part of the requirement for a doctorate at Virginia Tech. I am interested in learning about your perceptions of the school you have selected, the natural science course you are enrolled in, and about your expectations of the course and the school.

These questionnaires are anonymous. Only the overall general results will be reported. I would be happy to share these general results with any of you who are interested.

1. I would like to know about your goals for this course. Rate each of the following goals according to its importance as a goal for you. (CHECK ONE COLUMN FOR EACH ITEM)

<table>
<thead>
<tr>
<th>How would you rate these as objectives for you?</th>
<th>Primary Objective</th>
<th>Minor Objective</th>
<th>Not an Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting a good grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Getting credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning facts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning major concepts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaining skills specific to the subject of this class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaining general thinking skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaining general reading, writing, speaking skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing positive attitudes toward the subject of this class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoying social interaction with people</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing more self confidence</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E (Continued)

2. The following is a list of activities that might go on in class/room. For each check:
   U if it usually occurs in this class
   S if it sometimes occurs in this class
   N if it never occurs in this class

<table>
<thead>
<tr>
<th></th>
<th>U</th>
<th>S</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>lectures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>discussions-whole class</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>discussions-small group</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>demonstrations</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>skill practice</td>
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<td></td>
<td></td>
<td></td>
<td>use of audio visuals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>instructor answers student qtns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>student presentations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>group projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>reading aloud</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>going over handouts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>instructor questions student</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>other (specify)</td>
</tr>
</tbody>
</table>

3. What do you, yourself, do in class? For each activity, check:
   U if you usually do it
   S if you sometimes do it
   N if you never do it

<table>
<thead>
<tr>
<th></th>
<th>U</th>
<th>S</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>take notes from board/overhead</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>take notes from instructor's talk (not on board/overhead)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ask instructor questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>answer instructor's questions</td>
</tr>
</tbody>
</table>
Appendix E (Continued)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>S</td>
<td>N</td>
<td>talk to other students</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>do homework</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>listen and watch the instructor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>read course related books</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>in-class reading of other material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>in-class writing (other than notes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>practice skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>other (specify)</td>
</tr>
</tbody>
</table>

4. Outside the class, what activities do you do for this course? For each activity check: U if you usually do it, S if you sometimes do it, N if you never do it

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>S</td>
<td>N</td>
<td>read/study textbook</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>read/study notes from class</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>do some other reading</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>talk with instructor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>talk with other students</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>talk with tutor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>practice skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>library research</td>
</tr>
</tbody>
</table>
5. For each language skill mentioned below, do two things. First, rate it for importance to success in this class.
   1 - especially important
   2 - important
   3 - not important

   Then rate it for difficulty:
   1 - most difficult
   2 - difficult
   3 - not difficult

<table>
<thead>
<tr>
<th>Importance to your success</th>
<th>Difficulty for you</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Listened</td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
</tr>
<tr>
<td>Writing notes</td>
<td></td>
</tr>
<tr>
<td>Other writing</td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
</tr>
<tr>
<td>Observing</td>
<td></td>
</tr>
</tbody>
</table>

6. In thinking over your experiences in this course up to now, to what extent do you feel you have made progress or been benefitted in each of the following respects?

<table>
<thead>
<tr>
<th></th>
<th>Very much</th>
<th>Some</th>
<th>Very little</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication skills; skills to read, write, listen, and to speak effectively.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning skills; skills to locate and utilize information resources; knowledge of methods of inquiry.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical thinking skills; skills to recognize and solve problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpersonal skills; development of self-understanding, personal values, ethics, and social responsibility.</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix E (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Very much</th>
<th>Some</th>
<th>Very little</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational and computer skills; skills to understand and interpret numerical data.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding culture and society; development of attitudes and values for responsible citizenship.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding science and technology; knowledge of the scientific method of inquiry.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wellness; development of attitudes, values, and skills which promote physical and emotional well being.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

INSTRUCTOR QUESTIONNAIRE

I am conducting a research project for a doctoral dissertation at Virginia Tech. I am interested in learning about the instructional practices and course activities of general education natural science courses at selected public community colleges in Virginia.

The questionnaire asks questions about one of your classes currently being offered. All information gathered is treated as confidential and at no time will your answers be singled out. I recognize that the questionnaire is time-consuming and I appreciate your efforts in completing it. Thank you very much.

1. Course number and title

2. How many students are enrolled this semester?

3. Check each of the items below that you believe properly describes this course.

- [ ] Parallel or equivalent to a lower division college level course at transfer institutions.
- [ ] Designed for transfer students majoring in one of the natural resources fields (e.g., agriculture, forestry) or an allied health field (e.g., nursing, dental hygiene, etc.).
- [ ] Designed for transfer students majoring in one of the physical or biological sciences, engineering, mathematics, or the health sciences (e.g., pre-medicine, pre-dentistry).
- [ ] Designed for transfer students majoring in a non-science area.
- [ ] Designed as a high school make up or remedial course.
- [ ] Designed as a general education course for non-transfer and non-occupational students.
- [ ] Designed for further education or personal upgrading of adult students.
- [ ] Other (please specify)
4a. Instructors may desire many qualities for their students. Please select the one quality in the following list of four that you most want your students to achieve in this course.

___ Understand/appreciate interrelationships of science and technology with society.
___ Be able to understand scientific research literature.
___ Apply principles learned in course to solve qualitative and/or quantitative problems.
___ Develop proficiency in laboratory methods and techniques of the discipline.

b. Of the four qualities listed below, which one do you most want your students to achieve?

___ Relate knowledge acquired in class to real world systems and problems.
___ Understand the principles, concepts, and terminology of the discipline.
___ Develop appreciation/understanding of scientific method.
___ Gain "hands-on" or field experience in applied practice.

c. And from this list, which one do you most want your students to achieve in this course?

___ Learn to use tools of research in the sciences.
___ Gain qualities of mind useful in further education.
___ Understand self.
___ Develop the ability to think critically.

5. Over the entire term, what percentage of class time will be devoted to each of the following?

Your own lectures

Guest lecturers

Student verbal presentations

Class discussion

More or next page

___ %
Appendix F (Continued)

Viewing and/or listening to film or taped media
Simulation/gaming
Quizzes/examinations
Field trips
Lecture/demonstration experiments
Laboratory experiments by students
Laboratory practical examinations and quizzes
Other (please specify)

TOTAL 100%

6. How frequently are each of the following instructional media used in this class?

<table>
<thead>
<tr>
<th>Instructional Media</th>
<th>Frequently Used</th>
<th>Occasionally Used</th>
<th>Never Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Films</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhead projected transparencies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audiotapes, cassettes, records</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videotapes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television (broadcast/closed circuit)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maps, charts, displays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three dimensional models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural preserved or living specimens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture or demonstration experiments involving chemical reagents</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F (Continued)

7. Which of the following materials are used in this class?

<table>
<thead>
<tr>
<th>Material</th>
<th>How many pages in total are students required to read?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbooks</td>
<td></td>
</tr>
<tr>
<td>Laboratory materials and workbooks</td>
<td></td>
</tr>
<tr>
<td>Collections of readings</td>
<td></td>
</tr>
<tr>
<td>Reference books</td>
<td></td>
</tr>
<tr>
<td>Journal and/or magazine articles</td>
<td></td>
</tr>
<tr>
<td>Newspapers</td>
<td></td>
</tr>
<tr>
<td>Syllabi and handout materials</td>
<td></td>
</tr>
<tr>
<td>Problem books</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

8. Please indicate the emphasis given to each of the following student activities in this class.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Not included in determining student's grade</th>
<th>Included but counted less than 25% toward grade</th>
<th>Counted 25% or more toward grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papers written outside of class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papers written in class</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Quick-score/objective tests/exams</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Essay tests/exams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral recitations</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Workbook completion</td>
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<td></td>
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</tbody>
</table>
### Table: Components of Grade Calculation

<table>
<thead>
<tr>
<th>Component</th>
<th>Not Included in Determining Grade</th>
<th>Included but Counted Less Toward Grade</th>
<th>Counted 25% or More Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular class attendance</td>
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</tr>
<tr>
<td>Participation in class discussions</td>
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<tr>
<td>Individual discussions with instructor</td>
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<tr>
<td>Research reports</td>
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<td>Non-written projects</td>
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<td>Homework</td>
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<td>Laboratory reports</td>
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<td></td>
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<tr>
<td>Problem sets</td>
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<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Examinations or quizzes given to students may ask them to demonstrate various abilities. Please indicate the importance of each of these abilities in the tests you give in this course. (THREE COLUMNS FOR EACH ITEM)

<table>
<thead>
<tr>
<th>Ability</th>
<th>Very Important</th>
<th>Somewhat Important</th>
<th>Not Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery of a skill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquaintance with concepts of the discipline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recall of specific information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the significance of certain works, events, phenomena, and experiments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F (Continued)

<table>
<thead>
<tr>
<th>Ability to synthesize course content</th>
<th>Very important</th>
<th>Somewhat important</th>
<th>Not important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship of concepts to student's own values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. What was the relative emphasis given to each type of question in written quizzes and examinations? (CHECK ONE COLUMN FOR EACH ITEM)

<table>
<thead>
<tr>
<th>Frequently used</th>
<th>Seldom used</th>
<th>Never used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple response (including multiple choice and true/false)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solution of mathematical type problems where the work must be shown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of graphs, diagrams, chemical type equations, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Derivation of a mathematical relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. What grading practice do you employ in this class?

- ABCDF Pass/No credit
- ABCD/No credit No grades issued
- ABC/No credit (other (please specify))
- Pass/Fail
Appendix F (Continued)

Now, just a few questions about you...

12. How many years have you taught in any college?
   __ Less than one year
   __ 1-2 years
   __ 3-4 years
   __ 5-10 years
   __ 11-20 years
   __ Over 20 years

13. At this college are you considered to be a:
   __ full-time faculty member
   __ part-time faculty member
   __ department or division chairperson
   __ administrator
   __ Other (please specify)

14. Are you currently employed in a research or industrial position directly related to the discipline of this course?
   __ Yes  __ No

15. What is the highest degree you presently hold?
   __ Bachelor's
   __ Master's
   __ Doctorate
INSTRUCTOR: Dr. [Redacted]

OFFICE: Office hours are posted on the door. If these do not conform to your schedule, please see me before or after class to set up an appointment.

PREREQUISITE: Biology 101

SEMESTER CREDITS: 4 Lecture Hours: 3 Laboratory/Recitation Hours: 3

COURSE DESCRIPTION:

Continues to explore the fundamental characteristics of living matter, stressing the animal kingdom and the ecological community. Emphasis is placed on the general biological principles of these living organisms, their structure, function, and evolution.

EVALUATION: Written lecture and laboratory examinations

- Lecture exams 75%
- Laboratory exams 25%
- 5 including the final exam
- 2 lab exams

GRADING SYSTEM:

- A - 90-100
- B - 80-89
- C - 70-79
- D - 60-69
- F - 59 and below

POLICIES:

1. Students are expected to take exams on the day they are scheduled. If they are not taken by the next class period, make-up exams are given during final exam week. This is done so that fellow students may get their exams returned promptly.

2. Students may make tape recordings of the class as long as recording equipment does not block aisles.

3. You may not bring your children or other youngsters to class. Do not invite someone to attend class with you until you have received my consent to do this.

4. The names of students irregularly attending class may be removed from the class roll. Students who must be absent because of illness, employment schedules, family problems, or other difficulties should keep me informed of their situations. Often adjustments can be made.
## Appendix G (Continued)

Textbooks for BIO 102 General Biology


### Topical Description

<table>
<thead>
<tr>
<th>Topics</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucaryotes-Animal Survey</td>
<td>29-30</td>
</tr>
<tr>
<td>Systems Comparison</td>
<td>36-45</td>
</tr>
<tr>
<td>Physiology Related to Animal Systems</td>
<td></td>
</tr>
<tr>
<td>Embryology</td>
<td>43</td>
</tr>
<tr>
<td>Ecological Principles</td>
<td>48-49</td>
</tr>
<tr>
<td>Ecosystems and Structure</td>
<td></td>
</tr>
<tr>
<td>Energy Flow</td>
<td></td>
</tr>
<tr>
<td>Biomes--Mainly North America</td>
<td>46</td>
</tr>
<tr>
<td>The Marine Ecosystem</td>
<td>46</td>
</tr>
<tr>
<td>Freshwater Ecosystems--Flowing and Standing</td>
<td>46</td>
</tr>
<tr>
<td>Interaction and Relationships Between Populations</td>
<td>47</td>
</tr>
<tr>
<td>Population Dynamics Including Over Population and Its Effects (Pollution)</td>
<td>47</td>
</tr>
<tr>
<td>Darwinism</td>
<td>20-25</td>
</tr>
<tr>
<td>Speciation</td>
<td></td>
</tr>
<tr>
<td>Behavior</td>
<td>50</td>
</tr>
</tbody>
</table>

The textbook covers Units IV, V, VII, VIII.
MULTIPLE CHOICE QUESTIONS. ONLY ONE CHOICE IS CORRECT (2 pts each)

1. Plasma cells, which produce antibodies, are derived from
   A) T lymphocytes   B) B lymphocytes   C) monocytes   D) none of the above

2. Which sequence is INCORRECT for blood flowing through the human circulatory system?
   A) left ventricle ----> aorta   B) right ventricle ----> pulmonary vein
   C) pulmonary vein ----> left atrium   D) superior and inferior vena cava ----> right atrium

3. The main respiratory organs that are concerned with gas exchanges with the blood and which are made up of air sacs or alveoli are called the:
   A) lungs   B) nasal cavities   C) bronchi   D) oropharynx

4. A three-chambered heart is characteristic of:
   A) all vertebrates   B) mammals   C) fish   D) amphibians
   E) birds   F) none of the above

5. Essential nutrients:
   A) are substances an animal cannot make from precursors
   B) can vary from species to species of animal
   C) include vitamins and some amino acids
   D) all the above are correct
   E) none of the above are correct

6. Which anatomical sequence is INCORRECT?
   A) oral cavity ----> esophagus ----> stomach
   B) vein ----> capillary ----> artery
   C) trachea ----> bronchus ----> bronchioles
   D) stomach ----> small intestine ----> large intestine
   E) pulmonary arteries ----> lungs ----> pulmonary veins

7. The digestive role of the salivary glands in the mouth is continued later in digestion by the:
   A) liver   B) pancreas   C) gall bladder   D) colon

8. If you are a blood cell flowing through the pulmonary circuit, the very first chamber of the heart you will see again will be the
   A) left atrium
   B) right atrium
   C) left ventricle
   D) left or right atrium depending on which lung was visited

9. Which source of stored fuel do you suppose would be used first by a sprinter in a 100-yard dash?
   A) liver glycogen   B) body fat   C) muscle glycogen   D) muscle protein

10. Which of these enzymes has the lowest pH optimum?
    A) amylase   B) pepsin   C) lipase   D) trypsin
Appendix G (Continued)

11. Most nutrients are absorbed across the epithelium of the:
A) stomach  B) small intestine  C) large intestine  D) colon  E) esophagus

12. A closed circulatory system can be associated with
A) gills  B) lungs  C) both A and B  D) neither A nor B

13. Bile salts:
A) are enzymes  B) are fat emulsifiers produced by the liver  
C) increase the efficiency of pepsin action  D) are normally an ingredient of gastric juice  
E) all the above are correct

14. Blood pressure in the human circulatory system would be highest in the:
A) pulmonary vein  B) renal vein  C) aorta  
D) veins of the upper arm  E) arteries of the thigh

15. Valves are commonly located in the:
A) veins  B) lymphatic vessels  C) heart  D) all the above are correct

16. The absorptive area of the ileum and jejunum is increased by
A) villi  B) rugae  C) cecae  D) sphincters  
E) both B and C

17. An atrioventricular valve prevents the backflow or leakage of blood
A) from a ventricle into an atrium  B) between ventricles  
C) from the aorta into the left ventricle  D) from the pulmonary vein into the right atrium

18. Food and inhaled air normally both pass through which structure?
A) larynx  B) pharynx  C) esophagus  D) glottis  E) trachea

19. Most of the CO₂ in the blood is transported:
A) as the gas CO₂ in white blood cells  B) in the O₂ binding site of hemoglobin  
C) as bicarbonate ions  D) CO₂ is not transported in the blood

20. In the capillaries of the systemic circuit, which chemical reaction(s) take place?
A) oxygen is loaded onto hemoglobin  B) oxygen is released from hemoglobin  
C) CO₂ joins with H₂O to form bicarbonate  D) bicarbonate dissociates to form CO₂  
E) both B and C

21. Humoral immunity (antibodies) is mostly the function of:
A) T cells  B) B cells  C) erythrocytes  D) platelets  E) cytotoxic cel
22. Resistance to disease conferred by vaccination is an example of:
A) active immunity
B) passive immunity
C) autoimmunity
D) immunodeficiency

23. The AIDS virus (called human immunodeficiency virus or HIV) compromises the immune system mainly by attacking:
A) helper T cells
B) cytotoxic T cells
C) B cells
D) phagocytes
E) the epithelial cells of blood vessels

24. Lacteals function in the absorption of:
A) sugars
B) lipids
C) amino acids
D) none of the above

25. Both the small and large intestine:
A) absorb water
B) produce vitamin K
C) receive acid chyme

26. Which of the following constituents of blood would you expect to find in the lymphatic system:
A) plasma proteins
B) lymphocytes
C) both A and B

27. The term double circulation refers to:
A) two atria and two ventricles
B) separate blood flow to the lungs and systemic circulation
C) the possession of both arteries and veins

28. For a blood pressure of 130/80
A) the systolic pressure is 80
B) the diastolic pressure is 80
C) the pulse rate is 80 beats per minute
D) the blood pressure during heart contraction is 80
E) both A and C are correct

TRUE/FALSE QUESTIONS (IF THE QUESTION IS FALSE, CORRECT THE STATEMENT SO THAT IT IS TRUE FOR FULL CREDIT) 2 pts each

_____ Digestion is the process of breaking down food molecules into small enough pieces for the cells of the body to absorb.

_____ The blood cells of adult humans are made mainly in the bone marrow.

_____ A person can be overnourished and malnourished at the same time.

_____ The fluid of the lymphatic system is called chyme.
An antigen is a foreign substance, usually protein or polysaccharide, that induces a specific immune response.

The white blood cell called a neutrophil is one of the major phagocytes of the body.

Starch digestion starts in the mouth.

MATCHING TERMS  NOT ALL CHOICES WILL BE USED (1 pt each)

platelet  A) this enzyme breaks down fats in the small intestine
monocyte  B) helps to emulsify fats stored in the gall bladder
albumin  C) this white blood cell becomes a macrophage when it goes out into the tissues
erthrocyte  D) is essentially a cell fragment that is needed for normal clotting of blood
ertery  E) main function of this cell is O₂ transportation
capillary  F) a vessel that carries blood to the heart
semilunar valves  G) a vessel that carries blood away from the heart
hemoglobin  H) enzyme hydrolyzes polypeptides in the duodenum
capillary  I) are found in the two large arteries leaving the ventricles and prevent backflow of blood into the ventricles
semilunar valves  J) main function of this molecule is oxygen transportation
hemoglobin  K) contraction of the ventricles
defate  L) relaxation of the ventricles
pulse  M) transfer of substances between blood and tissues occurs using these blood vessels
blood pressure  N) a protein found in plasma that maintains osmotic balance
diastole  O) an antibody producing cell
trypsin  P) the pressure the blood exerts on the inner walls of blood vessels
lipase  Q) the expansion and recoil of an artery that occurs with each beat of the left ventricle
peristalsis  R) rhythmic waves of contraction of smooth muscles in the digestive tract

SHORT ANSWER QUESTIONS

1. What is atherosclerosis (4 pts)

2. Give two differences between the structure (anatomy) of a capillary and an artery. (4 pts)
3. Name and briefly explain the first two lines of defense (non-specific) of the body. (6 pts)

4. What is the Purkinje system? (where is it located and what does it do). (3 pts)
Appendix H
Instructor B—Syllabus and Sample Tests

BIO 102

TEXTS: BIOLOGY, NEIL CAMPBELL, FIRST EDITION
A GUIDE TO BIOLOGY LAB, THOMAS RUST, THIRD EDITION
INVESTIGATIONS FOR GENERAL BIOLOGY, CRITES AND KILLIAN FIFTH EDITION

TOPICAL LISTINGS

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>CHAPTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRINCIPLES OF CLASSIFICATION--DIVERSITY</td>
<td>26</td>
</tr>
<tr>
<td>INVERTEBRATES</td>
<td>29</td>
</tr>
<tr>
<td>VERTEBRATES</td>
<td>30</td>
</tr>
<tr>
<td>ANIMAL STRUCTURE</td>
<td>36</td>
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<tr>
<td>ANIMAL SYSTEMS</td>
<td></td>
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<tr>
<td>DIGESTIVE</td>
<td>37</td>
</tr>
<tr>
<td>CIRCULATION AND GAS EXCHANGE</td>
<td>38</td>
</tr>
<tr>
<td>OSMOREGULATION</td>
<td>40</td>
</tr>
<tr>
<td>NERVE</td>
<td>44-45</td>
</tr>
<tr>
<td>REPRODUCTION</td>
<td>42</td>
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<tr>
<td>EMBRYOLOGY</td>
<td>43</td>
</tr>
<tr>
<td>ENVIRONMENT AND ECOLOGY</td>
<td>46-48</td>
</tr>
<tr>
<td>EVOLUTION</td>
<td>20-23</td>
</tr>
<tr>
<td>BEHAVIOR</td>
<td>50</td>
</tr>
</tbody>
</table>

The topics listed above are to be covered in this course. I have listed the chapters that cover the topics. You may also want to check the table of contents and index to see if other pages cover the material. I do not follow the text. HOWEVER, I would suggest that you read the material to help you understand the lectures. You will find that most of the test questions come directly from my lecture notes. In other words, IT IS VERY IMPORTANT FOR YOU TO GET THE NOTES FROM THE CLASS. IF YOU MISS CLASS, IT IS YOUR RESPONSIBILITY TO GET THE MATERIAL FROM A FELLOW STUDENT. Also, if some handouts are given on a day that you miss class, again it is your responsibility to come to me and get them.

I do take attendance...if your absences become excessive, THE STUDENT HANDBOOK SAYS 30%, you may be dropped from the class. ALL TESTS SHOULD BE TAKEN AT THE SCHEDULED TIME. IF YOU MISS A TEST, IT WILL BE TAKEN AT THE END OF THE SEMESTER. ALL MAKE-UPS WILL BE TAKEN THEN. I grade on a 10 point basis 90, 80, 70, 60... Four tests will be given...one about the fourth week...then week eight...then week twelve, then week of final exams. The tests of week eight and final week will count double. Four mini-quizzies will be given between the other tests—each counting 25 points. There will be NO MAKE-UP on the mini-quizsies. There will also be three lab tests.

I have office hours posted on my door— If you need to come by and see me at other times, let me know so I can make arrangements. MY OFFICE PHONE NUMBER IS If you are having problems, don’t hesitate to come by and see me.
Appendix H (Continued)

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Jan. 8 - 12</td>
<td>Survey of Invertebrates</td>
</tr>
<tr>
<td>Jan. 15 - 19</td>
<td>Fetal Pig</td>
</tr>
<tr>
<td>Jan. 22 - 26</td>
<td>Fetal Pig</td>
</tr>
<tr>
<td>Jan. 29 - Feb. 2</td>
<td>Fetal Pig</td>
</tr>
<tr>
<td>Feb. 5 - 9</td>
<td>Fetal Pig Test</td>
</tr>
<tr>
<td>Feb. 12 - 16</td>
<td>Population Ecology</td>
</tr>
<tr>
<td>Feb. 19 - 23</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>Feb. 26 - Mar. 2</td>
<td>Wastewater Treatment or Skeletal System 22 or 17</td>
</tr>
<tr>
<td>Mar. 5 - 9</td>
<td>Wastewater Treatment or Skeletal System 22 or 17</td>
</tr>
<tr>
<td>Mar. 12 - 16</td>
<td>Interspecific Relationships</td>
</tr>
<tr>
<td>Mar. 19 - 23</td>
<td>Deciduous Forest or Science Museum or Lecture</td>
</tr>
<tr>
<td>Mar. 26 - 30</td>
<td>Deciduous Forest or Science Museum or Lecture</td>
</tr>
<tr>
<td>Apr. 4 - 10</td>
<td>Aquatic Field Trip or Extinction</td>
</tr>
<tr>
<td>Apr. 11,12,13,23,24</td>
<td>Aquatic Field Trip or Extinction</td>
</tr>
<tr>
<td>Apr. 25 - May 1</td>
<td>Wildflower Pilgrimage or Test</td>
</tr>
</tbody>
</table>
POLICIES

The class will meet according to the schedule of class and the calendar appearing in the current issue of the Virginia Western Community College catalog. Students should expect class to meet even in the event of inclement weather (including deep snow) unless the instructor cancels a class or the officers of the school close the school or suspend classes. Closure of the school or suspension of classes is usually announced by local broadcasting media.

Students enrolled in this course are expected to attend each class meeting. A student will be irregularly attending class if one or more of the following occur:

1) The number of unexcused absences reaches an amount equivalent to thirty percent of the total instructional time.

2) The student twice fails to take tests at the scheduled times.

3) The student frivolously or needlessly releases natural gas or compressed air into the classroom or otherwise endangers himself, herself, or others.

4) The student's behavior impedes instructional processes.

5) Disruptive talking in lectures or labs.

The names of students irregularly attending class may be removed from the class roll. Students who must be absent because of illness, employment schedules, family problems, or other difficulties should inform me of their difficulties. Often I can make adjustments that a student would not anticipate.

Tests will usually be graded and returned to the students promptly. Usually, a significant portion of class time will be devoted to a discussion of each test question.

Students may make tape recordings of the class. Any student who does so agrees to limit the use of the tape to students enrolled in this class. Students must not permit their recording equipment to block aisles or otherwise serve as a hazard to those walking about the classroom.

You may not bring your children or other youngsters to class. Do not invite a guest to attend the class until you have secured my consent to the invitation.

First time will be a warning—SECOND TIME WILL BE OUT OF CLASS!!
Mark Twain's description in "A Tramp Abroad" of how they hitch horses in Europe is a good example of the confusion caused by want of technical terms: "The man stands up the horse on each side of the thing that projects from the front end of the wagon, throws the gear on top of the horses, and passes the thing that goes forward through the ring, and hauls it aft, and passes the other thing through the other ring and hauls it aft on the other side of the other horse, opposite to the first one, after crossing them and bringing the loose end back, and then buckles the other thing underneath the horse, and takes another thing and wraps it around the thing I spoke of before, and puts another thing over each horse's head, and puts the iron thing in his mouth, and brings the ends of these things aft over his back, after hitching another one around under his neck, and hitching another thing on a thing that goes over his shoulders, and then takes the slack of the thing which I mentioned a little while ago and fetches it aft and makes it fast to the thing that pulls the wagon, and hauls the other thing up to the driver."
Appendix H (Continued)

Biology Laboratory Rules

1. No eating, drinking or smoking in the labs.

2. Work stations should be left in clean condition. Wash and rinse glassware thoroughly and dry by inverting on pegs over sinks. Depression slides should be rinsed and returned to their box. Discard coverslips and disposable slides in the glass receptacle. Place all broken glass in the glass receptacle. Rinse dissecting pans after use and invert to dry.

3. Shoes must be worn in the lab. Sturdy, comfortable shoes are recommended for all field trips. Wear inexpensive clothing that provides protection for your arms, legs and trunk.

4. Immediately report all accidents to your instructor. You are advised to seek medical attention for any accident no matter how insignificant a cut, scrape or burn may seem. Your instructor is not a physician.

5. Be familiar with the fire/bomb evacuation procedure. In the event of fire, explosion or other emergency, minimize any risk to your safety.

6. Handle squeeze bottles and medicine droppers with extreme care to prevent squirting or spills.

7. In removing an electrical plug from its socket, pull the plug, not the electrical cord. Report any problems with lab equipment to your instructor. Do not attempt to fix equipment.

8. Read through the lab exercise before class and know general procedure described for the lab. If there is any question about procedures or problems in the lab, ask the instructor before proceeding.

9. Students should know the location and be familiar with the eye wash bottles.

10. Use extreme care when handling dangerous equipment, chemicals, etc. (scalps and burners).

11. Notify your instructor of any allergies, conditions or medications that could be of concern in the lab or on a field trip (e.g., formalin allergy, severe reaction to bee stings, etc.)

12. Do not perform dissections on the lab counters—use a dissecting pan or newspapers.

13. No horseplay in the labs. Do not carry out unauthorized activities. If you wish to see equipment or specimens stored in the lab, ask your instructor. Do not help yourself to anything unless it is for your planned lab exercise. Do not play with the natural gas or air jets on the counters.

Approved by Biology Faculty, April 26, 1983.
1. List two functions of the skeleton.

2. List two characteristics of an herbivore skull that you should notice that are different from a carnivore skull. How are these differences important as to their adaptations to their niche.

3. Besides the number of "legs" list two skeletal differences between a bipedal and a quadrupedal animal. BE SPECIFIC.....

4. What is the function of the fertilization membrane??

5. Name the lowest spot on a food chain where a predator can be found. BE SPECIFIC...

6. The union of two gametes is called ____________________.

7. At what temperature is the chick egg incubated?______________.

8. When the first several cell divisions occur, what in general happens to the "developing embryo"?? Think about size.

9. What is Chick's Ringer Solution???? How did you use it in the lab??

10. T or F. In a human embryo, the heart does not start beating until the second trimester.

11. T or F. In a human, even though the lungs are set aside and develop quite early, the fetus does not start to breathe until the second trimester.

12. Define what is meant by a density independent factor and give a specific example,.....
309

Appendix H (Continued)

20-25. Fill in the chart below. Use a + for a beneficial condition, a - for a harmful condition and a 0 for a neutral condition.

<table>
<thead>
<tr>
<th></th>
<th>SPECIES A</th>
<th>SPECIES B</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUTUALISM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENSALISM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREDATION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

26-36. Draw a typical growth curve and label the various stages. Then compare this curve to the one for human population growth. Label the revolutions involving the human growth curve.

LABEL THE FOLLOWING

37. ____________________________ 44. ____________________________
38. ____________________________ 45. ____________________________
39. ____________________________ 46. ____________________________
40. ____________________________ 47. ____________________________
41. ____________________________ 48. ____________________________
42. ____________________________ 49. ____________________________
43. ____________________________ 50. ____________________________
Appendix H (Continued)

1. The greater the salt concentration in water, the more buoyant the water will be.
2. The profundal zone is especially evident in ponds.
3. By definition, the abiotic environment of an organism is all the nonliving things which effect it.
4. A population is a community of members of several species living together in a given area.
5. The condition in a plant community when the species change is called aestivator.
6. In an oligotrophic lake, the dissolved oxygen tends to remain relatively constant.
7. Warm monomictic lakes are typically found in the tropics.
8. The compensation point (where photo.= resp. rate) is found between the hypolimnion and the epilimnion.
9. Man, nutritionally speaking, is an omnivore.
10. Materials pass through cycles in the biological world in an endless fashion, but energy is channelled in a one-way flow system in which available energy is less at each level.
11. A crocodile has just eaten a lamb... A bird picks the crocodile’s teeth... therefore, the bird is a secondary consumer.
12. In a pyramid of mass, the total bulk of predators is considerably less than the total bulk of their prey.
13. With each level of a food chain, energy tends to increase, resulting in a larger organism at each level.
14. If a pyramid involves both herbivores and carnivores, the herbivores would be most numerous.
15. In pyramids of mass, energy, or numbers, the producer level is usually the smallest.

16. We often speak of limiting factors in a community. Which of the following factors would not limit photosynthesis? a. free oxygen b. carbon dioxide c. chlorophyll d. water e. light
17. In an oak forest, the greatest amount of energy turnover is accomplished by the a. oaks b. squirrels c. hawks d. fungi
18. Every ecosystem must have a continual external source of a. living adult organisms b. plant spores c. bacteria d. energy
19. The amount of oxygen depletion in the hypolimnion depends upon a. the amount of decaying matter in the hypolimnion b. the amount of decaying matter in the epilimnion c. the temperature of the epilimnion d. the amount of light in the epilimnion e. none of the above.
20. The marine organisms that float freely on the surface of the ocean in vast numbers and serve as the basic food for all other marine forms are collectively called a. littoral b. benthic c. plankton d. bathyl
21-23. List and explain three ways that heavy erosion may "hurt" the lake and the organisms in the lake as material is carried into it.

24-27. Discuss HOW, WHY, AND WHEN turnover occurs in a dimictic lake. RE COMPLETE...
List the three benefits of turnover to the lake community.

28-30. Which river in the STATE of VIRGINIA drains the greatest amount of the land???
List the geological provinces through which this river flows.

31-33. Differentiate between primary and secondary succession and give an example of each. Include the condition under which each occurs.

34. The number of organisms that an area can support at any one time is called its ________________________.

35. Define ammonification---

36. Describe how oxbow lakes form....
37-40. A man proposes the following money making scheme....He has a population of rats which he will feed grain and let grow and reproduce for a period of time. He then plans to feed some of the rats to some cats he owns. After the cats reproduce, he will skin some of the cats and sell the furs to a furrier. The carcasses of the cats will be fed, as needed, to the remaining rats and the cycle will start again. From his calculations, his food bill should only be for the grain he bought to feed the original rats....IS HE CORRECT???EXPLAIN.......  

41-42. Besides the food and hay they produce, explain why legumes are so important to farmers in effective land management.....  

43-45. As we discussed in class, water is used over and over. Briefly explain the major points of the water cycle and how water moves from one area of the cycle to another.....  

46-50.(Put your drawing on the back of this page)...Draw and label the neritic part of the marine ecosystem. Include information about the habitat and the environment peculiar to each......
Appendix I
Instructor C--Syllabus and Sample Tests

SCIENCE AND MATHEMATICS DIVISION
COURSE OUTLINE

Instructor: [Name]
Semester: Spring
Year: 1990

Course: BIO 102 General Biology II

Catalog Description: "Explores fundamental characteristics of living matter from the molecular level to the ecological community with emphasis on general biological principles. Introduces the diversity of living organisms, their structure, function and evolution."

Credit Hours: 4
Contact Hours: 6

Prerequisites: None

Textbooks and Other Materials:


General Biology Course Objectives: The general biology course is structured in the second semester of its sequence to provide adequate study to accomplish the following general course objectives:

1. You will be able to describe the classification in writing of the Kingdom Animalia which includes the invertebrates and the vertebrates.
2. You will be capable of explaining the evolution as well as the structure and functions of the various animal systems in writing including basic tissues, digestive, circulatory, respiratory, immune, urinary, integument, endocrine, reproductive, nervous, and muscular. In relation to these systems, animal development will also be included.
3. You will be expected to demonstrate in writing your knowledge regarding the history of evolution, how populations have evolved, the creation of species, and the continuing process of macroevolution.
4. You will be able to discuss in writing the behavior found in the living world.
5. You will be capable of describing the variations in the physical environment surrounding the living world, the ecology of populations, community structure and organization, and the effects of physical environmental factors on the ecosystems.

Last Day to Withhold from Class Without Penalty: Friday, March 9, 1990.

Instructional Methods: Instruction for this course will be based on the traditional lecture method with supplementation through the use of handouts, films, overhead transparencies, 2X slides, charts, and models.

Office Location and Hours: The instructor's office is located on the [Location]. Office hours and telephone number are posted on the office door.
Appendix I (Continued)

Attendance Policy: "Registration in a course presupposes that students will attend scheduled classes and laboratory sessions." Absences are allowed for unavoidable occurrences. However, if the number of absences reaches thirty percent of the total instructional time, the instructor will recommend that the student be dropped from the class. Since most of the course information is discussed during the lecture periods, it is the responsibility of each student to attend or to make up all of the work missed during these.

In order to receive assistance from the instructor, the student must give prior notification of his/her absence to the instructor and must give an important and/or reasonable and verifiable reason for the absence.

If tests, quizzes, examinations, or other graded exercises, either scheduled or with a turn-in deadline, are missed without prior notification or reasons given are not important and/or reasonable and verifiable, a grade of F may be assigned for that material or a penalized lower grade given. Any make-up activities that are allowed must be arranged and completed within one week after the original date. No make-up work will be done during the final exam week.

Grading and Grade Evaluation: "Each college student is considered to be a responsible adult, and it is assumed that men and women of college age will maintain standards of conduct appropriate to the membership in the college community." Misconduct in the form of academic dishonesty including cheating and plagiarism will not be tolerated. Such violations will be dealt with by the instructor and ultimately the college by imposing a variety of serious academic sanctions.

The grading scale for all lecture and laboratory assignments will be as follows:

<table>
<thead>
<tr>
<th>% of correct answers</th>
<th>letter grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 100</td>
<td>A</td>
</tr>
<tr>
<td>80 - 89</td>
<td>B</td>
</tr>
<tr>
<td>70 - 79</td>
<td>C</td>
</tr>
<tr>
<td>60 - 69</td>
<td>D</td>
</tr>
<tr>
<td>0 - 59</td>
<td>F</td>
</tr>
</tbody>
</table>

The final lecture grade will be determined by averaging the following at their respective percentages:

Hour Examinations (5) - 83.33%
Final Examination (1) - 16.67%

The final laboratory grade will be determined as follows:
Laboratory Quizzes (13-15 averaged) - 40%
Laboratory Test (3 averaged) - 60%

The final course grade will be determined as follows:
Final Lecture Grade - 71%
Final Laboratory Grade - 25%

Catalog/Handbook Requirements: All requirements of students not specifically mentioned herein, but contained in the Catalog/Handbook, are applicable in the administration of this course.
## Appendix I (Continued)

**COURSE SCHEDULE FOR BIO 102 GENERAL BIOLOGY LECTURE**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>SUBJECT</th>
<th>TEXT READING</th>
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<tbody>
<tr>
<td>Jan 8-12</td>
<td>Invertebrates and the Origin of Animal Diversity</td>
<td>Chap 29 600-635</td>
</tr>
<tr>
<td>Jan 15-19</td>
<td>The Vertebrate Genealogy</td>
<td>Chap 29 636-638</td>
</tr>
<tr>
<td>Jan 22-26</td>
<td>Introduction to Animal Structure and Physiology</td>
<td>Chap 36 769-787</td>
</tr>
<tr>
<td></td>
<td>Animal Nutrition</td>
<td>Chap 37 788-793</td>
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<tr>
<td></td>
<td>Hour Exam</td>
<td>Chap 29-30 600-670</td>
</tr>
<tr>
<td>Jan 29-30</td>
<td>Animal Nutrition</td>
<td>Chap 37 794-810</td>
</tr>
<tr>
<td>Feb 2</td>
<td>Circulation and Gas Exchange</td>
<td>Chap 38 811-829</td>
</tr>
<tr>
<td>Feb 5-9</td>
<td>The Immune System</td>
<td>Chap 38 830-841</td>
</tr>
<tr>
<td></td>
<td>Controlling the Internal Environment</td>
<td>Chap 39 842-858</td>
</tr>
<tr>
<td></td>
<td>Chemical Coordination</td>
<td>Chap 40 859-865</td>
</tr>
<tr>
<td>Feb 12-16</td>
<td>Hour Exam</td>
<td>Chap 40 866-880</td>
</tr>
<tr>
<td></td>
<td>Animal Reproduction</td>
<td>Chap 41 881-901</td>
</tr>
<tr>
<td>Feb 19-23</td>
<td>Animal Development</td>
<td>Chap 42 902-924</td>
</tr>
<tr>
<td>Mar 2</td>
<td>Nervous Systems</td>
<td>Chap 43 925-944</td>
</tr>
<tr>
<td>Mar 5-9</td>
<td>Receptors and Effectors</td>
<td>Chap 44 945-961</td>
</tr>
<tr>
<td></td>
<td>Descent with Modification: A Darwinian View of Life</td>
<td>Chap 45 962-986</td>
</tr>
<tr>
<td>Mar 12-16</td>
<td>How Populations Evolve</td>
<td>Chap 20 411-413</td>
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<tr>
<td></td>
<td>Hour Exam</td>
<td>Chap 21 414-432</td>
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<tr>
<td></td>
<td>Macromolecules</td>
<td>Chap 41-45 881-994</td>
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<tr>
<td>Mar 19-23</td>
<td>How Populations Evolve</td>
<td>Chap 21 438-451</td>
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<tr>
<td></td>
<td>The Origin of Species</td>
<td>Chap 22 452-469</td>
</tr>
<tr>
<td></td>
<td>Macromolecules</td>
<td>Chap 23 470-473</td>
</tr>
<tr>
<td>Mar 26-30</td>
<td>Behavior</td>
<td>Chap 23 474-496</td>
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<tr>
<td>Apr 2-3</td>
<td>Student Academic Advising Days</td>
<td>Chap 50 1078-1090</td>
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<td>Apr 4-6</td>
<td>Hour Exam</td>
<td>Chap 20-23 491-496</td>
</tr>
<tr>
<td></td>
<td>Behavior</td>
<td>Chap 50 1091-1102</td>
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</table>
### Appendix I (Continued)

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Chapters</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 9-13</td>
<td>The Physical Environment</td>
<td>Chap 46</td>
<td>995-1021</td>
</tr>
<tr>
<td></td>
<td>Population Ecology</td>
<td>Chap 47</td>
<td>1022-1030</td>
</tr>
<tr>
<td>Apr 16-20</td>
<td>Spring Break</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Apr 23-27</td>
<td>Population Ecology</td>
<td>Chap 47</td>
<td>1030-1038</td>
</tr>
<tr>
<td></td>
<td>Communities</td>
<td>Chap 48</td>
<td>1039-1057</td>
</tr>
<tr>
<td></td>
<td>Ecosystems</td>
<td>Chap 49</td>
<td>1058-1068</td>
</tr>
<tr>
<td>Apr 30-</td>
<td>&quot;</td>
<td>Chap 49</td>
<td>1069-1077</td>
</tr>
<tr>
<td>May</td>
<td>Final Exam</td>
<td>Chap 46-50</td>
<td>995-1101</td>
</tr>
<tr>
<td></td>
<td>(Thu. 10:00-11:40)</td>
<td>--------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>

Any of the above course schedule may be altered as the instructor deems necessary.
## Appendix I (Continued)

### Course Schedule for BIO 102 General Biology Laboratory

<table>
<thead>
<tr>
<th>DAY</th>
<th>Lab Subject</th>
<th>Lab Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 14</td>
<td>Survey of the Invertebrates</td>
<td>Lab 13</td>
</tr>
<tr>
<td>Jan 18</td>
<td>Survey of the Invertebrates Cont'd</td>
<td>Lab 13</td>
</tr>
<tr>
<td>Jan 25</td>
<td>Fetal Pig</td>
<td>A Guide to Biology Lab</td>
</tr>
<tr>
<td>Feb 1</td>
<td>Fetal Pig</td>
<td>&quot;</td>
</tr>
<tr>
<td>Feb 4</td>
<td>Fetal Pig</td>
<td>&quot;</td>
</tr>
<tr>
<td>Feb 15</td>
<td>Laboratory Test #1</td>
<td>Lab 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A Guide to Biology Lab</td>
</tr>
<tr>
<td>Feb 22</td>
<td>Developmental Biology</td>
<td>Lab 14</td>
</tr>
<tr>
<td>Mar 1</td>
<td>Skeletal System and Neuromuscular Relation</td>
<td>Lab 17</td>
</tr>
<tr>
<td>Mar 8</td>
<td>Population Ecology</td>
<td>Handout</td>
</tr>
<tr>
<td>Mar 15</td>
<td>Interspecific Relationships</td>
<td>Lab 20</td>
</tr>
<tr>
<td>Mar 22</td>
<td>Laboratory Test #2</td>
<td>Lab 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handout</td>
</tr>
<tr>
<td>Mar 29</td>
<td>Wastewater Treatment (Field Trip)</td>
<td>Lab 22</td>
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<tr>
<td></td>
<td></td>
<td>Handout</td>
</tr>
<tr>
<td>Apr 5</td>
<td>Study of an Ecosystem: Deciduous Forest (Field Trip)</td>
<td>Lab 18</td>
</tr>
<tr>
<td>Apr 12</td>
<td>Lab on Aquatic Ecosystem (Field Trip)</td>
<td>Lab 16</td>
</tr>
<tr>
<td>Apr 19</td>
<td>Spring Break</td>
<td></td>
</tr>
<tr>
<td>Apr 26</td>
<td>Laboratory Test #3</td>
<td>Lab 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handout</td>
</tr>
</tbody>
</table>

*Any of the above course schedule may be altered as the instructor deems necessary.*
Appendix I (Continued)

Instructions for BIO 102, Examination #1:

Do not remove this cover sheet. Complete the next line and place your name on the first test page.

Name ___________________________ Section ____________ 13

Complete this exam with only the aid of written materials - no help from other persons.

Please have this work completed by class, Thursday, February 8, 1990.

Remember: do this work on your own.
### Appendix I (Continued)

<table>
<thead>
<tr>
<th>BIO 102 GENERAL BIOLOGY</th>
<th>Name</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination #1 02/01/90</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Chapters 29 and 30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I. Match the following by placing the correct letter in each of the spaces provided:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. invertebrates</td>
<td>a. result from one side of the body growing faster than the other; found in the Class Gastropoda.</td>
<td></td>
</tr>
<tr>
<td>2. Phylum Echinodermata</td>
<td>b. including the lampreys and hagfishes, placoderms, sharks, skates, and rays, and bass, trout, perch, and tuna.</td>
<td></td>
</tr>
<tr>
<td>3. metamorphosis</td>
<td>c. existing physically with another organism and dependent for food from it.</td>
<td></td>
</tr>
<tr>
<td>4. diaphragm</td>
<td>d. the ability to absorb external heat rather than generate their own.</td>
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</tr>
<tr>
<td>5. regeneration</td>
<td>e. composed of sea stars, brittle stars, sea urchins, sea lilies, and sea cucumbers.</td>
<td></td>
</tr>
<tr>
<td>6. endothermy (homeothermy)</td>
<td>f. an air sac that helps control the buoyancy of a fish: not found in sharks.</td>
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</tr>
<tr>
<td>7. parthenogenesis</td>
<td>g. the ability to regulate body temperature by conserving heat that is generated by metabolism.</td>
<td></td>
</tr>
<tr>
<td>8. tetrapoda</td>
<td>h. characterized by ingestion, organized for greater complexity, having a life cycle dominated by the diploid stage, and having mostly sexual reproduction.</td>
<td></td>
</tr>
<tr>
<td>9. Phylum Chordata</td>
<td>i. a common chamber receiving digestive, excretory, and reproductive products and expelling them through a single vent.</td>
<td></td>
</tr>
<tr>
<td>10. torsion</td>
<td>j. a tendinous sheet of muscle used to help ventilate the lungs.</td>
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</tr>
<tr>
<td>11. molting</td>
<td>k. composed of two invertebrate subphyla and one vertebrate subphylum.</td>
<td></td>
</tr>
<tr>
<td>12. swim bladder</td>
<td>l. a shell enclosed egg with a contained fluid enabling vertebrates to complete their life cycles on the land.</td>
<td></td>
</tr>
<tr>
<td>13. free-living</td>
<td>m. reproduction of organisms from unfertilized eggs.</td>
<td></td>
</tr>
<tr>
<td>14. ectothermy (poikilothermy)</td>
<td>n. 95% of the animals which are also lacking a vertebral column.</td>
<td></td>
</tr>
<tr>
<td>15. coelom</td>
<td>o. shedding the old exoskeleton and secreting a larger one; found in the Phylum Arthropoda.</td>
<td></td>
</tr>
<tr>
<td>16. amniote egg</td>
<td>p. development that changes larva into adults.</td>
<td></td>
</tr>
<tr>
<td>17. Animalia</td>
<td>q. growth which replaces lost tissue or body parts.</td>
<td></td>
</tr>
<tr>
<td>18. cloaca</td>
<td>r. existing alone and without total dependency upon another organism.</td>
<td></td>
</tr>
<tr>
<td>19. parasitic</td>
<td>s. a body cavity that is completely lined with mesoderm.</td>
<td></td>
</tr>
<tr>
<td>20. pieces</td>
<td>t. including the frogs and salamanders, reptiles, birds, and mammals.</td>
<td></td>
</tr>
</tbody>
</table>
II. Place the correct letter, T (true) or F (false), in each of the spaces provided.

1. Radial symmetry is found in the Phylum Cnidaria (Coelenterata) and in the Phylum Echinodermata.
2. The origins of animal diversity include arising from a colonial flagellate, a hypothetical planuloid ancestor, or a hypothetical plakula ancestor like Trichoplax.
3. Cephalization was first associated with radial symmetry.
4. Fossil invertebrate chordates pre-date fossil vertebrates.
5. Bilateral acelomate organisms of the Phylum Platyhelminthes are triploblastic in the number of germ layers that they have.
6. Members of the Phylum Echinodermata are found in freshwater as well as the marine habitat.
7. The organisms of the Phylum Porifera are further classified by the composition of their structural elements.
8. Fleshy-finned fishes of the Devonian gave rise to the amphibians on land.
9. Cleavage in protostomes is spiral and indeterminate while that of the deuterostomes is radial and determinate.
10. Cetiosauria or "stem reptiles" gave rise to the mammalian line in one radiation and in a second radiation to the dinosaurs and the birds.
11. Flukes of the Class Trematoda usually have an intermediate, invertebrate host and a definitive, vertebrate host.
12. Among primates, prosimians are monkeys, apes, and man, while anthropoids are lemurs, lorises, bush babies, pottos, and tarsiers.
13. The phyla of organisms represented as the lophophorate animals are the Polychaeta, Bivalvia, and Brachiopoda.
14. The Class Reptilia consists of Apoda or caecilians, Squamata or lizards and snakes, Chelonia or turtles, and Crocodilia or alligators and crocodiles.
15. Diplopoda and Chilopoda are phyla of round worms.
16. Echinoderms metamorphose into bilateral adults from radial larvae.
17. Two major lines of arthropod evolution are the chelicerates and the mandibulates.
18. The Ediacaran period (680–570 million years ago) showed nearly all modern animal phyla compared to the limited worm-jellyfish fauna of the Cambrian period (570–500 million years ago).
19. Segmentation begins with the Phylum Annelida although one of its classes shows this characteristic superficially.
20. The skin of sea stars has spines, tiny pincers called pedicellariae, and small stils on its surface.
Appendix I (Continued)

III. Place the letter indicating the best answer in each of the spaces provided.

1. Which of the following is not a class within the Phylum Mollusca?
   a. Polychaeta
   b. Gastropoda
   c. Bivalvia
   d. Cephalopoda

2. Which of the following is not a phylum level characteristic of the chordates?
   a. having a notochord
   b. having a single, dorsal, and hollow nerve cord
   c. having a vertebral column
   d. having pharyngeal slits

3. Which of the following is not a characteristic of the Phylum Arthropoda?
   a. jointed appendages
   b. chitinous exoskeleton
   c. usually divided into a head, thorax, and abdomen
   d. closed circulatory system

4. The Class Chondrichthyes has
   a. an endoskeleton composed of cartilage
   b. an operculum covering the single gill chamber
   c. a lateral line system to detect vibrations
   d. two of the above

5. The Classes Trematoda, Cestoda, and Hirudinea have in common the following characteristic:
   a. segmentation
   b. deuterostomia development
   c. parasitic
   d. free-living

6. The Class Amphibia
   a. came on land during the Carboniferous period
   b. have two lives - one in the water and one on the land
   c. are only viviparous
   d. two of the above

7. The Phylum Nemertina has which of the following characteristic(s)?
   a. a simple circulatory system
   b. parthenogenic reproduction
   c. a digestive tube with a separate mouth and anus (complete)
   d. two of the above

8. The earliest primates resembled the modern
   a. monkeys
   b. prosimians
   c. tree shrews
   d. man

9. Polyp and medusa are body forms in the Phylum
   a. Chordata
   b. Cnidaria
   c. Ctenophora
   d. Chilopoda
Appendix I (Continued)

10. The order of development of the following characteristics in early man was
   a. upright posture then enlargement of the brain
   b. enlargement of the brain and then upright posture
   c. upright posture, tools, and enlargement of the brain
   d. enlargement of the brain, tools, and upright posture

11. Which of the following phyla does not contain hermaphroditic organisms?
   a. Porifera
   b. Annelida
   c. Nemertea
   d. Platyhelminthes

12. The Class Aves may be characterized by
   a. strong but light bones and a toothless head
   b. active metabolism, acute vision, and a larger brain
   c. wings with feathers
   d. all of the above

13. Which of the following is not a characteristic of the Phylum Mollusca?
   a. a dorsal visceral mass
   b. a ventral muscular foot
   c. a mantle
   d. an exoskeleton

14. Which of the following is not a characteristic of the Class Mammalia?
   a. presence of hair and mammary glands
   b. development of the young in eggs, a marsupium, or attached to a placenta
   c. having conical and uniform teeth like their reptilian ancestors
   d. having a diaphragm and seven cervical vertebrae

15. The rudimentary gut of an embryo forms as a blind pouch (the archenteron),
    which has a single opening to the outside known as the
    a. blastula
    b. blastocoel
    c. blastopore
    d. blastodisc

16. An extinct class of vertebrates in which jaws first appeared was
    a. Agnatha
    b. Placodermi
    c. Chondrichthyes
    d. Osteichthyes

17. Incomplete metamorphosis in insects such as grasshoppers never involves
    which of the following stage(s)?
    a. egg
    b. larva
    c. pupa
    d. adult

18. Which is not a characteristic of the Phylum Echinodermata?
    a. spiny skin
    b. pentaradial symmetry
    c. a water vascular system
    d. an exoskeleton of cuttin
Appendix I (Continued)

19. The book lung, gill, and tracheal system are respiratory structures of the phylum
   a. Annelida
   b. Cephalopods
   c. Arachnida
   d. Arthropoda

20. Metamorphosis in tadpoles (to frogs) involves
   a. changes in the mouth and digestive tract from herbivorous to carnivorous
   b. reabsorption of the tail and the development of four legs
   c. loss of the external gills in favor of internal lungs
   d. all of the above

IV. Answer the following as indicated:

1. List four characteristics (clues from comparative anatomy and embryology) used to determine animal phyla:
   1.  
   2.  
   3.  
   4.  

2. Explain how the echinoderms and the chordates are related as deuterostomes by defining their
   1. cleavage pattern -
   2. development of the coelom -
   3. formation of the mouth -

3. Give the phylum (if more than one class is involved) or the class (if only one is involved) for each of the following features:
   1. radula -
   2. miracidium and cercaria -
   3. cnidocytes -
   4. budding -
   5. amoebocytes -
   6. torsion -
   7. parthenogenesis -
   8. metamorphosis -
   9. hydrorhachidian skeleton -
   10. planula larva -
4. Give four evolutionary trends of the Order Primates.
   1.
   2.
   3.
   4.

5. Discuss the hominoid genera, *Australopithecus* and *Homo*. Consider their
general ancestry, fossil discoveries, dates of extinction, anatomical features,
and coexistence with other hominids.
Appendix I (Continued)

BIO 102: GENERAL BIOLOGY
Laboratory Quiz #1 (01/11- and 01/18/90)
Survey of the Invertebrates

Name

Section 17

Answer all of the following as indicated:

1. From the specimens observed in the laboratory, name, in order, the invertebrate phyla represented.

2. List three major habitats occupied by invertebrate organisms.

3. ___ An organism or a species may be dispersed by
   a. water currents if aquatic
   b. its own movement if capable
   c. by drooping eggs in different places
   d. all of the above

4. ___ A support system functions to
   a. deliver oxygen to the organism
   b. feed and nourish the organism
   c. maintain the body's customary shape and posture
   d. none of the above

5. If you were organizing your own lab on the great diversity of invertebrates, list four other important characteristics that you would include in a table of characteristics. (See lecture handout.)

6. ___ Supporting structures in the body wall of the sponge are called
   a. spicules
   b. siphons
   c. sockets
   d. all of the above

7. ___ Sea anemones have/are
   a. bilateral symmetry
   b. cnidoblasts
   c. complete digestive tract
   d. two of the above

8. ___ The Phylum Platyhelminthes consists of
   a. tapeworms
   b. flukes
   c. flukes
   d. all of the above

9. ___ Clams are shellfish because
   a. they have a water vascular system
   b. they have stelinite cells
   c. their mantle secretes a shell
   d. none of the above

OVER
Appendix I (Continued)

10. Having a pair of appendages (1st swimmerets) modified --- the male for sperm delivery is characteristic of
a. starfish
b. crayfish
c. grasshopper
d. sea anemone

11. Organism(s) that have specialized in reproduction is/are
a. flukes, tapeworms, nematodes
b. hydras, jellyfish, sea anemones
c. annelids, molluscs, arthropods
d. none of the above

12. Grasshoppers have
a. a head thorax (several parts), and an abdomen
b. three pair of walking legs
c. simple and compound eyes
d. all of the above

13. In clams, oxygen and food is secured from the water as it exits and enters through the
a. adductor muscles
b. foot and visceral mass
c. incumbent and excurrent sinuoms
d. all of the above

14. Annelids as represented by the earthworm have
a. five pair of hearts
b. a crop and gizzard
c. paired nephridia in each segment
d. all of the above

15. Starfish representing the Phylum Echinoidea show
a. pentaradial symmetry
b. a watervascular system
c. spine skin
d. all of the above
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